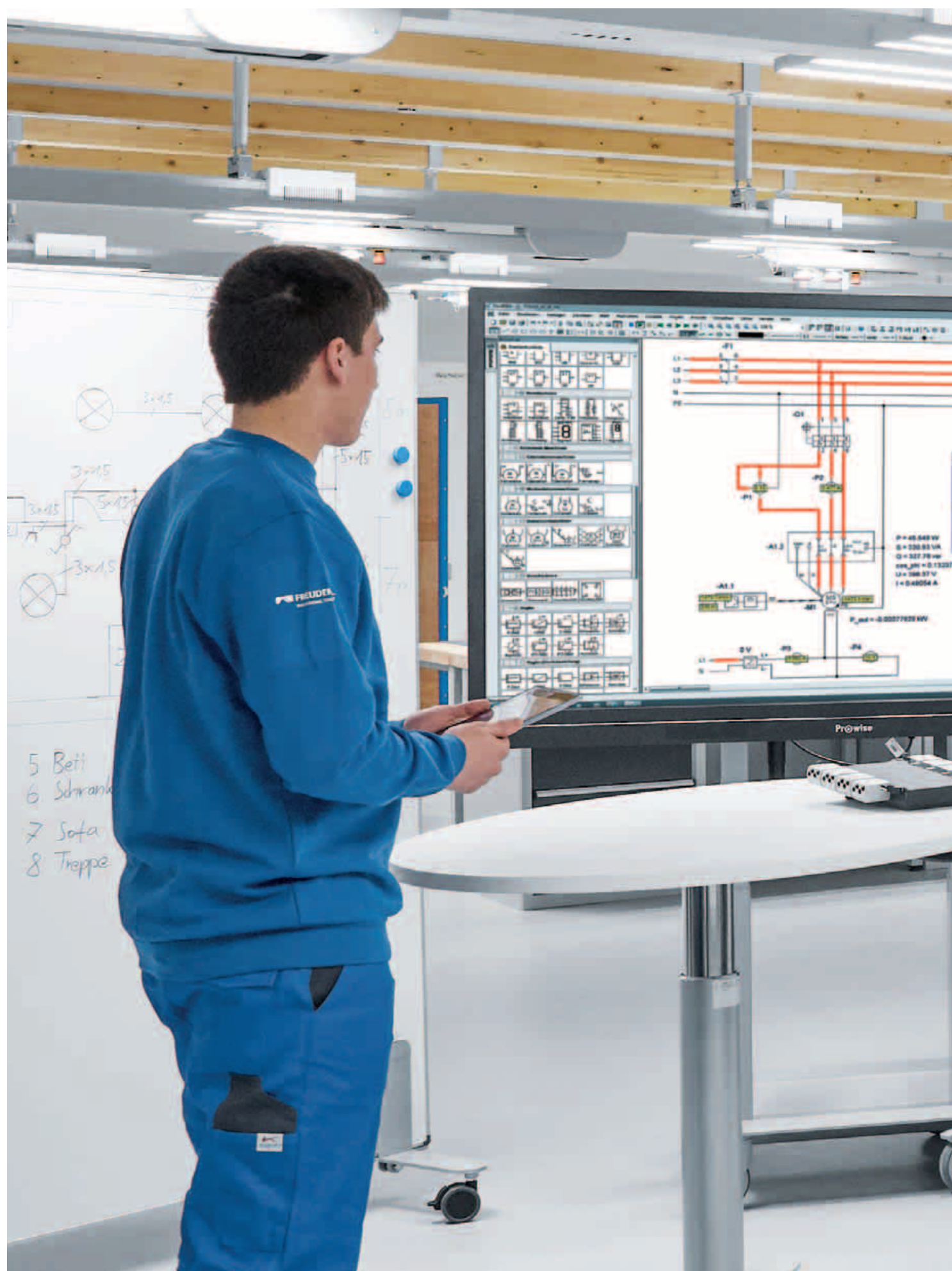


Electronics and Electrical Engineering

Learning solutions for basic and advanced training

FESTO







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Holistic and turnkey training solutions

Everything from a single source



Design, planning, and equipping of complete technology and training labs

Festo Didactic has set itself the goal of making learning even more effective, using its experience from 50 years of company history to develop learning solutions, as well as lab and workshop equipment, for the training sector.

We will support you with the conceptualization, planning, and equipping of your individual labs or workshops by means of a comprehensive range of learning systems and a broad spectrum of technologies in the area of technical training. Our range of products and services comprises complete learning systems, as well as industrial training and consultation.

The benefits for you

- Security during the planning process and professional consultation during the entire project
- State-of-the-art planning tools, as well as a range of products which are tailored to your requirements, ensure rapid and effective progress with projects
- Investment security and optimal utilization of laboratories customized for your training needs
- Professional lab design based on international standards
- State-of-the-art training equipment that combines Festo Didactic learning systems with products by other market leaders





Effective learning environments
for a positive learning experience

We offer a comprehensive range of services from project definition and planning through equipment installation, and training primarily for:

- Industrial training centers
- Vocational training centers
- Universities and teacher training colleges
- High schools
- Science laboratories



Virtual Tour
→ www.festo-turnkey-solutions.com



Electricity and electronics

Electricity and electronics are the prerequisites of a digitized, interconnected world. Several training packages help students learn electrical principles, electronic circuitry, and microcontrollers, as well as building automation.



Electric power technology

Our unique learning solutions address today's increasingly diversified training needs.

Covered topics include electric machines and motor controls and drives, as well as power generation and protection, with a strong focus on solar and wind energy sources, power storage, and E-mobility.

Room equipment for electrical engineering





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Flexible room concepts

Innovative workbenches



Equipping of learning rooms according to individual requirements

Flexible use of space

We will present you with an individual concept based on the spatial conditions and specific requirements of the location. In doing so, we will focus on cost-effective and optimal use of space, as well as multi-functional equipment. Training in the areas of electrical engineering, pneumatics, or mechatronics, as well as theoretical training or lectures, can take place in the same room. Using the ceiling system, industrial connectors, and universally mobile equipment, the room layout can be adapted in just a few minutes.

Efficient and versatile use of rooms saves space and cost.

Planning and consulting

We offer a special service in which our experts design your equipment setup for you. With your input, we develop an individual concept based on the spatial conditions and specific requirements of the location.

In doing so, we focus on cost-effective and optimized use of space as well as multi-functional equipment. During the consultation you will benefit from our years of experience in the education and training market, and from installing various training centers, complete workshops, and labs.

We take into account the latest safety requirements and guarantee a long service life thanks to our high quality standards. Working closely with architects and planners ensures that every stage of the project runs smoothly.





Main components of room concept



Storage

Both workbenches and equipment can be stored neatly and compactly in intelligent storage systems in the same room or in an adjoining room; an advantageous flexibility provided by our overall concept.



Workstation system

The mobile supports for the learning systems enable a high degree of flexibility with virtually unlimited options. The workbenches can be optimally adapted to any teaching situation, quickly and simply. This refitting option enables highly efficient space utilization, and therefore, the greatest possible cost efficiency and safety.



Power supply

The flexible ceiling system is a holistic concept for multi-functional rooms, which enables hands-on and theoretical teaching with appropriate utility supplies. With energy, compressed air, and a data connection directly at the learning location, the ceiling system is ideal for basic and specialized technical training.

Multi-functional teaching rooms

- Individual
- Flexible
- Cost-efficient

Our room concept offers individual options for your learning environment equipment. Mobile workbenches and ceiling-retractable utility supplies that you can fold back up into the ceiling ensure flexible and cost-efficient utilization of rooms.



Information about flexible room concepts
→ www.festo-didactic.com

Ceiling system

Individual and modular



TecDesign

The TecDesign furniture concept allows teaching rooms to be furnished individually. Mobile furniture and media supply from the ceiling ensure optimal and economic utilization of rooms. The TecDesign concept can be divided into the components learning system carrier, worktable, storage and power supply.

Modular media supply

The modular ceiling system is the heart of the TecDesign components. It is ideal for experimental and theoretical lessons with suitable equipment for any learning environment. The flexible media supply is a game-changer, providing a quick and easy way to adapt the room to each situation – whether it involves a conventional classroom style, project work in groups or an auditorium setting.

Individuality

With connection points for electric power, compressed air, and data directly at the learning location, the ceiling system is ideal for technical education and training. The folding energy stations can be equipped to suit each individual situation, and, in this way, provide exactly what is needed at each workstation.

The ceiling installation ensures that students are only able to access all media when required. This rules out the risk of trip hazards, tampering, and unauthorized use.



Integrated lighting

Integrate the lighting in the system. The installation of the lighting systems at the supply ducts ensures optimal illumination of the workstations without shading.



Outstanding economy

This flexible equipment concept and the versatile range of usage options it offers improve the performance and ensure that resources are used highly economically.

The connection cabinet is the central interface between all installations provided by the ceiling supply system. As a modular control center, it includes the electric power, data and compressed air connections. The connection cabinet is distinguished by its clear design and safe handling.

Frameline®

Mobile and flexible



The mobile solution

With the mobile workstation system, Frameline combines the Requirements of a highly flexible lab or classroom arrangement with multi-purpose setup possibilities, such as electrical engineering and pneumatics trainings on the same furniture.



Flexible

Components with a range of different designs can be accommodated – whether they are an ER unit, a DIN A4 frame, or a profile plate. A mounting frame is available to suit all inserts.

Space-saving

As the table legs are positioned at an angle to one another, the models can be set up back-to-back or parked one in front of the other in order to save space. This ensures that space is used as effectively as possible.

Flexible tables

Frameline side tables provide a convenient and secure space for setting up devices and experiment materials. They provide extensive table space and ample leg room. Thanks to their sturdy, high-quality construction, the tables are guaranteed to be suitable for even strict requirements. They are also available with a fold-out table top for space-saving storage.

Safe storage

In keeping with the overall concept of flexibility, Frameline mobile containers provide storage furniture and a standing workstation all rolled into one.

The different models available provide a range of options for careful, logical storage of teaching materials and accessories. As a result, the mobile container creates a structured workplace and saves time.

Frameline®

Your individual design



1 Mobile Frameline®, basic model 230 V

Mobile Frameline® basic frame with energy duct for individual lab and workshop design. Highly flexible and universal for basic and further technical training. Back-to-back positioning is possible, as well as compact, space-saving storage of 3 frames in a row to one meter deep. Compact design for extremely short setup times.

– Dimensions (W x D x H):

1505 x 700 x 830 – 1295 mm

Order no. **8075129**

2 Mobile Frameline®, basic model 400 V

Mobile Frameline® basic frame with energy duct for individual lab and workshop design. Highly flexible and universal for basic and further technical training. Can be positioned back to back, space-saving storage of 3 frames compactly in a row at a depth of one meter also possible, including test setup. Compact design for extremely short setup times.

– Dimensions (W x D x H):

1505 x 700 x 830 – 1295 mm

Order no. **8075130**

3 Mobile Frameline®, complete model 230 V

Mobile Frameline® basic frame with energy duct and setup with two DIN A4 lines and one ER line for individual lab and workshop design. Highly flexible and universal for basic and further technical training. Can be positioned back to back, space-saving storage of 3 frames compactly in a row at a depth of one meter also possible, including test setup. Compact design for extremely short setup times.

– Dimensions (W x D x H):

1505 x 700 x 1953 – 2073 mm

Order no. **8075131**

4 Mobile Frameline®, complete model 400 V

Mobile Frameline® basic frame with energy duct and setup with two DIN A4 lines and one ER line for individual lab and workshop design. Highly flexible and universal for basic and further technical training. Can be positioned back to back, space-saving storage of 3 frames compactly in a row at a depth of one meter also possible, including test setup.

Compact design for extremely short setup times.

– Dimensions (W x D x H):

1505 x 700 x 1953 – 2073 mm

Order no. **8075132**

5 Mobile Frameline®, complete model without energy duct

Mobile Frameline® basic frame and setup with two DIN A4 lines and one ER line for individual lab and workshop design. Highly flexible and universal for basic and further technical training. Can be positioned back to back, space-saving storage of 3 frames compactly in a row at a depth of one meter also possible, including test setup. Compact design for extremely short setup times.

– Dimensions (W x D x H):

1505 x 700 x 1953 – 2073 mm

Order no. **8075133**

6 Frameline® mobile table

– Dimensions (W x D x H):

1500 x 700 x 780 mm, with four

casters, two with parking brakes
– Table with four legs in accordance with DIN EN 1729, stable, welded design with light gray frame and legs made from precision profile steel tubing

– Tabletop made from 25 mm, three-ply, quality chipboard E1 in accordance with DIN 68765, melamine resin coating in light gray, and additional overlay edges, with 3 mm ABS edge band, homogeneously sealed

– Table legs inwardly offset to be adapted to the Mobile Frameline

Order no. **8087149**

7 Frameline® mobile folding table

– Dimensions (W x D x H):

1500 x 700 x 750 mm, with four

casters, two with parking brakes
– Table with four legs in accordance with DIN EN 1729, stable, welded design with light gray frame and legs made from precision profile steel tubing

– Maximum payload: 150 kg

– Folding tabletop for space-saving storage

– Tabletop with HPL coating

Order no. **8087150**

1 Frameline® mobile lab table

- Dimensions (W x D x H):
1500 x 750 x 750 mm, with four casters, two with parking brakes
- Stable, four-leg, welded design with additional bottom tray for storage
- Maximum payload: 250 kg
- Table legs inwardly offset to be adapted to the Mobile Frameline

Order no. **8087152****2 Frameline® mobile container with pull-outs for pneumatics TPs**

- Dimensions (W x D x H):
810 x 800 x 869 mm, chassis with four casters, two with parking brakes
- Three fully-opening drawers for the storage of Festo Didactic TPs with components. Components are arranged horizontally at a depth of 375 mm, leaving sufficient small-parts storage space behind them (W x D) 700 x 300 mm. Above the drawers there is storage space for a profile plate

Order no. **8087155****3 Frameline® mobile container for profile plates, 700 mm**

- On both the inside left and right there are eight blue brackets with a brush strip for convenient and simple insertion of eight profile plates 700 x 700 mm (order no. 159410) including profile plate adaptation
- Two hinged doors with 270° fittings, blue handles, and locking system
- Dimensions (W x D x H):
810 x 800 x 869 mm

Order no. **8087153****4 Frameline® mobile container for A4 plates**

- Inside shelf, (W x D) 770 x 760 mm, with slotted mat at top and bottom providing two compartments for the storage of A4 plates
- Two hinged doors with 270° fittings, blue handles, and locking system

Order no. **8087154****5 Frameline® mobile container for motor test bench**

- Inside shelf, (W x D) 770 x 760 mm, with with slotted mat at top and bottom providing two compartments: above for the storage of A4 plates, and below for the storage of motors and accessories
- Two hinged doors with 270° fittings, blue handles, and locking system

Order no. **8087156****6 Frameline® keyboard shelf**

- For placement of computer keyboard and mouse. Swivels to the side, if required.
- Bearing capacity 10 kg
- Storage area 640 x 172 mm
- Swing arm length 589 mm
- Swivel angle 180°
- Tilt 45°

Order no. **8087159****7 Frameline® monitor mounting bracket**

- Monitor folding arm, approx. length, 455 mm, including fall protection, max. weight 5 kg, infinitely adjustable in all directions.

Order no. **8087157****8 Frameline® profile plate 700 x 700 mm, removable**

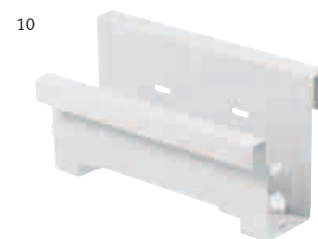
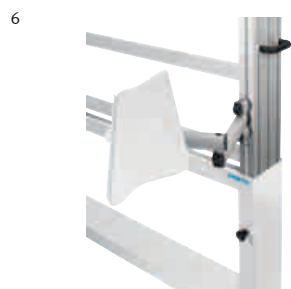
- Slots in grid dimension 50 mm for fastening of Quick-Fix components
- Suspension (metal rod with insertable adapter) for profile plate. Used diagonally the plate is placed on the table/mobile container.

Order no. **8087160****9 Cable guide**

- For a set of laboratory cables. Ensures that cables are kept neatly and in order.
- Dimensions (W x D x H):
150 x 136 x 63 mm.

Order no. **535812****10 Frameline® PC retaining bracket**

- Frameline® CPU retaining bracket for mini PCs, for insertion in the Frameline cable tray, maximum PC dimensions 360 x 175 x 417 mm.

Order no. **8087158**

Learnline

Stationary and functional



The stationary solution

With the stationary workstation systems, Learnline meets the requirements for typical desk systems while, at the same time, ensuring high functionality. They provide extensive table space and ample leg room due to the roller containers. The containers ensure quick access to the required components.

Variety for your individual requirements

The tried and tested profile plate is attached to the stable profile of the inclination unit. The inclination of the profile plate can therefore be infinitely adjusted up to the horizontal position. The exercise arrangement is therefore always in an ergonomically favorable position.

Tables for completely different applications are created with a few basic components. Whether 19" top elements, mounting frames for experimentation plates or perforated metal grids – we deliver the right solution.



Supply duct with electricity, compressed air and data

With the supply duct, all important interfaces are within reach: not only the electrical and pneumatic supply, but also PC interfaces, such as USB, Ethernet or serial interfaces, can be integrated in the supply duct.



You can equip the duct with CEE or shockproof sockets or safety sockets, depending on the application. A compressed air output with pressure regulators can be integrated likewise.

1 Basic stationary unit

Stable and with a high-quality coating, the basic worktables are guaranteed to fulfill your high requirements. (W x D x H): 1512 x 780 x 760 mm

Order no. **535835**

2/3 Energy duct

Pre-configured energy duct with interfaces for electricity, pneumatics and data.

Energy duct 230 V

- 230 V safety switching element with on/off-button, emergency off, 30 mA RDC (type B)
- 6 plug sockets, 230 V
- Fixed voltage, 24 V/5 A
- Ethernet socket
- Compressed air outlet with pressure gauge

Energy duct 400 V

- 400 V outlet via CEE socket and 4 mm safety socket L1, L2, L3, N, protective grounding
- 400 V safety switching element with on/off-button, emergency off, 30 mA RCD (type B)
- 4 plug sockets, 230 V
- Fixed voltage, 24 V/5 A, Ethernet socket, compressed air outlet with pressure gauge

Order no. **On request**

4/5/6 Wheeled drawer unit

Wheeled drawer unit with fully extending, lockable steel drawers with safety stop. External dimensions body W 476 x D 788 x H 657, usable inner dimensions W 375 x D 700. All wheels freely movable, 2 wheels with lockable brake.

Unit with 4 drawers **535834**

Unit with 3 drawers **539731**

Unit with 2 drawers **574152**

7 A4 mounting frame, 1500 mm

The A4 frame mounted on the profile column is height-adjustable and holds up to 6 A4 units.

Order no. **539021**

8 Mounting frame/set for A4 mounting

A4 mountings are mounted between the profile columns. Up to three rows of A4 mountings can be attached by means of two additional mounting sets for A4 mounting.

Mounting frame for A4 mounting

Order no. **8066141**

Mounting set for A4 mounting

Order no. **8065498**

9 Monitor bracket, short

Monitor bracket for TFT and LCD monitors with drill holes in accordance with the VESA standard (distance between holes 75 x 75 mm or 100 x 100 mm).

- Short swivel arm for minimum distance to the mounting surface (approx. 8 cm)
- For mounting on Learnline mounting frames or fastening to a wall
- Rotatable up to 180°, tiltable up to 45°
- Supplied complete with mounting material
- Maximum load capacity 23 kg

Order no. **556292**

10 Monitor bracket, long

Monitor bracket for TFT and LCD monitors with drill holes in accordance with the VESA standard (distance between holes 75 x 75 mm or 100 x 100 mm)

- Long telescopic articulated arm for a large swivel angle
- Rotatable up to 180°, tiltable up to 45°
- Supplied complete with mounting material
- Maximum load capacity 15 kg

Order no. **556293**

11/12/13 Protective earthing for workbenches

The products serve as protective earthing for workbenches as per the VDE 0100 standard.

11 Earthing kit

An earthing kit is required for connecting all conductive parts of one to two workbenches. The connector for the PE conductor of the power supply is included.

Order no. **8049368**

12 Connection kit

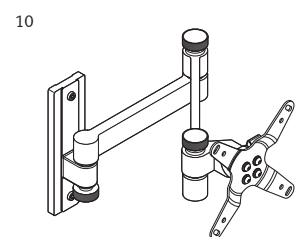
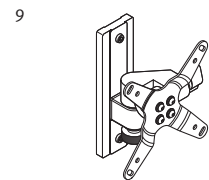
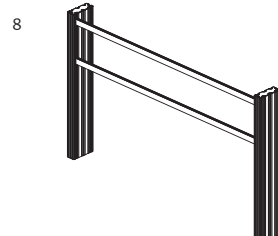
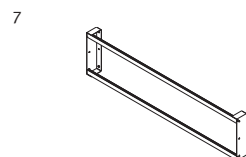
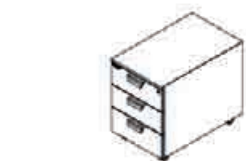
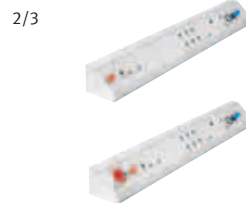
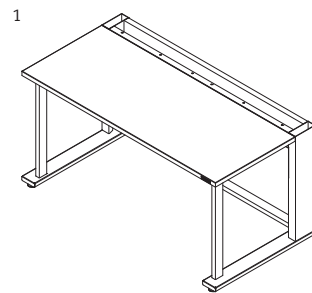
A connection kit is required for connecting a workbench to the PE conductor of the power supply.

Order no. **8049447**

13 T connector for PE conductors

A T connector lets you combine up to three PE conductors for connection to the power supply.

Order no. **8049442**



Seating and storage furniture



Comprehensive workstation equipment

Ergonomic chairs and functional cabinet systems for the practical storage of learning and teaching materials are essential at an optimally equipped workstation.

Ergonomic sitting

We offer chairs, both for students and teachers, in various designs to meet the individual requirements of the respective learning situations. The focus of all designs is always on optimum support and freedom of movement. Dynamic, ergonomic sitting not only ensures a healthy posture, but also leads to a significant increase in the students' ability to absorb and concentrate.



Functional storage

We offer an extensive range of cabinets, adapted to the design of our workstation systems, for the safe and functional storage of teaching and learning materials. Based on a simple planning framework, various tall cabinets, medium-high cabinets, side cabinets and top cabinets are available to choose from.



The modular system offers a maximum number of combinations and optimal design flexibility.

Student chairs

1 Cantilever chair Swing

The versatile cantilever chair Swing provides the same level of support and freedom of movement in all sitting positions. The spring effect of the seat shell is optimally designed for both the read-write position and the listening position (leaning back). Anthracite gray plastic seat shell, white aluminum frame, plastic slider.

Cantilever chair Swing On request

2 Swivel chair Cross G

The infinitely height-adjustable swivel chair Cross G is equipped with a swiveling seat shell. Anthracite gray plastic seat shell, white 5-star aluminum base, plastic slider, seat height of 400 – 530 mm.

Swivel chair Cross G On request

Double swivel castors On request

Teacher chairs

3 Swivel chair with mesh backrest

Black plastic base, backrest height of 520 mm, point-synchronous mechanism that can be locked in four positions, upholstered seat and backrest, rollers optionally for carpet or hard flooring.

Chair with mesh backrest On request

Height-adjustable armrests On request

Seat depth adjustment On request

Cabinets

4/5 Tall cabinets

Tall cabinet with closed wing doors, 1 construction floor, 4 shelves, 3-way security lock with olive-shaped handle.

Tall cupboard, right stop

W500 x D600 x H2020 mm On request

Tall cupboard, left stop

W500 x D600 x H2020 mm On request

Tall cupboard

W1000 x D600 x H2020 mm On request

6/7 Tall cabinets glazed

Tall cabinet with glazed wing doors, 1 construction floor, 4 shelves, 3-way security lock with olive-shaped handle Tall cabinet, right stop.

Tall cupboard, right stop

W500 x D600 x H2020 mm On request

Tall cupboard, left stop

W500 x D600 x H2020 mm On request

Tall cupboard

W1000 x D600 x H2020 mm On request

1



4/5



2



6/7



3



6/7



Multimedia

Equipment and creative zones



Upholstered furniture for work and relaxation

This creative furniture adds comfortable seating to the furnishings of multimedia and self-study centers, to form a vital zone for the social, communicative, and organizational life of the school.

Height-adjustable mobile tables

Tables of various shapes and sizes are essential in any creative space.

The single-column table is fully height-adjustable and can be moved around on rollers. Small groups can come together around it to talk, either sitting or standing, allowing flexible adaptation to any training situation. The table is available in various sizes and in two shapes, either oval or round.

For meetings of an entire team, the two-column table is best – it too has easy height adjustment and can be moved quickly to the right place in the room.



Flexible combinations

Upholstered furniture in various shapes and sizes creates a more relaxed training environment, while also creating a zone where small groups can work and discuss. The cushioned items also provide a place to sit back and relax during brief breaks. The upholstered units can be combined with one another in versatile ways, and are available in a variety of colors upon request.

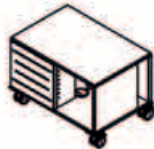


Creative furniture

Seating like the beanbag chair, seat island, and swing seat give part of the room a lounge aspect, forming a room-in-room arrangement for creative working. This furniture, too, is available in various colors upon request.

The sturdy training cabinets made from high-quality material provide practical storage for teaching materials and can be moved effortlessly to wherever they are currently required.

Visual presentation of content has a key role to play in teaching. We offer various kinds of projection screens and electronic whiteboards for this purpose. In all cases, the focus is on a high degree of interaction to enable all students to take an active part in the lesson and the discussions. This provides optimal conditions for knowledge transfer.



Training cabinet 1 x 2

- Cabinet is accessible from four sides
- Impact protection, 2 compartments, 4 rollers, 2 of which can be locked
- Interior fittings, column 1 – 2: 1 shelf
- Organizational panel (1 shelf high)
- Dimensions (W x D x H): 705 x 475 x 432 mm

Order no. On request



Training cabinet 3 x 1

- Cabinet is accessible from three sides
- Impact protection, 3 compartments, 4 rollers, 2 of which can be locked
- Interior fittings, column 1: 2 shelves
- Organizational panel (3 shelves high): left, right
- Dimensions (W x D x H): 364 x 475 x 1130 mm

Order no. On request



Training cabinet 3 x 2

- Cabinet is accessible from four sides
- Impact protection, 6 compartments, 4 rollers, 2 of which can be locked
- Interior fittings, column 1 – 2: 2 shelves
- Organizational panel (3 shelves high): left, right, front
- Dimensions (W x D x H): 705 x 475 x 1130 mm

Order no. On request

Not illustrated:

LED Multi-Touch display, 65"

- 65" Ultra HD LED Multi-Touch, resolution 3840 x 2160 (16:9) with integrated Soundbar 2.1 including interactive Prowise software
- Dimensions (W x D x H): 1591 x 116 x 961 mm

LED-Multi-Touch display 65" On request

LED Multi-Touch display, 84"

- 84" Ultra HD LED Multi-Touch, resolution 3840 x 2160 (16:9) with integrated Soundbar 2.1 including interactive Prowise software
- Dimensions (W x D x H): 2006 x 110 x 1192 mm

LED-Multi-Touch display 84" On request

Epson W28 projector

- WXGA 1280 x 800 (16:10), light output 3000 lumens, 1.2x optical zoom, integrated 2 W loudspeaker, includes remote control and soft carry bag.
- Dimensions (W x D x H): 297 x 234 x 77 mm

Epson W28 On request

Epson 955 W projector

- WXGA 1280 x 800 (16:10), light output 3000 lumens, 1.6x optical zoom, integrated 16 W loudspeaker, includes remote control and soft carry bag.
- Dimensions (W x D x H): 297 x 269 x 77 mm (16:10)

Epson 955 W On request

Universal projector mount

For ceiling mounting

Universal projector mount On request

Projector screen

Fabric projector screen in various dimensions and available with crank operation or electric operation. Includes mounting on wall or ceiling.

Projector screen On request

Round table

- Single-column round table, fully height-adjustable with gas spring, can be dismantled to save space, 5 rollers can be locked in place
- Dimensions:

Diameter: 700/800/900 mm

Table height: 770 – 1190 mm

Round table On request

Oval table

- Single-column table, fully height-adjustable with gas spring, can be dismantled to save space, 4 rollers can be locked in place
- Dimensions (W x D):

1100 x 710 mm

1200 x 770 mm

1300 x 840 mm

Table height: 770 – 1190 mm

Oval table On request

Team table

- Two-column table, fully height-adjustable with gas spring, can be dismantled to save space, 4 rollers can be locked in place
- Dimensions (W x D):

2200 x 1200 mm

Table height: 720 – 1020 mm

Team table On request

Beanbag chair

Fully upholstered

- Dimensions (D x H):

1000 x 700 mm

Beanbag chair On request

Swing seat

Fully upholstered, upholstery foam, flame retardant

- Dimensions (W x D x H):

610 x 1020 x 680 mm

Swing seat On request

Seat island

3-wing seat island, fully upholstered

- Dimensions (W x D x H):

1300 x 1140 x 420 mm

Seat island On request

Oval seat

Fully upholstered, can be used as a stool, footrest, or side table, can be used as a rocker by putting it on its side, upholstery foam, flame retardant

- Dimensions (W x D x H):

200 x 500 x 530 mm

Oval seat On request

Media





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Digital learning

Multimedia learning aids for technical education and training



eLearning courses

Our eLearning courses are the perfect companion to traditional in-person learning, and offer an excellent introduction to fundamental technical topics.

The interactive multimedia structure enables students to work through the course topics on their own, thus offering scope for teachers, instructors and further training staff to be more flexible in how they structure their lessons and training sessions.

Additional practical examples and in-depth questions ensure a transfer of knowledge to the educational standards expected.

Our eLearning courses include spoken text to improve the learning process.

Connected Learning

Software and hardware, theory and practice, student and teacher – connected Learning promotes intuitive, interactive learning.

Our patented solution for Connected Learning: **Tec2Screen®**. Guaranteed fun, motivated learning!

Tec2Screen®

Our all-in-one device

- One device for everything: learning, measuring, open and closed-loop control, simulation, programming locations – in the teaching lab, on the go, at home, etc.
- Available everywhere: at digital learning at various locations – in the teaching lab, on the go, at home, etc.
- Present dry theory in an exciting multimedia format
- Get off to a flying start with the intuitive operating concept

Classroom Manager Cloud

The Classroom Manager Cloud learning management system manages all digital learning media such as Tec2Screen® courses, simulations, eLearning courses and self-made documents and materials in a central library. Trainers also have the option of preparing their own tests or questionnaires.

These learning media can be used by the trainer to create their own teaching units and assign them to the students individually according to their abilities.

The Classroom Manager Cloud also provides a clear and structured model of each student's learning progress. The system for continuously monitoring learning progress means you always have an overview of individual learning progress – allowing you to encourage and support the students very specifically.

Service package for

Classroom Manager Cloud

- Initial provision of Classroom Manager Cloud for the purchased license level
- Training in a 30-minute expert webinar
- Adaptation of Classroom Manager Cloud to the corporate design of the customer (e.g. logo, colors)
- Extensive online help for the administrators
- Quarterly web sessions on innovations and functions of Classroom Manager Cloud

myleCampus

Classroom Manager Cloud



myleCampus is an ideal solution whenever there is no separate learning management system available at the business or the functions of a learning management system (e.g. learning progress, user management) are not required to use the eLearning course.

At myleCampus you pass individual eLearning courses (no Tec2Screen courses/simulations are used). They are activated quickly and easily by means of a voucher in the self-created user account at myleCampus. The vouchers are valid for one year after activation.

System requirements

A permanent Internet connection and Flash Player or a corresponding browser plug-in are required to use the eLearning courses.

Visit our myleCampus at <https://festo.my-e-campus.com/>

myleCampus

- You can find the order numbers for myleCampus vouchers on the detailed pages of the eLearning courses
- Valid for one year after activation
- Single use via myleCampus user account



Do you want to assign your students different training content, upload or create (external) training content and monitor your students' learning progress? Then the Classroom Manager Cloud learning management system is the right choice for you.

The new software as a solution cloud service offers a multitude of benefits: it doesn't need to be installed on or maintained within your own IT structure, the system updates are easy to install, and it can be accessed from anywhere. It also guarantees data security in accordance with the GDPR.

In the Classroom Manager Cloud, you can use both our eLearning courses and Tec2Screen® courses and simulations.

The Classroom Manager Cloud is available with a choice of license levels and subscription periods. The solution is thus rented for the term of the selected license.

License levels:

100 users at 10 workstations
200 users at 20 workstations
500 users at 50 workstations
1000 users at 100 workstations

Terms:

1 year
3 years
5 years

eLearning and Tec2Screen® courses must be ordered separately.

The service package for commissioning and customization must be included when ordering Classroom Manager Cloud for the first time.

- Initial provision of Classroom Manager Cloud for the purchased license level
- Training in a 30-minute expert webinar
- Adaptation of Classroom Manager Cloud to the corporate design of the customer (e.g. logo, colors)
- Extensive online help for the administrators
- Quarterly web sessions on innovations and functions of Classroom Manager Cloud

System requirements

A permanent Internet connection is required in order to use Classroom Manager Cloud.

Classroom Manager Cloud	8034067
Service package for Classroom Manager Cloud	8028154

Electrical protective measures



This interactive multimedia training program provides an introduction to the complex topic of protective measures. It explains what electrical protective measures are and how they are classified. Trainees will also become familiar with all the legal regulations in this area.

The measures that are effective in preventing direct and indirect contact are outlined using various specific examples and functional principles.

Finally, there is an explanation of how protective measures are tested and what actions should be taken in case of an accident involving electricity.

From the contents:

- The dangers of electricity
- Humans and electricity
- Electric shock hazards
- What are electrical protective measures and how are they classified?
- Protection levels
- Protective measures, protection classes

- Differences between DIN standards, VDE regulations and DIN-VDE standards, statutory requirements, and legal consequences.
- Definition and overview of protective measures to prevent direct contact
- Protection by insulating active components
- Protection by covering or cladding
- Protection by barriers
- Protection by distance
- Definition and overview of protective measures to prevent indirect contact
- Protection by disconnecting power supply
- Mains systems (TN, TT, IT systems)
- Protection by disconnection
- Testing protective measures
- Measurement and measuring devices
- Safety and assistance
- Summary and questions to check understanding

Single use via myleCampus

de/en/es/fr/zh

Order no. **571118**

Licenses via Classroom Manager Cloud

Order no. **8038116**

Actuators – DC motor



Using the everyday example of a car park access control system, the trainee learns the basics of a mechatronic system.

Building on this, the training program determines what function the actuators have in the controller. A DC motor is then studied in more detail as an example of a typical actuator, e.g., its structure and the laws which govern its operation. Further chapters cover speed control and the use of data sheets, as well as the transmission ratios which can be achieved by using a gearbox.

From the contents:

- The function of actuators in mechatronic systems
- Electric motors
- DC motor
- Torque and current
- Behavior of DC motors
- Induced voltage and speed control
- Characteristic torque/speed curve
- Working with data sheets
- Determining the transmission ratio

Single use via myleCampus

de/en/es/fr/el/zh

Order no. **540953**

Licenses via Classroom Manager Cloud

Order no. **8038124**

myleCampus

- You can find the order numbers for myleCampus vouchers on the detailed pages of the eLearning courses
- Valid for one year after activation
- Single use via myleCampus user account

Classroom Manager Cloud

Provision of the eLearning and Tec2Screen courses in the following variants with the following terms:

- 100 users at 10 workstations
- 200 users at 20 workstations
- 500 users at 50 workstations
- 1000 users at 100 workstations
- 1 year, 2 years or 5 years

Electrical engineering 1



The “Electrical engineering 1” training program is one of a series of new programs in the field of electrical engineering and electronics. These programs are real-world oriented and authentically structured. Case studies from practice provide a concise illustration of the topics covered. All training content is taught by means of audio clips. Additionally, the narrative text can be viewed on the sitemap.

Trainees experience a regular exchange of input and output, with phases of presentation and explanation alternating with phases of activity and interaction. This enhances motivation and learning.

Various tools are built-in to the training program, such as Excel worksheets, an integrated calculator, PDF files, and various downloads. The training programs contain both a comprehensive glossary and a full text search.

From the contents:

- Closed circuit
- Electrical conductivity
- Units and symbols
- Ohm's Law
- Measuring in the circuit
- Voltage supplies
- The resistor as a component
- Series connection of resistors
- Parallel connection of resistors
- Voltage divider
- The resistor as a sensor
- Battery-powered screwdriver
- Measuring range extension
- Temperature controlled heating
- Level detection

A range of practical examples provide a reference point for real-world use:

- Battery-powered screwdriver (components and functions, voltage measurement, current measurement)
- Measuring range extension (voltage measurement, current measurement, high-voltage shunt)
- Temperature controlled heating (control diagram, switching on closed-loop controller, upper and lower switching value, controlled heating, switching value setting via potentiometer)
- Level detection (level detection with full and empty tank, test in operation)

Single use via myleCampus
de/en/es/fr/fi/et/sv/el/zh

Order no. **549623**

Licenses via Classroom Manager Cloud

Order no. **8038117**

Electrical engineering 2



The “Electrical engineering 2” training program is one of a series of new training programs in the field of electrical engineering and electronics. These programs are real-world oriented and authentically structured. Case studies from practice provide a concise illustration of the topics covered. All training content is taught by means of audio clips. Additionally, the narrative text can be viewed on the sitemap.

Various tools are built into the training program, such as Excel worksheets, an integrated calculator, PDF files and various downloads. The training programs contain both a comprehensive glossary and a full text search.

From the contents:

- Electric charge
- Capacitor
- A capacitor in a DC circuit
- A capacitor in an AC circuit
- Applications of the capacitor
- Variable capacitor
- Coil
- A coil in a DC circuit
- A coil in an AC circuit
- Applications of the coil
- Physical variables
- Calculating with changing values
- Light switch-off delay
- Electrical behaviour of a grinder
- Power generation and transmission

A range of practical examples provide a reference point for real-world use:

- Light switch-off delay
- Electrical behaviour of a grinder (work, performance, efficiency)
- Power generation and transmission (generator 6 kV/10 kV, transformer 110 kV)

Single use via myleCampus
de/en/es/fr/fi/et/sv/el/zh

Order no. **549626**

Licenses via Classroom Manager Cloud

Order no. **8038118**

Electronics 1



The “Electronics 1” training program is one of a series of new programs in the field of electrical engineering and electronics. These programs are real-world oriented and authentically structured. Case studies from practice provide a concise illustration of the topics covered. All training content is taught by means of audio clips. Additionally, the narrative text can be viewed on the sitemap.

Trainees experience a regular exchange of input and output, with phases of presentation and explanation alternating with phases of activity and interaction. This enhances motivation and learning.

Various tools are built into the training program, such as Excel worksheets, an integrated calculator, PDF files and various downloads. The training programs contain both a comprehensive glossary and a full text search.

From the contents:

- Semiconductor technology
- Diodes
- Bipolar transistors
- Field-effect transistors

A range of practical examples provide a reference point for real-world use:

- Regulated power supply (transformer, rectifier, smoothing, voltage regulation by Zener diode, transistor amplifier, current limitation)
- Audio amplifier (components, FET preamplifier with volume controller, power end stage, loudspeaker with/without frequency shunt)
- Audio amplifier with sound control (preamplifier, power amplifier, low-pass, high-pass)

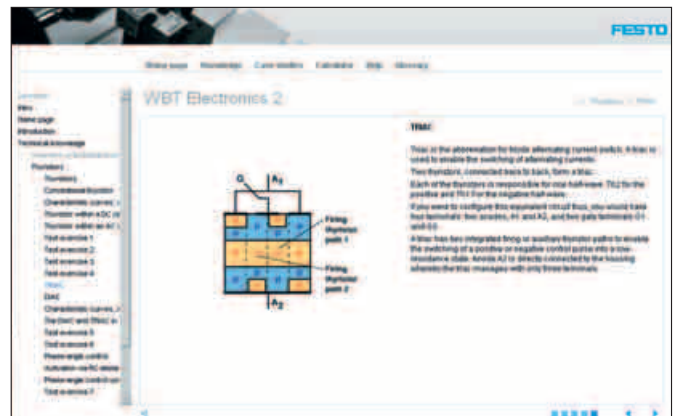
Single use via myleCampus
de/en/es/fr/fi/zh

Order No. **549629**

Licenses via Classroom Manager Cloud

Order No. **8038119**

Electronics 2



The “Electronics 2” training program is one of a series of new programs in the field of electrical engineering and electronics. These programs are real-world oriented and authentically structured. Real case studies provide a concise illustration of the topics covered. All training content is taught using audio clips. Additionally, the narrative text can be viewed on the sitemap.

Various tools are built into the training program, such as Excel worksheets, an integrated calculator, PDF files and various downloads. The training programs contain both a comprehensive glossary and a full text search.

From the contents:

- Signal types
- Integrated circuits
- Operational amplifier (OpAmp)
- AC voltage of various frequencies
- Characteristic values of amplifying circuits
- Circuit technology of amplifiers
- Filters
- Bistable flip-flop
- Single flip-flop
- Sine wave generator
- Rectangle generator

A range of practical examples provide a reference point for real-world use:

- Thyristor-controlled drilling machine
- Brightness control using a triac
- Adjusting the speed of an electric screwdriver (linear, synchronous)

Single use via myleCampus
de/en/es/fr/fi/zh

Order No. **549632**

Licenses via Classroom Manager Cloud

Order No. **8038120**

myleCampus

- You can find the order numbers for myleCampus vouchers on the detailed pages of the eLearning courses
- Valid for one year after activation
- Single use via myleCampus user account

Classroom Manager Cloud

Provision of the eLearning and Tec2Screen courses in the following variants with the following terms:

- 100 users at 10 workstations
- 200 users at 20 workstations
- 500 users at 50 workstations
- 1000 users at 100 workstations
- 1 year, 2 years or 5 years

Electric drives 1



The “Electric drives 1” interactive multimedia training program provides an engaging introduction to the world of electric motors.

The first section sets out the basic principles of electric drives. The second section illustrates the construction and functioning of DC motors, while the third section deals with the special features of AC motors.

From the contents:

- Basic principles of electric drives
- Familiarization with different motor types (stepper motor, asynchronous motor, universal motor)
- Mechanical principles (conversion of mechanical/electrical energy, motor - generator, circuit diagram and current direction, transmission variables (force, mechanical power, efficiency etc.), definitions of torque and speed)
- Electronic principles (basic principle of the motor, Lorentz force using the example of a conduction loop, electrical and magnetic fields, occurrence of torque, right-hand rule)
- Familiarization with different DC motors
- General (functional principles, commutation, technical data, brushless DC motor, load dependency, difference between series and parallel connection)
- Parallel connection behaviour
- AC motors
- Difference in power supply (DC, AC, three-phase AC)
- Familiarization with different AC motors
- General functional principle (difference between synchronous and asynchronous motor), technical data, rating plate, characteristic curves and their interpretation, definition of reactive, apparent, and effective power)
- Single-phase AC motor
- Three-phase AC motor special cases (stepper motors)
- Summary and review exercises

Single use via myleCampus
de/en/es/fr/zh

Order no. **571120**

Licenses via Classroom Manager Cloud

Order no. **8038125**

Electric drives 2



The training program “Electric drives 2” further explores the material covered in “Electric drives 1” and also includes new topic areas.

This training program is suitable for beginners and advanced students. The first two chapters address the topic of controlling DC and AC motors. The third chapter focuses on the energy efficiency of electric drives, looking at economic and environmental aspects.

From the contents:

- Controlling DC motors
 - Armature reaction
 - Speed control
 - Four-quadrant operation
- Controlling AC motors
 - Motor characteristic curve
 - Open-loop and closed-loop speed control
 - Frequency converters
 - Smooth start-up
- Energy efficiency
 - Economic aspects
 - Degree of efficiency
 - Minimizing losses
 - Reliability
 - Energy efficiency measures
 - Environmental aspects
 - Merits of electric motors

Single use via myleCampus
de/en/es/fr/zh

Order no. **573775**

Licenses via Classroom Manager Cloud

Order no. **8038126**

myleCampus

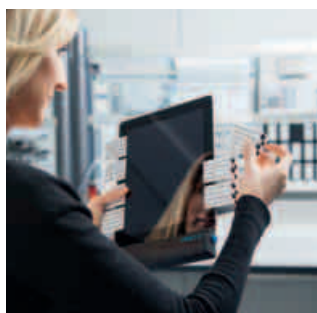
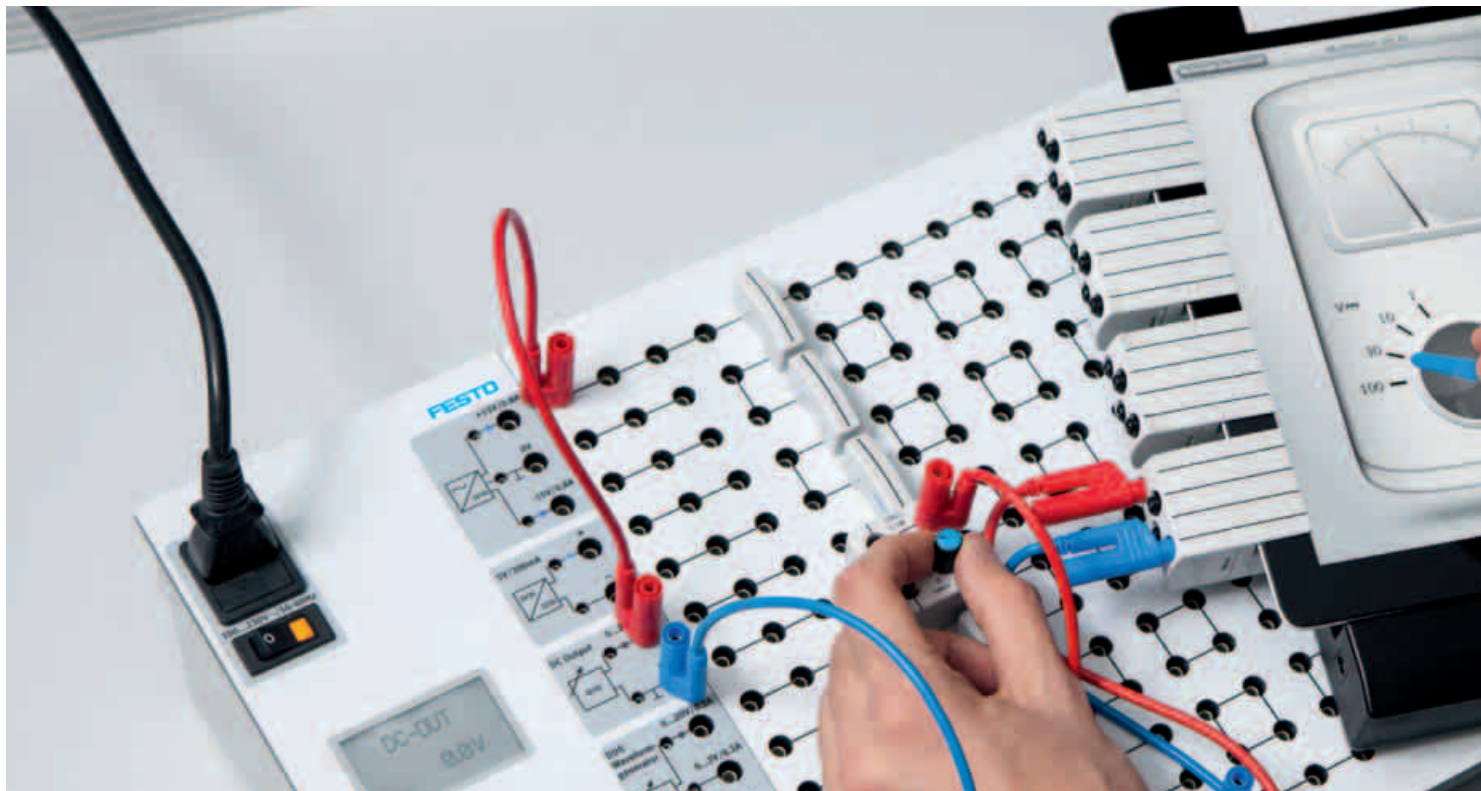
- You can find the order numbers for myleCampus vouchers on the detailed pages of the eLearning courses
- Valid for one year after activation
- Single use via myleCampus user account

Classroom Manager Cloud

- Provision of the eLearning and Tec2Screen courses in the following variants with the following terms:
- 100 users at 10 workstations
 - 200 users at 20 workstations
 - 500 users at 50 workstations
 - 1000 users at 100 workstations
 - 1 year, 2 years or 5 years

Tec2Screen®

Connected Learning for electronics and electrical engineering



The concept consists of:

- Tec2Screen® app
- Courses
- Simulations
- Connects
- Tec2Screen® hardware

You will also need Classroom Manager Cloud with the full range of learning management system functions, as this manages the Tec2Screen® system. You can also use the free Tec2Screen® Manager download without LMS functions.



Exciting courses for explorative learning

Videos, animations, measuring exercises, and test assignments inspire students to explore and discover. The measuring instruments integrated into the courses additionally make interactive troubleshooting exciting.

Completing the courses offline outside of the lab, is also possible, so that technical knowledge can be learned anywhere at any time.



Tec2Screen® courses

on the following main topics:

Direct Current Technology, e.g.

- Ohm's Law, Power, Work, Energy
- Resistors, Consumers

Alternating Current Technology, e.g.

- Characteristics
- RC Elements

Digital Technology, e.g.

- Basic Logic Functions
- Bistable Multivibrators



Understand the real world better thanks to simulations

As a component of modern training systems, the Tec2Screen® simulations can be used to test and simulate controllers and applications for PLC technology under realistic conditions. The new knowledge encourages practical and safe experimenting without real consequences or the need to purchase additional hardware.



What actually is Connected Learning?

Learning methods which frequently supplement and support each other and include the following:

- Practical learning
- Classroom-based learning
- Self-learning

With **Connected Learning**, these methods are fused into a single form of learning. The virtual and the real world are seamlessly integrated. Software and hardware, theory and practice, learner and teacher – Connected Learning promotes intuitive, interactive learning.

Our patented solution for Connected Learning: **Tec2Screen®**. Fun and motivation while learning are guaranteed!

Overview of all Tec2Screen® courses at:
→ www.tec2screen.com



New interfaces: Connects

To explore the connection between the real and the virtual world, we have developed the Connects – plug-in interface modules with a patented interface. The Connects enable direct interaction between software and hardware, and thus direct interaction between theory and practice.

Unique: the signal flow is completely transparent and easy to follow.



The hardware

As a basic unit, the Tec2Screen® base links the iPad® with the patented Connects. The iPad® can also be used as a fully functional tablet, independently of the Tec2Screen®, in the classroom and elsewhere.

Festo Didactic won the 2015 iF Design Award for the Tec2Screen®.



Tec2Screen Manager or ...

Tec2Screen® Manager allows you to use the courses and simulations on your iPad® and for offline learning.

Tec2Screen® Manager is available for the 20 user/20 workstation license level.



... the learning management system

The Classroom Manager manages courses and simulations, as well as self-made documents and materials. The trainer assigns these to the students individually and can simultaneously record their learning progress.

Tec2Screen® courses

Direct current technology



Direct Current Technology

Ohm's Law, Power, Work, Energy

Training content

- Basic electrical variables
- Voltage, current, charge
- Measuring voltage and current

Ohm's law

- Deriving Ohm's law from measurements and applying it
- The resistor as a component: designs, value ranges, color coding

Power, work, energy

- Learning about the terms power and work and how to calculate them
- Calculating costs when using electrical energy

Required Connects

- 2x Multimeter Connect
- 1x Analog In Connect

For Classroom Manager Cloud

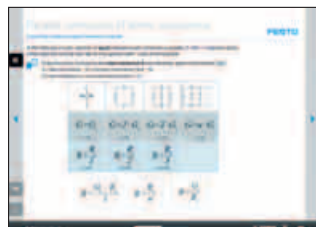
Order no. **8028129**

For Tec2Screen® Manager

Order no. **8118217**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics



Direct Current Technology

Resistors, Consumers

Training content

- Connecting ohmic resistors/ consumers in series
- Laws governing the series connection of ohmic consumers
- Calculating components and equivalent resistances
- Line resistances and voltage drop
- Series resistors for bulbs or LEDs

Connecting ohmic resistors/ consumers in parallel

- Laws governing the parallel connection of ohmic consumers
- Calculating components and equivalent resistances
- Power ratings of voltage sources

Mixed circuits

- Practice: Deriving laws from measurements
- Kirchhoff's second law
- Kirchhoff's first law
- Resistor networks
- Potentials and potential differences

Required Connects

- 1x Multimeter Connect
- 1x Analog In Connect

For Classroom Manager Cloud

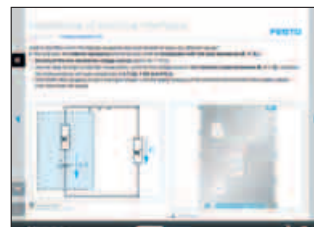
Order no. **8034077**

For Tec2Screen® Manager

Order no. **8118219**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics



Direct Current Technology

Voltage Sources, Adaptations

Training content

- Voltage sources: series connection
- Internal resistance
- Load conditions

Voltage sources: parallel connection

- Even and uneven voltage
- Even and uneven internal resistances
- With and without load resistance

Adaptations

- Interfaces between electrical circuits
- Voltage adaptation
- Power adaptation
- Current adaptation

Required Connects

- 2x Multimeter Connect
- 1x Analog In Connect

For Classroom Manager Cloud

Order no. **8034079**

For Tec2Screen® Manager

Order no. **8118221**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics



Direct Current Technology

Capacitors, Parameter-Dependent Resistors, Measuring

Training content

- Capacitors in DC circuits
- Functional principle and designs
- Calculating capacitance
- Permittivity and dielectric properties
- Electrolytic capacitors
- Charge and discharge curves
- Typical applications
- Series and parallel connection
- Capacitors as energy storage devices

Parameter-dependent resistors

- Non-linear, voltage-dependent, temperature-dependent, light-dependent resistors
- Characteristics, applications, characteristic curves
- Components for protective circuits, alarm systems

Measuring and measuring errors

- Multimeters: designs, safety, resolution, accuracy
- Direct and indirect measuring of resistance values
- Measuring circuits and measuring errors

Required Connects

- 2x Multimeter Connect
- 1x Analog In Connect

For Classroom Manager Cloud

Order no. **8034078**

For Tec2Screen® Manager

Order no. **8118219**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics

Tec2Screen® courses

Alternating current technology



Alternating Current Technology

Characteristics

Training content

- Generation of alternating current
- Signal shapes (sine, rectangular, triangular, sawtooth)
- Presentation forms: Pointer diagram and linear representation
- Frequency, period, amplitude, momentary values
- Current intensity and power (without phase shift)

Required Connects

- 1x Analog In Connect

For Classroom Manager Cloud

Order no. **8028116**

For Tec2Screen® Manager

Order no. **8118222**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics
- 4 mm Safety laboratory cables



Alternating Current Technology

Capacitors I

Training content

- Charging and discharging with rectangular voltage
- Measuring voltage and current at the capacitor with an oscilloscope
- Measuring and calculating phase shift of sine signals
- Frequency-dependent reactance
- Direct and indirect measuring procedures
- Power types at the capacitor with alternating current
- Calculating reactive power

Required Connects

- 1x Analog In Connect

For Classroom Manager Cloud

Order no. **8074467**

For Tec2Screen® Manager

Order no. **8118223**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics
- 4 mm Safety laboratory cables



Alternating Current Technology

Coils

Training content

- Application ranges, types and applications of coils
- Electromagnetism
- Types of electromagnetic induction
- Measuring voltage and current of a coil with the oscilloscope
- Measuring and calculating phase shift of sine signals
- Measuring and calculating frequency-dependent reactance
- Calculating reactive power
- Calculating inductance
- Constructive influencing variables of an inductance

Required Connects

- 1x Analog In Connect

For Classroom Manager Cloud

Order no. **8074469**

For Tec2Screen® Manager

Order no. **8118224**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics
- 4 mm Safety laboratory cables



Alternating Current Technology

RC Elements

Training content

- Resistor for alternating current: ohmic, capacitive and inductive resistors
- Phase shift
- Design and function of a low-pass filter
- Design and function of a high-pass filter
- Cut-off frequency of a filter

Required Connects

- 1x Analog In Connect

For Classroom Manager Cloud

Order no. **8034082**

For Tec2Screen® Manager

Order no. **8118225**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics
- 4 mm Safety laboratory cables

Tec2Screen® Manager

Free of charge as a download when ordering a course.

Available license level:

- 20 users at 20 workstations

Classroom Manager Cloud

Learning management system, subject to a fee

Available license levels:

- 100 users at 10 workstations
- 200 users at 20 workstations

- 500 users at 50 workstations

- 1000 users at 100 workstations

Available terms:

- 1 year
- 3 years
- 5 years

Tec2Screen® courses

Alternating current technology



Alternating Current Technology

Electric Power

Training content

- Measuring and calculating effective power
- Capacitive and inductive reactive power
- Apparent power
- Phase shift φ (phi) between active and reactive power
- Power factor: Ratio between the active power and the apparent power
- Reactive power using electric motor as an example

Required Connects

- 1x Analog In Connect

For Classroom Manager Cloud

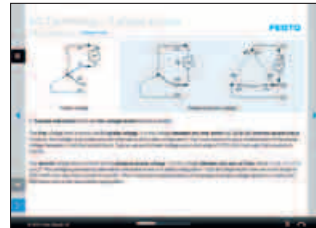
Order no. **8034084**

For Tec2Screen® Manager

Order no. **8118226**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics
- 4 mm Safety laboratory cables



Alternating Current Technology

Three-Phase Systems

Training content

- Generating three-phase current
- Presenting three-phase alternating current
- Star and delta circuits in generators and consumers
- Standardized casing colors for three-phase wires
- Circuit symbols
- Phase voltage and phase-to-phase voltage
- Concatenation factor (ratio of phase voltage to phase-to-phase voltage)
- Phase shift

Required Connects

- 1x Analog In Connect

For Classroom Manager Cloud

Order no. **8034085**

For Tec2Screen® Manager

Order no. **8118227**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1011
Fundamentals of electrical engineering/ electronics
- 4 mm Safety laboratory cables

Tec2Screen® courses

Digital technology



Digital Technology

Basic Logic Functions

Training content

- Statements and variables
- Truth tables
- AND function
- OR function
- NOT function
- XOR function
- NAND function
- NOR function

Required Connects

- 2x Digital I/O TTL (5 V) Connect

For Classroom Manager Cloud

Order no. **8046971**

For Tec2Screen® Manager

Order no. **8118212**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1012
Basic principles of digital technology
- 2 mm Safety laboratory cables
- 4x 4 mm – 2 mm safety measuring adapter



Digital Technology

Boolean Laws

Training content

- Boolean laws
- Commutative law
- Associative law
- Distributive law
- De Morgan's laws
- Simple Boolean relationships

Required Connects

- 2x Digital I/O TTL (5 V) Connect

For Classroom Manager Cloud

Order no. **8046972**

For Tec2Screen® Manager

Order no. **8118213**

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1012
Basic principles of digital technology
- 2 mm Safety laboratory cables
- 4x 4 mm – 2 mm safety measuring adapter



Digital Technology

Disjunctive and Conjunctive Normal Form

Training content

- Optimising logic circuits
- Disjunctive normal form
- Conjunctive normal form
- Karnaugh maps

Required Connects

- 2x Digital I/O TTL (5 V) Connect

For Classroom Manager Cloud

Order no. 8046973

For Tec2Screen® Manager

Order no. 8118214

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1012
 - Basic principles of digital technology
- 2 mm Safety laboratory cables
- 4x 4 mm – 2 mm safety measuring adapter



Digital Technology

Schmitt Triggers, Astable and Monostable Multivibrators

Training content

- Schmitt trigger
- Function and application, e.g. distorted signals
- Trigger levels and hysteresis
- Characteristic curves
- Debouncing switches

Astable and monostable multivibrators

- Function and application
- Edge control
- Retriggerability

Required Connects

- 2x Digital I/O TTL (5 V) Connect

For Classroom Manager Cloud

Order no. 8046991

For Tec2Screen® Manager

Order no. 8118215

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1012
 - Basic principles of digital technology
- 2 mm Safety laboratory cables
- 4x 4 mm – 2 mm safety measuring adapter



Digital Technology

Bistable Multivibrators

Training content

- Asynchronous multivibrators
- State-controlled synchronous multivibrators
- Edge-triggered synchronous multivibrators
- RS flip-flop, D flip-flop, JK flip-flop, T flip-flop, JKMS flip-flop

Required Connects

- 2x Digital I/O TTL (5 V) Connect

For Classroom Manager Cloud

Order no. 8046994

For Tec2Screen® Manager

Order no. 8118216

The accessories mentioned below are required to conduct the courses.

- 1x Equipment set TP 1012
 - Basic principles of digital technology
- 2 mm Safety laboratory cables
- 4x 4 mm – 2 mm safety measuring adapter

Tec2Screen® Manager

Free of charge as a download when ordering a course.

Available license level:

- 20 users at 20 workstations

Classroom Manager Cloud

Learning management system, subject to a fee

Available license levels:

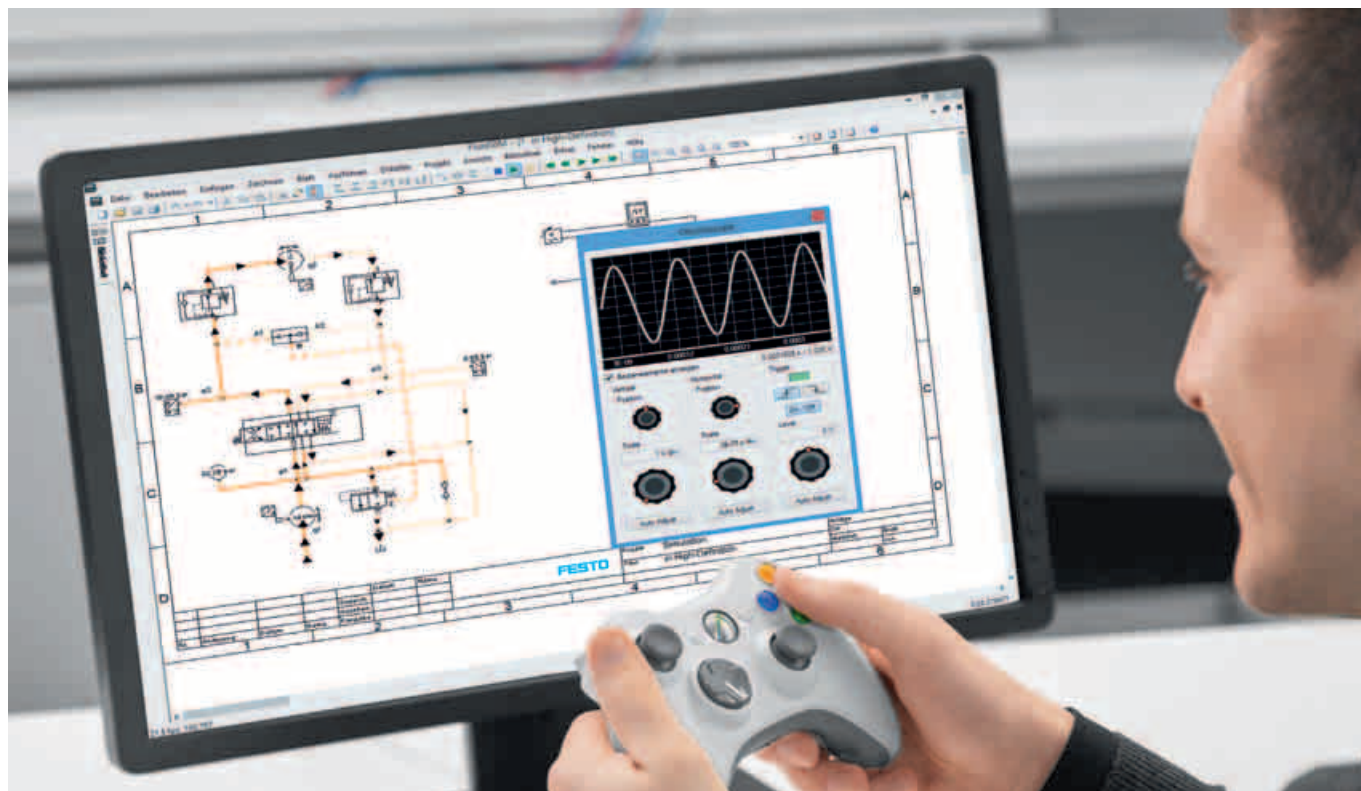
- 100 users at 10 workstations
- 200 users at 20 workstations

- 500 users at 50 workstations
 - 1000 users at 100 workstations
- Available terms:

- 1 year
- 3 years
- 5 years

FluidSIM® 5

Pneumatics/hydraulics/electrical engineering



For more than 20 years, FluidSIM® has been the world's leading circuit diagram design and simulation program for pneumatics, hydraulics, and now also for electrical engineering. Being able to freely design control systems is motivating, and promotes creativity and focus. Beyond that, FluidSIM® provides teachers with a wealth of text, images, and videos for multimedia-based lesson planning. Experience real-time simulations with apprentices, specialists, or students and celebrate successful learning at all levels!

One tool for all needs

As a teacher and trainer, you are the expert who masters tasks that are needed to prepare effective lessons, which is why FluidSIM® 5 offers the expert mode. Your trainees should initially concentrate on the essentials. They can work and learn successfully in the standard mode, which has a reduced range of functions and offers advantages for the learning process.

Testing in real time

Whether in a training environment or in an engineering office, the simulation of control systems and processes has long been standard in industry, helping to minimize losses due to crashes and ensuring greater efficiency and improved quality. The parameters of all components are identical to those of the training packages from Festo Didactic and can be fully adapted to the characteristics of other components.

The many aspects of GRAFCET

GRAFCET long-ago replaced the displacement-step diagram in training. FluidSIM® 5 does even more with GRAFCET:

- Editing – for documentation conforming to standards
- Visualizing – for maximum clarity
- Monitoring – colored signals indicate where the process is running correctly or not at all
- Control – for manufacturer-neutral control of all fluid systems and electrical systems

Speed made visible

The new simulation core of FluidSIM® 5 achieves simulation rates up to 10 kHz. The parameters of all actuators can be precisely adjusted. FluidSIM® 5 writes the simulation results in millisecond cycles and delivers them as a text file! The new simulated oscilloscopes make frequencies up to 100 kHz visible.

Learning with fun and success

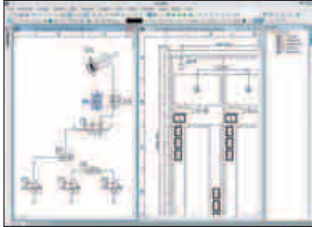
Theory is necessary for learning, but real practice provides motivation and promotes successful learning! In many situations, FluidSIM® 5 can easily be used as a controller for the real system: the EasyPort makes it possible – convenient, digital; and analog! New: with the joystick, FluidSIM® 5 is not only fun, but it now also allows several switches and valves to be operated simultaneously.

Wide range – maximum convenience

Pneumatics, hydraulics, electrical engineering: the libraries are available separately or together in the same program. The user decides which of the libraries to use in the program. All technologies interact optimally in a circuit diagram or project.

Flexible installation and use

Online registration, network license, usage at home: FluidSIM® 5 offers many license models that facilitate economical learning scenarios in a school or in a company. A new learner administration function even allows you to provide and monitor licenses for learning groups and to use the software at home.

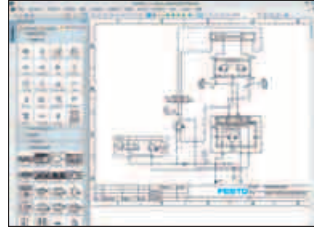


Professional CAD according to standards

- Convenient drawing with alignment lines and new snap functions
- Easy insertion of new symbols into existing connections
- Variable drawing frames
- Continuous scaling and rotation
- Dimensioning functions
- Intersection calculation of lines, rectangles and ellipses

Completely according to standards

- All symbols to DIN ISO 1219 or DIN EN 81346-2
- Connection identification according to new equipment identifier
- GRAFCET according to the current standard

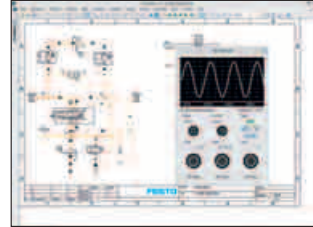


Libraries for new technologies

- Libraries for all levels of pneumatics and hydraulics training packages, including control technology and proportional technology
- New: drives in pneumatics
- Vacuum technology
- Sensors in pneumatics
- Safety in pneumatic systems
- Mobile hydraulics
- Electrical engineering, electronics
- Circuits with contacts

GRAFCET in various modes

- GrafEdit: create GRAFCETs in compliance with the standard
- GrafView: visualize the control sequence represented as a GRAFCET
- GrafControl: control the process with the GRAFCET, including error simulation and process monitoring
- GrafPLC

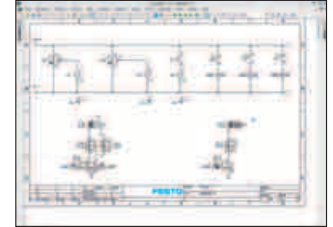


Simulation in high definition

- Signal processing up to 10 kHz
- Virtual oscilloscope for frequencies up to 100 kHz
- Simultaneous simulation of all circuits in a project
- Simulated values can be shown at run-time
- Several switches can be operated with the joystick

Learning material included

- Slides, pictures, animations, sectional drawings, video sequences
- Description of the physical-mathematical simulation models
- Training program for FluidSIM® beginners
- Details of all components at the push of a button
- Completed sample presentations for your training course
- Language changeover at run-time
- Multilingual (standard German/English)



Convenient documentation

- Project administration, drawing sheets
- Individual drawing frames in all sizes
- Automatic bills of materials, flow path numbering, switching element tables, terminal diagrams, cables, wiring lists, and tubing lists
- Exports into all common formats

FluidSIM® for homework

- New expansion for administering external users over the Internet
- Administration of learning groups
- Integrated chat functions
- Simple administration by the tutor
- New licensing solutions allow working with the full version from home

Electrical engineering

Local installation,
single license de/en/es/fr/pt/ro/ru

Order no. **8024359**

Network installation,
single license de/en/es/fr/pt/ro/ru

Order no. **8024362**

Pneumatik

Local installation,
single license de/en/es/fr/pt/ro/ru

Order no. **8024357**

Network installation,
single license de/en/es/fr/pt/ro/ru

Order no. **8024360**

Hydraulics

Local installation,
single license de/en/es/fr/pt/ro/ru

Order no. **8024358**

Network installation,
single license de/en/es/fr/pt/ro/ru

Order no. **8024361**

Recommended accessories:

X-Box Controller
without cable 8032252

Automotive mechatronics

All the components of TP 1011

→ page 50 and TP 1025 → page 53
are included in the electrical engineering library FluidSIM® 5. This library also contains extensive teaching material, adapted to the first year of training for automotive mechatronics technicians.

System requirements

- Windows 10
- Processor with at least 1 gigahertz
- At least 1 GB RAM
- Dual core processor (recommended)

We can meet your needs

Multiple licenses for local or network installation with as many licences as you necessary.

New languages – free of charge

In the future, you will receive new language variants free of charge on the Internet. They can be integrated into your existing version via an update.

Visit us on the Internet.

There you will find all the information you need on currently available versions and updates for existing FluidSIM® users



Legal security

Festo Didactic's teaching materials are already in widespread use for a diverse range of purposes. With the new licenses, the legal basis for individualized use has now been established. From now on, users have the option of choosing one of three types of license, to ensure an optimized – and legally secure – use of Festo's teaching materials tailored to your needs.

Choose from the following types of license:

Campus license

The standard option for commercial (professional) use. Ideal for all those wishing to use the training materials at a single location.

Enterprise license

For large (international) companies and educational institutions with multiple locations.

For information on each of the license types, please see the following table.

Note:

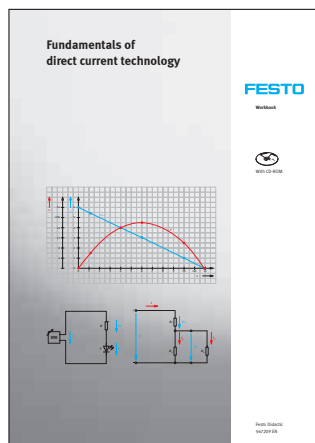
- The license types are valid for all Festo Didactic training materials.
- The full rights of use are set out in the legal information contained in the purchased training materials.

Properties	Campus license	Enterprise license
Scope of delivery	Teaching material (workbook with multimedia CD-ROM*)	As agreed
Document protection	–	–
Document can be modified	X	X
Reproduction rights	X	X
Multilingual version*	–	X*
Target group	Commercial/educational organizations (single location)	Commercial/educational organizations (multiple locations)
Shop	FESTO	FESTO

* The languages offered vary depending on the training material.

Electricity and electronics

Workbooks



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, behaviour 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:

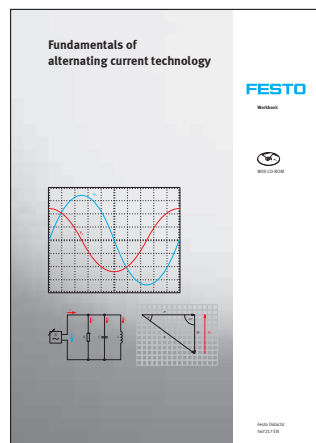
- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

C. Löffler

Edition 2010, 300 pages, in color, in folder.

Campus license (→ Page 35):

de	567207
en	567209
es	567211
fr	567213



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:

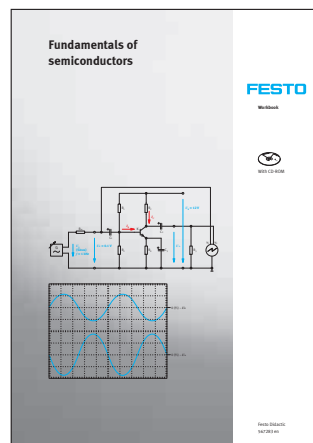
- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

C. Löffler

Edition 2010, 290 pages, in color, in folder.

Campus license (→ Page 35):

de	567215
en	567217
es	567219
fr	567221



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:

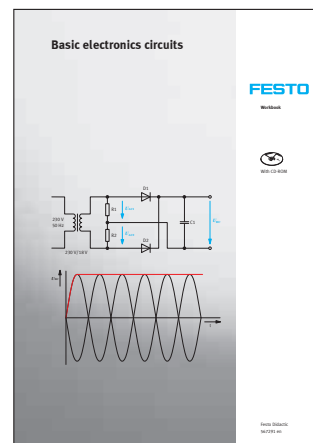
- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

M. Wäschle

Edition 2010, 208 pages, in color, in folder.

Campus license (→ Page 35):

de	567281
en	567283
es	567285
fr	567287



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:

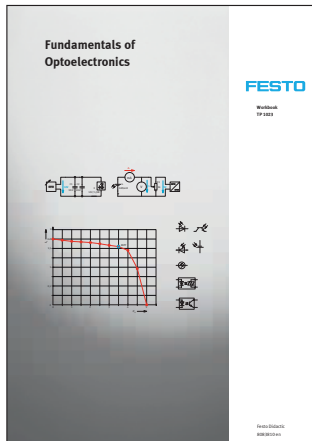
- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

K.-H. Drüke

Edition 2011, 382 pages, in color, in folder.

Campus license (→ Page 35):

de	567289
en	567291
es	567293
fr	567295



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
- Data storage medium with PDF files
- 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.

K.H. Drüke

Edition 2018, 120 pages, in color, in folder.

Campus license (→ Page 35):

de	8081038
en	8083810



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:

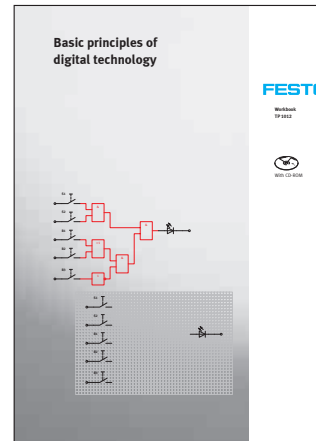
- Sample solutions
- Training notes
- Worksheets for the student
- USB stick

K.-H. Drüke

Edition 2015, 222 pages, in color, with USB Stick, in folder.

Campus license (→ Page 35):

de	8023586
en	8023587
es	8023588
fr	8023589



Basic principles of digital technology

The basic principles of digital technology 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
- Multimedia CD-ROM with graphics

S. Enderle

Edition 2012, 200 pages, in color, in folder.

Campus license (→ Page 35):

de	8023432
en	8023433
es	8023434
fr	8023435

Electricity and electronics

Workbooks



Basic principles of closed-loop control technology

The optimum introduction to the world of closed-loop systems is provided by the workbook, Basic principles 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
- Multimedia CD-ROM with graphics

J. Helmich
Edition 2013, 170 pages, in color, in folder.

Campus license (→ Page 35):	
de	8023436
en	8023437
es	8023438
fr	8023439



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

Matrix Technology Solution Limited
Edition 06/2018, 80 pages, in color, in folder.

Campus license (→ Page 35):	
de	8128594
en	8094009

Building system technology

Workbooks



Protective measures for metal occupations

The workbook “Electrical protective measures for metalworking occupations” 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
- Multimedia CD-ROM with graphics

J. Stumpp
Edition 2014, 110 pages, in color, in folder.

Campus license (→ Page 35):	
de	8023440
en	8023441
es	8023442
fr	8023443



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
- Multimedia CD-ROM with graphics

J. Stumpp
Edition 2012, 230 pages, in color, in folder.

Campus license (→ Page 35):	
de	567307
en	567309
es	567311
fr	567313



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
- Multimedia CD-ROM with 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 (→ Page 35):

de	8074437
en	8113396
es	8113397



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
- Multimedia CD-ROM with graphics

The worksheets support the learner in the information and planning phase as well as with execution, monitoring and documentation.

Campus license (→ Page 35):

de	8074441
en	8113398
es	8113399



Fluorescent lamps

The workbook introduces fluorescent lamp circuits and emergency light modules. Particular attention is paid to the design and function of the lamps and components.

Training content:

- Mode of operation of fluorescent lamps
- Function of the components
- Circuits with fluorescent lamps
- Emergency light
- Taught using practical project exercises

The workbook contains:

- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

Campus license (→ Page 35):

de	8074442
en	8113400
es	8113401



High-pressure discharge lamps

Mainly used for street and industrial lighting as well as floodlighting systems.

The work book provides practical project exercises for an introduction to high-pressure discharge lamps. Particular attention is paid to the mode of operation of the lamps and the light they produce, as well as to comparing them and their industrial energy efficiency.

Training content:

- Types of high-pressure discharge lamps
- Industrial energy efficiency of high-pressure discharge lamps
- Circuitry of high-pressure discharge lamps
- Application areas of high-pressure discharge lamps
- Taught using practical project exercises

Campus license (→ Page 35):

de	8074439
en	8111397
es	8111398

Building system technology

Workbooks



High-power LEDs

The most modern and energy efficient way of lighting.

The work book 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.

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 (→ Page 35):

de	8074440
en	8111399
es	8111400



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
- Multimedia CD-ROM with graphics

N. Karlsson

Edition 2013, 110 pages, in color, in folder

Campus license (→ Page 35):

de	8023444
en	8023445
es	8023446



Building HVAC Controls (BACnet)

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

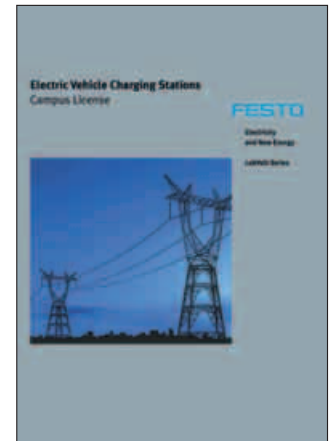
The workbook contains:

- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

Edition 2017, 170 pages, in color

Campus license (→ Page 35):

de	793120
en	793119
es	793122



Electric Vehicle Charging Stations

The following lab exercises are included:

- Electric Vehicles and Electric Vehicle Service Equipment
- Basic Charging Station Components and Operation
- Advanced Charging Stations
- Commissioning and Testing
- Troubleshooting Project

The workbook contains:

- Exercises and sample solutions
- Didactic recommendations
- Worksheets for learners
- Multimedia CD-ROM with graphics

The exercises are based on the training content and the hardware components of the training system.

Campus license (→ Page 35):

de	8096874
en	8096870
es	on request
fr	on request

Electric drive technology

Workbooks



Fundamentals of circuits with contacts

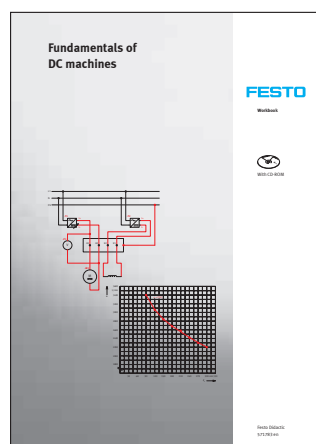
Contactors still have their place despite increasing automation and increasingly cost-effective control electronics. The workbook for the fundamentals of circuits with contacts covers the specific topics relating to relays and contactor controls in six realistic projects plus an additional project for 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
- Multimedia CD-ROM with graphics

J. Stumpp
Edition 2010, 120 pages, in color, in folder.

Campus license (→ Page 35):	
de	570901
en	567315
es	567317
fr	567319



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
- Multimedia CD-ROM with graphics

J. Stumpp
Edition 2011, 150 pages, in color, in folder.

Campus license (→ Page 35):	
de	571781
en	571783
es	571785



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
- Multimedia CD-ROM with graphics

J. Stumpp
Edition 2011, 152 pages, in color, in folder.

Campus license (→ Page 35):	
de	571789
en	571791
es	571793



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:

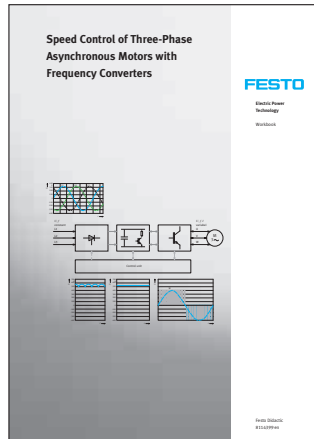
- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

J. Stumpp
Edition 2011, 166 pages, in color, in folder.

Campus license (→ Page 35):	
de	571797
en	571799
es	571801
fr	571803

Electric drive technology

Workbooks



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
- USB memory stick with PDF files

Wolfgang Kelz
Edition 2019, 158 pages, in color, in folder.

Campus license (→ Page 35):	
de	8114398
en	8114399
es	8114400
fr	8114401



Fundamentals of servo motor drive technology

Servo drives play a particularly important role in automation, as due to today's state-of-the-art controller technology, they have developed into the standard drive. The workbook for the fundamentals of servo motor drive technology uses practical exercises to provide a detailed introduction to the topics relating to modern servo drives.

The topics covered include the design and commissioning of a servo drive, RPM regulation, regulating torque, and homing as well as additional content, such as positioning with variable speeds, acceleration, braking and positioning tasks.

The workbook contains:

- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

F. Ebel, M. Pany
Edition 2010, 192 pages, in color, in folder.

Campus license (→ Page 35):	
de	571851
en	571853
es	571855
fr	571857



Basic principles of stepper motor drive technology

The workbook for the basic principles of stepper motor drive technology uses practical exercises to provide a detailed introduction to the topics relating to modern stepper motor drives.

In addition to basic content, including design and commissioning of stepper motor drives, practical topics, such as homing, speeds, positioning, acceleration, and braking ramps play an important role as well. More detailed content is also covered, i.e., current reduction for stepper motor drives.

The workbook contains:

- Sample solutions
- Training notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

F. Ebel, M. Pany
Edition 2010, 194 pages, in color, in folder.

Campus license (→ Page 35):	
de	571859
en	571861
es	571863



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.

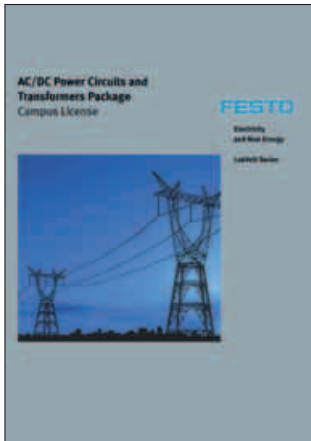
This book lists the main concepts in glossary format and provides brief explanations to facilitate a better understanding of these drives. However since there is more to an electrical drive than just the electric motor, it also touches on areas such as measurement systems, power electronics, gearboxes, controllers, and components for transmitting power.

S. Hesse
Edition 2004, 200 pages, in color, in folder.

Campus license (→ Page 35):	
de	539265

Electric power technology

Workbooks



AC and DC Power Circuits and Transformers Complete Package

Workbooks included:

- DC Power Circuits
- Single-Phase AC Power Circuits
- Three-Phase AC Power Circuits
- Single-Phase Power Transformer
- Three-Phase Transformer Banks

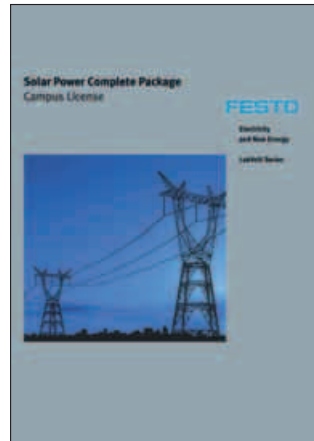
The workbooks contain:

- Exercises and sample solutions
- Didactic recommendations
- Worksheets for the student
- Multimedia CD-ROM with graphics

The exercises are based on the training content and the hardware components of the training system.

Campus license (→ Page 35):

de	on request
en	8093410
es	on request
fr	on request



Solar Power Complete Package

Workbooks included:

- Solar Power
- Photovoltaic Systems

Solar Power

- The Diode
- The Solar Panel (Photovoltaic Panel)
- Effect of Temperature on Solar Panel Performance
- Storing Energy from Solar Panels into Batteries
- Effect of Shading on Solar Panel Operation
- Solar Panel Orientation
- Solar Panel Performance vs. Insolation

Photovoltaic Systems

- Stand-Alone PV Systems for side-by-side Loads
- Use of an MPPT Charge Controller in Stand-Alone PV Systems
- Stand-Alone PV Systems for AC Loads
- Grid-Tied PV Systems

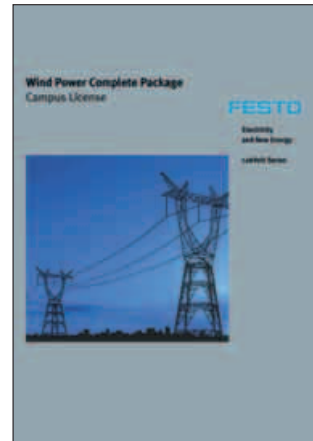
The workbook contains:

- Exercises and sample solutions
- Didactic recommendations
- Worksheets for the student
- Multimedia CD-ROM with graphics

The exercises are based on the training content and the hardware components of the training system.

Campus license (→ Page 35):

de	798367
en	596125
fr	8096492



Wind Power Complete Package

Workbooks included:

- Introduction to Wind Power
- Wind Power Systems

Introduction to Wind Power

- Voltage-Speed Characteristic of a Wind Turbine Generator
- Torque-Current Characteristic of a Wind Turbine Generator
- Power vs. Wind Speed
- Storing Energy from a Wind Turbine into Batteries

Wind Power Systems

- Stand-Alone Wind Power Systems for side-by-side Loads
- Stand-Alone Wind Power Systems for AC Loads

The workbook contains:

- Exercises and sample solutions
- Didactic recommendations
- Worksheets for the student
- Multimedia CD-ROM with graphics

The exercises are based on the training content and the hardware components of the training system.

Campus license (→ Page 35):

de	798369
en	596126
fr	8096504

Electrical engineering and electronics training packages





System description	46
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Equipment sets

Basic principles of electrical engineering/electronics	48
Basic principles of digital technology.....	54
Basic principles of control technology.....	56
Microcontroller development systems	58

Electrical engineering and electronics training packages

Modern and exciting training



Everything from a single source – Equipment for electrical engineering laboratories

Regardless of the control and drive technology used, electrical engineering always plays a role.

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.



Rapid transfer

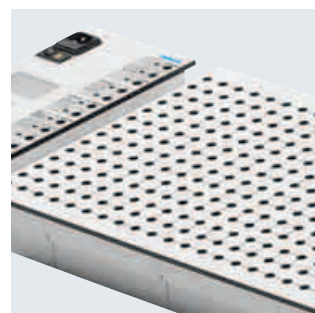
Whether in initial professional training or more advanced courses: It is essential to be able to recall what has been learned and apply it immediately. This is easier to do if the worlds of learning and work are as similar as possible. That is why the training packages for electrical engineering only contain industrial components, and the exercises in the course documents come from a typical, professional environment.



Maximum compatibility

Electrical engineering and electronics are fundamental components of automation. These training packages can therefore be used where mechatronics or bus technology are involved.

- 4 mm safety sockets and SysLink guarantee “electrical compatibility”
- A new standard coupling ensures that motors and driven elements are universally compatible
- H-rails and housing dimensions allow components from other manufacturers to be used



Useful modularity

The training packages for Electrical engineering and electronics are expandable. For example, they begin with electrical protective measures and a domestic connection. Later, they add the starter kit for sub-distribution and the topic of building automation. This modularity has a further benefit: each training device is smaller, more portable and can be housed in a cabinet more easily.



Proven training concept

Festo Didactic's proven and continuously upgraded teachware concept also underpins the training packages for electrical engineering.

It is based on project-based exercises that increase in complexity from one exercise to the next. The knowledge learned is revisited, reinforced and consolidated in subsequent exercises.

Theoretical content can be illustrated and communicated more clearly with the help of the photos and videos on the enclosed multimedia CD-ROM to communicate it more clearly.

Teacher and student versions of documents are provided, with identical page numbering to make it easier to answer questions. Exercise sheets can simply be printed as required.

All projects include practical problems. Drawings, images and videos give a broad view of industrial reality.



Safe connection technology

When it comes to dealing with electricity, safety and protective measures are a key focus. Of course, all of our electrical connections are fitted with safety sockets or plugs.

- The plug-in modules of the equipment set for the basic principles of electrical engineering/electronics
- Power supply units and power supplies
- Back plates 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 eLearning courses are available for all topics. Our range of digital training programs provides exciting learning scenarios and supplements the classroom-based parts of a course. The eLearning courses are particularly well suited for teaching the basic principles and thus provide the optimum supplement to practical experiments.



product
design
award

2011



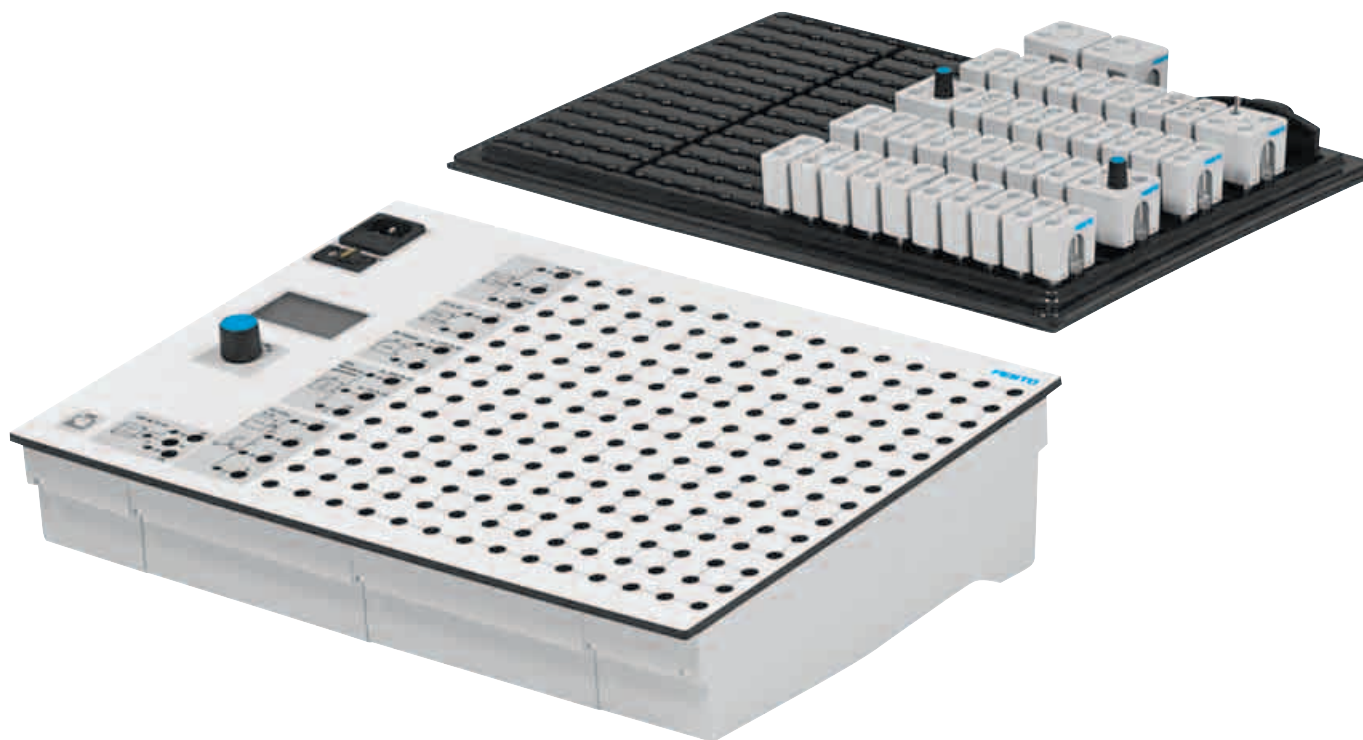
Winner

of the iF product design award 2011 and the Focus design award in Silver 2011:

Equipment set TP 1011
Basic principles of electrical engineering/electronics

Basic principles of electrical engineering for metalworking occupations

Equipment set TP 1010



Basic principles of electrical engineering for metalworking occupations

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 even in mechanical professions. It is important for understanding many functions and processes in complex systems.

The examples used by the training package Basic principles of electrical engineering for metalworking occupations to teach the basic principles 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 tests for DC and AC technology. The clearly labelled 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 → www.festo-didactic.com
4 mm Safety laboratory cables → Page 149
2x Digital Multimeter → Page 153
Digital storage oscilloscope → Page 155

Possibilities of expansion:

PSURemote Software, de/en	574179
Set of components for digital technology	574193

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Also order:

The setting and measurement software for TP 1010, TP 1011 and TP 1011 M**PSURemote Software**

Software incl. USB cable for PC-supported setting and measurement with the basic power supply unit EduTrainer®.

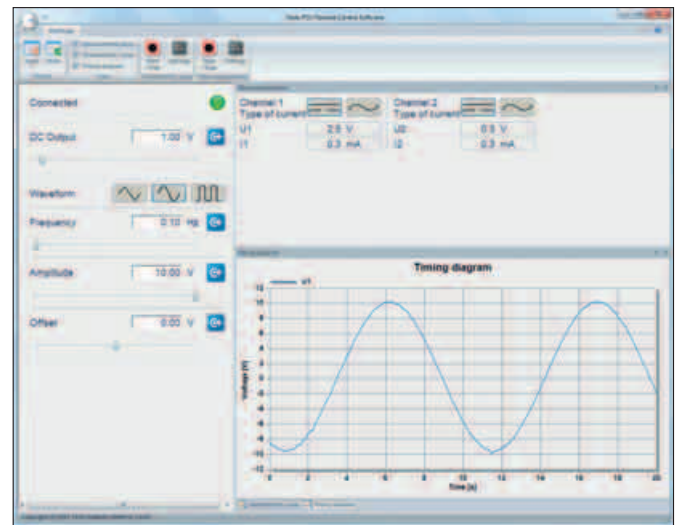
Basic functions:

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

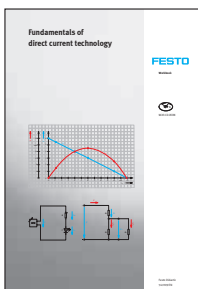
Also with the built-in measuring module on the power supply unit:

- 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 training media****Workbooks → Page 36**

- Fundamentals of direct current technology
- Fundamentals of alternating current technology



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

**Tec2Screen® courses**

→ Pages 28 – 30

Direct Current Technology

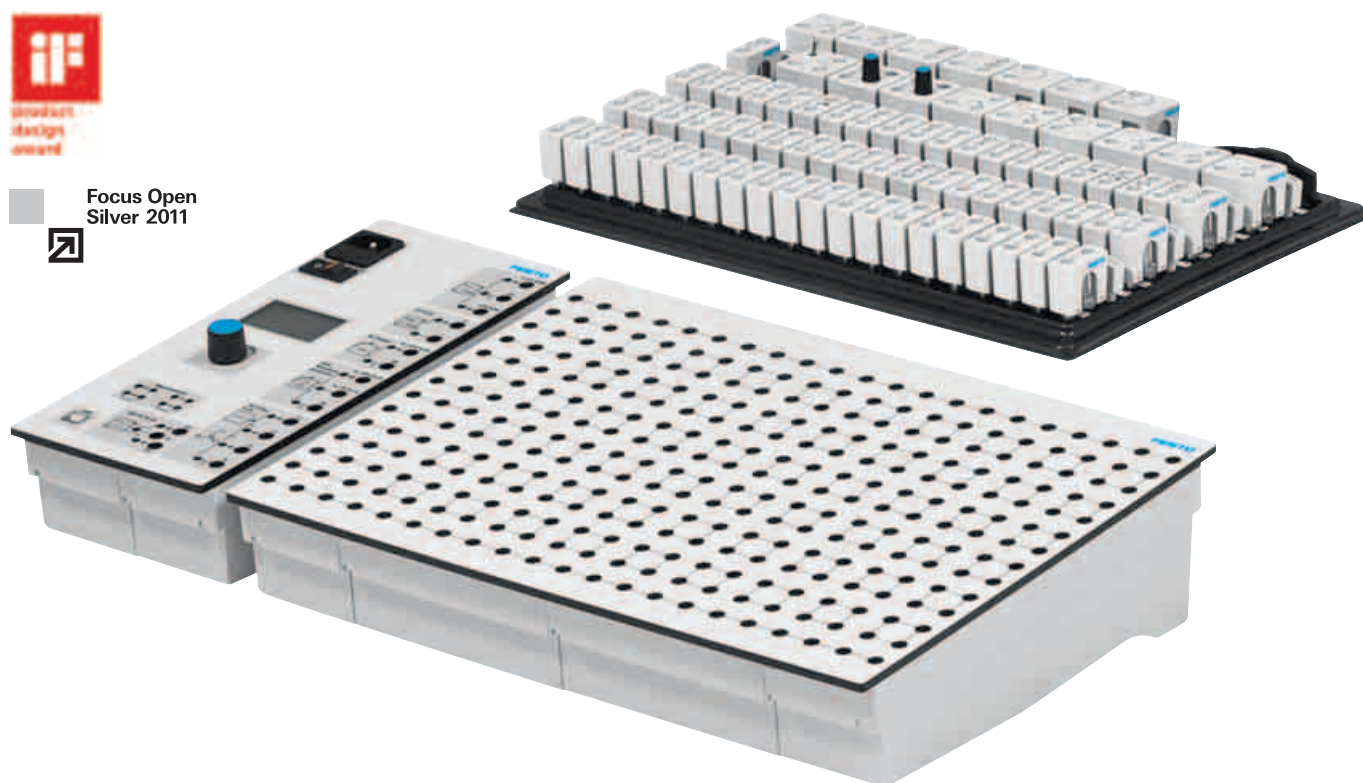
- Ohm's Law, Power, Work, Energy
- Resistors, Consumers
- Voltage Sources, Adaptations
- Capacitors, Parameter-Dependent Resistors, Measuring

Alternating Current Technology

- Characteristics
- Capacitors I
- Coils I
- Electric Power

Fundamentals of electrical engineering/electronics

Equipment set TP 1011



The basis of everything – Electrical engineering and electronics

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

With the component set, all basic tests of DC, AC and semiconductor technology can be performed and basic electronic circuits can be examined. The storage panel, with its clearly labelled 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 PSURemote 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	576624
2	1x Universal patch panel EduTrainer	567322
3	1x Component set for electrical engineering/electronics	567306
1	1x EduTrainer basic power supply unit with integrated measuring module	567321

Complete equipment set TP 1011 M 8029635

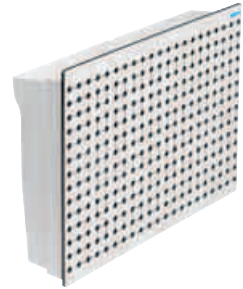
The most important components at a glance:

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, rot	576295
4x	2 mm Safety laboratory cables, 500 mm, blau	576296
8x	4 mm – 2 mm safety measuring adapter	8023960
1x	PSURemote Software, de/en → Page 49	574179

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2



3



4



Necessary accessories, also order:

IEC power cable → www.festo-didactic.com
4 mm Safety laboratory cables → Page 149
2x Digital Multimeter → Page 153
Digital storage oscilloscope → Page 155

Optional accessories:

Set of components for digital technology	574193
Set of components for control technology	8023963
Extension component set Installation and relay technology → Page 52	
Extension component set Optoelectronics → Page 52	
Extension component set Analog technology → Page 53	
Extension component set Motor vehicle mechatronics → Page 53	
Set of empty component housings, 2-pin	576289
Set of empty component housings, 3-pin	576290
Operational amplifier	576621

Also order:

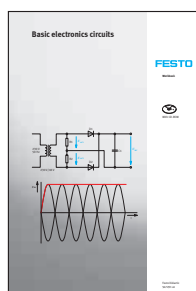
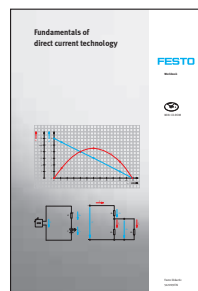
Workbooks → Page 36

- Fundamentals of direct current technology
- Fundamentals of alternating current technology
- Fundamentals of semiconductors
- Basic electronics circuits

The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbooks contain:

- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- Worksheets for learners

**Recommended Tec2Screen® courses**

→ Pages 28 – 30

Direct Current Technology

- Ohm's Law, Power, Work, Energy
- Resistors, Consumers
- Voltage Sources, Adaptations
- Capacitors, Parameter-Dependent Resistors, Measuring

Alternating Current Technology

- Characteristics
- Capacitors I
- Coils I
- Electric Power

Also order:

FluidSIM® Electrical engineering

→ Page 32

Extension component sets for TP 1011

Installation and relay technology

New



Extension component set Installation and relay technology TP 1022

The plug-in components (including TP 1011 or TP 1011 M) are 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.

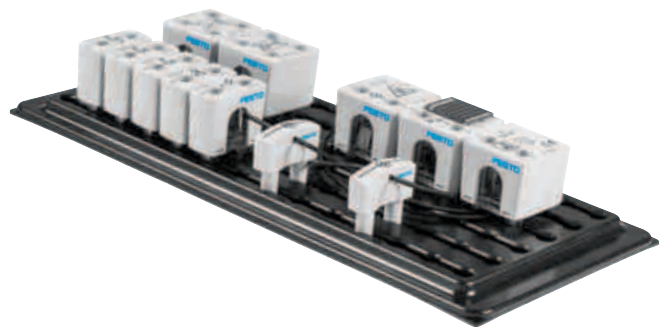
Training content

- 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

To carry out the exercises, you will need components from:

- Equipment set TP 1011 or
- Equipment set TP 1011 M
- Page 50

Optoelectronics



Extension component set Optoelectronics TP 1023

The training package Opto-electronics 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

To carry out the exercises, you will need components from:

- Equipment set TP 1011 or
- Equipment set TP 1011 M
- Page 50

Also order:

Workbook

Fundamentals of Optoelectronics
→ Page 37

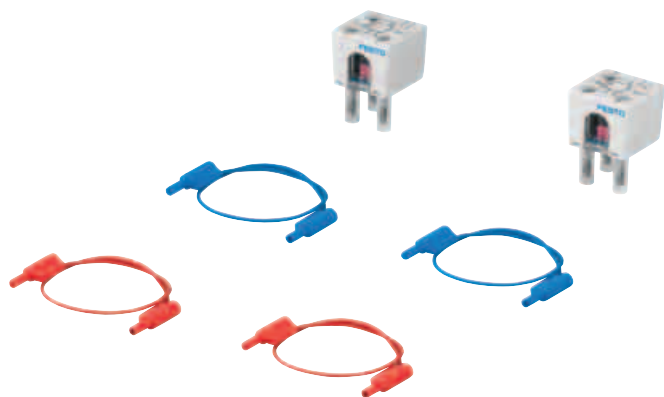
Extension component set for installation and relay technology TP 1022

8111819

Extension component set Optoelectronics TP 1023

8077920

Analog technology



Extension component set Analog technology TP 1024

The analog technology set of components extends the equipment sets TP 1011 and TP 1011 M, basics of electrical engineering/electronics, by 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

To carry out the exercises, you will need components from:

- Equipment set TP 1011 or
- Equipment set TP 1011 M

→ Page 50

Also order:

Workbook

Fundamentals of analog technology
→ Page 37

FluidSIM®-E → Page 32

Motor vehicle mechatronics

New



Extension component set Motor vehicle mechatronics TP 1025

The students set up simple motor vehicle-specific basic circuits.

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 FluidSIM® 5. 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

To carry out the exercises, you will need components from:

- Equipment set TP 1011 or
- Equipment set TP 1011 M

→ Page 50

Also order:

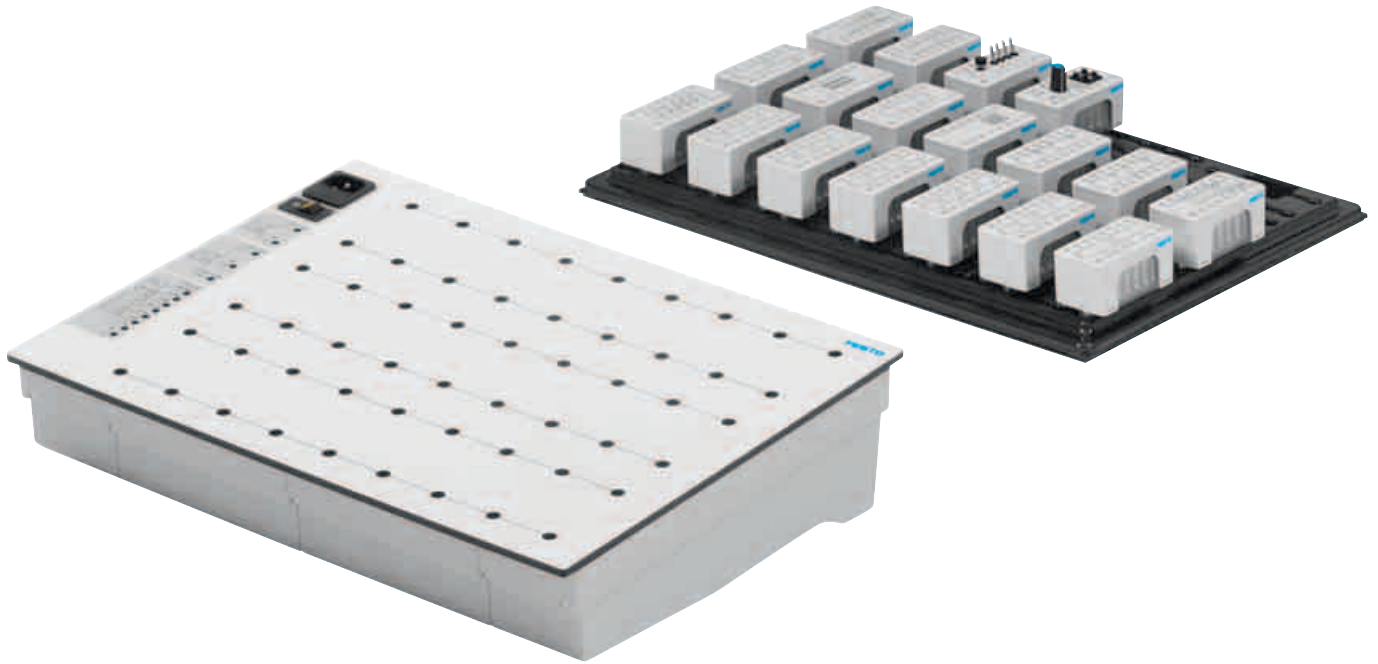
FluidSIM®-Electrical engineering
→ Page 32

Motor vehicle mechatronics extension component set TP 1025

8106705

Basic principles of digital technology

Equipment set 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 behaviour.
- The ICs contained in the components have a base 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 components of the control technology equipment set.

Components included

- 1x Inverter
- 2x AND
- 2x OR
- 1x NAND
- 1x NOR
- 1x XOR
- 1x Hex switch and analogue source 0 – 5 V
- 1x LED bar graph
- 1x Counter
- 1x 7-segment display
- 1x RS flip-flop
- 2x JK flip-flops
- 2x Shift registers
- 1x Full adder
- 1x Signal input

Training content

- Elementary logic modules
- Important symbols
- Designing and optimising 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 → www.festo-didactic.com

2 mm Safety laboratory cables → Page 150

Possibilities of expansion:

I/O level converter 5 V ↔ 24 V (8 E/A)	576622
IC zero insertion force socket	576623
Set of components for control technology	8023963

Recommended Tec2Screen® courses – Digital Technology, also order:

Basic Logic Functions → Page 30

Boolean Laws → Page 30

Disjunctive and Conjunctive Normal Form → Page 31

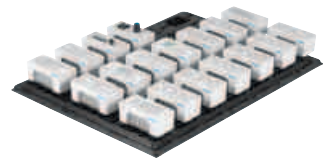
Schmitt Triggers, Astable and Monostable Multivibrators → Page 31

Bistable Multivibrators → Page 31

1



2



Also order:

WorkbookBasic principles of digital technology
→ Page 37

The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbooks contain:

- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- 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 (→ Page 35):

de	8023432
en	8023433
es	8023434
fr	8023435

**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

**IC zero insertion force socket**

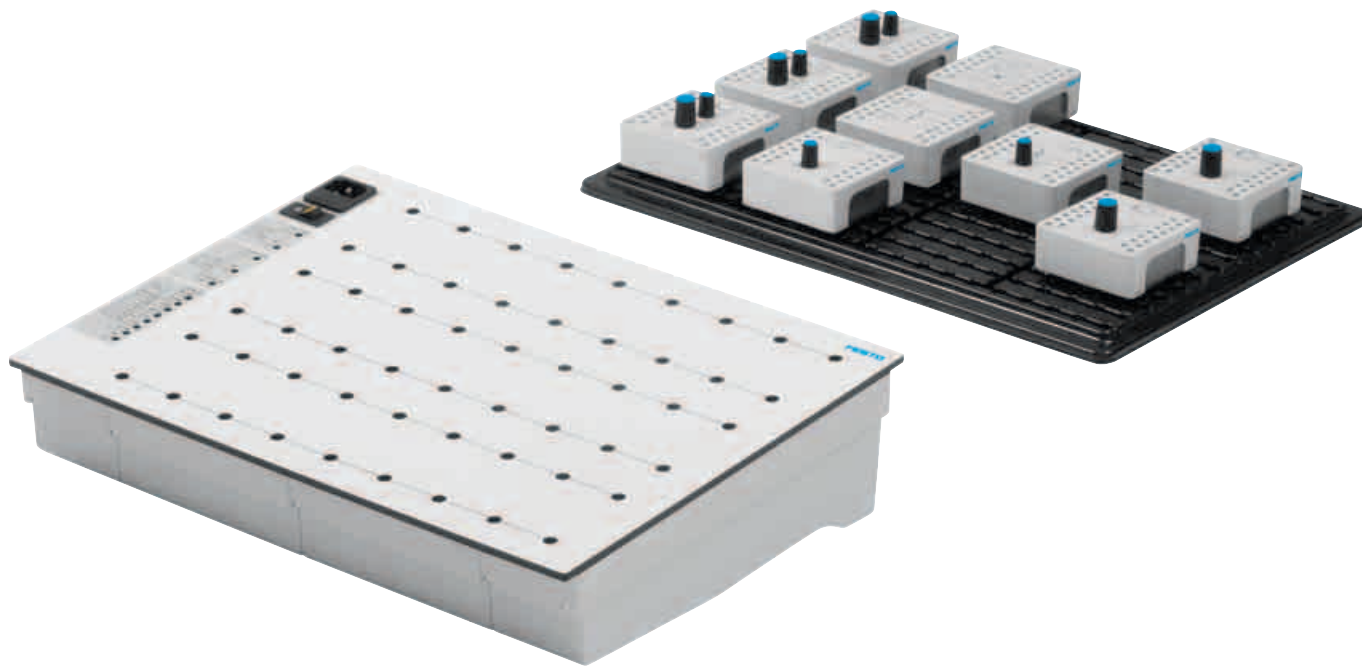
High-quality IC socket for tool-free adaptation of ICs, compatible with digital technology.

- 16 pins in a 2.54 mm grid
- Tool-free assembly using clamping lever
- Contacting with 2 mm safety plug

Order no. 576623

Basic principles of control technology

Equipment set 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 behaviour of various controllers and the structured analysis of requirements for controlled systems are particularly important here.

Ways and means of analysing 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 behaviour 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 Digital technology.

Components included

- 1x 2 differential inputs with subtractor
- 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
- Spring response, dynamic behaviour
- Standardising physical variables
- Bode diagram
- Modelling a controlled system
- Positive and negative feedback
- Two and three-step action controller
- P, I and PID controllers
- Stable and unstable behaviour
- Controller gain
- Delay behaviour according to Ziegler and Nichols

Complete equipment set TP 1013	8023964
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1

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 → www.festo-didactic.com

2 mm Safety laboratory cables → Page 150

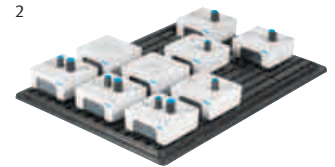
Digital storage oscilloscope → Page 155

Possibilities of expansion:

Set of components for digital technology	574193
--	--------



2



Also order:

Workbook

Basic principles of closed-loop control technology

→ Page 30



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbooks contain:

- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- 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 (→ Page 35):

de	8023436
en	8023437
es	8023438
fr	8023439

Also order:

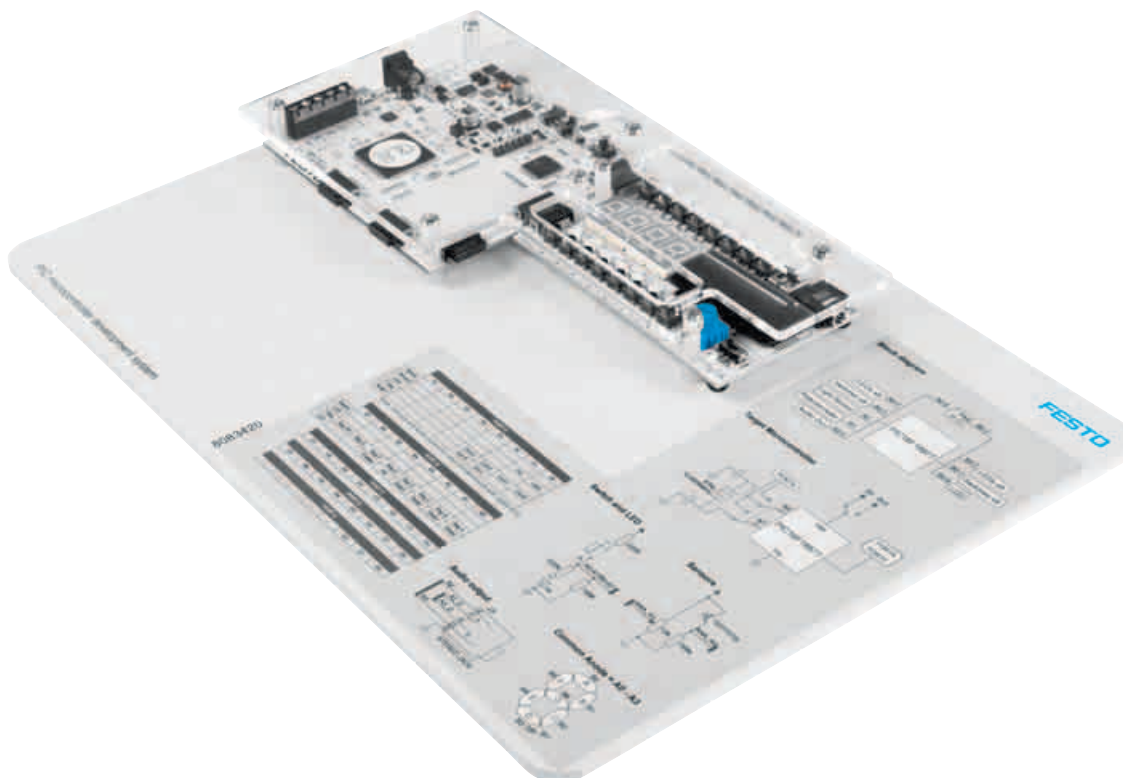
FluidSIM®-Electrical engineering

→ Page 32

Microcontroller development systems (PIC/Arduino)

Equipment sets TP 1515/TP 1516

New



Flexibility through modularity

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

The modular nature of the sets makes them highly flexible. Each set consists of a mounting panel, with a choice of microcontroller board technology – PIC or Arduino – and a standard expansion board. Optional expansion boards allow the creation of a wide variety of electronic systems.

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 training 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 training needs. Instructors can select the appropriate devices among input/output boards, wired/wireless boards, motors/actuators boards, sensor boards, prototype boards, and graphical displays.

Disciplines covered include computer science, electrical/electronic/mechanical engineering, mechatronics, design technology, and robotics.

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

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: expansion 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.

Courseware is provided with the equipment sets; further support is available through online forums.

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.

A 2D and 3D graphical development interface allows students to construct a complete electronic system on-screen, develop a program based on standard flowcharts, simulate the system and then produce hex code for programming a range of devices.

1 Complete equipment set TP 1515 8085562

The most important components at a glance:

- 1x 8-bit PIC microcontroller board → Page 60
- 1x Combo board → Page 62
- 1x Mounting panel
- 1x Power supply unit
- 1x USB cable
- 1x Storage tray

2 Complete equipment set TP 1516 8085563

The most important components at a glance:

- 1x Arduino microcontroller board → Page 60
- 1x Combo Board → Page 62
- 1x Mounting panel
- 1x Power supply unit
- 1x USB cable
- 1x Storage tray

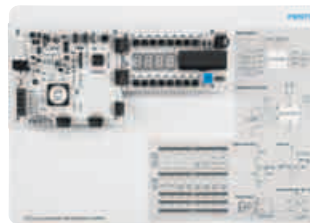
Necessary accessory for both equipment sets, please order:

Flowcode 8 → Page 61

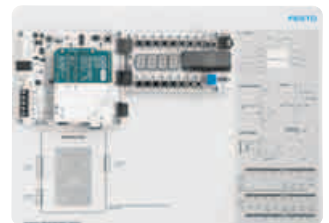
Expansion boards for equipment sets TP 1515/TP 1516

A wide selection of optional expansion boards see pages → 62 – 63

1



2



Workbook

Programming Microcontroller
→ Page 38



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

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.

Campus license (→ Page 35):

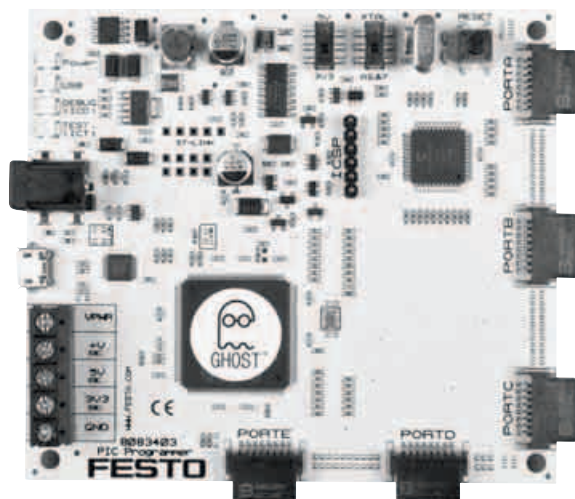
de	8128594
en	8094009

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.

Microcontroller boards

for equipment sets TP 1515/TP 1516



8-bit PIC microcontroller board

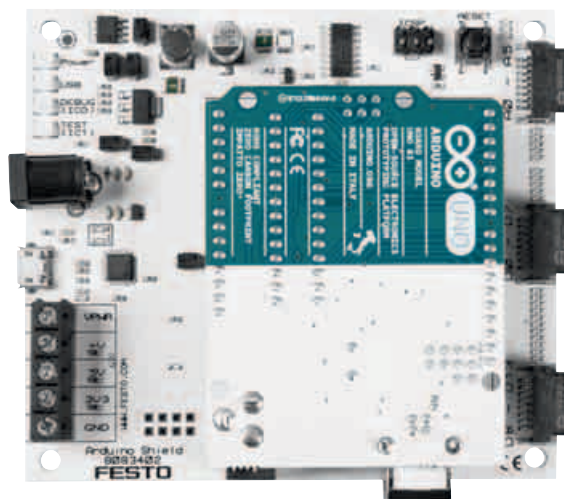
The 8-bit PIC microcontroller board is equipped with a powerful PIC16F18877 microcontroller.

This board contains the microcontroller that drives the training system. It is loaded with firmware to drive the required embedded functionality. The board presents all I/O pins collected together as ports sockets. The boards take power from an external power supply or from the micro USB port.

It can be used with various programming languages including Assembly, C, and Flowcode. Using the board with Flowcode allows the use of the advanced Ghost debugging features including in circuit debugging, real time pin monitoring and bus decoding.

Characteristics:

- Voltage selector 5 V/3.3 V
- 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 microcontroller board

The Arduino UNO microcontroller board is equipped with the Arduino UNO R3 PDIP.

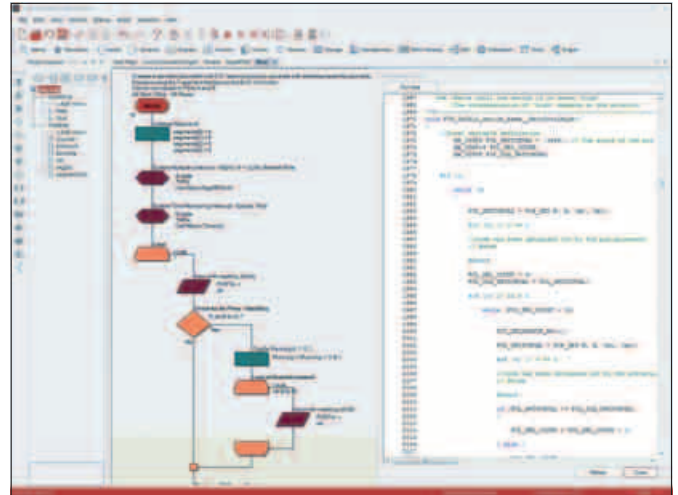
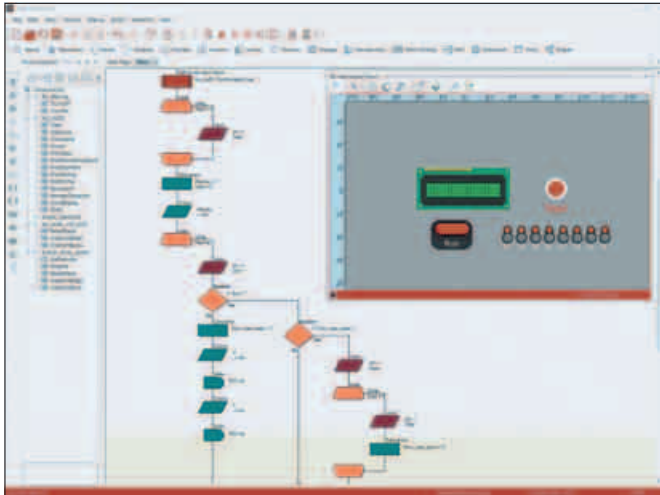
This board contains the microcontroller that drives the training system. It is loaded with firmware to drive the required embedded functionality. The board presents all I/O pins collected together as ports sockets. The boards take power from an external power supply or from the micro USB port.

It can be used with various programming languages including Assembly, C, Arduino IDE, and Flowcode. Using the board with Flowcode allows the use of the advanced Ghost debugging features including in circuit debugging, real time pin monitoring and bus decoding.

Characteristics:

- 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

Flowcode 8 – A visual programming environment for equipment sets TP 1515/TP 1516



Flowcode 8

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 8 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 expansion 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

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.

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 & debugging

Ghost Technology embedded on microcontroller 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 LEDs 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 Wi-Fi are available within the Flowcode environment.

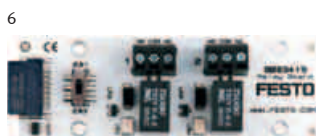
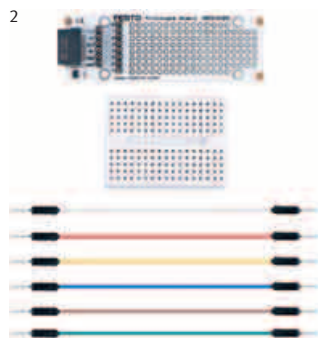
Flowcode 8 licenses

Flowcode for PIC academic, single license	585809
Flowcode for PIC academic, 10 licenses	585810
Flowcode for PIC academic, 50 licenses	585811
Flowcode for Arduino academic, single license	595168
Flowcode for Arduino academic, 10 licenses	595169
Flowcode for Arduino academic, 50 licenses	595164

Contact us for more licensing options

Expansion boards

for equipment sets TP 1515/TP 1516



1 Combo board

(Included in the Equipment set)

This flexible combination board is an ideal complement to our microcontroller boards for learning basic I/O programming and project development.

The board will work with any microcontroller system allowing multiple technologies to be explored using a single expansion board.

The board is ideally used in conjunction with our courseware to help learn programming using flow charts, C or assembly code.

The graphical LCD must be driven via an intelligent conversion module to allow it to be treated as a standard Alphanumeric HD44780 compatible device.

Order no. **8083412**

2 Prototype board

The Prototype board provides an array of standard 2.54 mm pitch holes which can be used to permanently solder electronics onto the board. The board is supplied with a small breadboard allowing for temporary electronics to be create and tested with the microcontroller system.

Order no. **8083406**

3 Keypad board

The Keypad board allows for simple data entry using an array of switches. The Keypad board is a useful tool as it allows you to enter numeric and textual data into the embedded system. The switches are all push to make type and read by controlling the logic level of the columns and reading back the state of the rows.

Order no. **8083408**

4 Actuators board

The Actuators board includes a DC motor with both analogue and digital feedback, a servo motor and a stepper motor, plus the circuitry to drive the motors.

The board features a DC socket to allow the various drivers to be powered from a secondary power supply.

Order no. **8083413**

5 Grove sensor board

The Grove sensor board can be used with up to four Grove modules at a time.

Care should be taken to ensure that the system voltage is compatible with all the connected Grove modules to avoid damaging the Grove module.

Order no. **8083414**

6 Relay board

The Relay board provides two electrically controllable relays which act as isolated switches.

The external connections to the relays are provided using screw terminals and each relay features an LED to indicate when the relay is active.

Order no. **8083419**

7 Bluetooth board

The Bluetooth board contains a Microchip RN4677 module. This module has a transmit power of +2 dBm, which should give a 100 meters transmission range at a data transfer rate of 50 Kbps.

The module is programmed using an asynchronous serial AT command style protocol which can be interfaced to any microcontroller with a UART facility.

Order no. **8089815**

8 WIFI board

The WIFI board allows the system to connect and communicate with an existing Wi-Fi network. It can also be used to create a data access point that other Wi-Fi enabled devices can connect to.

Wi-Fi is provided via the popular ESP12F module which is fully certified and ruggedized.

Order no. **8089816**

7



8



Additional expansion boards for equipment sets TP 1515/TP 1516

LED board	8083404
Switch board	8083405
LCD board, alphanumeric, monochrome	8083407
LCD board, graphical, monochrome	8089818
LCD board, graphical, colour	8089821
SD card board	8083409
Terminals board	On request
Servo motor board	On request
Manual patch board	On request
Splitter board	On request
ZigBee board router	On request
Microcontroller link board	On request
ZigBee board coordinator	On request
Ethernet board	On request
Click board*	On request
CAN bus board	On request
I/O expansion board	On request

* Compatible with MikroElektronika products

Building system technology training packages





Introduction	66
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Equipment sets

Introduction to building system technology

Fundamental electrical protective measures	68
Electrical safety measures for metalworking occupations	69
Power supply systems and protective measures	70
Basic principles of electrical installation	74

Energy-efficient lighting systems

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Mini control systems	89
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Building system technology

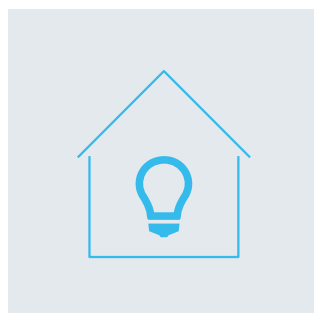
Learning solutions



Introduction to building system technology

The learning solutions teach a broad range of the basic knowledge required for the various technologies and requirements.

The training packages provide an introduction to the topic of electrical protective measures. They explain where and why dangers arise and how to avoid them. An additional training package covers the basic principles of electrical installation. Building system technology: learning solutions



Energy-efficient lighting systems

The lighting system of a building consumes significant amounts of energy. As a result, energy-efficient solutions are increasingly important in this area.

The training packages for this topic focus mainly on energy-efficient lighting technology, fluorescent lamps, high-intensity discharge lamps and high-power LEDs.



Building automation

Modern buildings are characterized by intelligent solutions, especially when it comes to lighting and air-conditioning. Building system technology and bus systems play an important role here.

With the aid of learning solutions based on KNX/EIB technology, the students will learn about the switching and dimming of light, light scene control systems, timer circuits, heating and air conditioning control systems, blind and shutter controllers, and much more.



Modular learning systems

Step by step to success

The digitization and networking of building control technology and the demand for reliable, energy-efficient and cross-system solutions present new challenges for teachers and students.

Different systems, such as for lighting, heating, renewable energy, blinds, alarm systems, etc., from different industries must communicate with each other and have to be operated by installers, technicians and users alike.



Building management systems

A complex control system is required for efficiently monitoring the climate of a building.

Our learning system provides the perfect foundations for teaching this knowledge and providing practical training using real-life components.

It covers components of the Direct Digital Control building automation system DDC-GA and provides an introduction to network architecture (BACnet MS/TP).

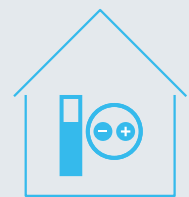


Renewable energy

These learning solutions provide practical experiments in the fields of photovoltaics and wind power, as well as grid supply and smart grid scenarios.

Several different training packages are available in order to cater to a variety of needs.

More information on this subject can be found in the Electric power technology section, which starts on → Page 118.



Electric vehicles

The increasing number of electric vehicles is presenting new challenges for building installations.

Our charging station for electric vehicle enables instructors to teach essential content such as planning and installing a charging station, including connection/commissioning, initial test/proof test and troubleshooting.

Fundamental electrical protective measures



Sensitizing people to dangers: the electrical protective measures

Protective measures protect people and the machine from harm.

Special rules must be followed when dealing with electrical energy, because electrical energy can be recognized only by its effects.

The three training packages provides an introduction to the topic of electrical protective measures. It explains where and why dangers arise and how to avoid them.

Fundamental electrical protective measures Edutrainee®

General functional explanation of protective measure, suitable for all professions and areas of activity.

Electrical protective measures for metalworking occupations, equipment set TP 1110

Training package developed especially for metalworking occupations, which addresses the typical sources of danger for this occupation.

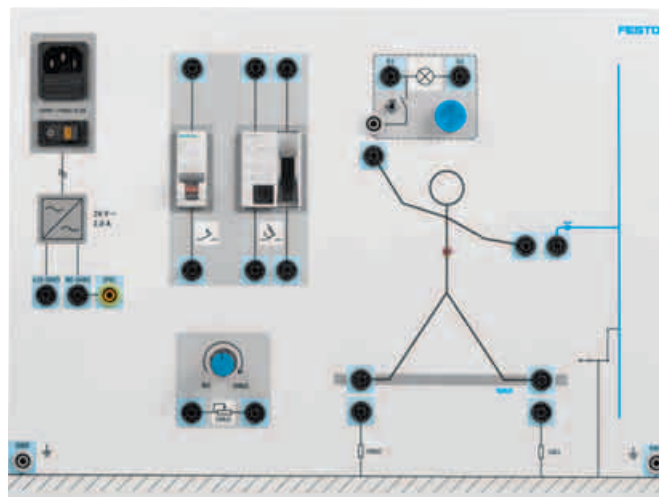
Power supply systems and protective measures, equipment set TP 1111

Training package for all occupations that require in-depth knowledge of protective measures and power supply systems

The numerous examples illustrate the particular issue of danger due to electrical energy and explain the necessary protective measures.

The exercises provide inspiration to examine the existing conditions and show the hazards resulting from a particular situation using concrete measurements.

The subsequent analysis and interpretation of the measurement results show the relationships and justify the protective measures taken.



A4 board for raising awareness and communicating the dangers of electric current. Hazards to human beings from electric current is in particular determined by the scale of the electric current that flows through the person. This device teaches the difference between circuit breakers for the protection of a system and residual current protection devices for the protection of persons.

Due to the built-in transformer, all training content is explained at a non-hazardous voltage level of 24 V. The scope of delivery includes the corresponding workbook.

Technical data

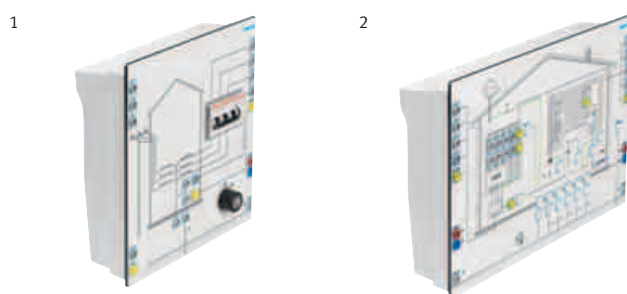
- Input voltage: 1 AC/240 V cold device connection
- Output voltage: 1 AC/24 V
- Line circuit breaker: 1 A
- Fault current protective circuit: 30 mA
- Fault simulation via potentiometer and fixed resistances
- Equipment: LED lamp with toggle switch for simulating housing faults
- Front panel: 266 mm 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

Electrical safety measures for metalworking occupations

Equipment set TP 1110



Complete Equipment set TP 1110

8023971

The most important components at a glance:

1	1x EduTrainer net board	571825
2	1x EduTrainer house installation	571826

Necessary accessories, also order:

4 mm safety laboratory cables → Page 149

Safety jumper plugs → Page 150

Installation tester for VDE 0100 → Page 154

Recommended training media, also order:

Electrical protective measures: eLearning course → Page 22

Also order:

Workbook

Protective measures for metal occupations

→ Page 38



Training content:

Mains 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 0100-610 and repeat tests acc. DIN VDE 0105 and BGV A3

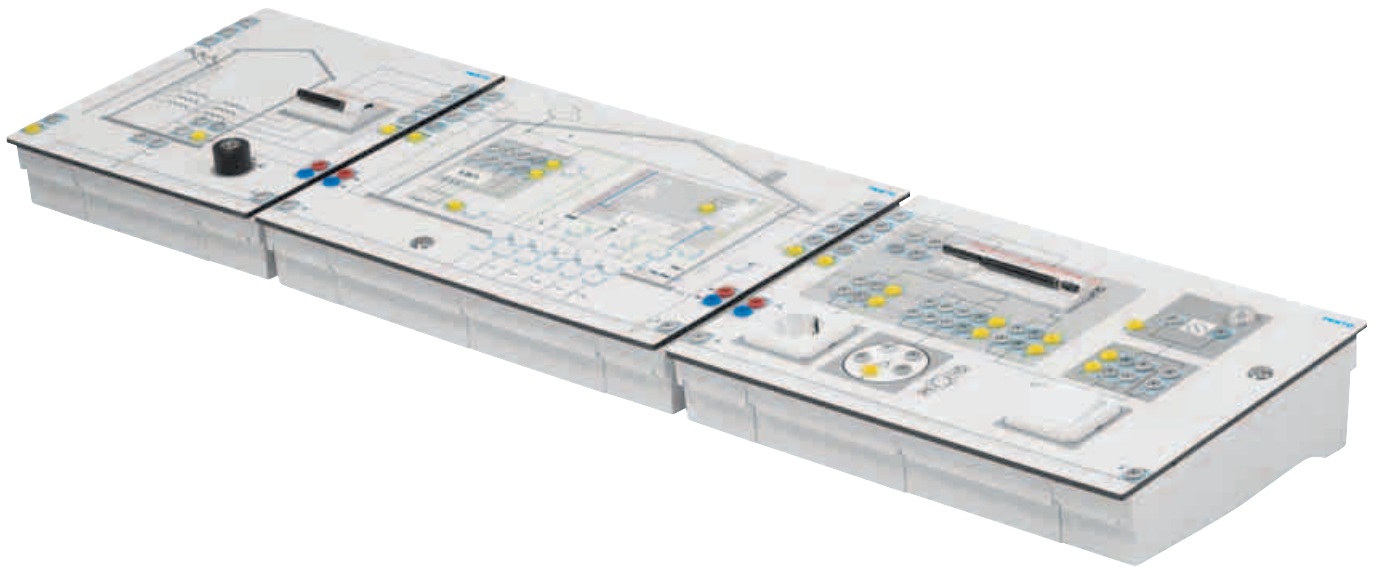
The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

Campus license (→ Page 35):

de	8023440
en	8023441
es	8023442
fr	8023443

Power supply systems and protective measures

Equipment set TP 1111



Fundamentals of electrical protective measures

Protecting people plays an important role when using electrical energy, as it is not visible and is recognisable only by its effects. Possible risks must therefore be minimised 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 0100-610 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

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 Systainer solution meets work, transport and storage requirements efficiently.

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 149

Safety jumper plugs → Page 150

Installation tester for VDE 0100 → Page 154

Possibilities of expansion:

Selective RCD EduTrainer → Page 72	574173
RCD A/B EduTrainer → Page 72	574174
IT network EduTrainer → Page 73	574178

Recommended training media, also order:

Electrical protective measures: eLearning course → Page 22

1



2



3



Also order:

Workbook

Power supply systems and protective measures → Page 38



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbook contains:

- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- 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 (→ Page 35):

de	567307
en	567309
es	567311
fr	567313

Recommended Tec2Screen® courses

→ Pages 28 – 30

Direct Current Technology

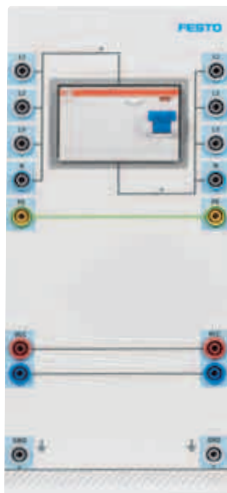
- Ohm's Law, Power, Work, Energy
- Resistors, Consumers
- Voltage sources, Adaptations
- Capacitors, Parameter-dependent resistors, Measuring

Alternating Current Technology

- Three-Phase Systems
- Characteristics
- Capacitors
- Coils
- RC-Elements
- Electric Power

Possibilities of expansion

for power supply systems and protective measures – TP 1111



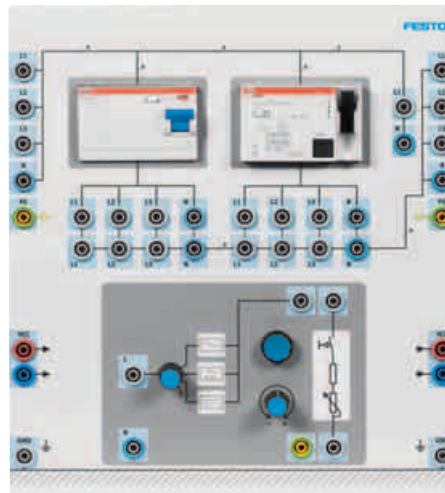
Selective RCD EduTrainer®

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



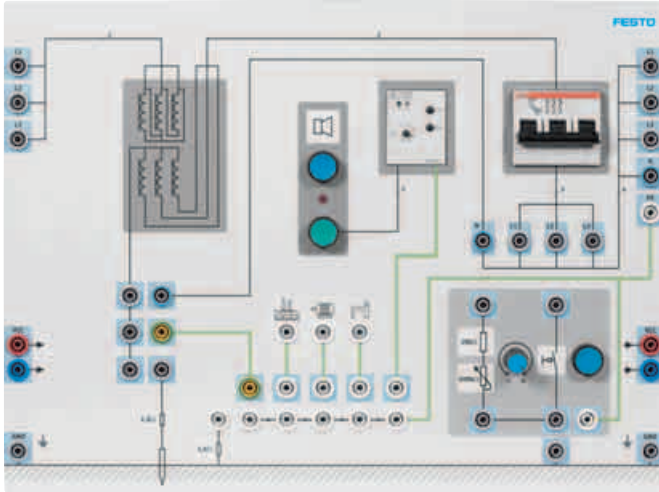
RCD A/B EduTrainer®

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



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 standardised and are laid out as safety sockets.

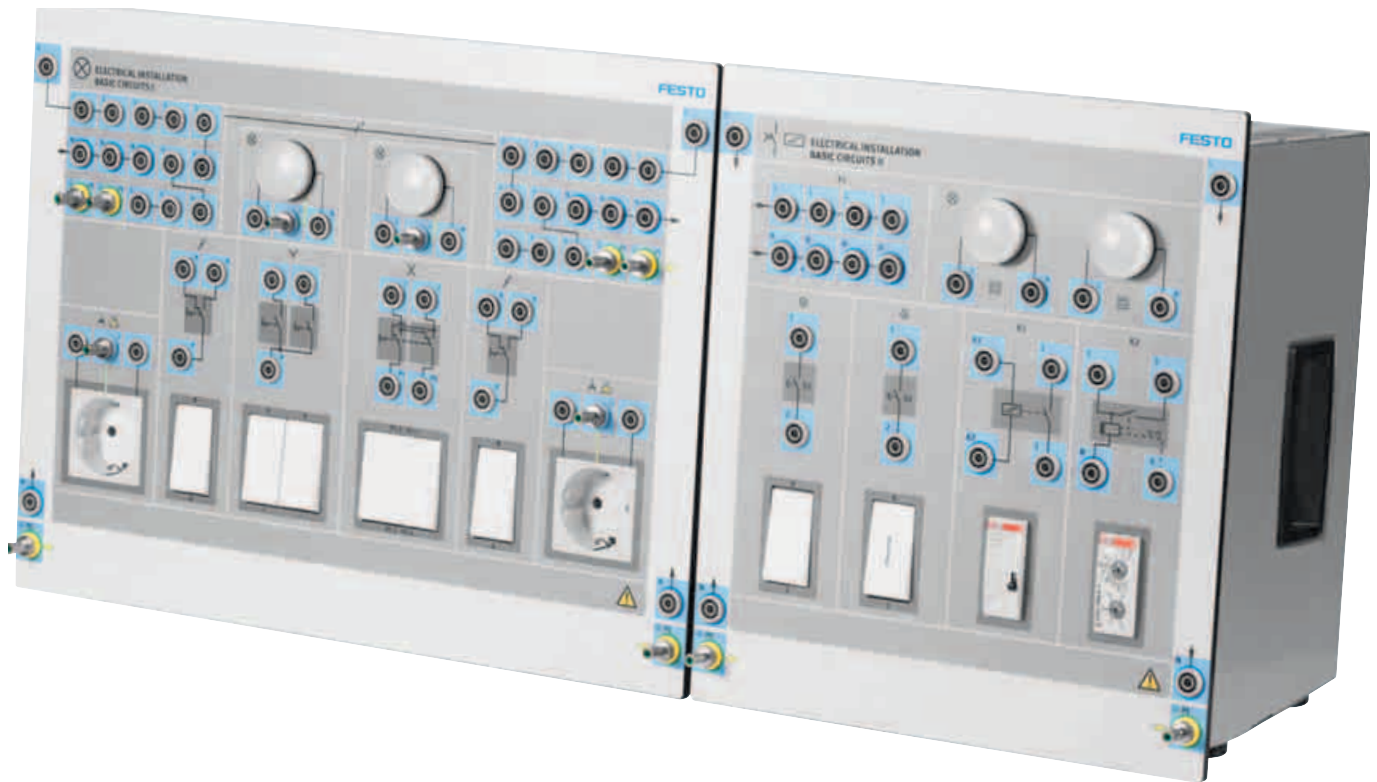
Technical data

- 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

Basic principles of electrical installation

Equipment set TP 1121

New



Basic principles of electrical installation

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

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 149

Safety jumper plugs → Page 150

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

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

1



2



Also order:

Workbook

Basic principles of electrical installation
→ Page 39



The workbook contains:

- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- 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 (→ Page 35):

en

8113396

The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

Energy-efficient lighting engineering

Equipment set TP 1141

New



Light can be produced in a variety of efficient ways

The equipment set provides an introduction to lighting engineering. Particularly the mode of operation of the lamps and the light they produce as well as their comparison, industrial energy efficiency and consumption costs and/or amortization of the acquisition can be considered.

The dimming of lamps with conventional and electronic dimmers is also possible.

An 8-piece cable set for 2 mm connections and measurements is included with the equipment set.

Training content

- Method of operation of lamps
- Industrial energy efficiency of lamps
- Light and light temperature
- Dimming properties
- 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 1141	8106863
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The most important components at a glance:

1 1x Room lighting EduTrainer	8064061
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Necessary accessories, also order:

4 mm safety laboratory cables → Page 149	
--	--

Safety jumper plugs → Page 150	
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Light meter	8064082
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Color card set	8087222
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1



Also order:

Workbook

Energy-efficient
lighting engineering
→ Page 39



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbook contains:

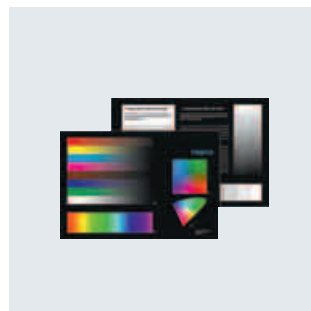
- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- Worksheets for learners

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 (→ Page 35):

en	8113398
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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

Order no.	8087222
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Light meter

The device is used to record technical light quantities during experiments on lighting technology.

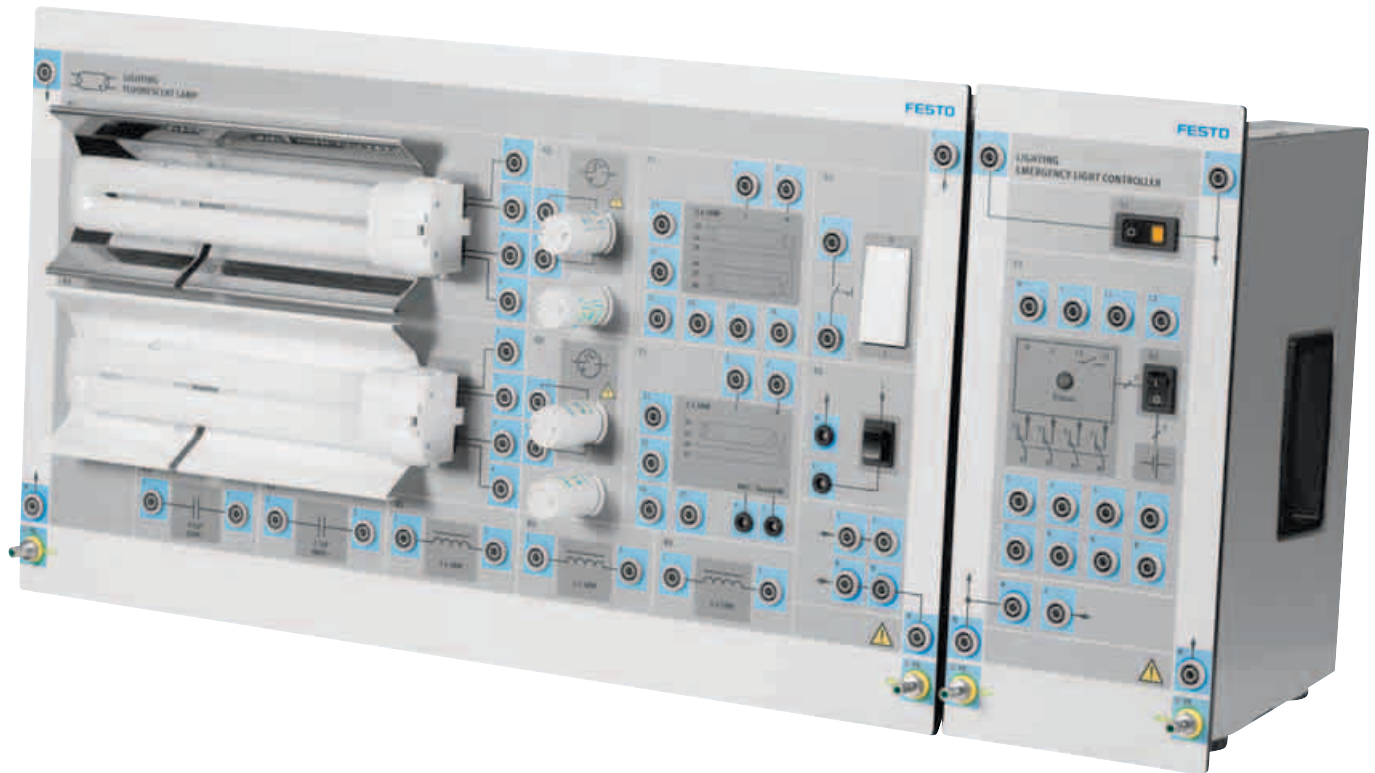
- Compact handheld measuring device
- Easy to use
- Various measurements of photometric parameters

Order no.	8064082
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Fluorescent lamps

Equipment set TP 1142

New



Fluorescent lamps are used for a variety of purposes and are wired differently

The equipment set provides an introduction into fluorescent lamp circuits and emergency light modules. The setup of extremely diverse circuits with one or two fluorescent lamps using conventional wiring or electronic ballasts as well as technical light and energy investigations is possible.

As a special feature, circuits with an emergency light module can also be set up and investigated.

An 8-piece cable set for 2 mm connections and measurements is included with the equipment set.

Training content

- Mode of operation of fluorescent lamps
- Function of the components
- Circuits with fluorescent lamps
- Emergency light
- Taught using practical project exercises

Advantages

- Complete function range
- Easy, fast and reliable setup
- Work book with theoretical part and project tasks

Emergency light module EduTrainer®

The emergency light module can be used to study the emergency lighting scenarios in the event of a power failure. The integrated rechargeable battery allows a fluorescent lamp to be operated autonomously. The power failure can be simulated on the module. The charge check is used for conditioning.

Fluorescent lamps EduTrainer®

The module can be used to set up a wide range of different circuits. In addition to conventional circuits for one fluorescent lamp, tandem and duo circuits can also be made by using both lamps. Electronic ballasts are also provided. The range of functions is topped off by a variety of reflectors.

Complete equipment set TP 1142	8106864
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The most important components at a glance:

1	1x Emergency light module EduTrainer	8064073
2	1x Fluorescent lamps EduTrainer	8064063

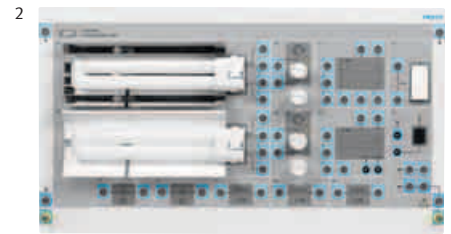
Necessary accessories, also order:

4 mm safety laboratory cables → Page 149

Safety jumper plugs → Page 150

Recommended accessories, also order:

Light meter	8064082
Color card set	8087222



Product features emergency light module EduTrainer®

- Emergency light module
- Power failure simulation
- Charge check

Product features Fluorescent lamps EduTrainer®

- 2x Fluorescent lamps
- 2x Different reflectors
- 1x Electronic ballast with DALI interface
- 1x Duo electronic ballast
- 1x Switches
- 1x Pushbutton
- 2x Capacitors
- 3x Chokes
- 4x Starters

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

Also order:

Workbook

Fluorescent lamps
→ Page 39



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbook contains:

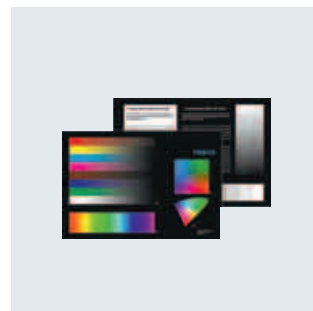
- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- Worksheets for learners

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 (→ Page 35):

en	8113400
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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

Order no. 8087222



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

Order no. 8064082

High-pressure discharge lamps

Equipment set TP 1143

New



Mainly used for street and industrial lighting as well as floodlighting systems

The high-pressure discharge lamps equipment set allows an introduction to sodium vapor lamps and metal halide lamps. It is possible to connect the lamps with electronic ballasts 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

- Types of high-pressure discharge lamps
- Industrial energy efficiency of high-pressure discharge lamps
- Circuitry of high-pressure discharge lamps
- Application areas of high-pressure discharge lamps
- 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 1143**8106865**

The most important components at a glance:

1	1x Metal halide lamp EduTrainer	8064065
2	1x Sodium vapor lamp EduTrainer	8064067

Necessary accessories, also order:

4 mm safety laboratory cables → Page 149

Safety jumper plugs → Page 150

Light meter	8064082
Color card set	8087222

1



2

**Product features**

- 1x Metal halide lamp
- 1x Sodium vapour lamp
- 1x Ballast with DALI interface
- 1x Switches
- 1x Pushbutton
- 1x Temperature sensor

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

Also order:

WorkbookHigh-pressure discharge lamps
→ Page 39

The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

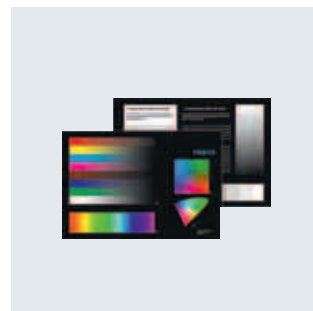
The workbook contains:

- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- 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 (→ Page 35):

en 8111397**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

Order no. 8087222

**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

Order no. 8064082

High-power LEDs

Equipment set TP 1144

New



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
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1



The most important components at a glance:

1 1x High-power LED EduTrainer	8064069
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Necessary accessories, also order:

4 mm safety laboratory cables → Page 149	
Safety jumper plugs → Page 150	
Light meter	8064082
Color card set	8087222

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

Also order:

Workbook

High-power LEDs
→ Page 40



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbook contains:

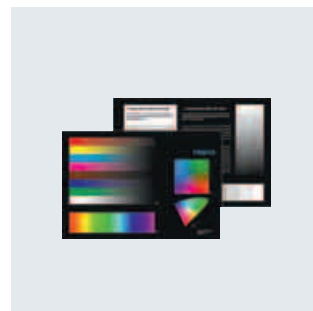
- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics
- Worksheets for learners

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 (→ Page 35):

en	8111399
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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

Order no.	8087222
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Light meter

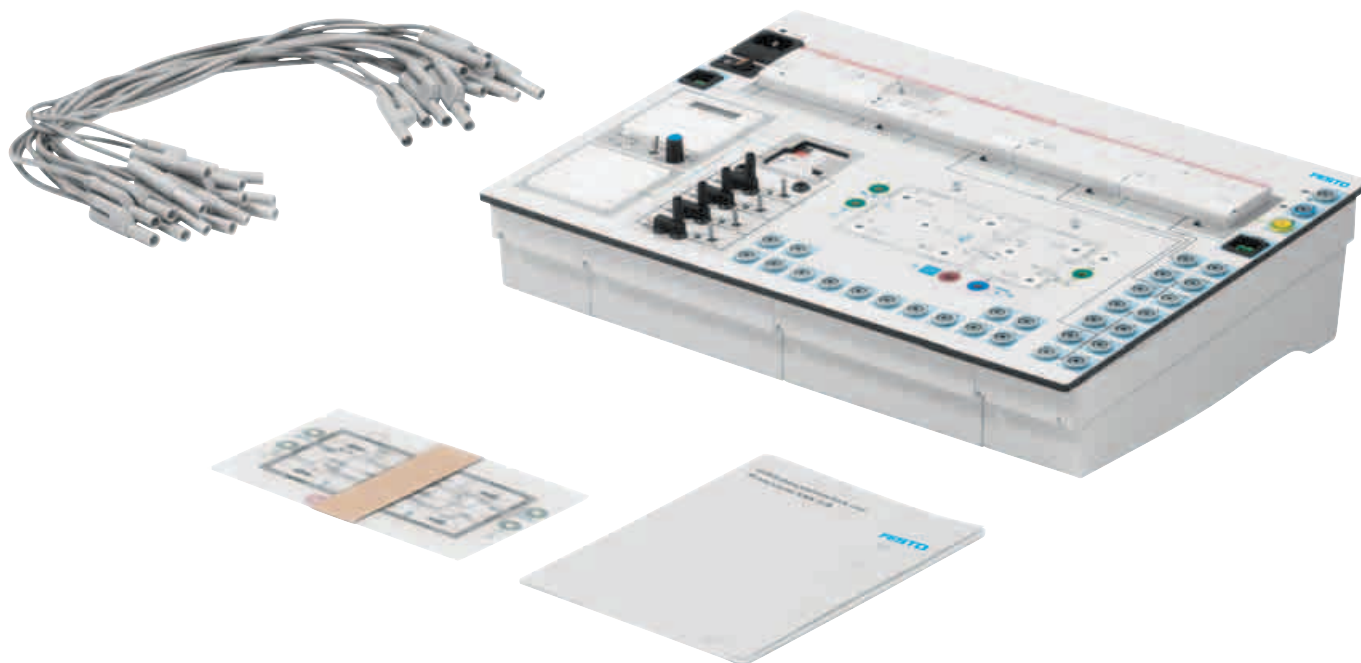
The device is used to record technical light quantities during experiments on lighting technology.

- Compact handheld measuring device
- Easy to use
- Various measurements of photometric parameters

Order no.	8064082
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KNX/EIB compact board

Equipment set TP 1131



Intelligent solutions

Modern buildings are characterised by intelligent lighting and air-conditioning solutions. Building automation systems and bus systems play a key role here.

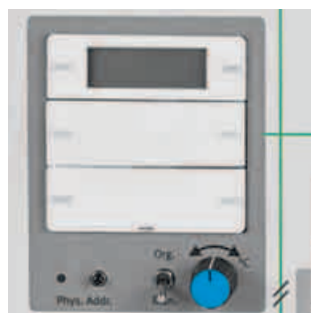
The KNX/EIB compact board Edu-Trainer® is used to explain use of this technology. Equipped with the latest generation of industrial components, it delivers state-of-the-art technology.

When selecting the devices used, efforts were made to ensure that the widest possible range of levels of complexity can be realised. Beginners are therefore not overwhelmed and can use the full range of functions to meet increasing requirements.

The optionally available Systainer solution meets work, transport and storage requirements efficiently, thus reducing the amount of work required before and after lessons.

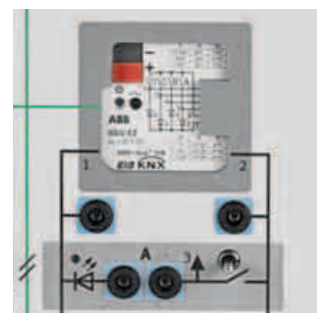
Training content

- KNX/EIB system fundamentals
- Using the system software ETS4
- Switching and dimming the light
- Two-way circuits
- Interval timers
- Staircase lighting timers
- Light scene control systems
- Different floor plans
- Heating and climate control
- Louvre and blind control systems
- Logic operation of signals



Functional

The pushbutton sensor elements can be used either as rockers or as independent buttons, the actual value of the integrated temperature controller can be specified and further processed using an external potentiometer.



Universal

The channels of the 4-fold universal interface can be parameterised as both binary input and outputs. This means, for example, that the LEDs can be used to indicate a wide variety of states or solid state relays can be controlled for electrothermal heating valve drives.

Complete equipment set TP 1131

571867

Scope of delivery

- KNX/EIB compact board
- Overlay masks
- 14 laboratory safety cables

Necessary accessories, also order:

1 KNX cable set	8023965
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Possibilities of expansion:

KNX EduTrainer heating actuator	574175
KNX EduTrainer line connector	574176
KNX EduTrainer louvre	574177
KNX EduTrainer universal experimental board	8023966
KNX IP/Wi-Fi function package	8111317
KNX logic/time function package	8023968
KNX room climate function package	8023969
KNX energy function package	8023970

Technical data

- Input voltage: 1 AC/230 V AC (50 Hz), short circuit and overload protection
- Phase display
- Output for the connection of additional KNX/EIB EduTrainer® modules
- Output voltage: 1 AC/230 V AC
- Integrated power supply unit 30 V DC 0.16 A
- USB interface
- 4/4-fold switching output/binary input
- 2-fold louvre actuator
- 2-fold dimming actuator
- 4-fold universal binary I/O
- 4-fold multi-function pushbutton sensor with 8 pushbuttons
- 2-fold multi-function pushbutton sensor with 4 pushbuttons, room temperature controller including setpoint and actual value input and display
- Integrated simulation panel with 14 colour LEDs, some dimmable
- KNX system connector for bus connection
- Connection via 4 mm and 2 mm safety connectors
- Front plate: 399 mm x 297 mm
- Control console housing with rubber feet for use in A4 frame or on tabletop

Also order:

Workbook

Building automation with KNX

→ Page 40



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

Particular emphasis is placed on independent execution, evaluation and documentation by the student.

Worksheets support the students through the required stages of introduction, planning and execution of exercises up to the evaluation of results and documentation.

The workbook contains:

- Sample solutions
- Educational instructions
- Multimedia CD-ROM with graphics-Worksheets for learners

Campus license (→ Page 35):

de	8023444
en	8023445
es	8023446

Recommended training media, also order:

KNX Manual on house and building systems technology

de	576265
en	576269

KNX Basic course documentation

de	576266
en	576270

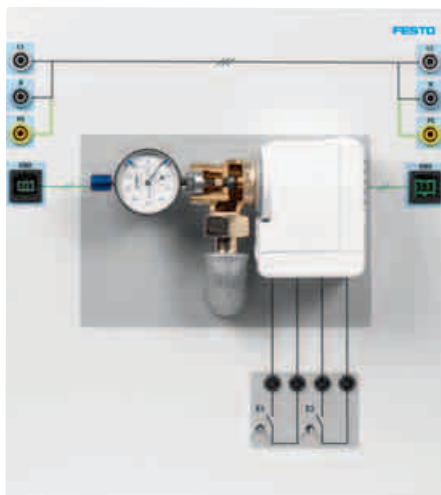
KNX Advanced course documentation

de	576267
en	576271

KNX Training documentation

de	576268
en	576272

Expansions for KNX/EIB compact board – TP 1131



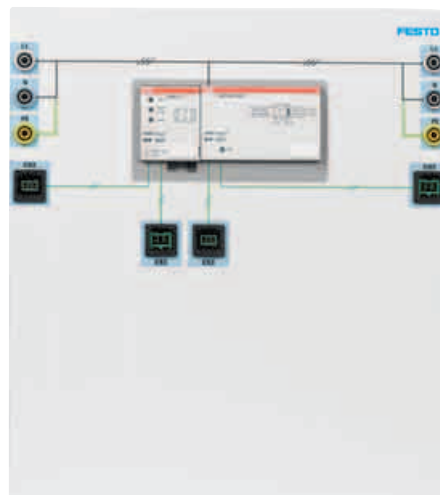
KNX EduTrainer® heating actuator

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



KNX EduTrainer® line connector

The line connector 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



KNX EduTrainer® louvre

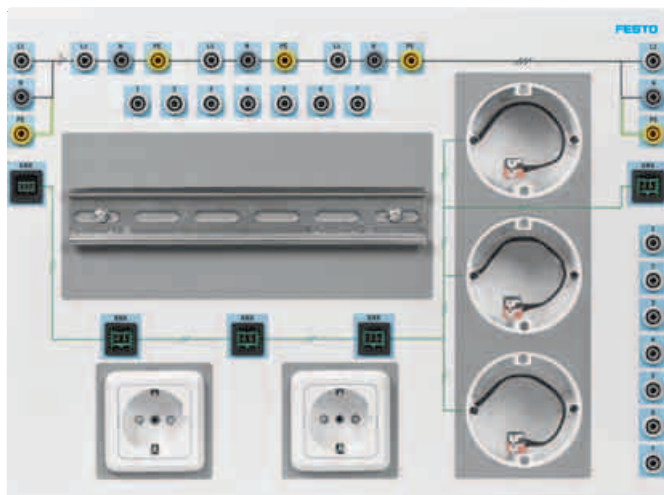
The louvre is used to emulate situations in building automation. For this purpose, the louvre can be raised or lowered and the slat position can be influenced. The connections for controlling “UP” and “DOWN” are routed to 4 mm safety sockets. The plate also contains the KNX system distributor for 230 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
- Louvre: Length 440 mm, stroke 160 mm
- Power consumption: 100 W, current max. 0.45 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
- Through-feed for KNX bus via compact KNX bus plug connectors
- Connection option for the louvre control to the KNX compact board via jumper plugs

KNX universal experimental board



The universal experimental board serves to integrate KNX bus devices of all kinds into the KNX learning system.

It makes it possible to integrate rail mounted devices and surface-mounted and flush-mounted devices. Both an operating voltage supply and bus connections are available for electrical connection of the equipment. The outputs are routed to positions suitable for the system. Two sockets make it possible to supply external equipment with voltage. In addition, the panel contains the KNX system distribution for 230 V.

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

Technical data

- Input voltage: 230 V AC
- Output voltage: 230 V AC
- 2 plug socket outlets for 230 V AC
- 7 output connections
- 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
- Connections for KNX bus via KNX bus plug connectors

Theme-based KNX function packages:

KNX IP/Wi-Fi function package

- KNX IP-Router
- WLAN Access Point

KNX logic/time function package

- Logic module

KNX room climate function package

- Air quality sensor

KNX energy function package

- Energy actuator

Each function package consists of the KNX component and the necessary accessories.



KNX room climate function package

The KNX Air Quality Sensor is a combined sensor for CO₂, temperature and humidity measurement (relative humidity). Three independent thresholds can be set for the CO₂ concentration and the relative humidity in addition to a threshold for the temperature.

The communication object Ventilation can be used for speed control or as a position indicator for ventilation flaps. The connection to the KNX is established using the bus connection terminals on the interior of the device.

Order no. **8023969**

KNX logic/time function package

The device contains logical function with the possibility of individual parameter parameterisation.

Function selection:

- Logic gates
- Gate
- Timer
- Multiplier
- Temperature comparison function
- Switch value
- Threshold sensing
- Format converter
- Scenes
- Counter
- Stairwell lighting

Order no. **8023968**

KNX IP/Wi-Fi function package

KNX IP router and WLAN access point for extending the KNX compact board.

Insert on the KNX Universal Experimental Board forms the interface between KNX systems and IP networks and thus permits data exchange.

Product features

- IP router and access point
- Auxiliary power supply
- Connecting cables

Order no. **8111317**

KNX energy function package

The device records the energy consumption of the connected consumers in the end power circuit. A range of electronic variables are monitored, and peak loads are limited by a simple load control device.

The energy actuator can switch resistive, inductive and capacitive loads.

In addition to this, the ETS application also provides simple load management functionality, which allows the user to interconnect up to ten energy actuators. The electrical consumers at the three potential-free switching outputs are switched manually via KNX or the device itself.

Order no. **8023970**

Order no. **8023966**

Themed function packages:

KNX IP/Wi-Fi function package	8111317
KNX logic/time function package	8023968
KNX room climate function package	8023969
KNX energy function package	8023970

EduTrainer® for mini control systems

For a basic introduction to control and monitoring tasks

Basic trainer for mini control systems

Mini control systems are becoming increasingly common in industry and trade. They are used for numerous small control and monitoring tasks for which a PLC would be oversized. Mini control systems or programmable control relays control and operate conveyors, monitor doors and gates, control heating, and so on.

For training purposes, they represent the link between classic safety circuits and programmable logic controllers. Functions can be implemented quickly and easily based on the learned ladder diagram or function chart methodology using simple programming software.

Mini control systems are characterized by the large number of features that they provide. They are easy to program and to connect, are flexible and low-cost, and are therefore indispensable in basic training.

Another advantage of these small and compact devices, which are suitable for mounting in 35 mm H-rails, is that they implement many functions in a single device.

Mini control systems include:

- Controllers
- Indicators
- Diagnostic tools
- Text displays with operating buttons
- Interfaces to fieldbus systems
- Web servers
- and many more

Numerous extension modules expand the possible functions.

The **EduTrainer® for mini control systems** provides a broad basic platform for your project work. The board is designed to hold mini control systems and expansion modules, for example the Siemens LOGO! 8, the EATON Easy family or a Controllino.

Up to 12 inputs can be picked off on 4 mm safety sockets. Four of these inputs can also be connected directly on the device using a pushbutton/latched switch. Up to 8 relay outputs can be changed to digital outputs using a toggle switch. Up to 2 analog outputs can also be connected to 4 mm safety sockets.

The device also includes two controllable analog encoders, which can be used to bridge voltages from 0 to 10 V at two inputs. An RJ45 Ethernet socket can connect the controller to the programming unit or network switch.

Please request a quotation for your individual requirements.



EduTrainer® Universal preferred versions laboratory

A4/A4 rack with SIMATIC S7-1500 and 19" simulation modules

1



1 S7-1512C-1PN	8065595
2 S7-1516-3PN/DP	8042524
3 S7-1516F-3PN/DP	8034574

Notes

Order no. 8065595, 8042524 and 8034574 are based on Siemens SCE Trainer Packages and each one contains one EduTrainer® including programming cable (Ethernet cable) and programming software STEP 7 TIA portal. When Siemens updates these Trainer Packages, the controllers are replaced by successor models. Subject to technical implementation.

Recommended accessories:

I/O data cable with SysLink connectors (IEEE 488), 2.5 m	34031
Analog cable, parallel, 2 m	529141
Safety laboratory cable, 3 m	571817
IEC power cable 90° → Page 148	

Other accessories:

Analog cable, crossover, 2 m	533039
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2



3



The ultimate in power and efficiency

The SIMATIC S7-1500 controller family represents the 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.

EduTrainer® Universal with:

CPU S7-1512C-1PN

- Main memory: 250 KB for program and 1 MB for data
- Memory card included
- Interface: PROFINET IRT with 2-port switch
- Inputs/outputs:
 - 32 digital inputs (24 V DC)
 - 32 digital outputs (24 V DC/0.5A)
 - 5x Analog inputs, 4x U/I, 1x R/RTD, 16-bit resolution
 - 2x Analog outputs, 2x U/I, 16-bit resolution

CPU S7-1516-3PN/DP

- Main memory: 1 MB for program and 5 MB for data
- Memory card included
- Interface 1: PROFINET IRT with 2-port switch
- Interface 2: Ethernet
- Interface 3: PROFIBUS, 10 ns bit performance
- Inputs/outputs:
 - 32 digital inputs (24 V DC)
 - 32 digital outputs (24 V DC/0.5A)
 - 8x Analog inputs, 8x U/I/RTD/TC, 16-bit resolution
 - 4x Analog outputs, 4x U/I, 16-bit resolution

CPU S7-1516F-3PN/DP

- Main memory: 1.5 MB for program and 5 MB for data
- Memory card included
- Interface 1: PROFINET IRT with 2 port switch
- Interface 2: Ethernet
- Interface 3: PROFIBUS, 10 ns bit performance
- Inputs/outputs:
 - 32 digital inputs (24 V DC)
 - 32 digital outputs (24 V DC/0.5 A)
 - 8x Analog inputs, 8x U/I/RTD/TC, 16-bit resolution
 - 4x Analog outputs, 4x U/I, 16-bit resolution

The mounting system

- EduTrainer® Universal, size 1 (W x H) 305 x 300 mm
- Can be placed on a desk or in an MPS station
- Stable, powder-coated, sheet-steel mounting system
- Integrated power supply unit, AC 110/230 V/DC 24 V, 4 A
- 19" module 16DIN (12 HP), 16 digital inputs on 4 mm safety sockets and 16 switches/push buttons for signal simulation
- 19" module 16DOU (12 HP), 16 digital outputs on 4 mm safety sockets
- 19" module 4AIN/2AOUT (12 HP), analog processing 4 analog inputs on 4 mm safety sockets can be switched to simulation via potentiometer and 2 analog outputs on 4 mm safety sockets
- 19" module 24 V/0 V (9 HP), 8 x 4 mm safety sockets, red for 24 V distribution, 8 x 4 mm safety sockets, blue for 0 V distribution
- 19" module simulation plate with 2x SysLink plug connector for MPS station and control panel, each with 8 digital inputs and 8 digital outputs and 1x Sub-D 15-pin plug connector with 4 analog inputs and 2 analog outputs; emergency stop jumper to connect a safety circuit for disconnecting 8 digital outputs.

Special license rules apply for schools and educational institutes in the commercial sector.

EduTrainer® Universal preferred versions MPS

A4 rack with SIMATIC S7-1500

The ultimate in power and efficiency

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.

EduTrainer® Universal with:

CPU S7-1512C-1PN (MPS)

- Main memory: 250 KB for programs and 1 MB for data
- Memory card included
- Interface: PROFINET IRT with 2-port switch

Inputs/outputs:

- 32 digital inputs (24 V DC)
- 32 digital outputs (24 V DC/0.5A)
- 5x Analog inputs, 4x U/I, 1x R/RTD, 16-bit resolution
- 2x Analog outputs, 2x U/I, 16-bit resolution

CPU S7-1516-3PN/DP (MPS)

- Main memory: 1 MB for program and 5 MB for data
- Memory card included
- Interface 1: PROFINET IRT with 2-port switch
- Interface 2: Ethernet
- Interface 3: PROFIBUS, 10 ns bit performance

Inputs/outputs:

- 32 digital inputs (24 V DC)
- 32 digital outputs (24 V DC/0.5A)
- 8x Analog inputs, 8x U/I/RTD/TC, 16-bit resolution
- 4x Analog outputs, 4x U/I, 16-bit resolution

The mounting system

- EduTrainer® Universal, size 1 (W x H) 305 mm x 300 mm
- Can be placed on a desk or in an MPS station
- Stable, powder-coated, sheet-steel mounting system
- Integrated power supply unit, AC 110/230 V/DC 24 V, 4 A
- 19" module simulation plate with 2x SysLink plug connector for MPS station and control panel, each with 8 digital inputs and 8 digital outputs and 1x Sub-D 15-pin plug connection with 4 analog inputs and 2 analog outputs; emergency stop jumper to connect a safety circuit for disconnecting 8 digital outputs.

1



1 S7-1512C-1PN (MPS)	8065452
2 S7-1516-3PN/DP (MPS)	8065594

Notes

Order no. 8065452 and 8065594 are based on Siemens SCE Trainer Packages and each one contains one EduTrainer® including programming cable (Ethernet cable) and programming software STEP 7 TIA portal. When Siemens updates these Trainer Packages, the controllers are replaced by successor models. Subject to technical implementation.

Recommended accessories:

I/O data cable with SysLink connectors (IEEE 488), 2.5 m	34031
Analog cable, parallel, 2 m	529141
Safety laboratory cable, 3 m	571817
IEC power cable 90° → Page 148	

Other accessories:

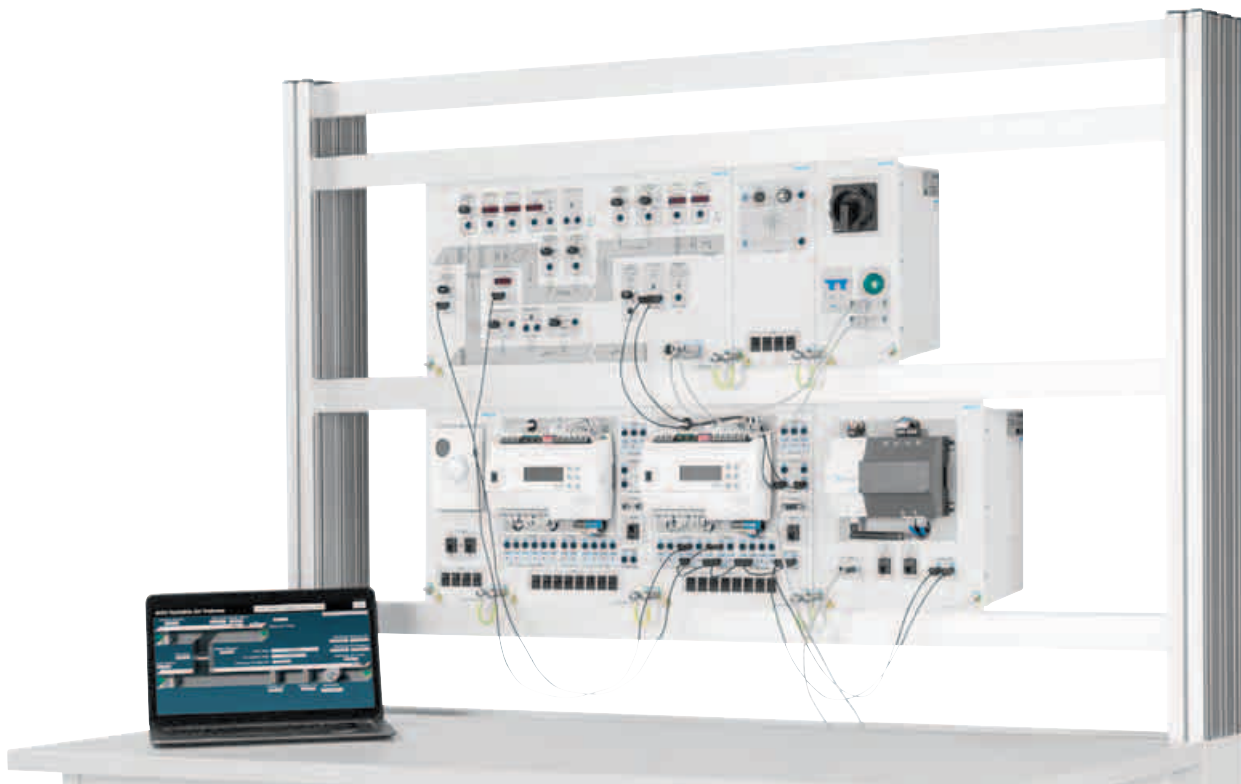
Analog cable, crossover, 2 m	533039
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2



Special license rules apply for schools and educational institutes in the commercial sector.

Building HVAC controls



[X]

Building management systems in the digital age

Most modern commercial buildings have heating, ventilation and air conditioning (HVAC) systems that are controlled automatically. HVAC control systems control the temperature, airflow, humidity and carbon-dioxide content of rooms based on the temperatures inside and outside of the building in question. This keeps the climate in the rooms pleasant and the power consumption low.

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)

Complete equipment set 594538

The most important components at a glance:

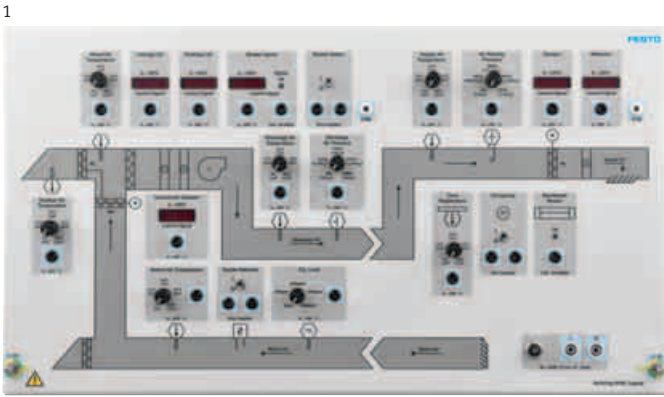
1	Building HVAC layout	594518
2	Supervisory controller	594519
3	2x Programmable controller	594516
4	Temperature network sensor	594517
5	Control transformer	594515
	Programmable controller software	588274
	Test lead kit	594520

Necessary accessories, also order:

1x	Mobile Frameline, complete model without energy duct*	8075133
1x	Frameline mobile table*	8087149

* Or equivalent

Also required:
PC with DVD drive running on Windows



Also order:

Workbook
Building HVAC Controls (BACnet)
→ Page 40



The workbook contains:
– Exercises and 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.

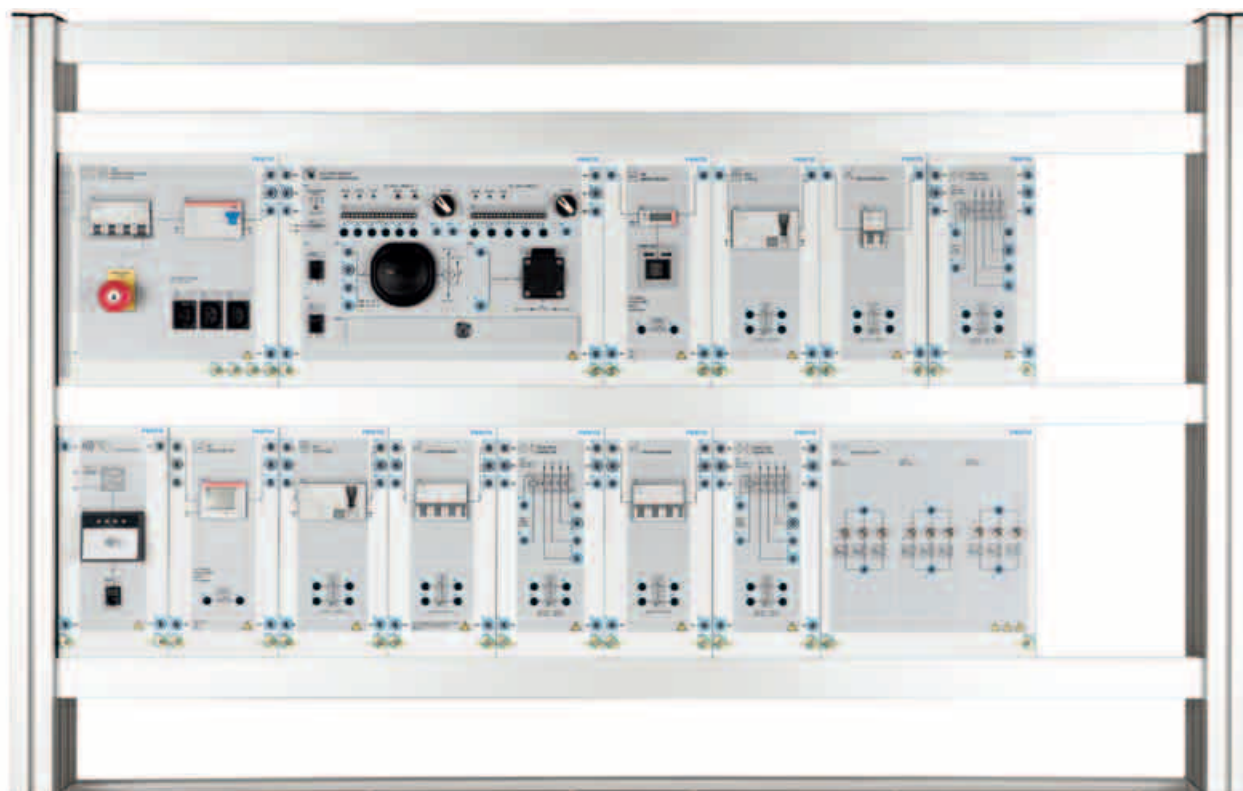
Campus license (→ Page 35):

de	793120
en	793119
es	793122

The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

Electric vehicle charging station

Equipment set TP 8014



Learn everything about charging stations for electric vehicles

Like all permanently-wired electrical installations, charging stations are required to meet stringent regulations to ensure proper operation and user safety. There is, therefore, a growing need for competent, well-trained personnel to install, commission, and service charging stations.

The Electric Vehicle Charging Station of Festo Didactic is designed for hands-on training in the planning, installation, testing, and troubleshooting of a modern charging station. The flexible, modular design enables easy set-up of various charging station configurations, ranging from a simple, single-phase station to more advanced, multi-phase stations that can simultaneously charge two users.

The advanced stations include electrically commuted power circuits that automatically adapt to the capacity of the detected charging cable. Among further options for advanced stations are energy meters to measure consumption during a charge, and RFID-based user identification and charge control.

The modules that make up the system are designed to be mounted in a standard A4 workstation. Each module has front-panel connections for power and for sensing/control signals. In addition, commercially-available protective devices, such as circuit breakers and residual current devices, are included as system modules.

Features

- Covers two independent charging points in accordance with VDE 0100-722
- Modular design allows the combination of packages
- Flexible packages for specific training and budget needs
- Designed for A4 mounting frames
- New and safer inter-module grounding methods
- Possibility to link with commercial devices
- Hidden faults to develop troubleshooting skills
- Includes commercial energy meters, RFID reader, EV charge controller and EV simulator/tester

Training content

Students will follow the scope of the training curriculum from an initial understanding of electric vehicles, batteries, and charging stations to installing, operating, and commissioning such a charging station.

The following topics will be covered:

- Types of vehicles and the charging cycle
- Electric vehicle charging modes
- Electrical hazards and protective measures
- Communication with the EV
- Single and three-phase installations (IEC 62196-2 Type 2)
- Common Components
- Safety interlocks
- RFID for user identification
- Adapting an existing installation
- Energy management
- Commissioning and testing
- Troubleshooting and analysis

Complete equipment set TP 8014	8108234
--------------------------------	----------------

The most important components at a glance:

1	1x Electric Vehicle Charge Controller	594525
2	1x 3 AC RCD Type B	594528
3	1x 1 AC RCD Type B	594530
4	1x 1 AC 16 A Circuit Breaker	594531
5	1x 3 AC 16 A Circuit Breaker	594529
	1x 3 AC 32 A Circuit Breaker	594903
6	3x Four-Pole Contactor	594527

Note

The equipment set covers single and three-phase installations. If you require only one of these configurations, consult your sales representative for a down-scaled equipment set.

Necessary accessories, also order:

1x	Connection Lead Set and Grounding Kit	594536
1x	Pocket Oscilloscope*	594535
1x	EV Simulator/Tester	8097073
1x	Mobile Frameline, complete model without energy duct**	8075133
1x	Frameline mobile table***	8087149
1x	3 AC Power Supply and Safety Unit****	594826

* The Pocket Oscilloscope can be replaced by a conventional oscilloscope.

** Or equivalent; a standard A4 workstation is required to hold the modules.

*** Or equivalent table.

**** Highly recommended accessory if your lab does not provide the suitable infrastructure. For safety regulations, the workstation shall be equipped with a safety unit with an emergency shutoff and a RCD to provide three-phase power to the system. Other units or energy panels could be used.

Optional accessories:

1x	Installation tester	8064024
1x	1 AC Energy Meter	594904
1x	3 AC Energy Meter	594532
1x	RFID Reader	594526
1x	Resistive Load*	594820
1x	Charging Station (Type 2)	8110638

* Can be used in conjunction with Festo energy counters to simulate a load.

Also order:

Workbook

Electric Vehicle Charging Stations

→ Page 40



The exercises in the workbook contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbook contains:

- Exercises and sample solutions
- Didactic recommendations
- Multimedia CD-ROM with graphics
- Worksheets for learners

The exercises in the workbooks contain the theory and lab activities that cover the above training content.

Campus license (→ Page 35):

de	8096874
en	8096870
fr	On request
es	On request

The Campus License includes teaching material for the TP 8014 Electric Vehicle Charging Station on both hard copy and CD-ROM. This also includes the reproduction rights for commercial and educational organizations.

1



2



3



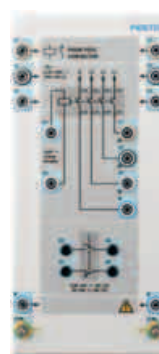
4



5



6



Electrical drive technology training packages

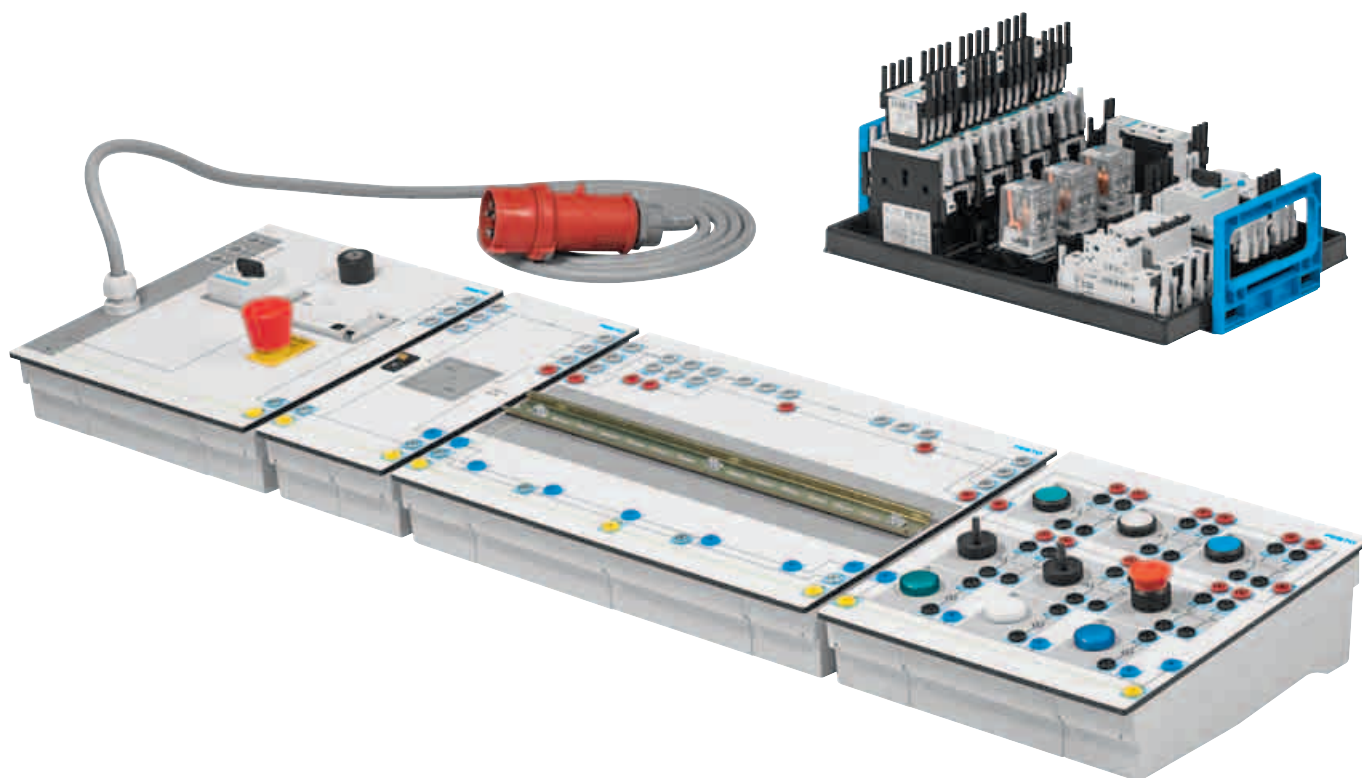




Equipment sets	
Basic principles	98
Servo brake and drive system	100
Servo motor drive technology	110
Stepper motor drive technology	112
Accessories	114

Basic principles of circuits with contacts

Equipment set TP 1211



Basic principles 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 safety 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
- Messages
- 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

- The three-phase AC supply guarantees the electrical safety of the workplace
- Extremely compact equipment
- Flexible thanks to the use of industrial components
- Easily expandable
- Jumper plugs for connecting the boards improve clarity
- Maximum effectiveness in combination with MPS transfer line or electric machines
- Stable angled screw-in sockets for contacting

The optional Systainer solution combines work, transport and storage requirements perfectly, thus reducing the amount of work required before and after lessons

Complete equipment set TP 1211**571811**

The most important components at a glance:

1	1x EduTrainer three-phase current supply	571812
2	1x EduTrainer 24 V power supply unit	571813
3	1x EduTrainer contactor board	571814
4	1x Motor technology contactor set	571816
5	1x EduTrainer operator and signalling unit	571815

Recommended accessories, also order:

4 mm Safety laboratory cables, 106 pieces, red, blue, and black	8092668
4 mm Safety laboratory cables, 58 pieces, brown, black, grey, blue with grey plugs	8092669
Safety jumper plugs → 150	
Electric machines → Page 102	
Amprobe rotary field and motor direction-of-rotation indicator PRM-6-EUR	8081205
MPS Transfer System → www.festo-didactic.com	

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

1



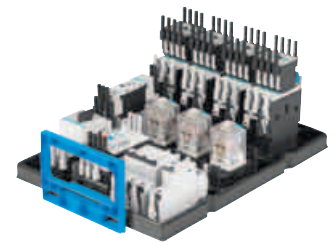
2



3



4



5



Also order:

Workbook

Fundamentals of circuits
with contacts
→ Page 41



The workbook contains:

- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

The worksheets help students from
the planning phase to execution and
documentation.

Each student must carry out, evalu-
ate and document the project on
their own as required in each exer-
cise.

Campus licence (→ Page 35):

de	570901
en	567315
es	567317
fr	567319

The exercises contain concrete, real-
istic projects with problem descrip-
tions, parameters and project tasks.

Servo brake and drive system

Equipment set TP 1410



Electric drive technology

Modern drives are characterised by the bringing together of electrical and mechanical components to create complete systems.

With rotating electric machines in particular, the basic principles of the individual components along with the system approach and practicality play a crucial role.

Enclosed in a compact housing, this equipment set incorporates a complete, flexible and convenient load and drive system, which is used to analyse 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

Scope of delivery

- Servo brake and drive system
- Transparent shaft cover
- Coupling sleeve
- DriveLab software
- USB connecting cable

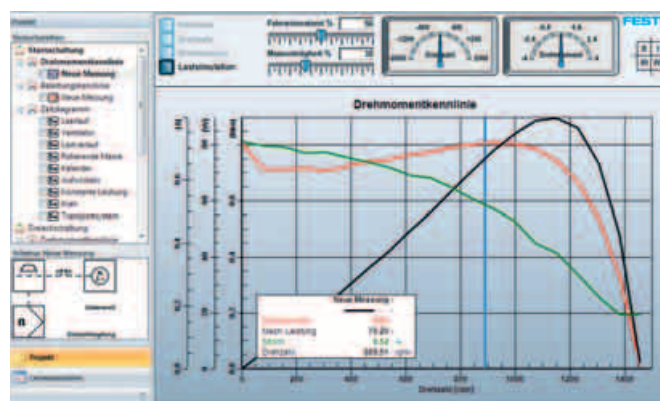
Complete equipment set TP 1410 **571870**

Possibilities of expansion:

Electric machines → Page 102	
3 AC Power Supply and Safety Unit → Page 103	
DC Motor Power Supply → Page 103	
EduTrainer load resistance → Page 104	
EduTrainer field rheostat → Page 104	
EduTrainer motor switches → 105	
EduTrainer Dahlander switch → Page 105	
Sinamics G120 EduTrainer → Page 108	
EduTrainer AC measurement board → Page 115	
Motor protection switch → Page 115	
EduTrainer 24 V power supply unit	571813
EduTrainer contactor board	571814
Motor technology contactor set	571816
EduTrainer operator and signalling unit	571815

Recommended training media, also order:

Electric drives 1: eLearning course → Page 25
Electric drives 2: eLearning course → Page 25



The convenient and intuitive **Drive-Lab** software supports the automatic recording of machine characteristic curves, the parameterisation of a static load and the simulation of load models for the examination of drives under realistic conditions

The comparison and optimisation 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

Also order:

Workbooks
→ Pages 41 – 42

The exercises contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The workbook contains:

- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

The worksheets help students from the planning phase to execution and documentation.

All exercises require independent performance, evaluation and documentation from the learner.

Fundamentals of DC machines

Campus licence (→ Page 35):

de	571781
en	571783
es	571785

Fundamentals of AC machines

Campus licence (→ Page 35):

de	571789
en	571791
es	571793

Fundamentals of three-phase current machines

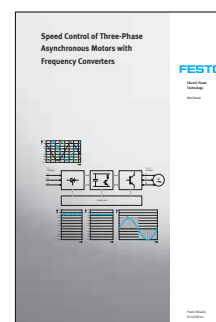
Campus licence (→ Page 35):

de	571797
en	571799
es	571801
fr	571803

Speed control of three-phase asynchronous motors with frequency converters

Campus licence (→ Page 35):

de	8114398
en	8114399
es	8114400
fr	8114401



Electric machines

for Servo brake and drive system – TP 1410



- Sturdy special design for training purposes
- Neutral rating plate
- Overtemperature 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
- Painted in RAL 7035

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

2 DC series machine

- Power rating: 0.3 kW
- Speed: 2,000 rpm
- 220 V/1.9 A

3 Universal motor

- Power rating: 0.2 kW
- Speed: 3,000 rpm
- AC 230 V/3.0 A
- DC 140 V/2.5 A

4 Capacitor motor

- Power rating: 0.25 kW
- Speed: 1,400 rpm
- $\cos \varphi$: 0.99
- AC 230 V/1.86 A
- Running/starting capacitor: 25 μ F/10 μ F

5 Three-phase current asynchronous motor 230/400 V

- Power rating: 0.25 kW
- Speed: 1,350 rpm
- $\cos \varphi$: 0.79
- Star circuit: 400 V/0.76 A
- Delta circuit: 230 V/1.32 A

6 Three-phase current asynchronous motor 400/690 V

- Power rating: 0.25 kW
- Speed: 1,350 rpm
- $\cos \varphi$: 0.78
- Star circuit: 690 V/0.45 A
- Delta circuit: 400 V/0.77 A

7 Synchronous machine

- Synchronous machine
- Power rating: 0.3 kW
- Speed: 1,500 rpm
- $\cos \varphi$: 0.97
- Exciter: 150 V/0.95 A
- Star circuit: 400 V/0.66 A
- Delta circuit: 230 V/1.14 A

DC compound machine

- Output: 0.3 kW
- Speed: 2000 r.p.m
- Armature: 220 V/1.8 A
- Field: 205 V/0.25 A

Three-phase AC multifunction machine

- (AC slip ring rotor, can be synchronised)
- Output: 0.27 kW
- Speed: 1360/1500 r.p.m. 50 Hz
- $\cos \varphi$: 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

Dahlander

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

11 Slip ring rotor

- Output: 0.27 kW
- Speed: 1360 r.p.m 50 Hz
- $\cos \varphi$: 0.72
- Star connection: 400 V/1.16 A
- Delta connection: 230 V/2 A
- U₂: 95V

Further machines are available on request.

1	DC shunt machine	571868
2	DC series machine	571869
3	Universal motor	571871
4	Capacitor motor	571872
5	Three-phase current asynchronous motor 230/400 V	571874
6	Three-phase current asynchronous motor 400/690 V	571875
7	Synchronous machine	572095
	DC compound machine	8023977
	Three-phase AC multifunction machine	8023978
	Dahlander	8023979
11	Slip ring rotor	8023980

3 AC Power Supply and Safety Unit



The 3 AC Power Supply and Safety Unit is an A4 module that ensures the electrical safety of a workplace. It provides protection against overload, shortcircuit and earth leakage, prevents automatic activation after voltage recovery and offers emergency cutoff on each phase. It is a fixed-voltage three-phase ac power source with an integrated circuit breaker providing protection against overload and shortcircuit and switches off when a voltage failure occurs. After voltage recovery, the system must be switched on again.

The all-current-sensitive RCD switch type B releases on fault currents of any voltage form. The integrated, lockable emergency stop switches off the output voltage on all phases when actuated.

The color-coded 4 mm safety jacks at standardized locations allow the connection of further system component, additional IEC C13 connectors allow safe connection of various system devices on standard single-phase voltage. Indicator lamps indicate the presence of the three phase power on the output jacks.

Technical data

- Input voltage: 3 AC/400 V/50 Hz
- Power cord with CEE-plug 16 A, length 3 m
- Output voltage: 3 AC/400 V/10 A (max.), protected against shortcircuit and overload
- RCD protection, Type B, 30 mA
- One three-phase outlet via 4 mm safety jacks
- Three single-phase IEC C13 outlets
- Phase indicator on each phase for output voltage
- Lockable Emergency Stop
- Designed for A4 mounting frames
- Dimensions (H x W x D): 297 x 266 x 140 mm
- Weight: 4.6 kg

DC Motor Power Supply



The DC Motor Power Supply is an A4 module that provides electrical supplies for electric 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.

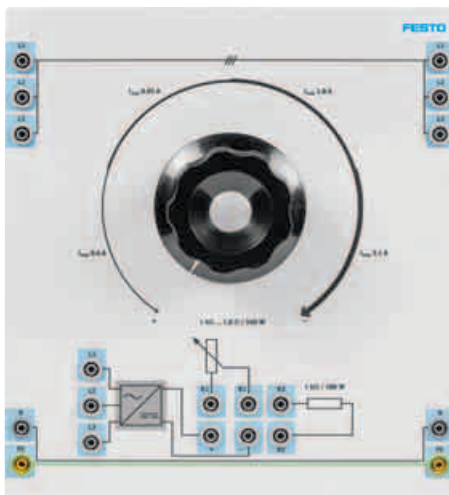
The variable DC power source voltage can be easily adjusted using the front panel knob and digital display. A second front-panel knob allows the current to be limited for certain applications.

The Power Supply for DC motors shall consist of a module that provides one fixed DC power output and one variable DC power output to run dc machine experiments.

Technical Data

- Input voltage: 3 AC/400 V/50 Hz (all phases pass through the module from left to right but only L1 is used to provide power to the equipment)
- Fixed DC voltage output: 210 V/8 A
- Variable DC voltage output: 0 – 240 V/6 A protected against short circuit and overload
- Peak current limiting on variable DC voltage output: 0 – 10 A
- Designed for A4 mounting frames
- Dimensions (H x W x D): 297 x 266 x 140 mm
- Weight: 6.1 kg

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

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

Technical data

- Max. 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 3x 400 V AC

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.

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

Technical data

- Max. 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 – 1.5 kΩ, 0.25 A
- Front panel: 133 x 297 mm
- For use in an A4 frame
- Connection via 4 mm safety plugs
- Through-feed for 3x 400 V AC

EduTrainer® motor switches



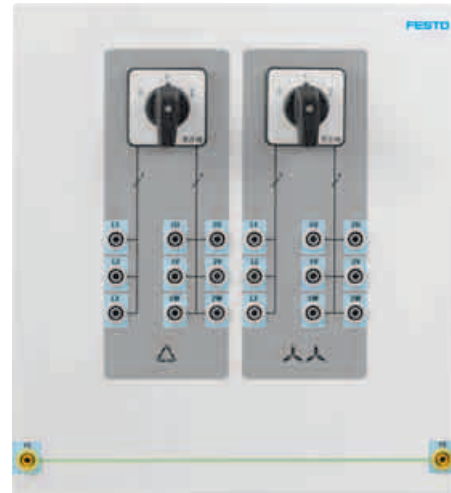
The motor switches are designed for direct switch activation of electric machines. Equipped with on/off switch, polarity reversal switch and star/delta switch.

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

Technical data

- Input voltage: 3x 400 V AC
- Output voltage: 3x 400 V AC
- Load rating: Max. 16 A
- Front panel: 266 x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plugs

EduTrainer® Dahlander switch



The motor switches are designed for direct switch activation of electric machines. Fitted with a Dahlander switch and a switch for asynchronous motors with separate windings.

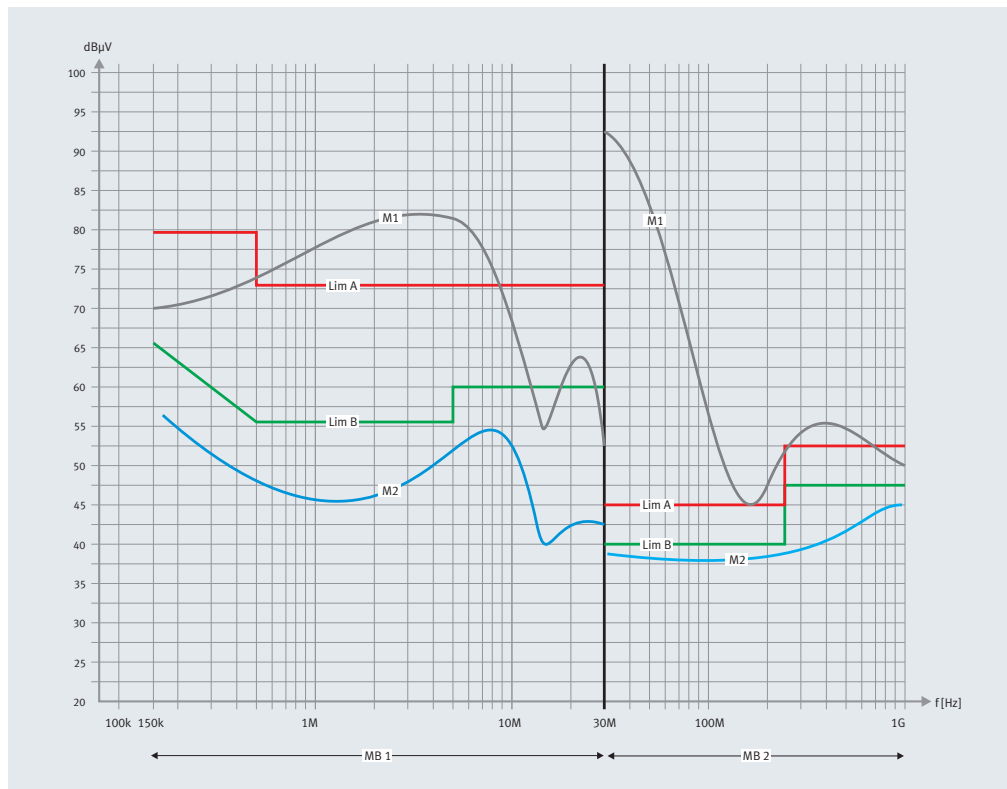
The locations of all connections are standardised and are routed to safety sockets or system plugs.

Technical data

- Input voltage: 3x 400 V AC
- Output voltage: 3x 400 V AC
- Load rating: Max. 16 A
- Front panel: 266 x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plugs

EMC-resistant drive systems

Information and backgrounds



Key to illustration:

- MB1 (measuring range 1):
150 kHz – 30 MHz, measurement of the conducted emission
- MB2 (measuring range 2):
30 MHz – 1 GHz, measurement of the radiated emission
- Lim A: Limit curve per DIN EN 55011, Class A (industrial devices)
- Lim B: Limit curve per DIN EN 55011, Class B (domestic and small commercial devices)
- M1: Interference emission without EMC measures
- M2: Interference emission with EMC measures

The graph shows the two areas of application. The red line shows the limit value for Class A devices, the green line the limit value for Class B devices.

The black curve shows the interference emission for a frequency converter without a housing. The blue curve shows how the interference emission can be significantly reduced with additional measures like filtering, screening, enclosed metal housings and appropriate component arrangements.

Areas of application

The EMC standards define two areas of application: use in “industrial environments” and in “residential/small company” applications.

The industrial environment is characterised by separation of the internal low-voltage grid from the public medium or high-voltage grid via a dedicated transformer. The limits for emitted interference of these industrial devices (Class A devices) are higher than the limits for residential devices (Class B devices) where many independent users are connected to the same low-voltage grid.

What is EMC?

Modern systems and plants are becoming increasingly technically-demanding, and in particular their electrical components are increasingly complex. In particular the growing amount of power electronics and microelectronics makes ever stricter demands of the components to guarantee trouble free and reliable operation.

EMC stands for “electromagnetic compatibility” and refers to “the ability of an equipment of system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to other equipment in that environment”.

Resistance to interference and interference emission

In general, a device is examined for both of these phenomena. When testing the resistance to interference, the device is operated and subjected to various defined disturbance variables. These tests include typical electrical phenomena, such as static discharge or surge voltage (lightning strikes) and test for immunity against external interference sources.

By contrast, the emitted interference is tested by operating the device in a condition in which the maximum interference emission is to be expected. The emissions must not exceed a limit specified in the standards.

CE marking

EU directives define minimum standards for various product groups which products are required to comply with. The characteristics are entirely different depending on the product group.

Manufacturers use the CE marking to confirm that the device complies with all relevant EU directives. This is confirmed by applying corresponding standards. Devices which do not fulfil the required directives may not bear the CE marking. The market supervisory authority can prohibit sales.

The following EU directives are relevant for CE marking of frequency converters:

- Low Voltage Directive (2006/95/EC)
- EMC (2014/30/EU)
- RoHS (2011/65/EU)

The low voltage directive requires that products do not cause electric hazards.

The EMC directive requires that electric devices must only influence one another to a limited extent.

The RoHS directive requires a limit to hazardous substances such as lead, mercury, cadmium or chrome.

**On the safe side with Festo Didactic**

In close cooperation with test laboratories, Festo Didactic has developed the optimal solution for operating frequency converters in training: The EMC-compliant frequency converters are designed to manufacturer's specifications, compact and safe to use.

The new design of the frequency converter fulfils all directives, as is confirmed by the CE marking. That means that the device can be operated safely in all laboratory environments without further measures.

Your advantages

Depending on the type of drive tasks, whether simple or complex, a range of frequency converters with suitable motors are available in various designs. The accessories for parameterisation and configuration are also available, as is a test system for measurements and loading the drive systems.

All relevant device interfaces are clearly arranged on a front panel. The control section of the frequency converter can be used there and replaced if necessary.

The motor is connected via a special EMC-compatible cable. The industry plug connector on the cabinet and the shielded clamp on the motor ensure EMC-compatible design of the drive system. The 4 mm safety plug on the motor side also focuses on the didactic aspect.

The interior structure and the consistent shielding concept clearly shows how EMC must be implemented practically. As a result the solution adds didactic value, as important training content on EMC-compliant design is taught.

The devices can be used both in the A4 mounting frame and as table-top devices. Furniture and storage systems for optimal classroom use are also available.

Sinamics G120 EduTrainer®



The next generation of the Sinamics G120 frequency converter – Optimised 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 encoder input (available only in 8105137 and 8105421) 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 fully pre-assembled 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 control panel IOP-2 is included in the scope of delivery of order no. 8105137 and 8105421. The control panels for the G120-DP variant (IOP-2 and BOP-2) are available as accessories.

Special characteristics

- Simple parametrisation via START-ER/STARTDRIVE and the BOP-2 or IOP-2 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 parameterised as failsafe inputs
- 3 digital outputs
- 1 analogue input
- 2 analogue outputs
- USB parameterisation interface (3 m USB cable included)
- Connections for temperature sensor and for external braking resistor
- Dimensions (H x W x D)
297 x 266 x 340 – 360 mm, depending on the variant
- Input Voltage:
 - 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)
 - 3x 400 V AC, 0.75 kW (Order no. 8105421)
 - 3x 230 V AC, 0.75 kW (Order no. 8105137)

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

Extension options and accessories

for frequency converters Sinamics G120 EduTrainer®



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.

Contains de, en, fr, it and es language packages. Updatable and extendable via USB interface.

Order no. **8022476**



Basic Operator Panel (BOP-2)

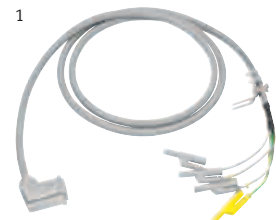
Operator panel with 2-line display and basic startup menu navigation. Two percentages can be numerically displayed at the same time for frequency converter diagnostics.

Order no. **8022475**

1 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**



2 Set of feet and device handle

Using the frequency converter on the table-top is even 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. Suitable for all EMC-compliant frequency converters.

Order no. **8036788**



3 Startdrive Basic

Software for parametrization, startup, optimisation, diagnostics and control.

Order no. **8105776**

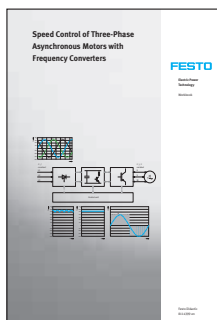


Also order:

Workbook

Speed control of three-phase asynchronous motors with frequency converters

→ Page 42



The exercises contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The worksheets help students from the planning phase to execution and documentation.

All exercises require independent-performance, evaluation and documentation from the learner.

The workbook contains:

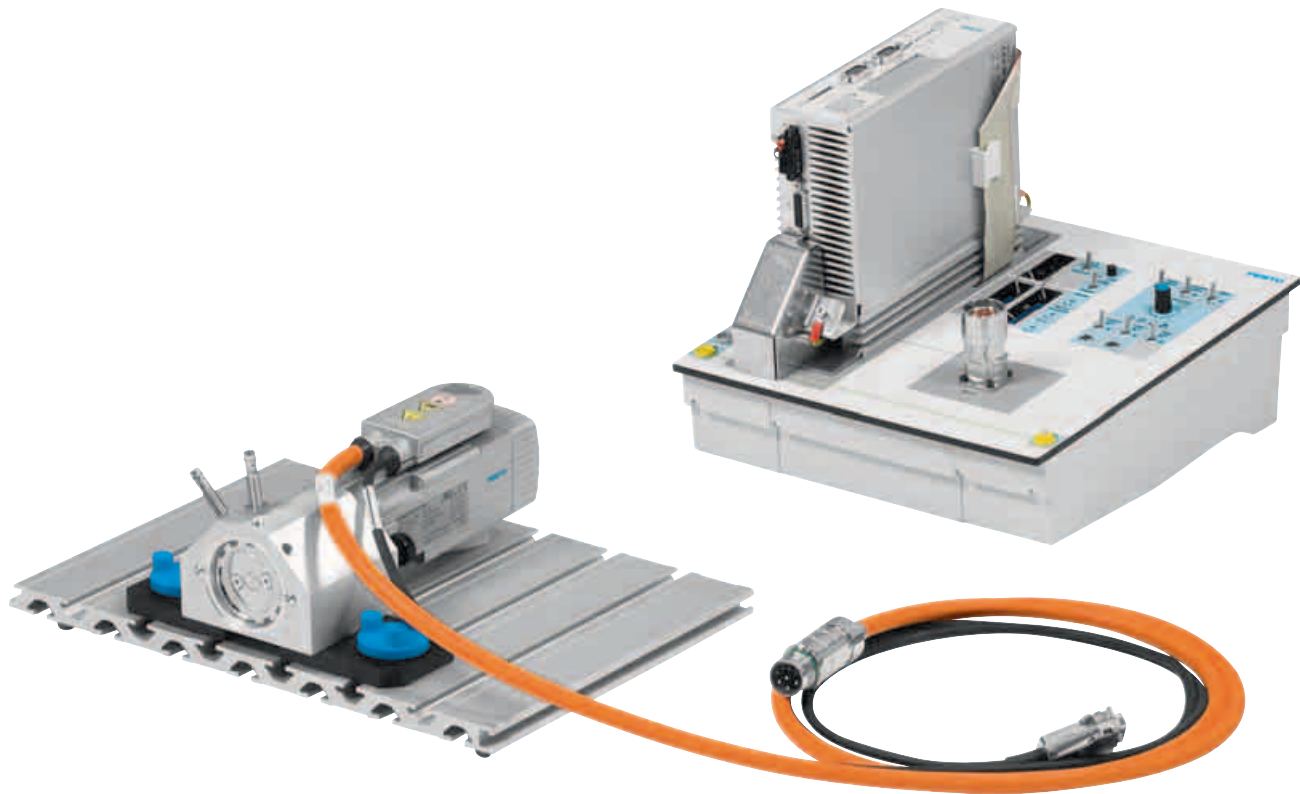
- Sample solutions
- Training notes
- Worksheets for students
- USB memory stick with PDF files

Campus licence (→ Page 35):

de	8114398
en	8114399
es	8114400
fr	8114401

Servo motor drive technology

Equipment set TP 1421



Drives with servo motors

Modern servo drives have become indispensable for a wide variety of automation tasks thanks to their combination of high precision, dynamic response and torque. Basic knowledge of the areas of application and the components of modern servo drives is therefore essential.

The use of the latest generation of Festo controllers and motors guarantees that this equipment set is up-to-date, while the supplied PC software facilitates project engineering.

Reliable and flexible

The rotary disk guarantees simple and reliable handling of the system throughout all stages of the introductory course. The integrated limit switches support the simulation of an axis on a range of rotation of approx. 340°. Metering can be implemented for extended training content.

Advantages

- The latest generation of modern drive components from Festo
- Integrated SysLink interfaces
- Integrated test box for all important I/Os
- Standardised concept from basic principles to application
- The component set contains all of the components for carrying out basic experiments and provides clear assignment thanks to its printed storage panel.

Training content

- Components of a drive system
- Design
- Commissioning
- RPM regulation
- Regulating torque
- Homing
- Positions
- Ramps

Complete equipment set TP 1421	571849
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The most important components at a glance:

1	1x EduTrainer servo motor controller	On request
2	1x Servo motor drive unit	On request
3	1x Null modem cable	On request

Possibilities of expansion:

4	EGC linear axis 600 mm including mounting kit → Page 114	571873
	MPS Handling station, electrical	567203

Recommended accessories, also order:

RS232 USB adapter	540699
Electric drives 1: eLearning course → Page 25	
Electric drives 2: eLearning course → Page 25	

1



4



2



3



Also order:

Workbook

Fundamentals of
servo motor drive technology
→ Page 42



All exercises require independent-
performance, evaluation and docu-
mentation from the learner.

The workbook contains:

- Solutions
- Didactic notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

Campus licence (→ Page 35):

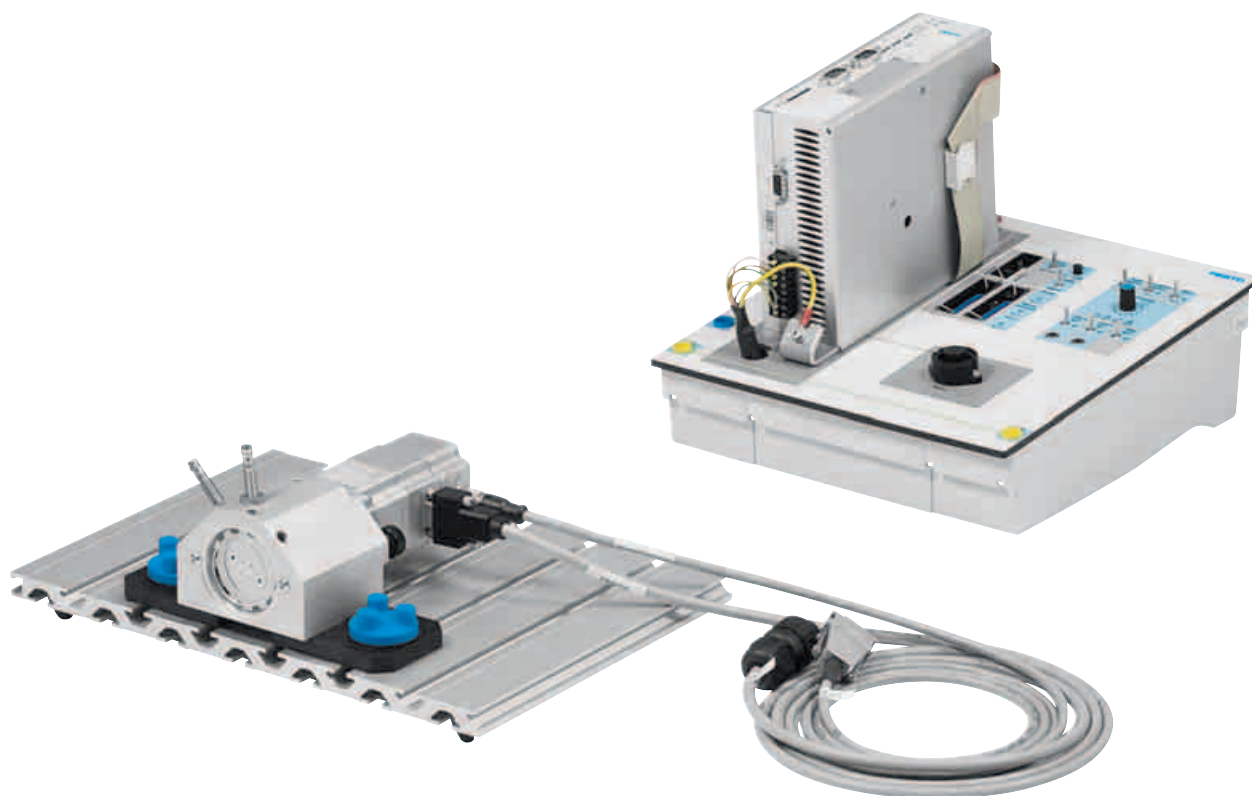
de	571851
en	571853
es	571855
fr	571857

The exercises contain concrete, real-
istic projects with problem descrip-
tions, parameters and project tasks.

The worksheets help students from
the planning phase to execution and
documentation.

Stepper motor drive technology

Equipment set TP 1422



Drives with stepper motors

One of the main reasons why drive tasks are implemented with stepper motor drives in modern systems is the cost benefit. However, the weaknesses associated with their design mean that basic knowledge of the components and areas of application is essential.

The current components in the equipment set and the supplied PC software provide a useful introduction to this topic.

Convenient and open

The integrated simulation box allows the connection of the required inputs and displays the states of all important outputs. This allows convenient operation without any additional hardware. The analogue and digital SysLink interfaces make it easy to integrate the drives in complete systems for explaining additional content.

Advantages

- The latest generation of modern drive components from Festo
- Integrated SysLink interfaces
- Integrated test box for all important I/Os
- Standardised concept from basic principles to application
- The component set contains all of the components for carrying out basic experiments and provides clear assignment thanks to its printed storage panel.

Training content

- Components of a drive system
- Design
- Commissioning
- RPM regulation
- Homing
- Positions
- Ramps

Complete equipment set TP 1422	571850
--------------------------------	--------

The most important components at a glance:

1	1x EduTrainer stepper motor controller	On request
2	1x Stepper motor drive unit	On request
3	1x Null modem cable	On request

Possibilities of expansion:

4	EGC linear axis 600 mm including mounting kit → Page 114	571873
	MPS handling station, electric	567203

Recommended accessories, also order:

	USB adapter RS232	540699
	Electric drives 1: eLearning course → Page 25	
	Electric drives 2: eLearning course → Page 25	

1



4



2



3



Also order:

Workbook

Fundamentals of stepper motor drive technology

→ Page 42



All exercises require independent performance, evaluation and documentation from the learner.

The workbook contains:

- Sample solutions
- Training notes
- Worksheets for the student
- Multimedia CD-ROM with graphics

Campus licence (→ Page 35):

de	571859
en	571861
es	571863

The exercises contain concrete, realistic projects with problem descriptions, parameters and project tasks.

The worksheets help students from the planning phase to execution and documentation.

EGC linear axis 600 mm including mounting kit



Linear axis for work on additional teaching content together with the basic training packages for servo or stepper motor drive technology.

Advantages:

- The latest generation of modern drive components from Festo
- Built-in quick coupling for connection to basic training drive packages
- Complete with Quick-Fix holder for slotted assembly board
- Limit switches included in scope of delivery

Technical data

- 600 mm working stroke
- Maximum speed 3 m/s
- Maximum acceleration 50 m/s²
- Feed force maximum 50 N
- Dimensions: (H x W x D)
600 x 60 x 50 mm

EduTrainer[®] supply unit



The supply unit ensures safe operation of single-phase servo controllers or frequency converters at workstations where there is no corresponding infrastructure.

It is connected to the mains supply via a non-heating device cable and makes it possible to provide an electrically safe workstation even in places where there is no separate fuse protection or type B RCD protection available.

The unit offers the following functions:

- Short circuit protection
- RCD protection, type B
- Emergency stop for the workstation
- Safety when restarting after voltage recovery
- Switching the workstation power supply on and off

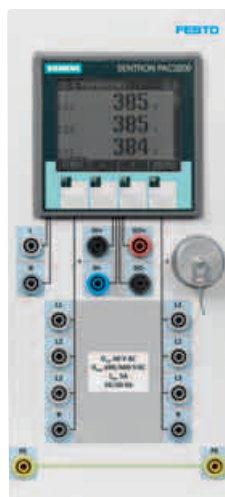
It also provides the 24 V DC voltage necessary for operation.

The locations of all connections are standardised and are laid out as safety sockets.

Technical data

- Supply voltage: 1 AC/230 V (50 Hz)
- Output voltage: 1 AC 230 V with type B RCD protection 30 mA, output current max. 10 A
- DC 24 V, 2 A
- All outputs protected against short circuits and overload
- Front panel: 133 x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Power supply via non-heating device connection
- Phase monitoring for polarity reversal and failure
- Lockable on/off switch
- Outputs for 4 mm safety plugs

EduTrainer® AC measurement board



The measurement board is designed for measuring the electrical variables of voltage, current, apparent, real and reactive power, power factor and frequency of one- and three-phase loads. Other functions include min-max values, real and reactive energy, dual tariff recording, average power demand MIN/MAX, hours-run meter and energy meter.

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

Ethernet port for integration in higher-level systems.

Technical data

- Supply voltage: 1 AC/95 – 240 V
- Measured voltage:
 - 1 AC/40 – 400 V, 3 AC/40 – 690 V
- Measured current max. 5 A
- Front panel: 133 x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plugs
- Floating switching output and meter input
- Cover cap for Ethernet connection

Motor protection switch for Servo brake and drive system TP 1410



High-quality, industrial switching device from Siemens with 4 mm safety elbow adapters for professional protection of rotating electric machines.

Technical data

- Mounting on 35 mm H-rail
- Auxiliary contacts
 - 1 N/O contact + 1 N/C contact

Available with the following values:

- 0.35 – 0.5 A
- 0.55 – 0.8 A
- 1.1 – 1.6 A
- 1.8 – 2.5 A
- 2.2 – 3.2 A

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

Electric power technology training packages





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Electric power technology

System description



Optimum qualification for a delicate field of industry

The production of energy using renewable natural resources has gained much importance in recent years. The need for innovative technologies to make the grid smarter has recently emerged as a major trend, as the worldwide increase in electrical power demand makes it harder for the actual grid in many countries to keep up.

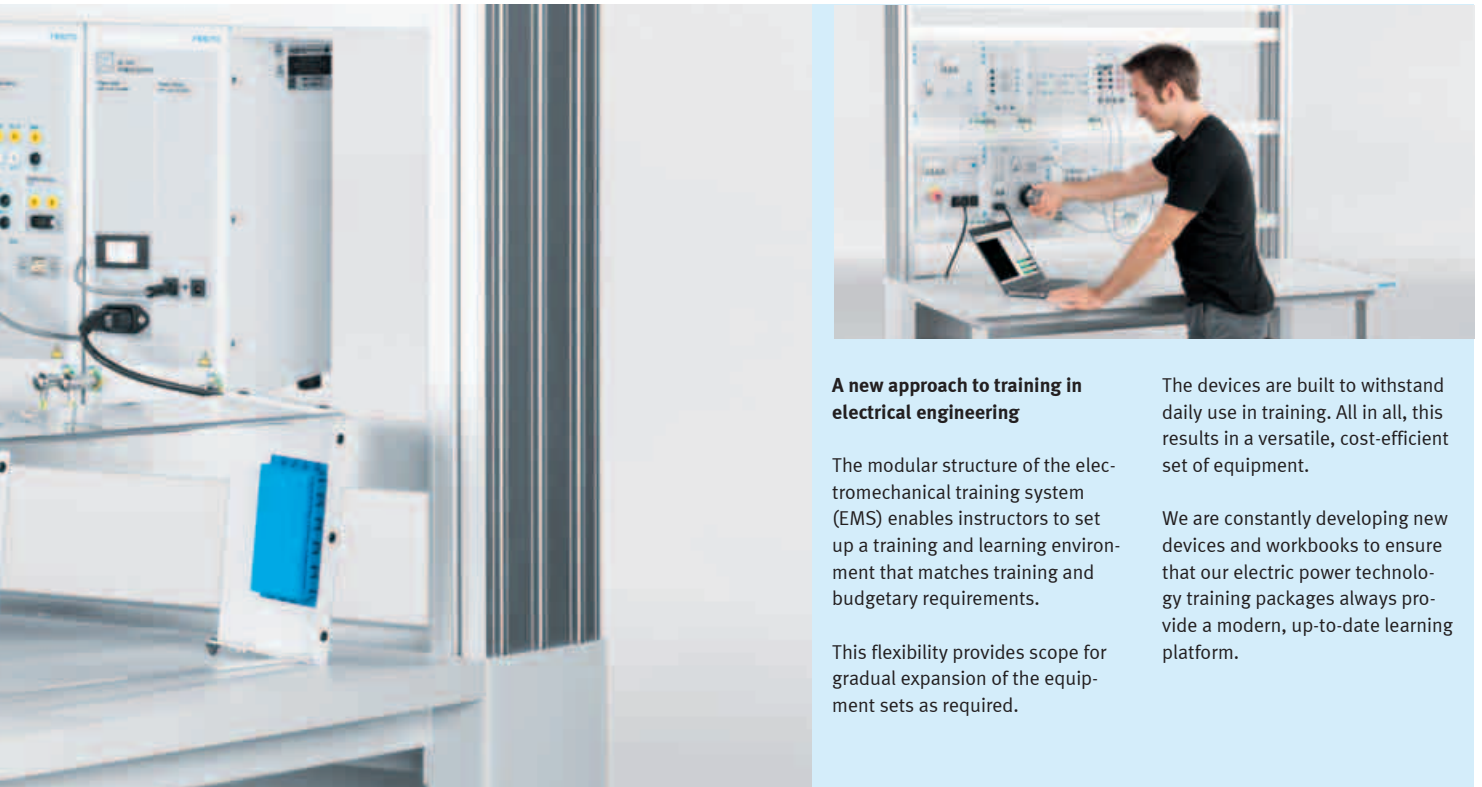
This situation is very demanding in terms of the qualifications of the specialist staff and managers involved in it.

Versatile equipment sets based on a renowned platform

The electric power technology equipment sets constitute a unique, modular pedagogical concept – a combination of turnkey courseware, practical software, and rugged hardware designed for instructional purposes. This methodically and efficiently builds student knowledge and skills in electric power technology.

Special features

- Modular design; the combination of different equipment sets fulfills specific training and budgetary requirements
- Safe grounding for the individual modules
- Optimized data acquisition and control interface (DACI) designed for learning purposes
- Convenient collection and clear presentation of the data using measurement tools suitable for the students
- Simultaneous logging of multiple signals using the oscilloscope; up to four high-voltage inputs and up to four high-current inputs
- Real time monitoring with computer-based measurement tools, e.g. for the evaluation of the complex amplitudes of current and voltage using Phasor Analyzer
- Simple and clear display and evaluation of measurements using the LVDAC-EMS software



A new approach to training in electrical engineering

The modular structure of the electromechanical training system (EMS) enables instructors to set up a training and learning environment that matches training and budgetary requirements.

This flexibility provides scope for gradual expansion of the equipment sets as required.

The devices are built to withstand daily use in training. All in all, this results in a versatile, cost-efficient set of equipment.

We are constantly developing new devices and workbooks to ensure that our electric power technology training packages always provide a modern, up-to-date learning platform.

A wide range of topics

Wind power

- Introduction to Wind Power
- Voltage-Speed Characteristic of a Wind Turbine Generator
- Torque-Current Characteristic of a Wind Turbine Generator
- Power vs. Wind Speed
- Storing Energy from a Wind Turbine into Batteries
- Stand-Alone Wind Power Systems for side-by-side Loads
- Stand-Alone Wind Power Systems for DC Loads
- Stand-Alone Wind Power Systems for AC Loads

Solar power

- The Diode
- The Solar Panel (Photovoltaic Panel)
- Effect of Temperature on Solar Panel Performance
- Storing Energy from Solar Panels into Batteries (optional)
- Effect of Shading on Solar Panel Operation
- Solar Panel Orientation
- Solar Panel Performance versus Insolation
- Stand-Alone PV Systems for DC Loads
- Use of an MPPT Charge Controller in Stand-Alone PV Systems
- Stand-Alone PV Systems for AC Loads
- Grid-Tied PV Systems

AC/DC power circuits and transformers

- Voltage, Current, Ohm's Law
- Equivalent Resistance
- Power in DC Circuits
- Series and Parallel Circuits
- The Sine Wave, Phase Angle and Phase Shift
- Instantaneous Power and Average Power
- Inductive and Capacitive Reactance
- Impedance
- Active, Reactive and Apparent Power
- Solving AC Circuits Methods
- Three-Phase Circuits
- Three-Phase Power Measurement
- Phase Sequence
- Voltage and Current Ratios
- Transformer Winding Polarity and Interconnection
- Transformer Losses, Efficiency, and Regulation
- Transformer Rating
- Effect of Frequency on Transformer Rating
- The Autotransformer
- Three-Phase Power Transformers and their configurations

Electric power technology

Computer-based instrumentation

A safe working environment

Festo Didactic provides a wide array of equipment to perform the practical exercises. Equipment sets suggest a learning path linking hardware and courseware, yet the modularity allows instructors to create divergent paths for customized solutions.

A variety of electrical loads, power supplies, motors and generators, inverters, power electronics components, transformers, mechanical loads, and other devices are available to ensure that student training builds the relevant skills for the future.

The hardware provides a new, innovative, and safer grounding method, which protects devices against reverse polarity and short circuits, and an electrical mechanism that prevents driving motors without the protective guard. All these features meet the highest safety levels in the educational market, while ensuring student safety and protecting the long-term investment value.

Computerized tools optimize learning and lab sessions

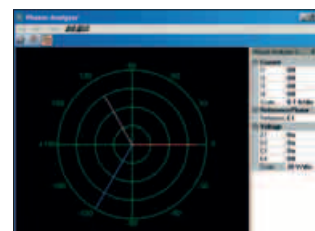
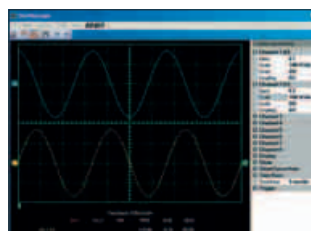
Once students have the foundational skills for using standard measuring tools, they can use computer-based tools to accelerate understanding, enabling more lab time to deepen comprehension.

These tools are meant not only to measure and calculate, but also to control and emulate a variety of real-world applications. If new controllers are needed, the proper firmware can be activated in the relevant hardware, eliminating the need for multiple controllers, and firmware functions can easily be upgraded over time.

Courseware

Workbooks are available for each equipment set. Each workbook includes up to ten full lab exercises (including required theory) to train students on the specific topics. Workbooks can be ordered separately or bundled in a campus license.

The illustrated student manuals provide all the required theory, guided lab exercises for equipment set procedures, and review questions that test student knowledge. The instructor guide provides all lab results and answers to questions.



Computer-based tools

Oscilloscope and phasor analyzer

Modules and software

Hand-in-hand functionality



Data Acquisition and Control Interface

Festo Didactic provides state-of-the-art data acquisition tools for quick, easy and safe measurements to help accelerate lab set-up, and reduce the downtime of using standard measuring instruments.

The Data Acquisition and Control Interface (DACI) is a versatile module used for measuring, observing, and analyzing electrical and mechanical parameters in electric power systems and power electronics circuits.

A set of computer-based instruments, as well as a variety of control functions, are available for the DACI and are quickly accessed through the LVDAC-EMS software.

This module is the main pillar of the learning concept and can later be easily and cost-efficiently upgraded to also perform numerous power electronics control applications (choppers, inverters, drives, etc.)

Data Acquisition and Control Interface (including computer-based instrumentation for 2x current inputs and 2x voltage inputs)

Order no. **595912**

Data Acquisition and Control Interface (including computer-based instrumentation for 1x current input and 1x voltage input)

Order no. **594500**

Data Acquisition and Control Interface (including complete computer-based instrumentation for all inputs)

Order no. **594499**

→ Page 128



4-Quadrant Power Supply and Dynamometer Controller

Emulating the right loads is a challenge that Festo Didactic takes seriously, and one that is met with the second pillar of the learning concept: the 4-Quadrant Dynamometer and Power Supply.

Depending on lab requirements, this module can easily be configured as a prime mover/brake with several options, a fully flexible AC/DC power supply, or an emulator of specific loads (from simple mechanical loads to more complex applications like wind turbine, hydraulic turbine, or solar panel). These control function sets can be accessed through the LVDAC-EMS software.

4-Quadrant Power Supply and Dynamometer Controller (including Manual and Computer-Based Control)

Order no. **595028**

4-Quadrant Power Supply and Dynamometer Controller (including Manual and Computer-Based Control, Lead-Acid Battery Charger, Turbine Emulator)

Order no. **596127**

→ Page 128



LVDAC-EMS

The LabVolt Data Acquisition and Control (LVDAC-EMS) software package supports the use of the measurement and control interface and the four-quadrant power supply with dynamometer control unit. LVDAC-EMS offers many options for controlling and monitoring EMS modules. In addition to this, the software package also makes calculation and configuration easier for complex applications.

For example, the software configures the computer-based measurement tools of the Data Acquisition and Control Interface. In order to make setup as simple as possible, the settings can be saved and exported, as can any existing measurements and evaluations. This special training software includes features such as a multiple oscilloscope and a Phasor Analyzer for tasks such as evaluation of the complex amplitudes of voltage and current.

LVDAC-EMS software and upgrades are available free on our website.



SCADA for LVDAC-EMS

The Supervisory Control and Data Acquisition (SCADA) software package for LVDAC-EMS is designed for monitoring and controlling technical processes, such as an automation system.

In learning and training environments, SCADA simulates a complete grid with several different applications running at the same time. A local desktop computer with LVDACEMS in the SCADA network can be monitored and controlled from the higher-level SCADA computer.

SCADA-EMS provides options for cross-manufacturer and cross-platform communication so that users can develop their own interfaces, in particular using Open Platform Communications (OPC). This standard for universal data exchange in the field of automation technology is suitable for addressing, controlling and monitoring third-party applications, such as those on desktop computers.

SCADA for LVDAC-EMS (5 workstations)

Order no. **8094377**

AC/DC power circuits and power transformers



The ideal starting point for training in electric power technology

Providing students with comprehensive and realistic training in the fundamental principles of electricity is the solid foundation on which all further studies in this area are built.

As part of its continuously-growing portfolio in electrical engineering, Festo offers a series of learning packages for teaching the basics of continuous and alternating current power circuits, as well as power transformers, from fundamentals to three-phase circuit configurations.

Our learning solutions in this field are fully modular to meet student and lab-specific needs, and can be combined with other equipment sets to create perfectly customized labs.

Features

- Unrivalled data acquisition and control interface specifically designed for learning purposes
- Ability to demonstrate multiple, high-power electrical signals with student-proof measuring instruments

Workbooks

The equipment sets are supported by five workbooks with a combined total of 24 full lab exercises. Students begin with fundamentals, such as Ohm's Law and series vs. parallel in DC, and continue to AC fundamentals, including the principles of phase angle, active/reactive/apparent power, impedance, and solving different single-phase AC circuits, and finally to understanding three-phase circuits.

Students then progress to electro-magnetism principles and transformers operation, examining all the necessary facets of these important electrical circuit components, including three-phase configurations.

Equipment set TP 8012-8 – AC/DC Power Circuits and Transformers 8093321

TP 8012-8 combines TP 8012-6 and TP 8012-7 without duplication of hardware components.

Recommended accessories for all equipment sets, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	594536
1x 3 AC Power Supply and Safety Unit*	594826

* Highly recommended accessory if your lab does not provide the suitable infrastructure.

Equipment set TP 8012-6 – AC/DC Power Circuits 8093319

TP 8012-6 covers DC, and AC single- and three-phase power circuits.

The most important components at a glance:

1x Resistive Load	594820
1x Inductive Load	594821
1x Capacitive Load	594822
1x 3 AC 400 V/DC 230 V/Power Supply	594825
1x AC 24 V Power Supply	772050
1x AC 230 V/DC 325 V Variable Power Supply*	8089266
1x Data Acquisition and Control Interface	594499

* This item can be replaced by 4-Quadrant Power Supply and Dynamometer Controller

→ Page 128

Equipment set TP 8012-7 – Power Transformers 8093320

TP 8012-7 covers single- and three-phase power transformers.

The most important components at a glance:

1x Resistive Load	594820
1x 3 AC Transformer Bank	594823
1x 1 AC Transformer	594824
1x 3 AC 400 V/DC 230 V/Power Supply	594825
1x AC 24 V Power Supply	772050
1x AC 230 V/DC 325 V Variable Power Supply*	8089266
1x Data Acquisition and Control Interface	594499

* This item can be replaced by 4-Quadrant Power Supply and Dynamometer Controller

→ Page 128

Also required:

PC with DVD drive running on Windows.

Also order:

Workbooks

AC and DC Power Circuits and Transformers Complete Package



The workbooks contain:

- Sample solutions
- Educational instructions
- Worksheets for learners

The exercises in the workbooks contain the theory and lab activities that cover the above training content.

The “AC and DC Power Circuits and Transformers Package” campus license covers one print copy of the guidelines for instructors and the following workbooks for students:

- DC Power Circuits
- Single- and Three-Phase AC Power Circuits
- Single- and Three-Phase Power Transformer

PDF documents are available on a CD-ROM.

Campus license (→ Page 35):

de	On request
en	8093410
es	On request
fr	On request

Topics**DC Power Circuits**

- Voltage, Current, Ohm’s Law
- Equivalent Resistance
- Power in DC circuits
- Series and Parallel Circuits

Single-Phase AC Power Circuits

- The Sine Wave
- Phase Angle and Phase Shift
- Instantaneous Power and Average Power
- Inductive Reactance
- Capacitive Reactance
- Impedance
- Active and Reactive Power
- Apparent Power and the Power Triangle
- Solving Simple AC Circuits using Circuit Impedance Calculation
- Solving AC Circuits using the Power Triangle Method

Three-Phase AC Power Circuits

- Three-Phase Power Measurement
- Phase Sequence

Single-Phase Power Transformers

- Voltage and Current Ratios
- Transformer Winding Polarity and Interconnection
- Transformer Losses, Efficiency, and Regulation
- Transformer Rating
- Effect of Frequency on Transformer Rating
- The Autotransformer

Three-Phase Power Transformers

- Three-Phase Transformer Configurations

Solar power



Solar power production

Solar power has become commonplace in recent years, making it more affordable for residential use, which is increasing worldwide. As a result, there is an urgent need to train and qualify technicians to understand and maintain these systems.

Our modular, solar power learning solutions meet your training needs, from the fundamentals and functions of photovoltaic panels to actual operation of stand-alone or grid-tied photovoltaic energy production systems.

Computerized tools made for learning

To guide students through their learning path, Festo Didactic provides state-of-the-art data acquisition tools for easy, safe and fast measurements in order to speed up the setup time but also reduce the downtime of using standard measuring instruments.

The Data Acquisition and Control Interface comes also with an oscilloscope, a phasor analyzer, a data table and a graph on specifically designed software optimized for learning purposes.

Features

- Solar Panel Emulator, for experiments requiring additional power
- PWM and MPPT inverters
- State-of-the-art data acquisition and control interface designed specifically for learning purposes

Equipment set TP 8012-5 – Solar Power (Complete) 596088

TP 8012-5 combines TP 8012-3 and TP 8012-4 without duplication of hardware components.

Recommended accessories for TP 8012-5, also order:

2x Digital Multimeter	579782
1x Communications Gateway*	595054
1x Connection Lead Set and Grounding Kit	594536

* Only one per lab is necessary.

Optional accessories (for outdoor experiments):

1x Heavy-Duty Tripod	583216
1x Pyranometer	579784

Equipment set TP 8012-3 – Introduction to Solar Power 596086

A cost-effective package covering the fundamentals of solar power.

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)

Recommended accessories for TP 8012-3, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	594536

Equipment set TP 8012-4 – Photovoltaic Systems 596087

Covers the concepts of solar power production in stand-alone and also grid-tied scenarios.

The most important components at a glance:

1x DC 48 V Lamps	595055
1x AC 230 V Lamps	595056
2x 1 AC Energy Meter	594904
1x 48 V Lead-Acid Battery Pack	595059
1x DC 48 V PWM Charge Controller	595051
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 (Manual and Computer-Based Control Specifications)	595028
1x Firmware Function (4Q Power Supply/Dynamometer, Solar Panel Emulator)	581440
1x Data Acquisition and Control Interface (including Computer-Based Instrumentation for 1x current input and 1x voltage input)	595912

Recommended accessories for TP 8012-4, also order:

1x Communications Gateway*	595054
1x Connection Lead Set and Grounding Kit	594536

* Only one per lab is necessary.

Also required:

PC with DVD drive running on Windows.

Also order:

Workbooks**Solar Power Complete Package**

The workbooks contain:

- Sample solutions
- Educational instructions
- Worksheets for learners

The exercises in the workbooks contain the theory and lab activities that cover the above training content.

The first workbook focusses on the Photovoltaic module itself, including how it is manufactured and how it is used under a variety of conditions. The second workbook gives students the opportunity for practical experimentation with production scenarios in off-grid or parallel operation.

The “Solar power” campus license covers one print copy of the guidelines for instructors and the following workbooks for students:

- Solar power
- Photovoltaic systems

PDF documents are available on a CD-ROM.

Campus license (→ Page 35):

de	798367
en	596125
fr	8096492
es	798368

Topics**Solar Power**

- The Diode
- The Solar Panel (Photovoltaic Panel)
- Effect of Temperature on Solar Panel Performance
- Storing Energy from Solar Panels into Batteries
- Effect of Shading on Solar Panel Operation
- Solar Panel Orientation
- Solar Panel Performance vs. Insolation

Photovoltaic Systems

- Stand-Alone PV Systems for side-by-side Loads
- Use of an MPPT Charge Controller in Stand-Alone PV Systems
- Stand-Alone PV Systems for AC Loads
- Grid-Tied PV Systems

Wind power



Wind power you can touch

Similar to solar power systems, wind turbines are becoming increasingly widespread due to their simple design and environmental friendliness. Small wind turbines are playing an especially important role as power grids become increasingly decentralized.

Our training and education solutions for wind energy are modular and can therefore be combined with other products. The “Introduction to Wind Power” equipment set contains components from real wind turbines. A dynamometer simulates real wind conditions and generates force/torque curves.

If you require practical exercises specifically for power generation, you can upgrade this equipment set with the components specified below to our TP 8012-2: Wind Energy equipment set at any time.

Features

- Modular design with module in A4 format. This allows for combinations with modules of other equipments sets
- New protective grounding terminals on the modules for safe working
- Wind turbine emulator embedded in a flexible dynamometer
- Components of a real wind turbine in a safe learning environment
- Data acquisition and control interface designed for learning purposes
- Latest data acquisition tools for safe and fast measurements

Equipment set TP 8012-2 – Wind Power (Complete) 596085

TP 8012-2 combines TP 8012-0 and TP 8012-1 without duplication of hardware components.

Necessary accessories for TP 8012-2, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	594536

Equipment set TP 8012-0 – Introduction to Wind Power 596083

TP 8012-0 contains all the equipment and courseware necessary to give students an introduction to wind power production on small scale wind turbines.

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	595059
1x 4-Quadrant Power Supply and Dynamometer Controller (including Manual and Computer-Based Control, Lead-Acid Battery Charger, Turbine Emulator)	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

* for two adjacent devices

Recommended accessories for TP 8012-0, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	594536

Equipment set TP 8012-1 – Wind Power Systems 596084

TP 8012-1 contains all the equipment and courseware necessary for studying wind power production and supplying different types of loads.

The most important components at a glance:

1x Wind Turbine Generator/Controller	595061
1x DC 48 V Lamps	595055
1x AC 230 V Lamps	595056
1x 48 V Lead-Acid Battery Pack	595059
1x AC 24 V Power Supply	772050
1x 1 AC 230 V Stand-Alone Inverter	595052
1x 4-Quadrant Power Supply and Dynamometer Controller (including Manual and Computer-Based Control, Lead-Acid Battery Charger, Turbine Emulator)	596127
1x 4-Quadrant Dynamometer Motor	595062
1x Data Acquisition and Control Interface ((including computer-based instrumentation for 2x current inputs and 2x voltage inputs)	595912
1x Timing Belt	793141
1x Protective Guard – Side-by-Side*	794195

* for two adjacent devices

Recommended accessories for TP 8012-1, also order:

1x Connection Lead Set and Grounding Kit	594536
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Also required:

PC with DVD drive running on Windows.

Also order:

Workbooks

Wind power Complete Package



The workbooks contain:

- Sample solutions
- Educational instructions
- Worksheets for learners

The exercises in the workbooks contain the theory and lab activities that cover the above training content.

The “Wind power” campus license covers one print copy of the guidelines for instructors and the following workbooks for students:

- Introduction to Wind Power
- Wind Power Systems

PDF documents are available on a CD-ROM.

Campus license (→ Page 35):

de	798369
en	596126
fr	8096504
es	798370

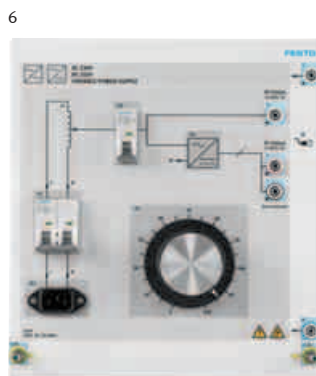
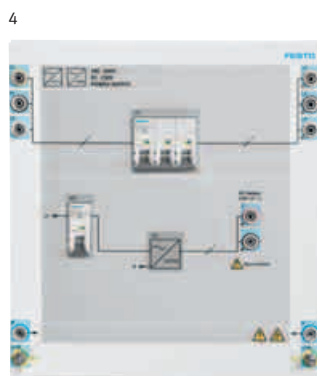
Topics**Introduction to Wind Power**

- Voltage-Speed Characteristic of a Wind Turbine Generator
- Torque-Current Characteristic of a Wind Turbine Generator
- Power vs. Wind Speed
- Storing Energy from a Wind Turbine into Batteries

Wind Power Systems

- Stand-Alone Wind Power Systems for side-by-side Loads
- Stand-Alone Wind Power Systems for AC Loads

Description of the components



1 Data Acquisition and Control Interface

The Data Acquisition and Control Interface (DACI) is versatile and complete device in an A4 module used for measuring, observing, and analyzing electrical and mechanical parameters in electric power systems and power electronics circuits.

Order no. **595912**

2 4-Quadrant Power Supply and Dynamometer Controller

The 4-Quadrant Power Supply and Dynamometer Controller is an A4 module that offers two main operating modes: Power supply and dynamometer. For the dynamometer, a dynamometer motor is also required. In the power supply mode, the unit acts as a versatile four-quadrant voltage or current source. In the dynamometer mode, the unit acts as a fully configurable mechanical brake or prime mover.

Order no. **596127**

3 4-Quadrant Dynamometer Motor

The 4-Quadrant Dynamometer Motor consists of a 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, a motor test bench and can also emulate various types of predefined loads and even custom ones.

Order no. **595062**

4 3 AC 400 V/DC 230 V/Power Supply

The 3 AC 400 V DC 230 V Power Supply is an A4 module that provides electrical supplies for a wide range of experiments on a workplace. The integrated circuit breakers provides protection for all following system components, which can be connected via the color-coded 4 mm safety jacks at standardized locations.

Order no. **594825**

5 AC 24 V Power Supply

The AC 24 V power supply provides auxiliary power for various system components. The power switch includes a thermal breaker that will switch off in case of an incident.

Order no. **772050**

6 AC 230 V/DC 325 V Variable Power Supply

The AC 230 V/DC 325 V Variable Power Supply provides two source outputs, one variable from 0 to 230 V ac single-phase and the other one from 0 – 325 V dc. Both outputs are commanded by the same control knob. The power supply itself is connected to the ac line voltage, supplies the necessary power single-phase ac and dc experiments.

Order no. **8089266**

7 AC 230 V Power Supply

The AC 230 V Power Supply consists of a 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. The output comes in two forms, one is through a C14 socket and the second is via two 4 mm output jacks.

Order no. **595930**

1 Wind Turbine Generator/Controller

The Wind Turbine Generator and Controller consists of an industrial wind turbine generator and controller of a real small wind turbine. By coupling it to our dynamometer, different wind situations can be simulated and the behavior of the small wind turbine can be examined. The integrated charge controller allows the generated energy to be stored in batteries. Finally, with the help of inverters, AC consumers can be operated.

Order no. **595061**

2 Wind Turbine Load Resistors

The wind turbine resistive load is an A4 module that provides a resistive electrical load for wind turbine experiments. It consists of three 15 Ω resistors, that are protected by a thermal circuit breaker each.

Order no. **594819**

3 Solar Panel Test Bench

The Solar Panel Test Bench is a tabletop module where the solar panel mounts into so that it can be illuminated and experiments can be conducted. It consists of a mounting frame to hold the solar panel and a lamp that can be dimmed to illuminate the panel at different levels. An integrated fan can be switched on to cool the panel to experiment on the effect of temperature on solar panels.

Order no. **595057**

4 Monocrystalline Silicon Solar Panel

The Monocrystalline Silicon Solar Panel consists of two independent photovoltaic (PV) modules 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. Two monocrystalline silicon solar panels mounted on a heat sink in a frame that allows experimentation in the solar panel test bench or on a tripod. It consists of two independent panels that can be connected in series or parallel additionally diodes and load are included to be able to run experiments.

Order no. **595058**

5 DC 48 V Lamps

The DC 48 V lamps is an A4 module that provides different 48 V lamps. It consists of two 48 V lamps, an incandescent lamp and a LED lamp and allows comparing these different loads in different experiments.

Order no. **595055**

6 AC 230 V Lamps

The AC 230 V lamps is an A4 module that provides different 230 V lamps. It consists of three 230V lamps, an incandescent lamp, a CFL lamp and a LED lamp and allows comparing these different loads.

Order no. **595056**

7 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 insolation.

Order no. **579784**

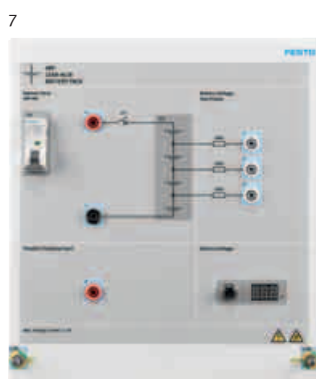
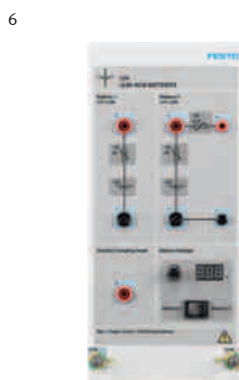
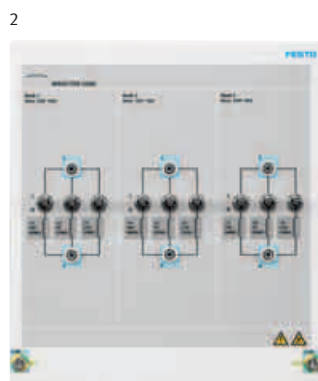
8 1 AC Energy Meter

The 1 AC Energy Meter is an A4 module that includes a single-phase energy meter. It consists of an industrial type single phase energy meter and a switch to select the power flow direction.

Order no. **594904**



Description of the components



1 Resistive Load

The Resistive Load consists of a module housing nine wire-wound power resistors arranged in three identical banks. Each bank consists of three resistors connected in parallel that can be switched on or off with toggle switches to obtain various resistance values. This allows the total (necessary) resistance of each bank to be increased or decreased by steps. Six 4 mm safety jacks on the module front panel provide access to each resistor bank.

Order no. **594820**

2 Inductive Load

The Inductive Load is a module that provides a universal inductive electrical load for a wide range of experiments. Each bank consists of three inductors connected in parallel that can be switched on or off with toggle switches to obtain various inductance values.

Order no. **594821**

3 Capacitive Load

The capacitive load is an A4 module that provides a universal capacitive electrical load for a wide range of experiments. Each bank consists of three capacitors connected in parallel that can be switched on or off with toggle switches to obtain various capacitance values.

Order no. **594822**

4 1 AC Transformer

The 1 AC Transformer is an A4 module that includes a single phase transformer with both primary and secondary sides are made of two identical separate windings. The 1 AC Transformer has a turns ratio of 1:5. A thermistor output allows monitoring of transformer temperature to prevent overheating.

Order no. **594824**

5 3 AC Transformer Bank

The 3 AC transformer bank is an A4 module that includes three independent power transformers. It includes three identical, independent transformers that can be connected in wye or delta configurations. The primary sides consist of a single 400V winding each, the secondary winding is split at 230/170 V each.

Order no. **594823**

6 12 V Lead-Acid Batteries

The 12 V Lead-Acid Batteries consists of two 12 V batteries mounted in an A4 module. It consists of two similar rechargeable batteries, each with its own protection, a common charging input and a battery voltage check.

Order no. **595060**

7 48 V Lead-Acid Battery Pack

The 48 V Lead-Acid Battery Pack consists of four 12 V lead accumulators mounted in series. The voltage of each individual battery can be measured via 4 mm safety jacks on the front panel. The batteries have a power switch, common charging input, a battery selector switch and a battery voltage indicator.

Order no. **595059**

1 DC 48 V PWM Charge Controller

The DC 48 V PWM charge controller is an A4 module used to perform charge controlling experiments with batteries and DC energy sources like solar. It consists of an industrial type PWM charge controller that stores power from a source in a battery. This type of controller will pull down the voltage of the solar array near that of the battery.

Order no. **595051**

2 DC 48 V MPPT Charge Controller

The DC 48 V MPPT charge controller is an A4 module that is used to control the charge of batteries with DC energy sources like solar panels. It uses the MPPT technology which adjust its input voltage and find the maximum power operating point from the solar array and transfer this power to the battery and load. DC side reverse polarity and over-voltage protection.

Order no. **595050**

3 1 AC 230 V Stand-Alone Inverter

The 1 AC 230 V Stand-Alone Inverter converts a DC power source such as batteries in an AC power source for "off-the-grid" applications. It consists of an industrial pure sine wave inverter that converts a power source of 48 V DC into a pure sine wave similar to the required AC line voltage for stand-alone applications. DC side reverse polarity and overvoltage protection.

Order no. **595052**

4 1 AC 230 V Grid-Tied Inverter

The 1 AC 230 V grid tied inverter is used to return power from a DC power source such as batteries directly to the grid and it is mounted in an A4 module. It consists of an industrial inverter that matches precisely the grid voltage and frequency in order to return power to the grid. The returned power usually comes from solar panels or wind turbines.

Order no. **595053**

5 Communications Gateway

The communications gateway is an A4 module that is used to communicate and set grid-tied inverters over the AC line voltage directly. The gateway is connected on the AC line voltage just like the inverters it needs to communicate with. Using that line voltage, the gateway monitors the grid-tied inverters operation and enables the user to program them with specific operating parameters.

Order no. **595054**

1



4



2



5



3



Protective relaying

Based on the SIPROTEC 5 series from Siemens



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 different 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 (both the software and USB are included with each relay and the software license is free for educational purposes). Relay function settings can also be performed 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 of the Numerical Distance Relay is through a removable panel located at the back of the relay enclosure.

Access to the relay Ethernet port, binary inputs, and binary outputs (e.g., trip contacts) is also through this removable panel. Each relay is powered via an ac power inlet mounted on the front 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.

Comprehensive courseware

Theoretical knowledge and hands-on training exercises teach students the basic and advanced relay protection functions. The available range of relays and manuals provide coverage of these topics:

Also order:

Workbooks

Overcurrent/Overload Protection

- Evolution of protective relays
- Overcurrent protection
- Overcurrent and overload protection of AC machines and power transformers
- Overcurrent protection of radial feeders

Student Manual, en	589887
Instructor Guide, en	589888

Directional Protection

- Protection of parallel power lines using overcurrent relays
- Directional overcurrent protection
- Directional comparison protection
- Directional power protection

Student Manual, en	589889
Instructor Guide, en	589890

Differential Protection

- Effect of the current measuring error on the sensitivity of current differential protection
- Percentage restrained differential protection
- Application of differential protection

Student Manual, en	590085
Instructor Guide, en	590086

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

Student Manual, en	593880
Instructor Guide, en	593881

Note: PDF version also available.

Siemens DIGSI 5 software

License for non-educational user only

Order no.	779959
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Numerical Directional Overcurrent Relay

- 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 (ANSI 27, 37, 38, 46, 59, 74, 81, 86, and 87N)

Standard Version

Order no.	589061
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Variant with external connection jacks

Order no.	589110
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Numerical Distance Relay

- 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 (ANSI 27, 37, 38, 46, 59, 68, 74, 81, 86, and 87N)

Standard Version

Order no.	589062
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Variant with external connection jacks

Order no.	589111
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Numerical Differential Protective Relay

- Transformer differential (87T)
- Instantaneous phase overcurrent (50)
- Instantaneous ground overcurrent (50N)
- Phase overcurrent (51)
- Ground overcurrent (51N)
- Other possible functions (ANSI 37, 38, 46, 74, 86, 87N, and 87M)

Standard Version

Order no.	589891
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Variant with external connection jacks

Order no.	592529
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Notes

- The numbers in parenthesis are the corresponding ANSI/IEE protection functions.
- Required accessory for the three relays: IEC Power Cable see page 148.

Protective Relay	Workbooks			
	Overcurrent/ Overload Protection	Directional Protection	Differential Protection	Distance Protection
Numerical Overcurrent Relay	x	x		
Numerical Distance Relay	x	x		x
Numerical Differential Relay	x		x	

Radar technology





Training systems	136
Modules, accessories, optional components	142

Radar training systems

The only real radar trainer that operates safely inside a classroom or a lab



LabVolt Series 8096

The Radar Training Systems provide students with real – not simulated – hands-on experience in the use of radar to detect and track passive targets at very short range in the presence of noise and clutter.

After more than 25 years, it is still the only real radar trainer that operates safely inside a classroom or lab. The level of technical advancement achieved by this system has been unequalled since. Affordable price, a fraction of real equipment.

The upgrade through the addition of computer-based control of the radar's processing and display functions ensure it will continue to be a leading-edge pedagogical product for many years.

High pedagogical value and interactivity

The Radar Training System is unique since it presents the realism of a real-world system while using the power of modern computer technologies. This realism makes the system very motivating to use by students and encourages their experimentation with the system.

The system is not a simulator: its operation is totally real. All outside world signals entering the system can be monitored and measured using the built-in virtual instruments. Conversely, several signals generated by the system, and made available on the Radar Training System's connectors and external test points can be measured with hardware instruments such as conventional oscilloscopes. This ensures that the system is perceived as real by the students.

Highlights

- Innovative design combining real-world radar with the power of modern surveillance technology
- Computer-based control of the radar's processing and display functions
- Comprehensive courseware and system level training with lab exercises
- Fault-insertion capability for the teaching of troubleshooting
- Turnkey, cost-effective training solution including instrumentation
- Powerful DSP, FPGA, and Data Acquisition System for Digital Analysis
- Realistic, high-gain parabolic antenna for high azimuth (angular) resolution
- Several subsystems allow delving into specific topics to expand knowledge and skills
- Can expand and complete existing telecommunication programs (satellite, antenna, microwave, etc.)

Training content

- Principles of radar systems
- Analog MTI processing
- Digital MTD processing
- Tracking radar
- Radar in an active target environment
- The phased array antenna
- RCS, SAR and ISAR measurements
- Radar Pulse Compression

Modularity through subsystems

Subsystems 8096-1 and 8096-2 provide students with hands-on training in the principles and operation of analog and digital radar. Subsystems 8096-3 and 8096-4 adds tracking and active jamming possibilities to the system to train students in the principles and scenarios of Electronic Warfare (EW). Subsystem 8096-6 provides students with training in the principles of electronically steered antennas. Subsystem 8096-A allows radar cross section (RCS) measurement of different targets as well as inverse synthetic aperture radar (ISAR) imagery. Subsystem 8096-B introduces students to the basic principles and operation of synthetic aperture radar (SAR). Finally, subsystem 8096-C demystifies the principles of radar phase-coded pulse compression.

Based on a versatile module

The Radar Training System is based on a reconfigurable training module (RTM) including a powerful DSP and a large FPGA. The RTM allows the Radar Training System to be used in many different modes with little or no hardware changes. This “programmable hardware” approach is achieved using a firmware uploaded and executed by the DSP and FPGA chips. The system interacts with the outside world through a series of small, low-cost plug-in modules inserted into the RTM. The RTM, together with the modularity of the system, facilitates expansion of the system without unnecessary duplication of equipment.

Comprehensive courseware

Manuals contain step-by-step, hands-on exercise procedures that guide the student through various experimentations on numerous radar topics. All experiments are highly repeatable, thanks to the stability of digital processing techniques. This enhances student motivation and system credibility.

Safety

The Radar Training System is totally safe for use in a classroom or lab, unlike radars used in the industry. All voltages and microwave power levels are well below accepted safety standards. Low RF power prevents wildlife from being exposed to harmful microwave levels.

Fault insertion

Real system and electronic faults can easily be inserted through the Faults control window in the LVRTS software. Several features are built into the system to enhance its pedagogical usefulness. These are features that would not normally be included in real-world radars.

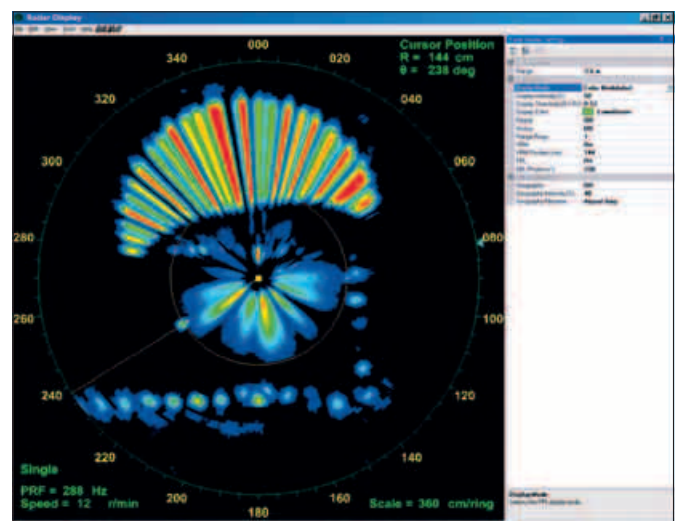
LVRTS software

The LVRTS software is a Windows® based application used to download programs into the DSP and FPGA memory of the RTM, to select the type of radar which is implemented. It also has an intuitive user interface to:

- Select the radar processing functions and adjust other parameters of the radar, such as the video gain, detection threshold, etc.
- Control the radar display functions such as the PPI display mode selection, Variable Range Marker (VRM), Electronic Bearing Line (EBL), etc.
- Display diagrams that show how to connect the equipment.
- Display the functional block diagrams of the complete radar and radar processor/display subsystem.
- Connect virtual probes to test points in the block diagrams to observe real signals using the built-in oscilloscope.

- Use the Data Monitor to observe and analyze the signal processing sequence involved in Moving Target Detection
- Insert faults in the system (password-protected feature) for troubleshooting purposes.
- Set the parameters that control the generation of clutter and interference.
- Obtain on-line help screens.

The software can be download for free on our website.



Basic Radar Training System

LabVolt Series 8097-1

The Basic Radar Training System is a complete set of hardware, courseware, and all necessary accessories such as targets and interconnecting cables that allows the principles of pulse, CW Doppler, and FM-CW radar systems to be studied. The Basic Radar Training System consists of a transmitter, a receiver, three instrumentation modules, an antenna with pedestal, a target positioning system, and a set of accessories.

A comprehensive student manual and an instructor guide, which may be ordered separately, are also provided. An oscilloscope is required for target echo visualization on an A-scope display as well as time-domain observation of signals at outputs and test points.

	en	es	fr
Basic Radar Training System	8112495	8112497	8112496

The most important components at a glance:

- 1x Horn Antenna
- 1x Power Supply/Antenna Motor Driver
- 1x Radar Synchronizer/Antenna Controller
- 1x Rotating-Antenna Pedestal
- 1x Radar Antenna
- 1x Dual-Channel Sampler
- 1x Target Positioning System
- 1x Radar Transmitter
- 1x Radar Receiver
- 1x Accessories for 8096-1

Manual included:

Principles of Radar Systems	en	es	fr
Student Manual	580402	580404	580403
Instructor Guide	580405	580407	580406

Note: PDF version also available.

Additional required equipment

- 1x Dual Trace Oscilloscope (or a similar oscilloscope)

Radar Processor/Display Add-On

LabVolt Series 8097-2

The Radar Processor/Display is used in conjunction with the Basic Radar Training System to form a complete and modern pulse radar system. The Radar Processor/Display adds the following elements to the Basic Radar Training System: radar echo signal processing functions, PPI display functions, on-screen block diagrams of the complete radar and radar processor/display subsystem, and computer-based instruments (oscilloscope and data monitoring system). Two major types of radar echo signal processing function are available: Moving Target Indication (MTI) and Moving Target Detection (MTD). The Radar Processor/Display also provides computer controlled generation of clutter and interference to allow study of the MTI processing function. The following types of clutter and interference can be generated: sea clutter, rain clutter, second-trace echo, noise, and pulse interference.

The RTM, which uses state-of-the-art digital signal processor (DSP) technology, can be programmed to act as either an analog pulse radar (i.e., a pulse radar with MTI processing) or a digital pulse radar (i.e., a pulse radar using MTD, correlation and interpolation, and surveillance processing).

	en	es	fr
Radar Processor/Display Add-On	8112498	8112500	8112499

The most important components at a glance:

- 1x Power Supply
- 1x Reconfigurable Training Module (RTM)
- 1x Analog/Digital Signal Combiner
- 1x Data Acquisition Interface
- 1x Radar Analog/Digital Output Interface
- 1x Accessories for 8096-2

Manuals included:

Analog MTI Processing	en	es	fr
Student Manual	580412	588936	580413
Digital MTD Processing			
Student Manual	580418	580420	580419
User Guide			
Order no.	580414	580416	580415

Note: PDF version also available.

Additional required equipment

- 1x Dual Trace Oscilloscope (or a similar oscilloscope)
- 1x Radar Host Computer (Or an equivalent Windows® based host computer)
- 1x Basic Radar Training System (8096-1)
- 1x Dual Function Generator (or a similar function generator)
- 1x Frequency Counter (or a similar frequency counter)

Radar Tracking Training System Add-On

LabVolt Series 8097-3

The Radar Tracking Training System adds on to the pulse radar implemented with the Basic Radar Training System and the Radar Processor/Display to form a continuous tracking radar. This radar can track a passive target that moves in the classroom laboratory.

The tracking radar can operate in three different modes (Scan, Manual, and Lock), which are selected through the hand-controller buttons. In scan mode, the antenna rotates at constant speed, allowing observation of targets on the PPI display. In manual mode, the operator can isolate a fixed or moving target of their choice, using the hand controller to control the antenna azimuth and to position an electronic marker (range gate) over the target echo signal. A computer-based O-scope display is used to monitor the position of the range gate relative to the echo signal of the target to be tracked. When the range gate straddles the target echo signal, the lock mode can be activated and the target is automatically tracked in range and azimuth by the system.

Range tracking is achieved by means of the split range-gate technique, whereas angle tracking is accomplished using lobe switching (sequential lobing). The study of these two techniques allows students to understand the principles of radar tracking.

	en	es	fr
Radar Tracking Training System Add-On	8112501	8112503	8112502

The most important components at a glance:

- 1x Dual Feed Parabolic Antenna
- 1x Radar Target Tracking Interface
- 1x Accessories for 8096-3
- 1x Radar Tracker Hand Controller (USB)

Manual included:

	en	es	fr
Tracking Radar			
Student Manual	580422		580423

Note: PDF version also available.

Additional required equipment

- 1x Basic Radar Training System (8096-1)
- 1x Radar Processor/Display (8096-2)

Radar Active Target Training System Add-On

LabVolt Series 8097-4

Radar Active Target (RAT) Training System is used in conjunction with the three previous subsystems to train students in the principles and scenarios of EW. This is a truly unique system that places real-time, safe, and unclassified EW demonstrations into the hands of students. The RAT Training System consists of an active jamming pod trainer, an elaborate set of accessories, and a comprehensive student manual.

The jamming pod trainer is a Self-Screening Jammer (SSJ) target that can perform direct or modulated noise jamming as well as repeater jamming. It includes a remote controller to select the type of jamming and set the jamming parameters. The jamming pod trainer and the included accessories are designed for use with the Radar to implement real EW situations. This provides an effective means of introducing students to a real-time jamming situation that necessitates a response, that is, the use of an appropriate ECCM to prevent losing track of the target.

	en	es	fr
Radar Active Target Training System Add-On	8112504	8112506	8112505

The most important components at a glance:

- 1x Horn Antenna
- 1x Radar Jamming Pod Trainer Support
- 1x Radar Jamming Pod Trainer
- 1x Power Supply (Radar Electronic Warfare)
- 1x Accessories for 8096-4

Manuals included:

Electronic warfare	en	es	fr
Reference Book	580343		580346
Radar in an Active Target Environment			
Student Manual	580425		580426

Note: PDF version also available.

Additional required equipment

- 1x Basic Radar Training System (8096-1)
- 1x Radar Processor/Display (8096-2)
- 1x Radar Tracking Training System (8096-3)

Radar Phased Array Antenna Training System Add-On

LabVolt Series 8097-6

The Radar Phased Array Antenna Training System is specifically designed to be used with the complete, pulse radar system that can be implemented with the Basic Radar Training System (8096-1) and the Radar Processor/Display (8096-2).

Beam steering in the Radar Phased Array Antenna Training System is achieved using a microwave switch coupled to a Rotman lens and microstrip tapered slot array antennas. Beam steering control can be manual, continuous or synchronized on the PRF (pulse repetition frequency). Scan speeds of up to 1080 scans/min can be achieved, thereby allowing the PPI display (sector scan) of the radar system to be refreshed at much higher rates than with a conventional mechanically rotated parabolic antenna. Targets can thus be followed in near real time.

	en	es	fr
Radar Phased Array Antenna	8112507	8112509	8112508

The most important components at a glance:

- 1x Phased Array Antenna
- 1x Phased Array Antenna Controller
- 1x Accessories for 8096-6

Manual included:

The Phased Array Antenna	en	es	fr
Student Manual	580428		580429

Note: PDF version also available.

Additional required equipment

- 1x Basic Radar Training System (8096-1)
- 1x Radar Processor/Display (8096-2)

RCS and ISAR Measurement Training System Add-On

LabVolt Series 8097-A

The RCS and ISAR Measurement Training System adds on to the Radar Processor/Display (8096-2) to form a computer-based, pulse-mode system that can measure the radar cross section (RCS) of targets and produce inverse synthetic-aperture radar (ISAR) images of targets.

The system can generate RCS patterns of targets of up to 75 cm (30 in) in length when the longest pulse width is used. The system can also generate high-resolution ISAR images of much larger targets when the shortest pulse width is used. Because the system is based on pulse operation, it does not need to be operated in an anechoic chamber or in an outdoor range. Background clutter is rejected using time-gating and subtraction techniques during the measurement process.

The RCS and ISAR Measurement Training System includes a low-RCS target support to achieve precise RCS measurements; an RCS/ISAR data acquisition interface; an RCS measurement/ISAR imagery software included in the LVRTS software; an RCS/ISAR measurement interface module; a set of accessories including a reflective scale model of a 777 Boeing aircraft; and a system user guide. Note that RTM 9431-2 (and newer) from the Radar Processor/Display add-on is required to use this add-on.

	en	es	fr
RCS and ISAR Measurement Training System	8122693		

The most important components at a glance:

- 1x RCS/ISAR Measurement Interface
- 1x RCS/ISAR Data Acquisition Interface
- 1x Accessories for 8096-A

Additional required equipment

- 1x Basic Radar Training System (8096-1)
- 1x Radar Processor/Display (8096-2)

Optional equipment

- 1x B2 RCS Scale Model
- 1xF-117A RCS Scale Model

Synthetic Aperture Radar (SAR) Training System Add-On

LabVolt Series 8097-B

The Synthetic-Aperture Radar (SAR) Training System adds on to the RCS and ISAR Measurement Training System (8096-A) to form a synthetic aperture radar that can produce high-resolution images. This system introduces students to the basic principles and operation of synthetic aperture radar (SAR).

The SAR Training System synthesizes a large aperture antenna through motion of a small-aperture (low directivity) horn antenna. Motion of the horn antenna is achieved using the Target Positioning System, LabVolt Series 9607-1, included in the Basic Radar Training System, LabVolt Series 8069-1, and an antenna-motion control module (SAR controller). Target radar echoes produced during a complete antenna scan are sampled and stored in the SAR processor then processed using a range Doppler algorithm to obtain high resolution SAR images.

The SAR Training System consist of SAR processing and imagery software included in the LVRTS software, a SAR controller module, the necessary cables and accessories, and a system user guide. Note that RTM 9431-2 from the Radar Processor/Display add-on is required to use this add-on. Reflective scale models of aircraft that can be used with the SAR Training System are optionally available.

Note

This add-on system is currently not CE-compliant; get in touch with a sales representative for details.

	en	es	fr
Synthetic Aperture Radar Training System Add-On	592583		

The most important components at a glance:

- 1x SAR Controller
- 1x Accessories for 8096-B

Additional required equipment

- 1x Basic Radar Training System (8096-1)
- 1x Radar Processor/Display (8096-2)
- 1x RCS and ISAR Measurement Training System (8096-A)

Optional equipment

- 1x B2 RCS Scale Model
- 1xF-117A RCS Scale Model

Radar Phase-Coded Pulse Compression Training System

LabVolt Series 8097-C

Radar Pulse Compression is a signal processing technique used to increase the range resolution and signal-to-noise ratio of any pulse radar. The design of a radar is usually a question of compromise. In many cases, a trade-off must be made between desirable characteristics. For only a modest increase in cost and complexity, pulse compression improves the range resolution without sacrificing the signal-to-noise ratio.

The Phase-Coded Pulse Compression System is an add-on to the Basic Radar and Radar Processor/Display Training Systems. The system includes the Phase-Coded Pulse Compression Processor that encodes the radar pulses before transmission and compresses the received pulses. It also includes the Pulse Compression Parabolic Dish Antenna, which is designed to prevent internal reflections from interfering with the radar signal, and two attenuators (4 dB and 10 dB) used to facilitate measurements. The Phase-Coded Pulse Compression application is already included in the LVRTS software.

	en	es	fr
Radar Phase-Coded Pulse Compression Training System	8112510		8131025

The most important components at a glance:

- 1x Pulse Compression Radar Antenna
- 1x Phase-Coded Pulse Compression Processor
- 1x Power Cord

Manual included:

Phase-coded pulse compression	en	es	fr
Student Manual	593926		
Instructor Guide	593927		

Note: PDF version also available.

Modules, accessories, and optional components



1 Power Supply

The power supply is the power source for the Reconfigurable Training Module (RTM) used in various communications training systems. Its back panel has two multi-pin connector outputs that provide regulated DC voltages. Each multi-pin connector output can supply power to one RTM. Auto-reset fuses protect the outputs of the Power Supply against short-circuits.

For all configurations 592595

2 Reconfigurable Training Module (RTM)

The Reconfigurable Training Module (RTM) consists mainly of a powerful digital signal processor (DSP), with three slots on the module front panel for installing interface modules. An Ethernet port (RJ-45) connector, located on the back panel, allows local or distant connection of the RTM to the host computer. The functionality of the training system is determined by downloading a program into the DSP memory using the host computer that runs the software. Electrical power is supplied to the RTM by the Power Supply through a multipin cable that connects to the back panel.

Order no. 587443

3 Horn Antenna

The Horn antenna is used to perform experiments related to a variety of topics, such as FM-CW radar, antenna gain, and microwaves. When used in conjunction with the Radar Antenna, the Horn Antenna allows separate transmission and reception of RF signals. It is also used in certain EW demonstrations.

Order no. 581847

4 Power Supply/ Antenna Motor Driver

The Power Supply/Antenna motor driver is the physical base for the Basic Radar Training System. The power supply distributes three unregulated dc voltages to the stacked modules through self-aligning connectors. The antenna motor driver supplies power to the Rotating-Antenna Pedestal. The Pulse-Width-Modulated (PWM) motor driver uses a 4-quadrant chopper requiring a command signal from the antenna controller or radar target tracking system.

120 V/60 Hz	en	es	fr
Order no.	581922	581924	581923
220 V/50 Hz			
Order no.	581925	581927	581926
220 V/60 Hz			
Order no.	581929		
240 V/50 Hz			
Order no.	581928		

5 Radar Synchronizer/ Antenna Controller

The Radar Synchronizer/Antenna Controller is used for Pulse Repetition Frequency (PRF) generation and synchronization of the different radar components. It also controls the operating parameters of the radar antenna.

	en	es	fr
Order no.	581930	581932	581931

1 Rotating Antenna Pedestal

The Rotating antenna pedestal is the mount and drive motor for the radar antenna. It provides the RF connection between the antenna and the radar transmitter and receiver. Antenna position feedback is obtained from an incremental optical shaft encoder, the output of which may be monitored through front-panel test points. The RF section includes a circulator for simultaneous transmission and reception. A rotary joint provides RF coupling to the rotating antenna mount.

	en	es	fr
Order no.	581933	581935	581934

2 Radar Antenna

The Radar antenna mounts on the rotating-antenna pedestal and has a miniature plug-in connector for quick RF coupling. It uses an offset-feed design to reduce masking effects. A screen of microwave-radiation absorbing material is also supplied, which, although not required due to the low level of RF power radiated by the system, provides training in microwave safety techniques as well as preventing interference with surrounding radar stations.

Order no.	581936
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3 Dual Feed Parabolic Antenna

The Dual Feed Parabolic Antenna mounts on the rotating antenna pedestal and is fully compatible with the miniature plug-in RF quick connector. The dual-feed horns are connected to a microwave SPDT switch that allows alternating transmission and reception of the signal from each horn through the single rotary joint of the antenna pedestal.

Order no.	581937
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4 Pulse Compression Radar Antenna

The Radar pulse compression antenna mounts on the rotating antenna pedestal and is fully compatible with the miniature plug-in RF quick connector. It uses an offset-feed design to reduce masking effects. It also comprises a low-loss cable for adding delay in pulse-compression exercises.

Order no.	592570
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5 Dual-Channel Sampler

The Dual-channel sampler performs time expansion of the I- and Q-channel baseband signals from the radar receiver to allow further processing and display. It has three switches to select the system observation range, as well as control knobs for adjusting the system range origin, the balance of the I- and Q-channel output signals, and the DC offsets at the I- and Q-channel outputs. A time base output is provided to obtain an A-scope display on a conventional oscilloscope.

	en	es	fr
Order no.	581938	581940	581939

6 Target Positioning System

Consists of a mobile target table, a remote target controller module connected to the table via a multi-way cable, and four types of targets (a sphere, a cylinder, a 90-degree reflector, three metal plates and a plexiglass plate). The surface of the target table measures 90 by 90 cm and is marked with a 1-cm grid. The system provides closed-loop DC servo control of the position and speed of the target in X and Y.

120 V/60 Hz	en	es	fr
Order no.	581941	581943	581942
220 V/50 Hz			
Order no.	581944	581946	581945
220 V/60 Hz			
Order no.	581948		
240 V/50 Hz			
Order no.	581947		



Modules, accessories, and optional components



1 Radar Jamming Pod Trainer
Self-screening jammer (SSJ) target in a compact enclosure. It is designed to be placed on the target positioning system to electronically attack the radar training system by masking the target echo signal with noise or causing either range or angle deception. The radar jamming pod trainer mainly consists of an RF signal source, a variable attenuator, transmitting and receiving horn antennas, a signal repeater, an amplitude modulator, and a remote controller.

	en	es	fr
Order no.	581949	581951	581950

Radar Jamming Pod Trainer Support
This support is a mast designed to support the Radar Jamming Pod Trainer when it is used to perform electronic jamming against the Radar. Soft pads allow the mast to glide softly over the surface of the Target Positioning System.

Order no.	581916
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2 Power Supply
The Power supply can be installed under the surface of the target positioning system to provide power to the radar jamming pod trainer. It provides the same unregulated DC voltages as the power supply/antenna motor driver through a multi-pin connector located on its top panel.

120 V/60 Hz	en	es	fr
Order no.	581952	581954	581953
220 V/50 Hz			
Order no.	581955	581957	581956
220 V/60 Hz			
Order no.	581959		
240 V/50 Hz			
Order no.	581958		

3 RCS/ISAR Measurement Interface
The RCS/ISAR measurement Interface contains additional RF circuitry that allows RCS and ISAR measurements to be performed using the basic radar training system and the radar processor/display add-on. This RF circuitry also allows the basic radar training system to be converted into a synthetic aperture radar (SAR).

	en	es	fr
Order no.	581960	587459	581961

4 Phased Array Antenna
The phased array antenna is specifically designed to be used with the radar training system. It allows a horizontal sector to be scanned (azimuthal scanning) without any antenna motion. The antenna can be tilted 90° to demonstrate elevation scanning. It consists of a microwave switch coupled to a Rotman lens and microstrip tapered slot array antennas. A built-in circulator allows simultaneous transmission and reception.

	en	es	fr
Order no.	581966	587460	581967

5 Phased Array Antenna Controller
The phased array antenna controller is used for beam steering control of the Phased array antenna (PAA). It allows the PAA to be operated in three scan modes: manual, continuous, and PRF locked (radar PRF dependent). The beam sequence can be either linear or pseudo random, or consists of even numbered beams only.

	en	es	fr
Order no.	581968	587461	581969

6 Phase-Coded Pulse Compression Processor
The phase-coded pulse compression processor allows to experiment pulse compression with the radar training system. It is divided into three sections: dual-channel sampler, pulse compressor and pulse generator. The dual-channel sampler samples the I- and Q-Channel baseband signals from the receiver and stretch these signals in time to facilitate observation and measurement.

	en	es	fr
Order no.	592571		

1 SAR Controller

The SAR Controller allows motion control of the small-aperture horn antenna installed on the moveable carriage of the Target Positioning System when the Basic Radar Training System is used as a synthetic aperture radar. It also ensures that the radar echo signal acquisition is properly synchronized with the horn antenna motion. The SAR Controller is complemented by the Synthetic Aperture Software – a Windows®-based application, included in the LVRTS software, that allows to produce signals acquired during a scan of the small-aperture horn antenna over the complete aperture length.

en es fr

Order no. 581970 587462 581971

2 Radar Transmitter

The Radar Transmitter is an instructional module designed to provide training in system- and module-level troubleshooting. It has switches that the instructor can use to insert faults. It generates an RF signal that can be either frequency modulated or amplitude modulated. It includes an RF oscillator, a pulse generator, and an amplitude modulator.

en es fr

Order no. 581972 581974 581973

3 Radar Receiver

The Radar Receiver is an instructional module designed to provide training in system- and module-level troubleshooting. It has switches that the instructor can use to insert faults. The Radar Receiver down-converts the received RF signal to baseband directly (homodyne receiver) for the three types of radar that can be implemented (CW, FM-CW, and pulse radars).

en es fr

Order no. 581975 581977 581976

4 Analog/Digital Signal Combiner

The Analog/Digital Signal Combiner is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. This module converts the clutter and interference generated by the DSP of the RTM to analog format, and adds it to the I- and Q-channel echo signals coming from the Radar Receiver.

Order no. 581978

5 Data Acquisition Interface

The Data Acquisition Interface is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. This module receives the I- and Q-channel echo signals of the radar, perturbed or not, and converts them to digital format. It also receives the PRF and synchronization signals as well as azimuth information from the Radar Synchronizer/Antenna Controller. All these signals are then routed to the RTM for digital signal processing.

Order no. 581979

6 Radar Analog/Digital Output Interface

The Analog/Digital Output Interface is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. This module provides analog and digital output signals generated by the RTM. The nature of the signals generated depends on the type of radar processing that the RTM performs.

Order no. 581980

1



2



3



4



5



6



Modules, accessories, and optional components



1 Radar Target Tracking Interface

Compact module designed to be installed into one of the slots on the RTM of the radar processor/display. The module provides the lobe switching control signal and the RF circuitry (bias tee and DC blocking capacitor) required to perform lobe switching with the dual feed parabolic antenna.

Order no. **581981**

2 RCS/ISAR Data Acquisition Interface

The RCS/ISAR data acquisition interface is a compact module designed to be installed into one of the slots on the RTM of the radar processor/display. This module receives the I- and Q-channel echo signals of the radar and converts them to digital format. It also receives the PRF and synchronization signals as well as azimuth information from the radar synchronizer/antenna controller. All these signals are then routed to the RTM for digital signal processing.

Order no. **592573**

3 Accessories for 8096-1

Containing all the cables and accessories required for the operation of the basic radar training system. These include: SMA flexible cables, BNC cables, a DB9 cable, an antenna motor driver cable, BNC tees, SMA attenuators, an SMA 50 Ω load, a measuring tape, a level, a waveguide-to-coax adapter, a horn antenna.

Order no. **581982**

4 Accessories for 8096-2

Containing a DB15 cable, a USB port cable, an RJ-45 connector crossover cable, an Ethernet adapter (network card) to be installed in the radar host computer, two semi-circular targets, a multiple target holder to be used with the target positioning system and the LVRTS software CD-ROM.

Order no. **581983**

5 Accessories for 8096-3

Containing a cylinder target, two zig-zag targets, and a BNC connector-to-miniature banana jack cable.

Order no. **581984**

Accessories for 8096-4

Containing a chaff cloud simulation device, a multifunction stand, a triangular (stealth) shield to cover the radar jamming pod trainer, radiation absorbing material (RAM), a set of microwave components and cables, and a sample of actual chaff.

Order no. **581985**

Accessories for 8096-6

Containing two short SMA cables with built-in passive limiters, two low-loss long SMA cables, a 30 dB SMA attenuator, a DB25 cable, and a microwave absorbing pen.

Order no. **581987**

6 Accessories for 8096-A

Containing a low-RCS target support with a support stand, an adjustable base and long interconnection cables for the rotating-antenna pedestal, additional BNC and SMA cables, a tripod with an antenna mast, a large horn antenna, a small metal plate target with radar absorbing material (RAM) on one side, and a reflective aircraft target (777 Boeing scale model).

Order no. **581986**

7 Accessories for 8096-B

Containing two medium-length BNC cables, two long BNC cables, a low loss long SMA cable, a short multi-way cable (to connect the SAR controller to the target controller of the target positioning system), a long USB port cable, a two-axis adjustable antenna support, and a radiation absorbing material (RAM) panel.

Order no. **581988**

1 Radar Tracker Hand Controller

The radar tracker hand controller is a joystick-type device designed to be connected to a USB port of a personal computer. It is used to select specific targets when the tracking radar is in the manual mode of operation. Fore and aft motion of the handle allows range positioning of a tracking radar cursor (range gate). Left-right motion of the handle controls the direction of the antenna's rotation, thereby allowing the antenna to be rotated to a specific azimuth.

Order no.	587464
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2 Dual Trace Oscilloscope

Economical and highly reliable solid-state instrument, ideal for general purpose use in laboratory and training applications. Students can measure phase difference between waveforms using the X-Y operation mode, and video signals can be measured quickly with the special TV sync separation circuit. The dual trace oscilloscope includes CH 1, CH 2, CHOP, and ALT display modes. An operating instruction manual, one fuse, one line cord, and two low capacitance probes are provided with the oscilloscope.

Order no.	580849
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3 RCS Scale Models

Scale models of different aircrafts for RCS measurement. Color may vary.

Boeing 777	582122
B2	587493
F-117A	587494

4 Dual Function Generator

Module consisting of two independent function generators (A and B), each capable of generating a sine wave signal, a square-wave signal, a triangular-wave signal, a saw tooth-wave signal, and a pulse signal with variable pulse-width. The signal frequency can be varied from 10 Hz to 100 kHz through four ranges.

	en	es	fr
Order no.	581549	581551	581550

5 Frequency Counter

Direct counting frequency counter with an 8-digit display. It determines the frequency of the input signal and displays the frequency in Hz, kHz, or MHz, it determines the period of the input signal and displays the period in s or ms, and it works as an event counter when the counter function is selected. The frequency/period resolution is switch-selectable from 0.1 to 100 Hz (0.1 to 100 ns).

	en	es	fr
Order no.	581552	581554	581553

Radar Host Computer

The radar host computer is a Windows® based computer with the LVRTS software installed, two monitors, and a dual-output display adapter (video card) compatible with Microsoft DirectX® version 9 or later.

120 V/60 Hz	en	es	fr
Order no.	587465		589842
220 V/50 Hz			
Order no.	587466		589843
240 V/50 Hz			
Order no.	587472		



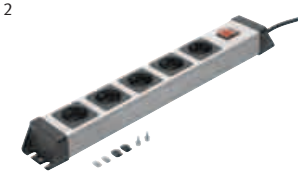
Accessories and measuring technology



1 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
- Through-hole for 3 AC/400 V

Order no. **571813**



2 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**



3 IEC power cable

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

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**

4 IEC power cable 90°

One end fitted with a 90° IEC 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

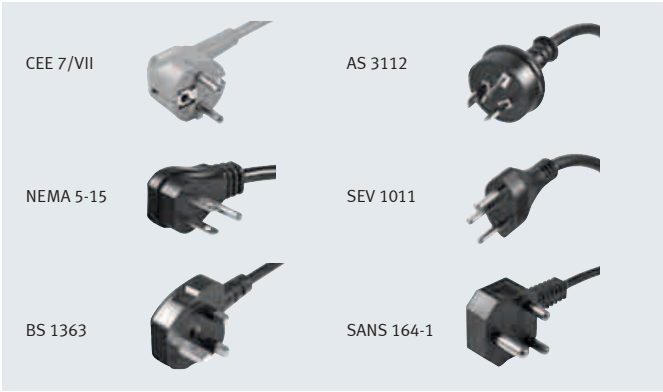
Order no. **549863**

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**



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 colour, 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

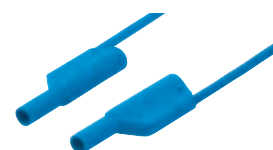
red	8092639
blue	8092640
black	8092641
gray-gray	8092642
brown-gray	8092643
black-gray	8092644
blue-gray	8092645
yellow	8092646
green/yellow-yellow	8092647

4 mm Safety laboratory cables, 1000 mm

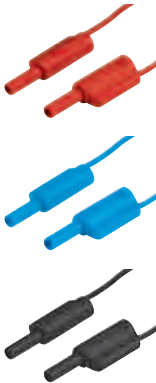
red	8092648
blue	8092649
black	8092650
gray-gray	8092651
brown-gray	8092652
black-gray	8092653
blue-gray	8092654
yellow	8092655
green/yellow-yellow	8092656

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 and measuring technology



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, grey, grey-blue:

- 8x red
- 8x blue
- 16x gray
- 4x grey-blue

Order no.	8092677
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Safety jumper plugs, 28 pieces, grey-black

Complete set, consisting of 28 grey-black safety jumper plugs. Suitable for the universal patch panel Edu-Trainer®, the jumper plugs are used to clearly establish connections when designing circuits.

- 28x grey-black

Order no.	571809
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Safety jumper plugs, 19 mm

red	572097
blue	572098
black	572099
grey	572100
grey-blue	572120
grey-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 colours 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
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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 lead 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
-----------	---------

Protective conductor connecting cables with special socket

- 6 mm special sockets
- Conductor cross section 4 mm²
- Pre-fitted with terminal socket at both ends
- Easy to recognize, allowing quick and simple assessment of safety-relevant connections at a work-station

1 Protective conductor connecting cables with special socket, 14 pieces

Complete set, consisting of 14 pre-assembled connector cables with 6 mm special connector for protective grounding terminal.

- 8x 100 mm
- 3x 400 mm
- 3x 1500 mm

Order no. **8067503**

Protective conductor connecting cable with special socket

100 mm	8067504
400 mm	8067505
1500 mm	8067506

2 Safety Adapter, 20 pieces

Complete set for conversion of protective conductor connections with 4 mm safety sockets to 6 mm special plug system.

- Special connectors are deliberately distinguishable from 4 mm safety sockets
- Easy to install using common tools
- For long-lasting service and conversion
- Including assembly tool and assembly instructions

Order no. **8067500**

3 BNC – 4 mm safety measuring adapter

Measuring lead for BNC plug on 4 mm safety plug for use with the oscilloscope Connect.

- Insulated BNC plug
- 4 mm plug with rigid protective sleeve and axial socket contact
- 600 V CAT II
- Length: 1600 mm

Order no. **8023959**

4 4 mm to 2 mm safety socket adapter

This adapter is designed to be inserted into a 4 mm safety socket and convert it into a 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 pc, fork

Set comprising 20 angled adapters with rigid protective sleeve and open clevis end for the bonding of devices.

- Fork width 7.5 mm
- Fork length 12 mm
- Suitable for M4 screws
- 1000 V CAT II
- Load capacity: 16 A

grey **576287**

black **576288**

6 Set of 4 mm angled safety adapters, 20 pc, pin

Set comprising 20 angled adapters with rigid protective sleeve and pin end to fix to industrial device terminals.

- Pin width 2 mm
- Pin length 12 mm
- 1000 V CAT II
- Load capacity: 16 A

grey **576285**

black **576286**



Accessories and measuring technology



A4 empty housing

Medium-grey front panel with removable protective sheet, rear cover, rubber feet and screws fully mounted.

- Front panel: 133 x 297 mm
- Front panel: 266 x 297 mm
- Front panel: 399 x 297 mm
- Depth: 90 mm

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



1 Fluke 115 digital multimeter

Standard meter for basic training in electrical engineering.

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, min./max./mean value, display hold, bar graph, true effective value measurement (TRMS).

- Voltage: 0.1 mV – 600 V
- Current: 0.1 mA – 10 A
- Resistance: 0.1 Ω – 40 MΩ
- Frequency: 0.01 Hz – 50 kHz
- Capacitance: 1 nF – 10,000 μF
- Measuring circuit category CAT III/600 V

Scope of delivery

- Measuring cables
- Holster
- 9 V battery
- Manual

Order no. **571830**

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

Scope of delivery

- Measuring cables
- 80BK temperature probe
- Holster
- 9 V battery
- Manual

Order no. **571831**

3 Beha-Amprobe AM-510 digital multimeter

Simple entry-level device for basic training.

Automatic and manual range selection, 3¾-digit LCD display, measurement of direct and alternating voltage, direct and alternating current, resistance, continuity, flow diode test, capacity and frequency measurement.

- Voltage: 1 mV – 600 V
- Current: 0.1 μA – 10 A
- Resistance: 0.1 Ω – 40 MΩ
- Frequency: 1 Hz – 10 MHz
- Capacity: 0.01 nF – 100 μF
- Measuring circuit category CAT III/600 V

Scope of delivery

- Measuring leads
- Battery
- Operating instructions

Order no. **8040005**

4 Beha-Amprobe AM-555 digital multimeter

Low-cost device with a full range of functions for basic training.

Automatic and manual range selection, 3¾-digit LCD display, measurement of direct and alternating voltage, direct and alternating current, resistance, continuity, flow, diode test, capacity and frequency measurement, temperature measurement. Min/max, data hold, bar display (61 segments), real effective value measurement (TRMS).

- Voltage: 1 mV – 1000 V
- Current: 0.1 μA – 20 A
- Resistance: 0.1 Ω – 60 MΩ
- Frequency: 1 Hz – 60 MHz
- Capacity: 60 nF – 60 μF
- Measuring circuit category CAT III/1000 V
- Measuring circuit category CAT IV/600 V

Scope of delivery

- Measuring leads
- Temperature probe
- Carry strap
- Battery
- Operating instructions

Order no. **8089140**

1



2



3



4



Accessories and measuring technology

1



1 Fluke 1664 FC installation tester

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 (residual current devices), 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.

Scope of delivery

- Hard-shell case
- Set of measuring cables
- Quick guide, CD manual
- AA batteries
- Padded carrying strap

Order no. **8064024**

2



2 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 EduTrainers® 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.

Scope of delivery

- Set of measuring cables
- Carrying strap
- Carrying case
- Brief instruction, manual on CD
- Batteries

Order no. **8040008**

Software for Beha-Amprobe Telaris ProInstall-0100

Convenient, extendible software for logging measurement data per DIN VDE 0100/0105. Log design per ZVEH protocol. Includes interface adapter TL USB.

Order no. **8040009**

3



3 T110 VDE voltage and continuity tester

Ideally suited for basic training in electrical engineering, with switching load.

VDE-tested and EN 243-3:2010-compliant, with measurement peaks 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

Scope of delivery

- Batteries
- Brief instructions

Order no. **8040007**

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: 2 X USB2.0, Wi-Fi, Ethernet port
- Record length : 20 Mpoints
- 32 automated measurement mode
- CE, UL, CSA

Scope of delivery

- Power cord
- 4x probes TPP0100
- Documentation CD
- Installation, safety, programmer manuals
- Calibration certificate

Order no. **8068879**

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

Scope of delivery

- Measuring cables
- Bag
- 1.5 V battery
- Manual

Order no. **571848**

2 Function generator

- Signal types: Sinusoidal, square, triangular, TTL
- Frequency range: 0.1 Hz – 500 kHz
- Voltage output: DC
- Offset: -15 – +15 V
- Voltage amplitude: 0 – 30 V

Order no. **152918**

3 Cable BNC – 4 mm

Cable with BNC socket and 2 jack-plugs (4 mm). For use in conjunction with a function generator and oscilloscope.

Order no. **152919**

Cable BNC – BNC

Order no. **158357**

T-piece BNC

Order no. **159298**

4 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.

Functions

- 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 with or without de-energized battery possible

Scope of delivery

- 3 measuring cables
- 3 probe tips
- 3 crocodile clamps
- Operating instructions
- Carrying case
- Batteries

Order no. **8081205**

1



2



3



4



Services





Services	158
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- Demos and reading samples
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- Extended warranty



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Customized service contracts give you peace of mind as our team takes care of your equipment. Available services include on-site hardware maintenance and calibration, warranty extension and repairs, continuous instructor training, and much more.



Personal advice

We will be glad to provide a consultation regarding concept and planning on site.

For more information, please contact your Festo contact person or write to: seminare@festo.com

Notes

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