LUCAS-NÜLLE

BUILDING WIRING INSTALLATION

From conventional electrical installation to “Smart Living”

4th Edition

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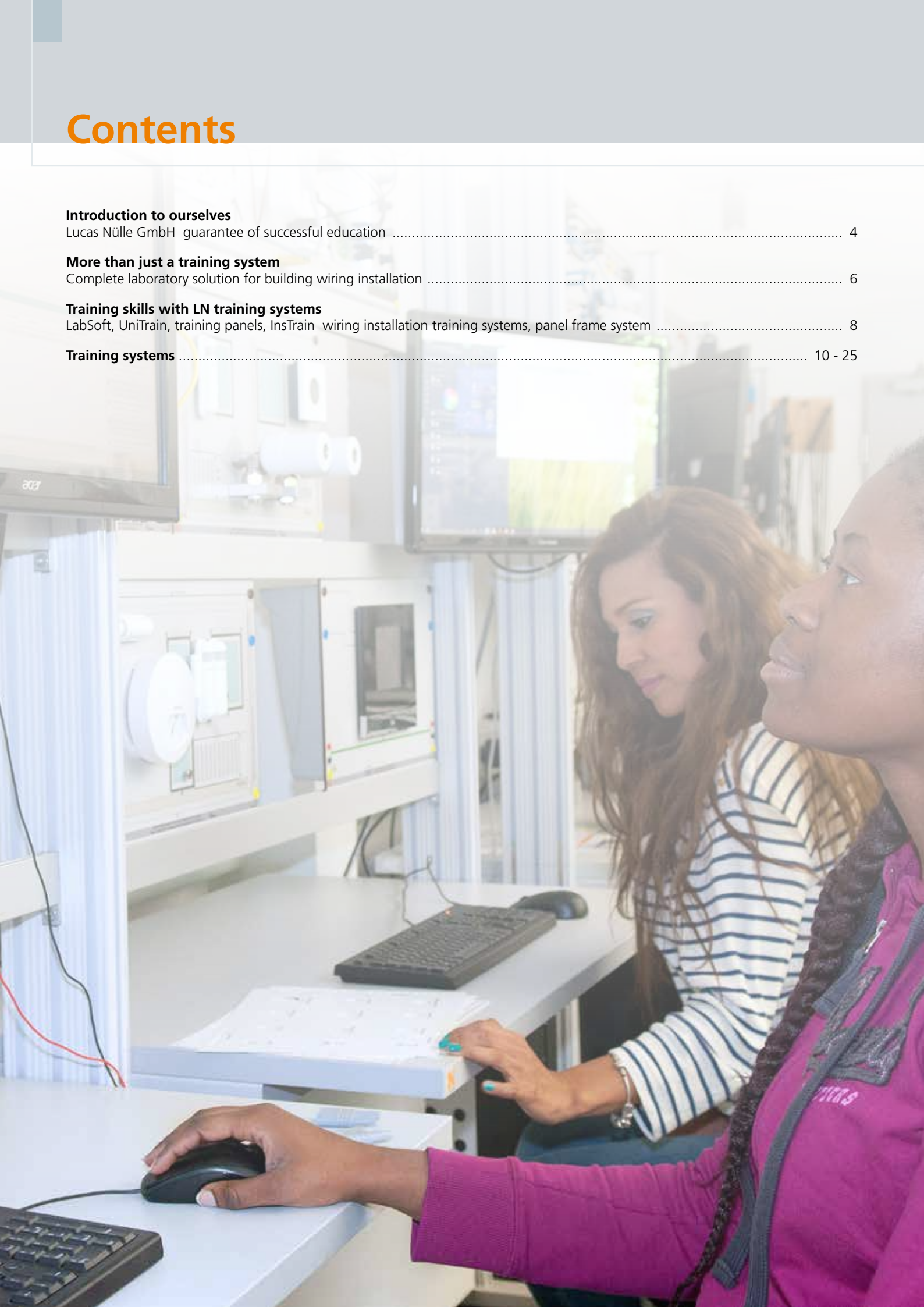

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Mastering modern procedures and techniques, as well as complying with international recognised standards and quality requirements, represents a key challenge to the technical skills of electricians, technicians engineers and scientists, both now and in the future.

Lucas-Nülle is pledged to meet this challenge. That is why we develop and manufacture training systems and products for key technologies in the context of the traditionally high quality of German vocational and engineering education.

A high level of qualification with an intrinsic practical focus guarantees that students acquire the skills required by the specialist professions and industry. These are prerequisites for the mastery of complex technologies. They demand both knowledge and aptitude. Experimenting with our instruments and systems, which are optimised for educational benefit, forms a link between theory and practice, turns knowledge into expertise and ensures enduring development of skills.

"A Guarantee of Successful Education"

In addition to our classic training systems our latest generation of PC-assisted systems is providing an answer to the rising demand for blended-learning solutions in the field of automotive mechanics which is now prevailing throughout the world.

The educational aims which remain at the forefront of our concerns throughout the development Lucas-Nülle training systems are to awaken interest and enthusiasm, to provide insight into the technical interactions and to allow students to gain skills which will be of practical use to them during their careers.

These technical systems are supplemented by specific literature and experiment instructions, which not only ensure that the necessary technical knowledge is conveyed, but also allow for successful and safe conduct of experiments. Thanks to their technical expertise and skill, their cooperative readiness and their personal commitment, our employees each play a key role in making certain of the company's success. Their professional interaction is based on lively team spirit, which is bedded into the streamlined organisational structure of our business.

Let us introduce ourselves

The Very Highest Standards of Production

Lucas-Nülle's training systems are manufactured at our own factory in Germany, on the same premises as our headquarters in Kerpen. The complexity and variety of our product range is only achievable thanks to our highly motivated team of skilled, responsible and experienced technicians and engineers.

Efficient Manufacturing Procedures

The efficient control of manufacture is handled by a modern PPS system. This allows us to ensure that delivery deadlines agreed with customers can be met.

Quality Assurance – Setting Standards

In LN's business philosophy, quality occupies a fundamental place as a key strategic element. In addition to continuous quality assurance to meet our agreed quality objectives in compliance with ISO 9001, there are numerous other certificates which underline our focus on quality. The procedures, standards and testing which those certificates describe and authorise are there to ensure that our products and services always meet the expectations of quality and reliability which are our hallmark.

Comprehensive Testing of Functionality

Alle Geräte durchlaufen einen lückenlosen Funktionstest, bevor sie das Haus verlassen. Dabei setzen wir höchste Maßstäbe und prüfen weit über das vorgeschriebene Maß hinaus.

Lutz Schulz, Dipl.-Ing.
Product manager for wiring installation and building management

Heike Schoermann, Dipl.-Ing.
Product manager for wiring installation and building management

More Than Just A Training System

Complete Laboratory Solution for Building Wiring Installation

Vivid presentation of complex educational content by means of modern training media

Our multimedia **wiring installation training system, InsTrain**, uses a project-oriented scheme to convey the topics involved in electrical wiring of buildings.

Imparting knowledge through multimedia with **UniTrain** "E-learning" and experiments to ensure enduring acquisition of knowledge

Everything at your fingertips whenever you need it
Lucas Nülle's **Classroom Manager** allows you to manage your students, adapt training resources to their needs and keep check on their current progress at any time.

The combination of ILA courses with **modular training panel systems** encourages individual learning in all possible topics.

LabSoft
Lucas-Nülle's course software accompanies all its training systems with theoretical and practical content, experiment instructions, videos, animations and numerous examples.

Training Skills With LN Training Systems

Lucas-Nülle offers a variety of training systems to accelerate the individual learning curves of every single trainee. This enables the individual areas of electricity supply, wiring installation and building management systems to be taught in optimal and efficient fashion. At the heart of this lies the close link between experiment hardware and training software.

All the systems can be used together in any combination or operated as a stand-alone unit. Thus the following training systems are on offer for the teaching of wiring installation:

- UniTrain
- Training panel systems
- InsTrain

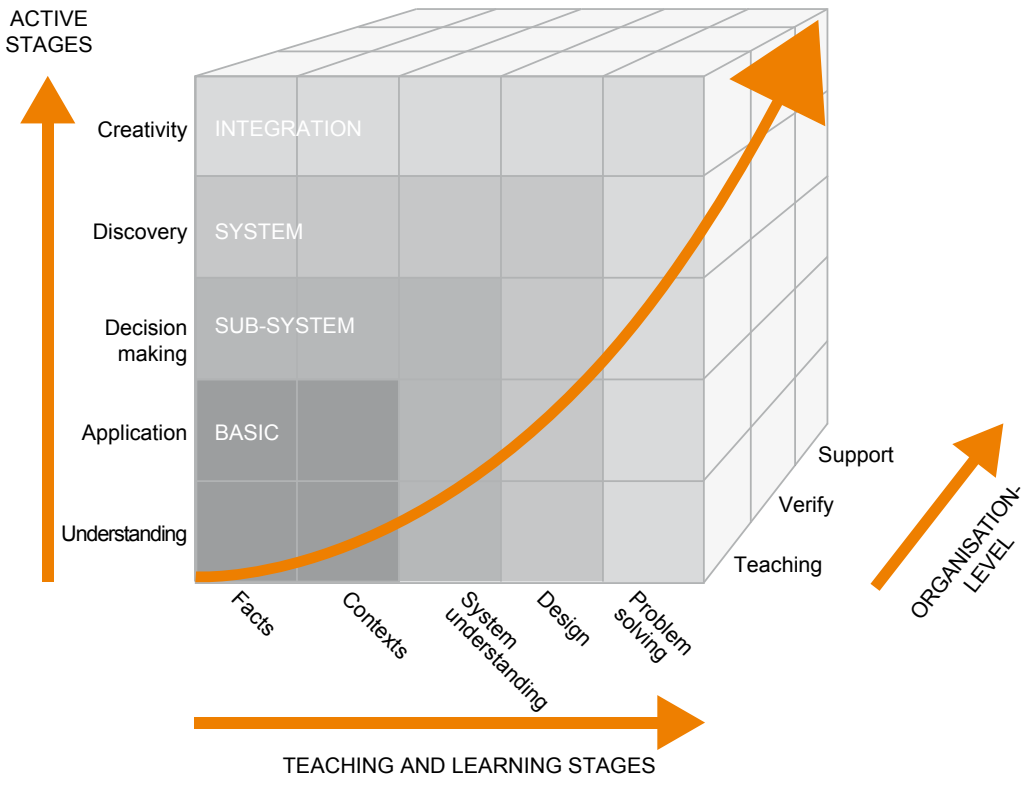
The reason for the wide variety of different systems has its basis in the complexity of the topics and the differing educational status of trainees.

UniTrain is particularly well suited for the teaching of fundamental aspects. Basic topics of electrical engineering are modelled and taught by means of countless experiments. The modular training panel systems provide step-by-step preparation for the disciplines of electricity supply, wiring installation and building management systems in both theoretical and practical spheres. The individual panels can be combined with one another.

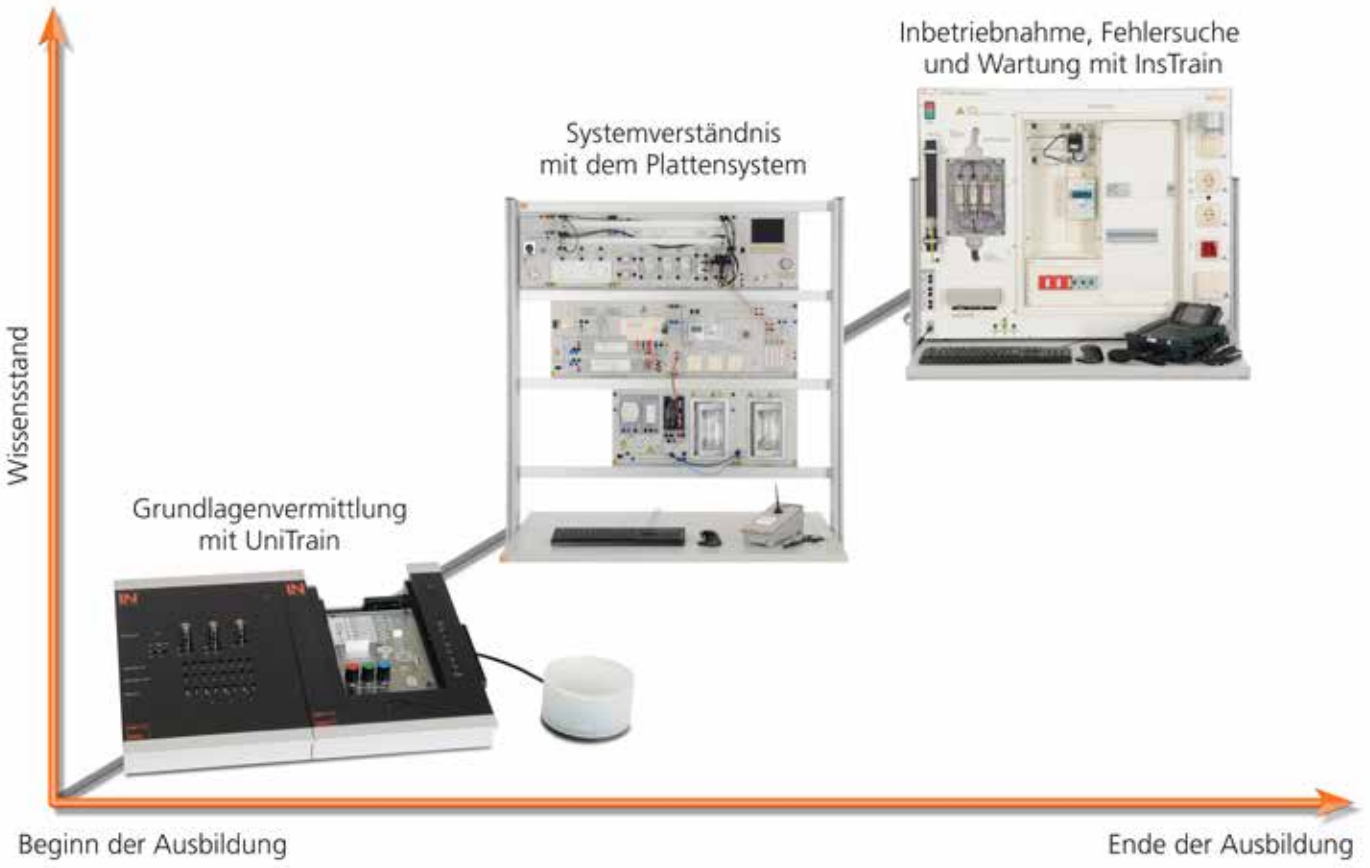
InsTrain is designed for training of installation and troubleshooting using compact training boards.

It does not matter which of the systems you choose to employ. Every one of them is supplied with an extensive multimedia course (LabSoft). These courses are conceived in such a way that students can work through the program on their own initiative.

They are taught the theory and their progress can be monitored by way of tests of knowledge. However, things do not stop at theory alone. All the experiment instructions are illustrated with the help of animations. Thereafter the experiments themselves can also be assessed.



Skills cube with active, teaching and organisational components



Training Skills

The complexity of modern wiring installations requires new ways of accomplishing their teaching. With the help of Lucas-Nülle training systems, students can learn to understand wiring installation techniques step by step.

Introduction is covered by the UniTrain system. This deals with the fundamental aspects.

The experiment hardware makes it possible to carry out electrical measurements, set parameters and test functions. Teachers and training instructors have the option to check on the progress of their students at any time with the help of Classroom

Manager (see page 14). Each course covers its own topic and thereby progresses students to the next stage of their learning development.

Once the fundamentals have been grasped, trainees can move on to using the training panels to advance their understanding of the relevant systems. They then work with typical components and equipment, which are grouped into topic areas. This enables them to learn about the operating principles, installation, usage and programming of such equipment.

InsTrain makes it possible for students to learn about putting systems into operation and keeping them maintained. Troubleshooting for faults is another aspect which is of key importance in this learning process.

All these systems are supplied with an extensive and educationally conceived multimedia course, which not only imparts theoretical background, but also incorporates tests of knowledge and instructions for practical experiments.

The training systems aid training instructors and teachers in their aims of turning students into well educated, responsible and self-reliant electricians.

Training Systems

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18 InsTrain – wiring installation training systems

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LabSoft – The Multimedia Training Platform for All LN Training Systems

Digital Learning via LabSoft

LabSoft links the experiment hardware with an educationally designed multimedia course. Users are guided step by step through the program and can develop the various skills themselves at their own pace.

Multimedia courses (ILA and UniTrain)
Technically well-founded content conveys the theory, along with practically oriented set-up instructions which guide students through the experiments. Graphics and animations enhance their understanding. Questions and assignments help monitor the students' progress.

LabSoft for all systems
The learning platform accompanies all the training systems (UniTrain, panel system, InsTrain, CarTrain etc.). That makes for rapid set-up and consistent operating methods for all users.

Navigation
The built-in navigation window on the left enables direct access to all LabSoft courses installed on the system. Thanks to the open tree structure you can navigate through to any particular section of a course.

Simulation or real modes
So that you can prepare your future practical lessons even better, you can also run LabSoft in simulation mode without any hardware. This means theoretical basics can be covered in advance, leaving more time for actual experimentation in the lab.

Virtuelle Instrumente

The "Instruments" menu option gives you full access to all the virtual instruments and power supply tools.

Speicherung

Saving measurement results is easily achieved by copying them into the relevant placeholders on the course pages by means of "drag and drop".

Support for any language
LabSoft supports any of the languages supported by HTML. You can swap between languages yourself, in order to teach examples of foreign jargon, for instance.

LabSoft in networks
You can install LabSoft directly on your own computer or onto a network. To make them easier to integrate into a modern learning management system (LMS), the, LabSoft courses are all developed to comply with international standards (SCORM).

Software-based training platform
Continuous communication between the experiment hardware and the multimedia course ensures that the learning platform can always provide the optimum experience.

Functions of LabSoft
- HTML-based multimedia courses
- All languages supported by HTML
- Animations and graphics
- Theory and lab experiments in a single learning platform
- Documentation of results
- Questions for testing knowledge
- Access to all virtual instruments
- Log-in with user data
- Choice of language
- Choice of courses
- Saving of custom learning workspaces

Aufbauanimationen

Set-up animations explain the procedure for each experiment step by step.

Wissenstests

The tests of knowledge included in the courses mean that you can continually monitor the progress of students. Not only the students themselves can see how their knowledge is progressing, but their teachers can too.

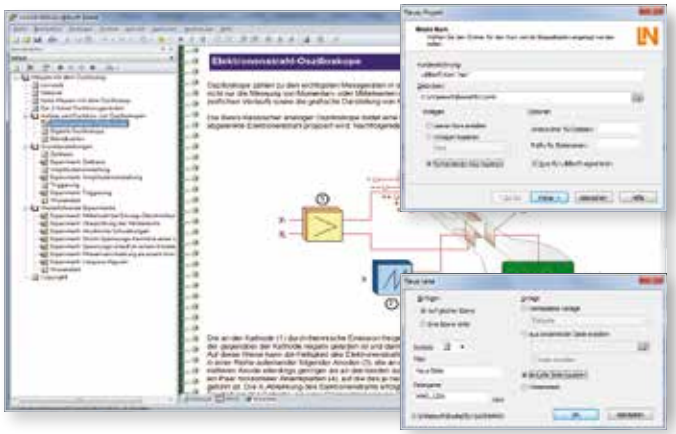
LabSoft-Classroom-Manager

Administration, Customisation, Testing and Assessment

Benefits of LabSoft Classroom Manager

- **Optimal use of resources**
  Take advantage of Classroom Manager to make best use of the training concept which underlies Lucas-Nülle's training systems.
- **Minimise administration work**
  Save on time and paper by utilising electronic management for all the LabSoft courses and all your students with the aid of LabSoft Manager. Organise content, user groups, and users themselves.
- **Consistent maximisation of learning success**
  Use the LabSoft Editor tool to modify your LabSoft courses in order to meet the current needs of your own students. Put together your own questions, experiments, measuring exercises and even your own courses, which you can instantly make available to your students.
- **Check on learning progress any time, anywhere**
  Set up your own tests in TestCreator with just a handful of mouse clicks. Use the pre-prepared assignment collections with questions and measuring exercises to test students' knowledge and skills.
- **Everything at your fingertips whenever you need it**
  It is possible to access student progress and test results at any time with the help of LabSoft Reporter. Easy-to-follow select functions quickly guide you to the desired summary.

LabSoft-Editor



LabSoft Editor provides numerous wizards to help you set up new courses and guide your students step by step through the tasks they need to accomplish.

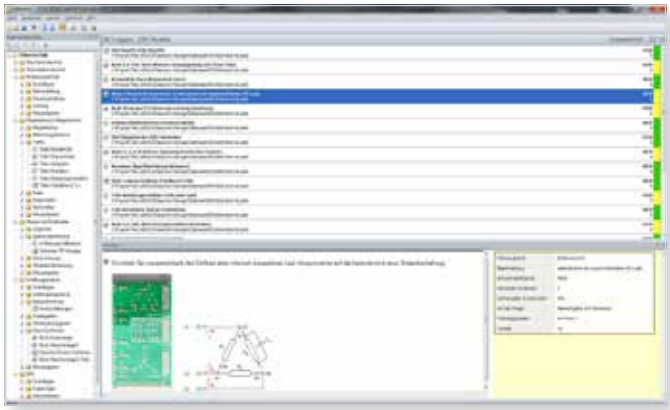
LabSoft-Questioner

To help you design questions, **measurement exercises and test assignments, LabSoft-Questioner** makes a variety of question types available. Assignments and questions can then be incorporated into courses and tests.

LabSoft-TestCreator

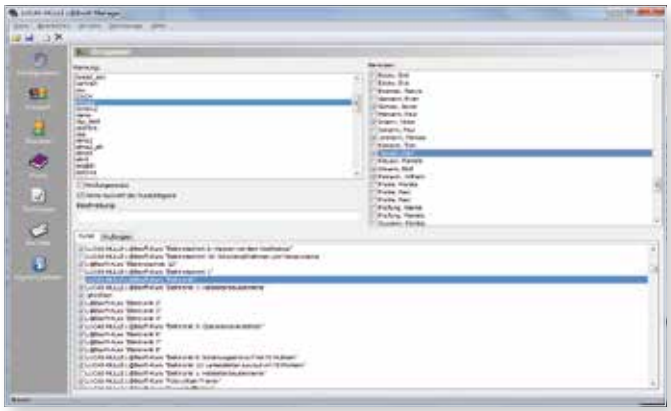
LabSoft TestCreator lets you set up tests in which knowledge and skills can both be tested simultaneously. Filter functions help you pick out the text questions, not only in manual mode but even automatically.

LabSoft-TestCreator



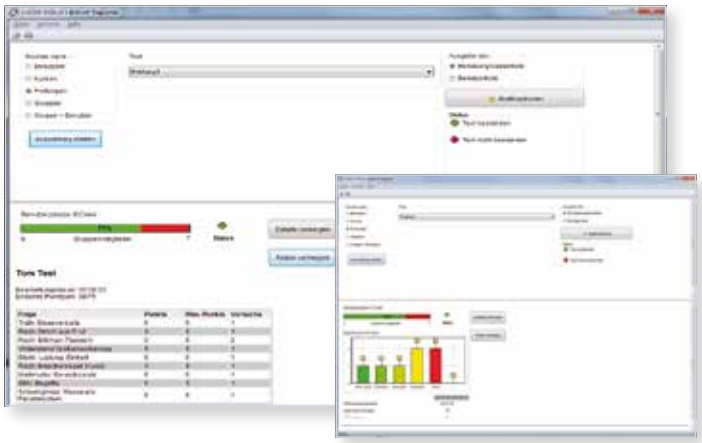
Use **TestCreator** to devise tests which are perfectly tailored to your needs in a flash.

LabSoft-Manager



Manage all your LabSoft courses, students and training groups with the help of **LabSoft-Manager**. This helps you be certain that you always have available the training content your students actually need.

LabSoft-Reporter



Learning progress and test results can be monitored and displayed using **LabSoft-Reporter**. Its numerous assessment options for individuals or group results in courses and tests enable you to carry out tailored monitoring really quickly.

UniTrain – Makes Teaching the Basics Easy

Introduction to Wiring Installation via Multimedia and Courses Reflecting Genuine Practice

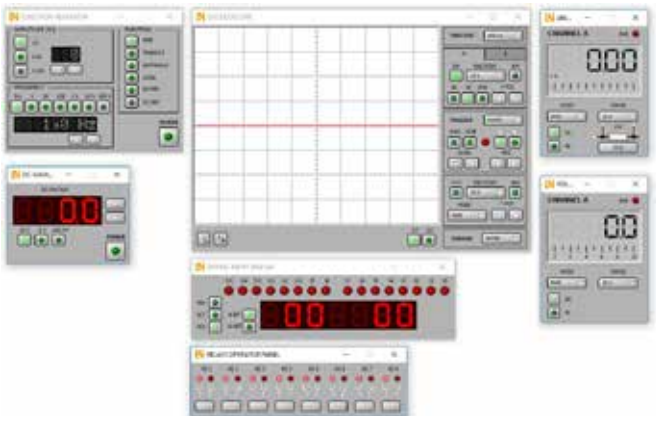
Your benefits

- Theory and practice at the same place, same time
- Excellent motivation of students with the help of PCs and modern media
- Successful results quickly thanks to structured course design
- Rapid understanding thanks to animated theory
- Practical skills trained by students carrying out experiments themselves
- Continuous feedback from questions to monitor students' understanding as well as tests of knowledge
- Guided troubleshooting using built-in fault simulation function
- Use of safety extra low voltage (SELV) keeps you and your students safe
- Huge selection of courses
- Sample solutions for teachers

The multimedia experimentation and training system UniTrain not only provides students with clearly structured course, software but also offers text, graphics, animations and tests of knowledge to guide them through the theory and the experiments.

In addition to the training software, every course is accompanied by a set of experiment cards on which the practical assignments are to be carried out.

UniTrain multimedia courses make use of countless experiments and animations to give students an insight into the current state of the art as regards the supply of electrical energy. The fundamentals of AC, DC and three-phase electricity, as well as processes involved in distribution networks and supply grids are all covered in the various courses. Typical procedures requiring special attention with regard to generation and distribution of electrical energy are handled in easy-to-understand ways in experiments using safe low-voltage electricity.



LabSoft training and experiment software

- Large selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of measurement results
- Tests of knowledge available in your own language
- Printable version of course contents

Built-in measuring instruments and power supplies

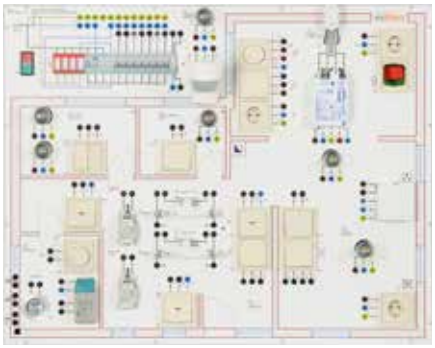
- Multimeters, ammeters, voltmeters
- 2-Channel oscilloscope
- Function and waveform generator
- Three-way power supply for AC and DC
- Three-phase power supply
- ... and many more instruments

InsTrain – The Multimedia Wiring Installation

Training in Electricity Supply and Wiring Installation with "InsTrain" (Installation, Troubleshooting, Maintenance)

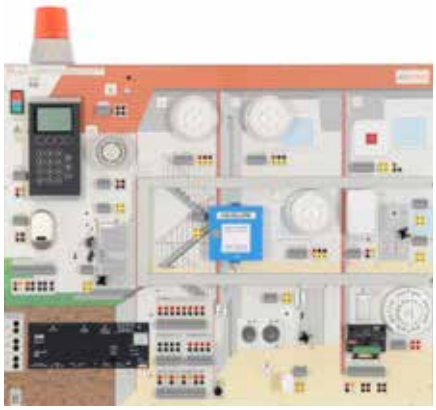
Building supply feed

Industrial supply feeds



Lighting and appliance circuits

Communications technology



Hazard alarm systems

Electric vehicles

InsTrain – The Multimedia Wiring Installation

Training in Electricity Supply and Wiring Installation with "InsTrain" (Installation, Troubleshooting, Maintenance)

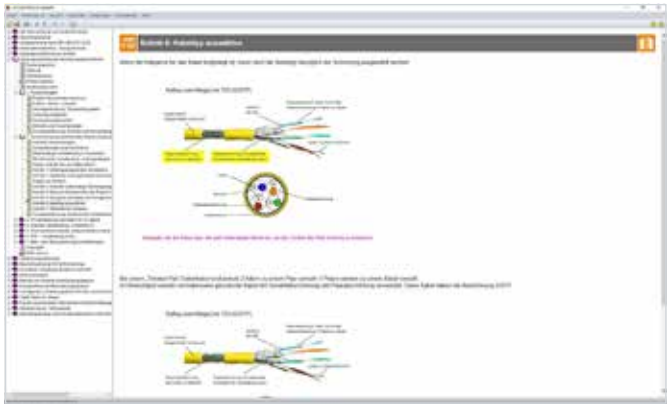
The InsTrain wiring installation training systems show trainees how to install and maintain various wiring circuits. This is essential so that they can assess the functionality and safety of existing installations. With the support of a built-in fault simulation capacity, students receive a variety of assignments, which they must accomplish using typical measuring instruments as well as compiling suitable documentation.

A host of systems for training wiring installation in buildings are available for use with the InsTrain training platform, always accompanied by the Labsoft multimedia training platform and courses covering all the various areas of electrical wiring installation.

InsTrain wiring installation training systems help cement skills not just by imparting the theoretical background, but also guiding students through numerous measuring exercises on pre-prepared installation set-ups. This is aided by connecting the wiring installation training systems to a measuring interface and learning platform software. With the help of virtual measuring instruments as well as using real, commercially available equipment, it is possible to analyse installations and save measurement results direct to the training platform.

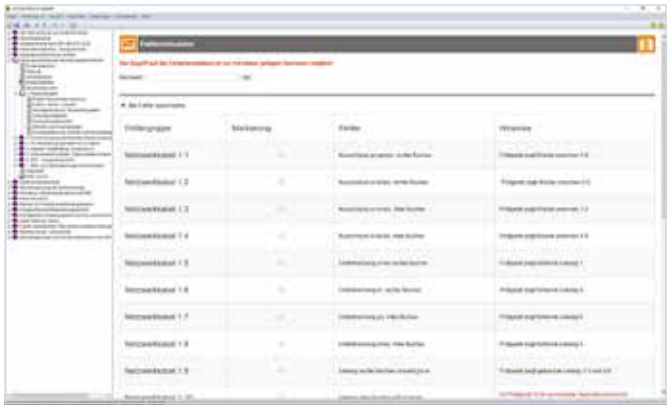
Installation

InsTrain wiring installation training systems work with commercially available equipment, which initially needs to be installed and put into operation. LabSoft courses accompany this procedure, providing the necessary theoretical background in a way which is easy to understand.



Troubleshooting

All InsTrain systems are equipped with built-in fault simulation capacity. This means that all the experiments can be carried out not only on a fault-free installation, but also with common faults deliberately introduced. By combining faults in various ways, it is possible to set up a wide range of training exercises.



Measurement

Every wiring installation training system has its own intelligent interface connected via USB. In combination with the system's virtual instruments, this provides some really high-quality measuring equipment.

With the help of virtual measuring instruments as well as using real, commercially available equipment, it is possible to analyse installations and save measurement results directly to the training platform.

Training Panel Systems – Perfect for Modular Training

Versatile and Flexible Modular Systems

Flexibility

Whether you use them for classroom lessons or practically oriented student experiments, training panel systems allow you to employ many different teaching and learning methods. The height of these experimentation panels corresponds to the familiar A4 format. This makes it easy to mount them in the specially designed frames.

One of the key conceptual features of Lucas-Nülle training systems lies in their direct link to authentic practice. All LN systems are constructed using components commonly used in industry. The measurements involved in the various experiments are carried out using commercially available measuring instruments.

Modularity and Versatility

The popular A4 dimensions, in conjunction with a console-type housing makes for a universal training system, which can be used as stand-alone or combined with other training systems.

The time it takes to set the systems up is reduced to a minimum, so that best use can be made of lesson time. There are training panels available for practically all topics relating to wiring installation for buildings.

Safety

All the necessary terminals are implemented using safety sockets.

Where terminals handle safety extra-low voltage (conforming to VDE 0100), they are implemented using 2-mm safety sockets. Voltages in higher ranges use 4-mm safety sockets.

Easy To Understand

The new generation of panels with colour printing on the front offer an even more easily understandable design which can feature a photo-realistic look.

In the development of the LN training panels, particular attention was paid to printing symbols and labelling of terminals in full compliance with the applicable standards.

LabSoft

The training panels also benefit from support by LabSoft. The ILA courses go hand in hand with the hardware and clearly demonstrate theory, installation and operation. The measuring lab using both virtual and real instruments allows for experiments to be carried out which closely follow authentic practice. Plenty of pictures, videos and animations make the theory and practice equally clear. That is how LabSoft and the experiment panels together make up a multimedia learning platform.

Your benefits

- Versatile and flexible thanks to modular design
- Suitable for student exercises and demonstration purposes
- Reliable safety thanks to double insulation (safety sockets and leads)
- Incorporation of industrial equipment means the systems can be used as they typically are in industry
- Easily understood thanks to high-contrast, scratch-resistant printing on the front of the panels
- Modern measuring instruments linked to PCs
- Colour experiment and technical practice manuals
- LabSoft courses can be readily combined
- Student worksheets and sample solutions

Installation Practice Systems

Panel Frame Systems for Installation Practice

These systems, along with the relevant practice resources, allow for rapid assembly of circuitry and measuring exercises.
The perforated metal panels are made of 1.5-mm-steel sheet with powder coating.

Your benefits

- Planning and execution of projects
- Training in the subject of connectors
- Close relevance to authentic practice thanks to typical technical documentation and software
- Circuits are implemented using components typically used in practice.
- Complete project documentation

The perforated panels to which the equipment is to be mounted are fitted between the rails of the training panel frames.

This means it is possible to work with a combination of A4 training panels and perforated panels accommodating installation components.

The system of interchangeable frames means the attachable perforated panels are simply mounted in front of the aluminium profiles of the frames.

So the experiment panels and perforated panels can be swapped over more quickly.

The walk-in installation cabin acts as a base for installation projects in an environment which closely resembles practice.

Its own assembly and dimensions are selected in such that students can work in it without injuring themselves no matter how complicated the assignment (ceiling installation, corners etc.)

Wiring Installation for Buildings

30 Fundamentals of electricity supply and wiring installation

40 General wiring installation for buildings

66 Building automation/smart homes

82 Building communications

92 Building security

98 Industrial wiring installation

110 Renewable energies/environmental protection

120 Supplementary sets

132 Matrix of sets for topic areas

Building Wiring Installation in Changing Times

It is not that long ago that it was necessary to get up and flick a switch to turn the lights on and off. If you left the house having forgotten to turn off the coffee machine or the radiator, they remained switched on until you got back.

The electrical wiring only had to guarantee that there was sufficient electricity for household appliances and lights. It was simple and its structure was obvious. It would include:

- Installation of wiring
- Assembly of distribution boxes, overload current protection, RCDs and other circuit breakers
- Lights, appliances, electrical machines, sensors (motion sensors or dimmer switches), switches, push-buttons and socket outlets
- Subsequent measurement to check the effectiveness of the protective systems.

Nowadays people are woken in the morning by soft music, the blinds open automatically, lights are turned on gently and the coffee machine starts brewing of its own accord. When you leave the house, all the appliances and lights turn off as if by magic and the blinds roll down by themselves.

Climate change and the ever advancing demand for more comfort and safety mean that we can no longer talk of mere electrical installation, but instead about **building management**.

New technologies have made buildings with all these benefits possible:

- Greater energy efficiency
- More comfort
- Adaptability to residents' own uniquely different requirements
- And ever more safety.

Thus, in addition to the traditional activities of electricians, these new challenges are redefining the area of building management:

- Networks
- Automation
- Control systems
- Visualisation of lighting, heating, solar energy, safety and security, entertainment electronics, information technology and telecommunications systems

Lucas-Nülle is helping to incorporate the aspects of such change into education.

Our training systems are equipped with the latest technology and state-of-the-art systems. Technically thorough literature in the form of multimedia courses accompanies the hardware. This gives you the optimum basis for keeping yourself up with the latest developments and providing your students with up-to-the minute education.

Fundamentals of Electricity Supply and Wiring Installation

32 DC circuits

33 AC circuits

34 Three-phase circuitry

35 Measuring with multimeters

36 Magnetism/electromagnetism

37 Electromagnetic compatibility

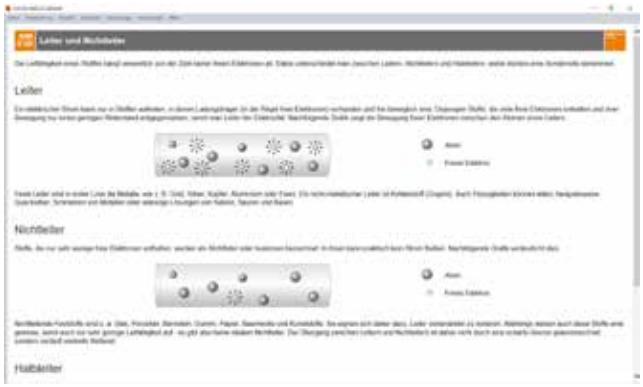
38 Circuit analysis

39 Lighting systems

DC circuits

Current, Voltage and Resistance in Circuits

Learn about current, voltage and resistance, the foundations of electrical engineering, in hands-on fashion. The course covers the fundamental laws of electrical engineering in numerous easily understood experiments, animations and textual explanations.



Topic

EBT 1 | EGT 1

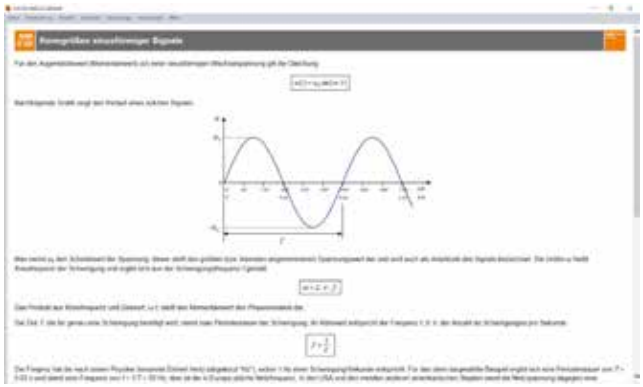
Training contents

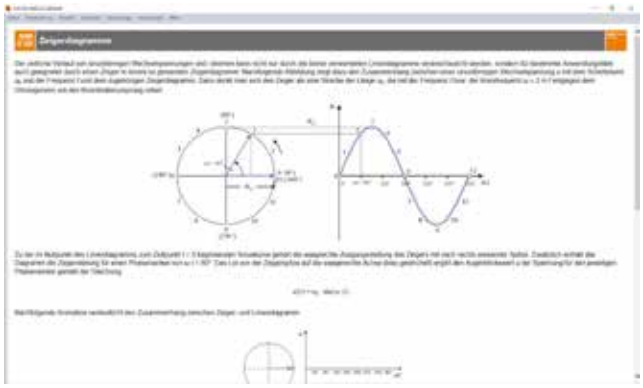
- Basic terminology: Electric charge, electric field, current, voltage, resistance and power
- Handling of power sources and measuring instruments
- Experimental demonstration of Ohm's law and the laws of Kirchhoff
- Measurements on series and parallel circuits as well as voltage dividers
- Recording of characteristics for variable resistors (LDRs, NTC and PTC thermistors, VDRs)
- Investigation of coils and capacitors in CD circuits
- Troubleshooting

AC Circuits

Inductance, Capacitance, Resonant Circuits, Transformers

How do coils and capacitors respond to alternating current? What is a resonant circuit and how do transformers work?





Topic

EBT 1 | EGT 1

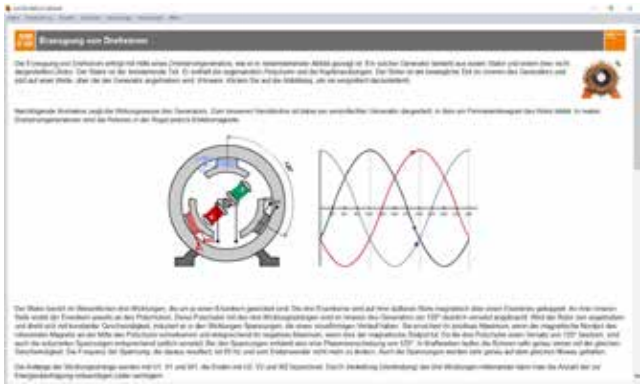
Training contents

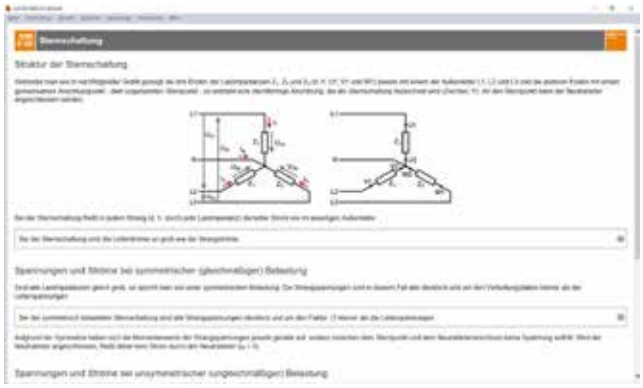
- Characteristic parameters of periodic and sinusoidal signals
- Dealing with vector diagrams
- Experimental determination of reactance for coils and capacitors
- Explanation of reactive, reactive and apparent power
- Determination of frequency bands for simple filter circuits
- Electric resonance circuits: Resonance, quality, band width and cut-off frequencies
- Measurement of frequency response in series and parallel circuits
- Load, open-circuit and short-circuit measurements
- Frequency response of transformers and repeaters
- Troubleshooting
- Course duration: 8 hour approx. (including about 1 hour of troubleshooting)

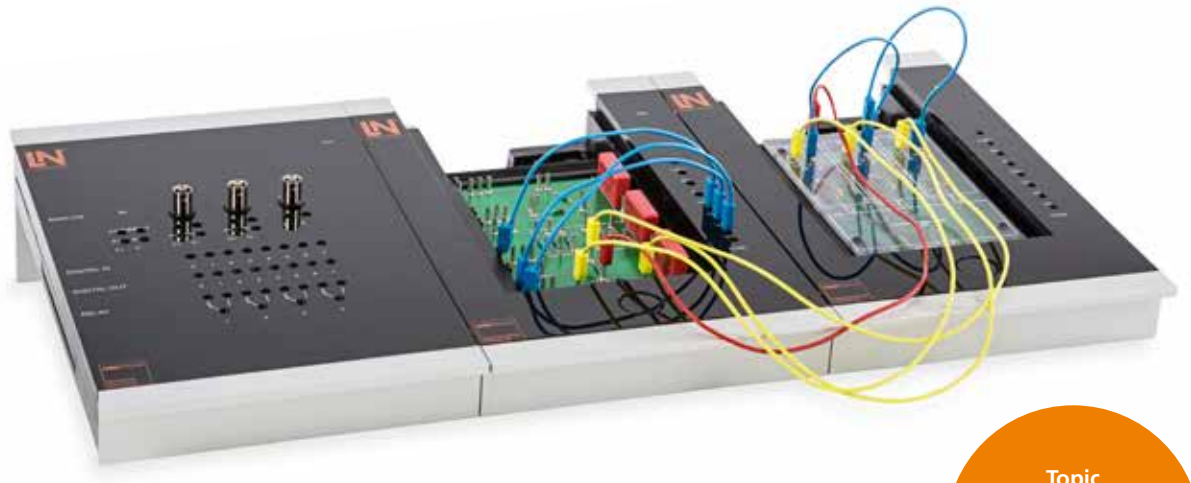
Three-Phase Circuitry

Star and Delta Circuits, Three-Phase Generators

Three-phase electricity is of outstanding importance for supply of electrical energy and for electric drive systems. It plays a key role in the generation and the transmission of electrical energy, as well as in the operation of powerful, industrial machines.







Topic

EBT 1 | EGT 1

Training contents

- Measurement of phase-to-phase and line-to-line properties in three-phase electricity networks
- Experimental verification of laws concerning line-to-line and phase-to-phase voltages
- Resistive and capacitive loads in star and delta configured circuits
- Phase shift between line-to-line and phase-to-phase voltages
- Measurement of compensating currents in a neutral conductor
- Effect of breaks in neutral conductors
- Measurement of current and voltage with symmetric and asymmetric loads
- Measurement of power consumed by three-phase loads
- Course duration: 4 hours approx.

Measuring with Multimeters

Measurement of Current, Voltage, Resistance and Diodes

How to do proper measurements and work safely – this course teaches safe handling of commercially available multimeters by means of countless measuring exercises and animations.

Topic

EBT 1 | EGT 1

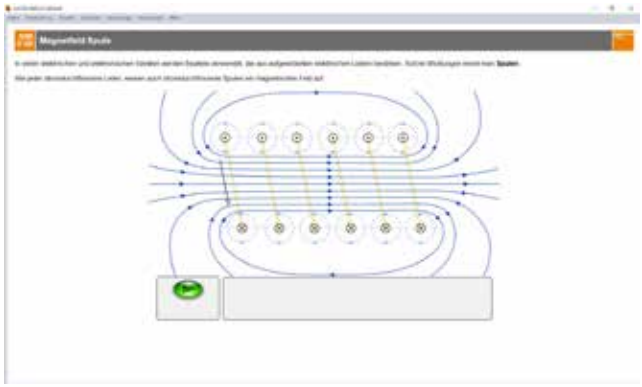
Training contents

- Getting to know the controls of a multimeter
- Hazards during measurements of electric circuits
- Measurement of AC and DC voltages with a multimeter
- Measurement of AC and DC current with a multimeter
- Measurements on resistors and diodes
- Zero calibration and continuity measurements
- Adapting measuring ranges
- Identifying possible sources of error in measurements
- Identifying components of an unknown circuit by means of current and voltage measurements
- Course duration: 3 hours approx.

Magnetism/Electromagnetism

Magnetic Fields, Induction, Circuit Components

Magnetism and electricity are very closely linked. Many electric components make use of (electro-)magnetic effects.



Topic

EBT 1, 3

EGT 1, 3

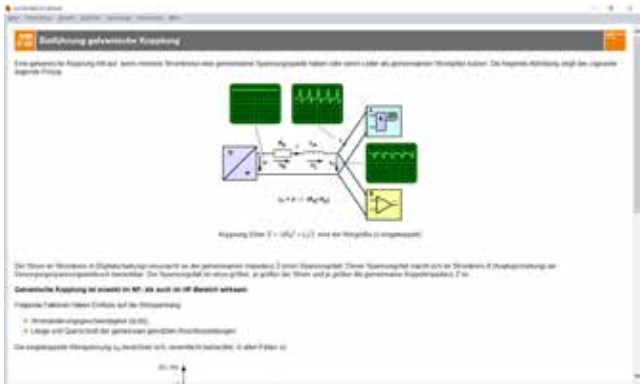
Training contents

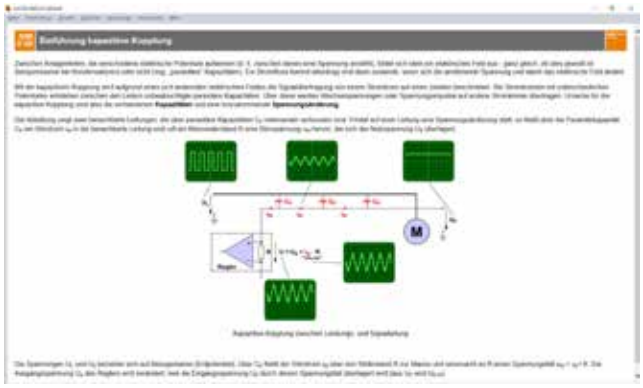
- Magnetism: Magnetic poles, magnetic fields, field lines and field strength
- Hard and soft magnetic materials, hysteresis
- Investigation of the magnetic field associated with a current-carrying conductor
- Investigation of the magnetic field associated with a coil (filled with air or with a metal core)
- Electromagnetic induction and the Lorentz force
- Investigation of a transformer under various loads
- Design and function of electromagnetic components: Relays, reed switches, Hall switches
- Investigation of applied circuits
- Course duration: 4 hours approx.

Electromagnetic Compatibility

Galvanic, Capacitive and Inductive Coupling

This course conveys fundamental knowledge concerning electromagnetic compatibility (EMC) in both theory and practice. Practical investigation of coupling mechanisms (galvanic, inductive and capacitive) form the focus of the course.





Topic

EBT 1, 3

EGT 1, 3

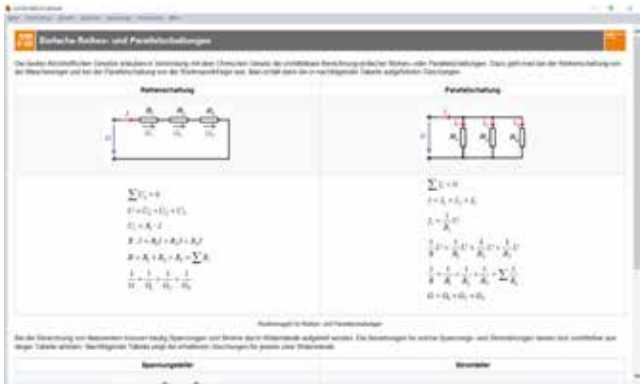
Training contents

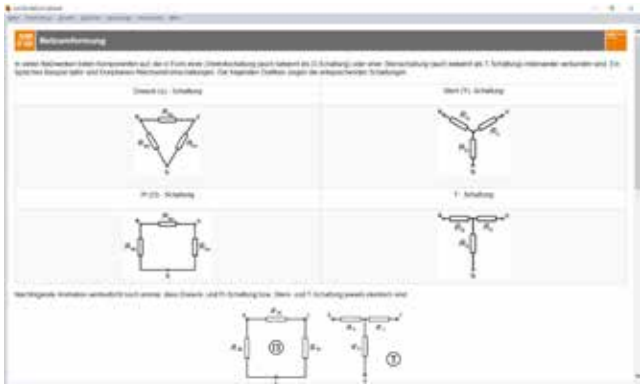
- Introduction to EMC
- Models of EMC influence
- Basic terminology and definitions
- Coupling mechanisms
  - Galvanic coupling
  - Inductive coupling
  - Capacitive coupling

Circuit Analysis

Analysis of Component Networks

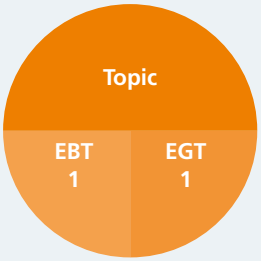
This course conveys fundamental information about the analysis of DC circuits. This involves introducing and experimentally verifying various analytic methods which help us to understand the distribution of voltage and current, even in circuits with complex networks of components.





Training contents

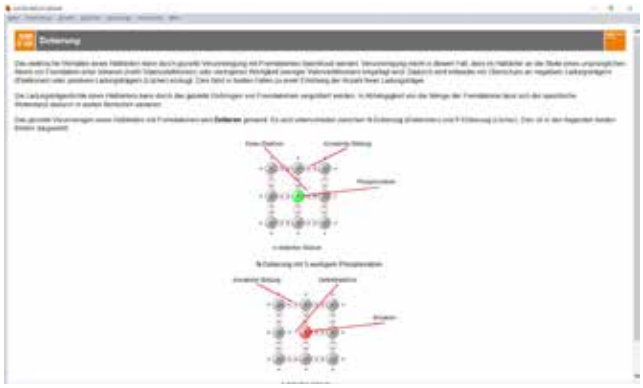
- Basic equations for electrical component networks
- Power compensation
- Network reshaping (conversion from star-delta and delta-star configurations)
- Principle of superposition
- Cross-section method
- Equivalent sources (Thevenin, Norton and Millman theorems)
- Methods using Kirchhoff's second law (loop or mesh law)
- Methods using Kirchhoff's first law (junction or node law)



Lighting Systems

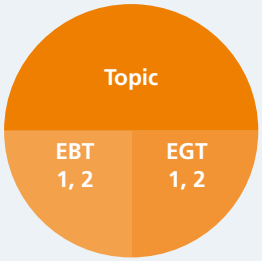
LEDs

Light emitting diodes are playing an ever more important role in lighting installations. In particular, their energy-saving properties and compact construction are paving the way for innovative changes in lighting technology. This course explains how LEDs works and ways they can be used. Among other things, the contents covered include topics like current consumption, brightness, colour mixing and colour recognition.



Training contents

- Familiarisation with various types of LED
- Brightness control for various LEDs using PWM
- Recording characteristics and measuring brightness
- Additive colour mixing and establishing colour temperature
- Recognition and reproduction of colour
- Course duration: 10 hours approx.



General Wiring Installation for Buildings

42 Protective systems conforming to VDE/EN

54 Lighting systems

60 Installation practice systems

Protecting Systems Conforming

Key Standards Applicable to Education of Electricity Supply Electronics Engineers

Laws and regulations, e.g. Germany's ArbSchG., BetrSichV., TRBS, DGUV and standards

VDE 0100 part 600/EN 60364-6 VDE 0105/EN 5010	VDE 0701-0702	VDE 0113 / EN 60204

Inspection

Testing and active measurement

Measurements with no voltage present

R_{low} – Measurement of protective earth, grounding and equipotential bonding conductors as well as continuity of connections to casings and people's bodies

R_{iso} – Measurement of all active conductors with respect to PE and each other (excluding national NC connection)

Measurements with voltage present

Measurement of tripping conditions for protective circuitry Z_{Loop} or Z	Measurement of current in protective earth conductor I_{PE}	
Measuring and testing of RCD parameters t_a and I_Δ	Measurement of contact current I_B	Testing of voltage and residual voltage
Measurement of voltage, voltage drop and three-phase rotating field – U, ΔU and U_B	Optional testing of PRCDs, where present	Measurement of tripping conditions for protective systems, Z_{Loop}
Measurement of earth resistance – R_E		Optional high-voltage testing

Documentation and archiving

Protective Measures and Earthing Systems

This training system lays down a basis for understanding safe handling of current and voltage. Specifically for career electrical engineers, but in other professions as well, being able to handle electric current and voltage safely is of key importance. How such safe handling can be guaranteed, which protective measures need to be taken and how installations are tested can all be experienced by students themselves.

Topic

EBT 1, 5

EGT 1, 5

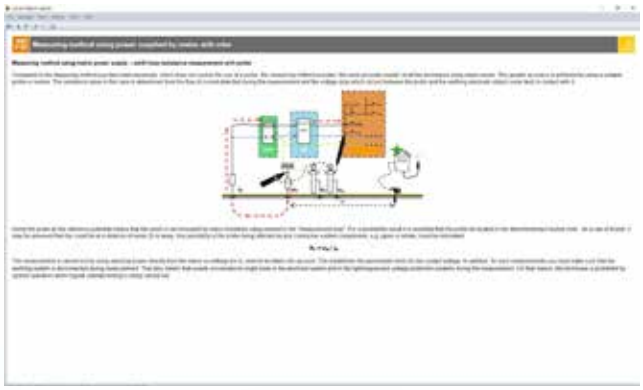
Training contents

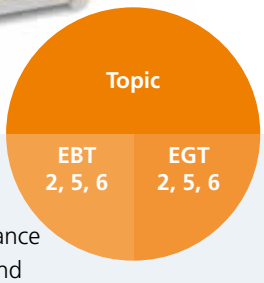
- Design of various earthing systems (TN, TT, IT)
- Protection against direct and indirect contact with electricity
- Protection via isolation
- Protection via safety extra-low voltage (SELV)
- Excess current protection systems
- Leakage current protection (RCDs)
- Measurements and investigation of protective systems
- Measurement of protective earth resistance
- RCD testing with and without tripping
- Measurement of earthing electrodes

Protective Systems Conforming

Earthing systems and protective measures

The topic of protection against excessively high current in the event of contact (protection in compliance with VDE 0100) is essential for anyone whose profession deals with installation, operation and repair of electrical systems, in particular for students studying for professions of this kind. This training system offers optimum support for both theoretical and practical lessons to teach protective measures complying with VDE 0100 or other national standards for existing types of earthing. The direct relationship to real professional practice is one of the key features of LN training systems. The measurements made in the individual experiments are carried out using commonly available measuring instruments.





Training contents

- Various earthing systems used in consumer installations (TT-, TN-, TN-C-, TN-S-, TN-C-S or IT systems)
- Variety and operating principles of various protective systems in networks with different earthing systems
- Familiarisation with various protective systems and how they should be tested using appropriate instruments
- Execution of initial testing and subsequent repeat tests in accordance with DIN VDE 0100-600
- Testing of RCDs
- Measurement of loop impedance Local insulation impedance and insulation resistance
- Hazards of electric current
- Advising and instructing persons about the hazards associated with electrical installations
- Assessment of measurements and targeted fault finding
- Compilation of documentation and test reports
- Continuity of equipotential bonding conductors

Testing of Protective Systems for Machines and Plantin Compliance with VDE0113/EN60204

As a supplement to the topic of testing protective measures in compliance with DIN VDE 0100 or other national standards, which is a fundamental prerequisite in the sphere of electrical engineering, another topic has been specially developed for electronics engineers working in applications engineering, for those working on appliances and systems and also for"mechatronics" engineers who need to understand about protective measures for machines and plant complying with European standard EN60204 (VDE113). The board helps to impart the individual steps involved in measuring and testing to this standard and particularly the differences from pre-existing standards, such as Germany's VDE 0110.

Topic

EBT 2, 5, 6

EGT 2, 5, 6

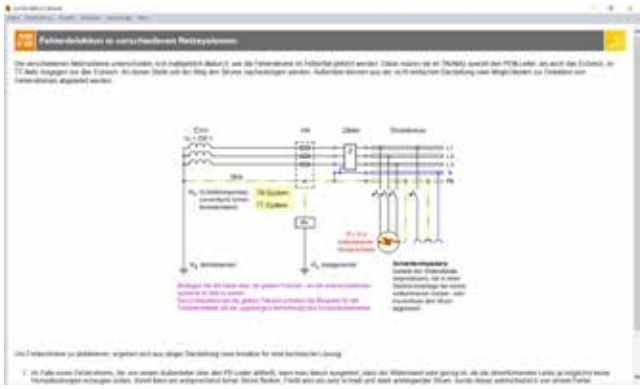
Training contents

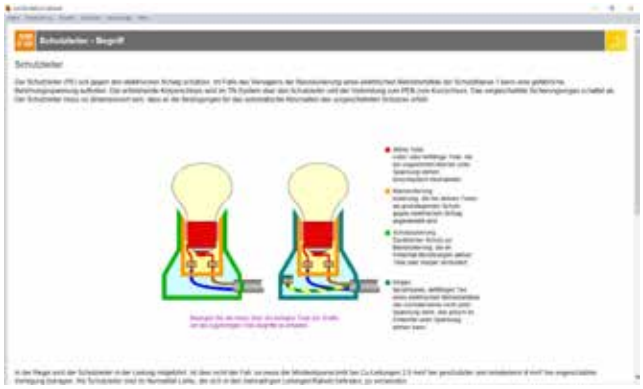
- Inspection of installations to be tested
- Identifying the correct testing standard to be used for the equipment in question
- Establishing the necessary measurement and testing steps from the applicable standard
- Execution of measurements
- Interpretation of measurement results
- Application of secondary measuring methods under specific conditions.

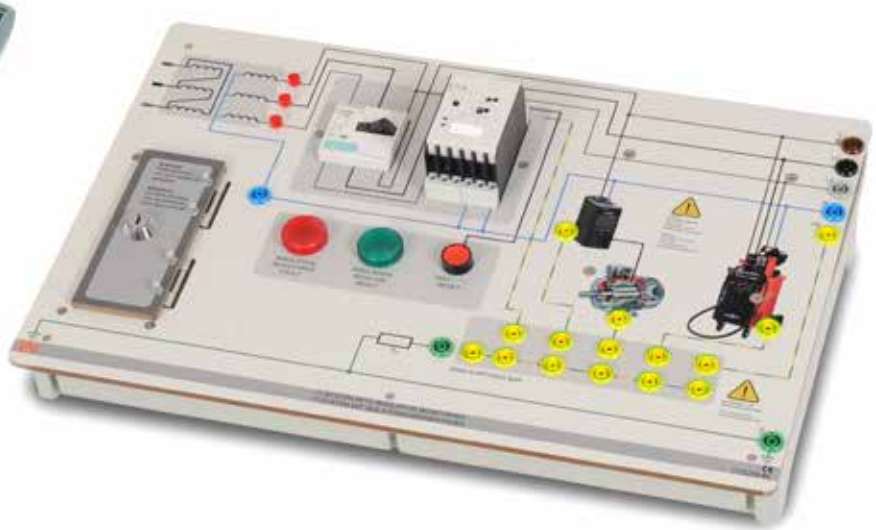
Protective Systems Conforming

IT Systems

IT systems involve a particular kind of earthing mechanism, which is primarily used in stand-alone installations, such as in mining, remote electricity provision for the military or emergency supply of power to hospitals. It is a kind of earthing system which makes very specific demands of trainees. The board is equipped with an isolating transformer and an insulation monitor. Additional fault simulation capability and simulations of various applications make it possible to carry out initial and repeat testing in compliance with DIN VDE 0100 under a variety of different conditions. In conjunction with other components it is possible to implement quite extensive project assignments.

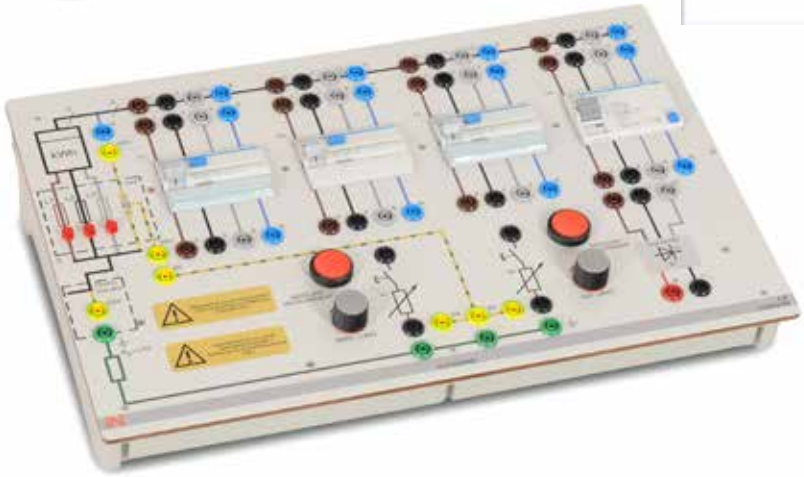






Protection via RCDs as per VDE/EN

The RCD board demonstrates the design and operating principle of various RCDs (residual current protective devices) and how to wire them together sensibly. The following training contents can be taught with the help of the RCD board: RCD boards in TN or TT systems, measurement and assessment of tripping parameters (time, leakage), effect on tripping parameters of altered resistance values (Rloop, RE). Learning differences, between various types of RCDs, type A and type B. Tripping parameters for Type B RCDs Investigation of selectivity for RCDs connected in series. Measurement of leakage current in the event of AC fault currents, pulsing DC fault currents and pure DC fault currents.



Topic

EBT 2, 5, 9

EGT 2, 5

Training contents

- Design and operating principle of various circuit breakers/RCDs
- Use of RCDs with various earthing systems (TN, TT)
- Selection of correct RCDs to match your application (DIN VDE 0100-530:2005-06)
- Design of selectively staged leakage current protection (DIN VDE 0100-300:1996-01)
- Use of RCDs for additional protection in compliance with DIN IEC 60364-4-41 (VDE 0100-410)
- Use of type B RCDs in classrooms (DIN VDE 0100-723)
- Use of type A or type B RCDs for various types of fault current
- Measurement and assessment of various tripping criteria for DC and AC

Protective Systems Conforming

Equipment Simulator Set for Measuring Exercises Conforming to VDE 0701-0702

All electrical appliances in public and commercial use need to be continuously inspected. The required regular testing and specific tests following any repairs or modifications to electrical equipment are specified in standards and regulations. Only trained electricians are permitted to undertake such tests. An expert level of technical knowledge is needed for this. Terms referring to protection class, protective earth and insulation resistance need to be familiar, as well as the associated permissible for these aspects. Knowing how to handle appropriate measuring instruments makes it easier for their users to assess electrical appliances. Built-in fault simulation makes it possible to undertake tests of appliances under a variety of simulated operating conditions.

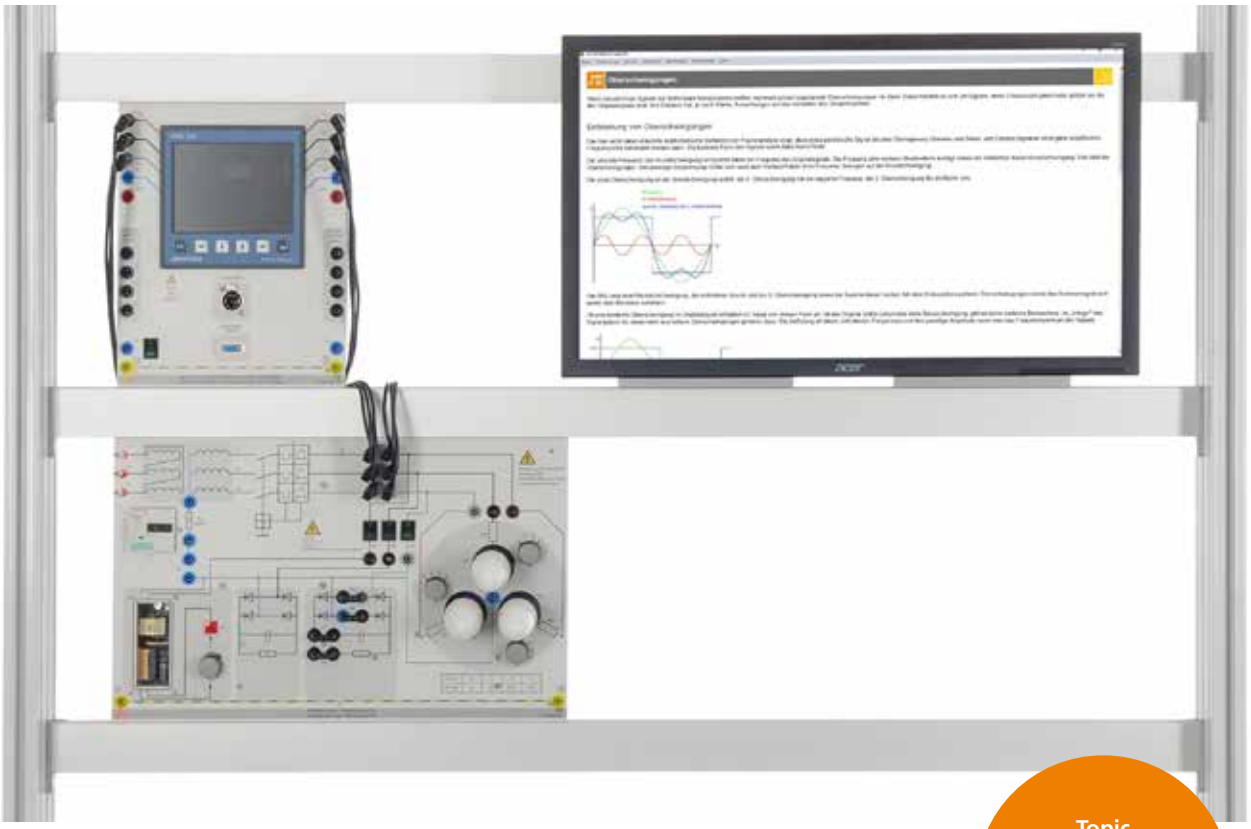
Topic	
EBT	EGT
5, 6	5, 6, 10

Training contents

- Understanding legal prerequisites
- Devising test procedures
- How to adapt measurements as appropriate for equipment in protection classes I, II, III
- Assimilating data from rating plates
- Selecting suitable testing and measuring instruments
- Carrying out various measurements
- Compiling test reports
- Assessing measurements in accordance with standard stipulations, such as those of BDV A3 and VDE 0701-0702
- Systematic troubleshooting of electrical components

Mains Quality and Loading of Neutral Conductor

Consumption of non-sinusoidal current by electronic equipment, starting of large electric motors and asymmetric distribution of load or switching operations can lead to damaging feedback effects on the mains electricity grid and therefore diminish the quality of the mains supply itself. Similar symptoms can be caused by quality shortcomings of your own making, such as poor choice of conductor cross-sections, non-compliance with selectivity requirements and incorrect wiring of PEN conductors. In order to recognise the effects and make appropriate assessments of them, it is essential to carry out thorough analysis of the power supply network by measurement.



Topic

EBT	EGT
2, 5	2, 5, 10

Training contents

- Additional loading due to asymmetry
- Additional loading due to non-linearity
- Non-linear lighting equipment
- Dangers of overloading
- Mains quality

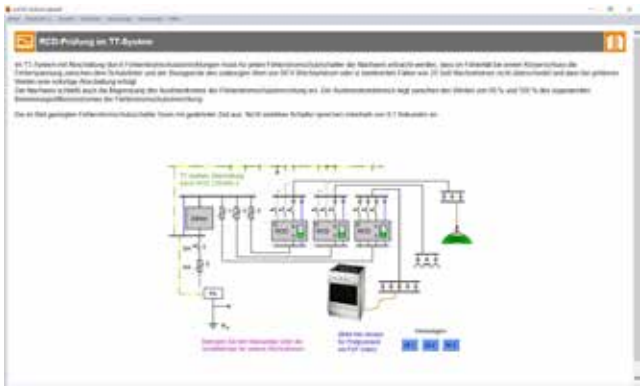
Protective Systems Conforming

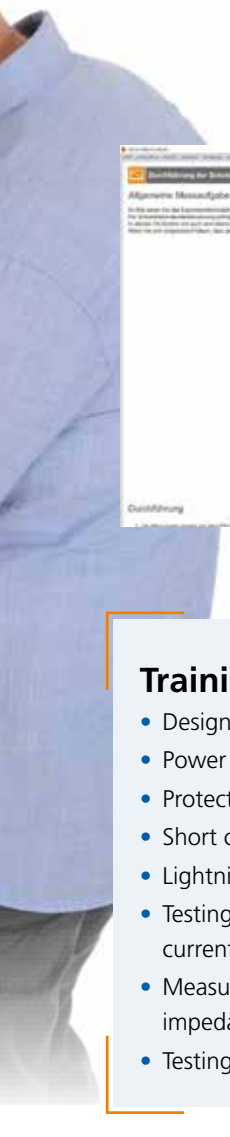
Building Power Feed (Service Entry Point)

The „Building power feed“ wiring installation training system is concerned with the electricity supply service entry to a building and how it is connected to the building‘s own electrical installation, as well as how this system should be set up and tested according to regulations. Several experiments related to authentic practice are already included. The fault simulation capability incorporated into the hardware makes it possible to set up various measuring exercises to be carried out by students themselves. Distribution grids, power feeds (service entry points) and consumer systems are all dealt with, taking into account the specific protective measures they require.

Experimenting, Learning, Testing and Understanding

In order to make a clear assessment regarding the functionality and safety of existing electrical installations, the following aspects need to be considered:
The system must be made operational. Then extensive function testing must be carried out. It is often necessary for all the documentation to be revised or rewritten from scratch. Afterwards fault analysis must be undertaken, along with rectification of any faults identified. Then a hand-over report must be completed in compliance with requisite standards. The extent of the responsibility testers need to accept is further underlined to the customer by the requirement for them to put their own signature to the handover report.





Topic

EBT 1, 3, 5, 9

EGT 1, 3, 5

Training contents

- Design of public electricity grids
- Power feed, energy distribution
- Protective measures against electric shock
- Short circuits, faults to frame, faults to ground
- Lightning and excess voltage protection
- Testing of electrical installations in compliance with currently applicable standards
- Measurement of insulation, earthing systems and loop impedance
- Testing of rotating field
- Measurements on protective earth and equipotential bonding
- Operating principles of conventional and electronic electricity meters
- Testing of protective systems according to regulations for initial and repeat tests
- Sub-distribution, planning and installation
- Network systems
- Testing of TN/TT systems
- Testing of residual current protective devices (RCDs)

Protective Systems Conforming

Industrial Power Feeds

The power feed to an industrial, electricity distribution or sub-distribution system differs in many aspects from feeds to domestic or commercial buildings. The main differences are not only in the design of such systems but in their use of different components and the different installation regulations which apply. The training model is intended to provide direct practical experience for a career as an electronics engineer in applications engineering
or as a mechatronics engineer. For example, by contrast with domestic buildings, it is essential to use RCDs of different types (type B and type F RCDs). This inevitably gives rise to more stringent demands for special knowledge of how to test such systems when carrying out initial or repeat testing.

The InsTrain systems for instruction in industrial power feeds thus represent the crown of the InsTrain multimedia training platform. Its specialised training and learning environment allows for targeted education, specifically aligned to authentic practice tailored to the career for which the training is devised. All the benefits of LabSoft multimedia training software are also implemented in the models. The equipment always features fault simulation capability with PC support and all the now familiar PC measuring inputs.

Topic	
EBT 1, 3, 5, 10	EGT 1, 3, 5

Training contents

- Design of public electricity grids
- Power feed, energy distribution
- Protective measures against electric shock
- Short circuits, faults to frame, faults to ground
- Lightning and excess voltage protection
- Testing of electrical installations in compliance with currently applicable standards
- Measurement of insulation, earthing systems and loop impedance
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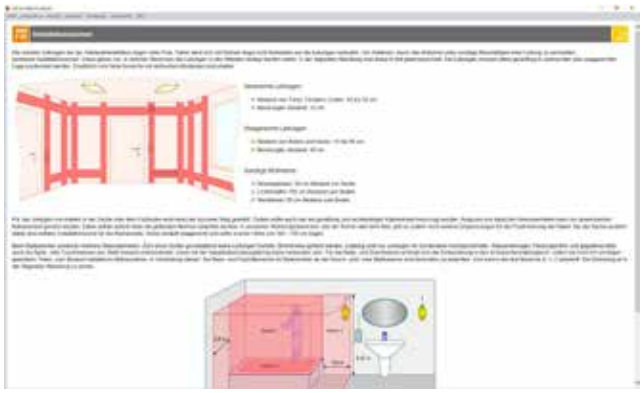
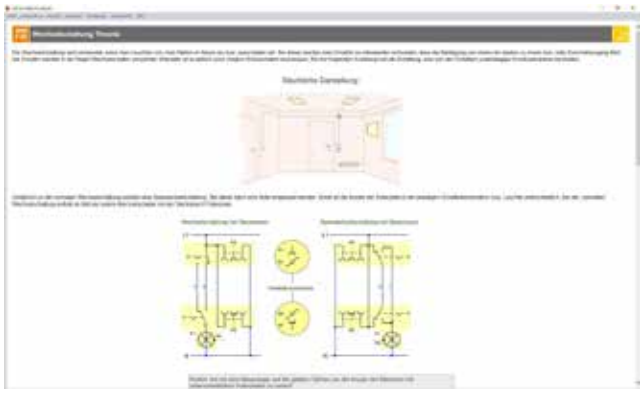
- Testing of TN/TT systems
- Testing of residual current protective devices (RCDs)

Lighting Systems

Electrical Installations for Houses and Buildings

The systems on the topic of conventional lighting implementations feature all the standard wiring installation circuits. Setting up and working with various types of circuit diagram, along with deriving the necessary wiring of the experiments from them, make for an ideal introduction to wiring installation and form the basis for more advanced topics and more complex system circuitry.





Topic

EBT 1, 2, 5, 9

EGT 1, 2, 5, 9

Training contents

- Analysis of wiring installation plans
- Lighting circuits including simple on-off circuits, sequenced switch circuits, intermediate and multi-way circuits with and without earthed socket outlets
- Standards, guidelines and protective systems

Energy-Efficient Lighting

Electricity is the engine driving a sophisticated and modern society. Its use and provision is an outstanding and pioneering achievement. Unfortunately, though, many pieces of operational equipment work inefficiently and thus waste more energy than necessary. This unnecessarily increases their impact on the environment.

Lighting accounts for about 15% of global electricity consumption. With more efficient lighting technology it is possible to make considerable reductions in electricity consumption, thereby helping the environment, reducing energy costs but also providing better quality of lighting.

This course shows how existing lighting can be optimised to save energy by the use of energy-efficient lighting technology.

Topic

EBT 1, 2, 5, 9

EGT 1, 2, 5, 9

Training contents

- Lighting components their properties and efficiency in saving energy
- Dimming techniques/types of dimmers, operating components
- Proper use of lighting and operating components including dimmers
- Foundations of lighting management (DALI)
- Diagnostics using ammeters/voltmeters and oscilloscopes

Lighting Systems

Metal Vapour Lights

Discharge lamps operating under various degrees of pressure are commonly known as metal vapour lights because they contain metal vapours in addition to inert gases. Such lights are particularly characterised by their excellent efficiency, along with high light output and are therefore very popular for use in places where a lot of light is needed. For this same reason they are less prevalent in more domestic settings. In industry, though, as well as for lighting of roads and conurbations, they are an essential part of the modern scenery. In this course you will learn how metal vapour lights work and how they are installed.

Topic

EBT 1, 2, 5, 9

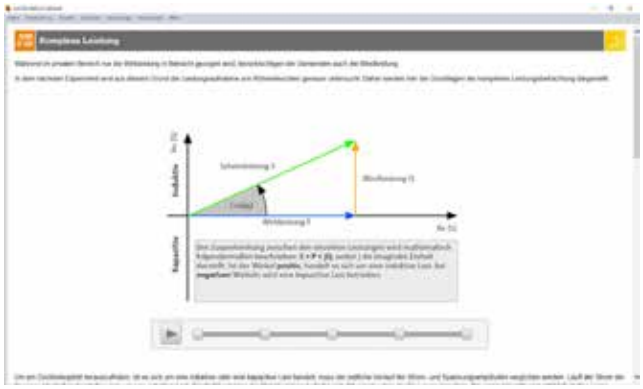
EGT 1, 2, 5, 9

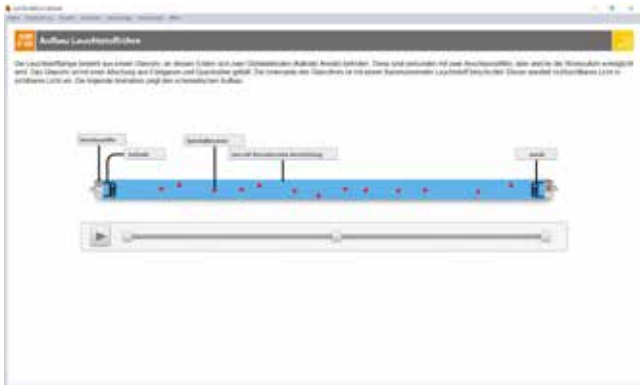
Training contents

- Halogen-metal vapour lights, high-pressure sodium metal vapour lights
- Operation with conventional ballast
- Operation with electronic ballast
- Control via DALI in conjunction with a DALI controller

LED Tube Lights Using DALI

Fluorescent lamps are favoured for use in office spaces and industrial premises as well as in large public buildings. Their advantages are obvious: They are inexpensive, work efficiently and have relatively good colour rendering.





Topic

EBT 1, 2, 5, 9

EGT 1, 2, 5, 9

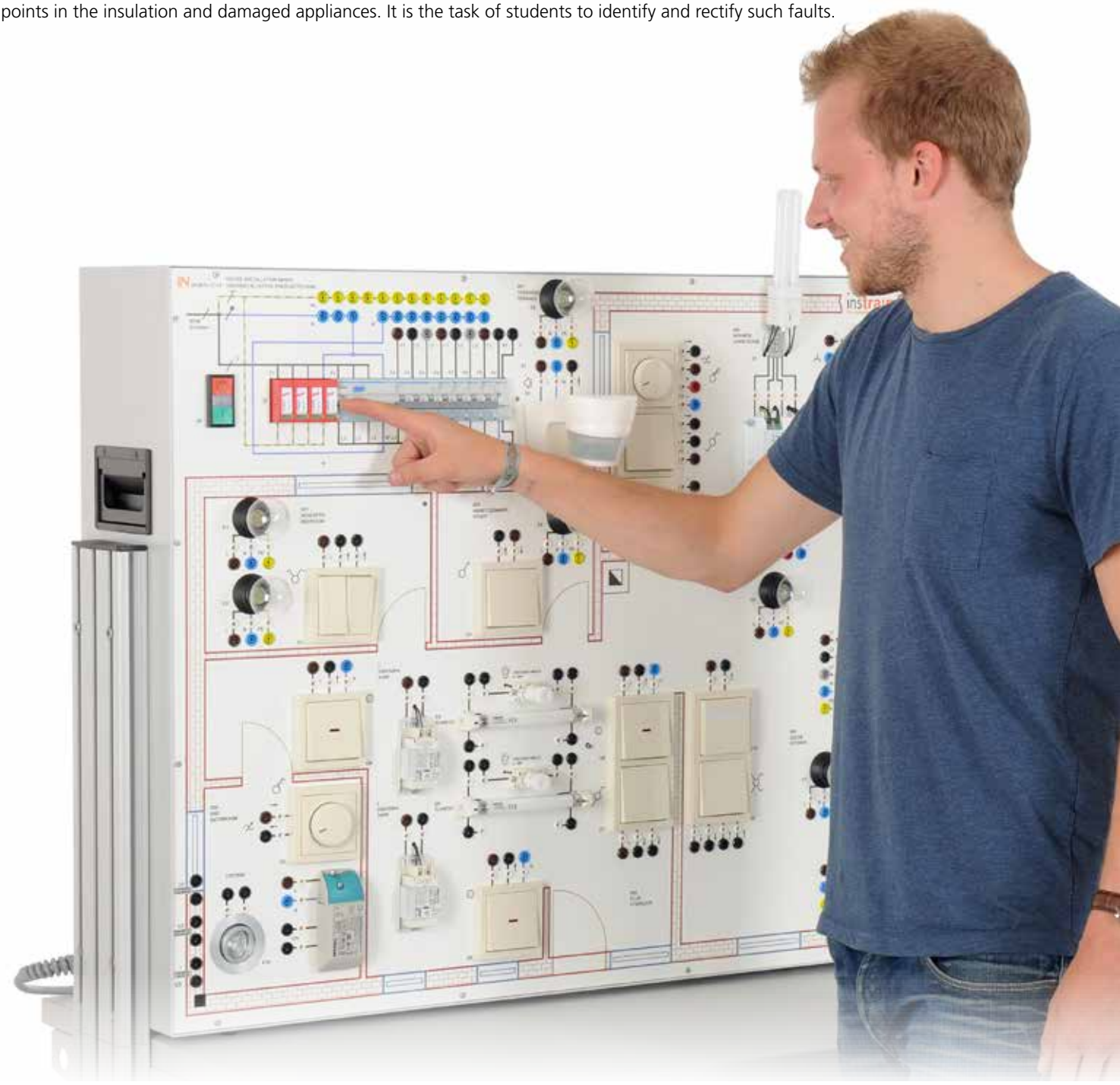
Training contents

- Turning fluorescent lights on and off
- Tandem and dual circuits for fluorescent lights
- Compensation for fluorescent lights
- Swapping ordinary ballast components for DALI ballasts
- Replacement of fluorescent tubes with LED tubes

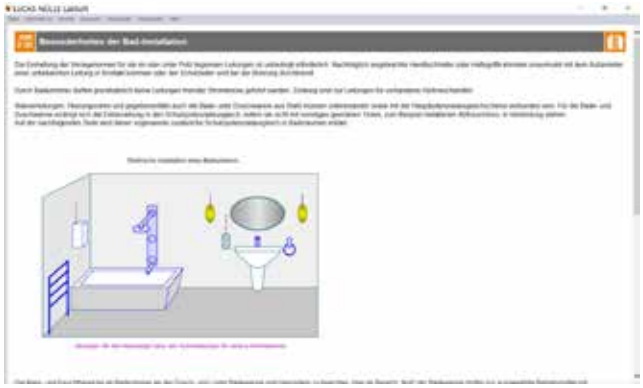
Lighting Systems

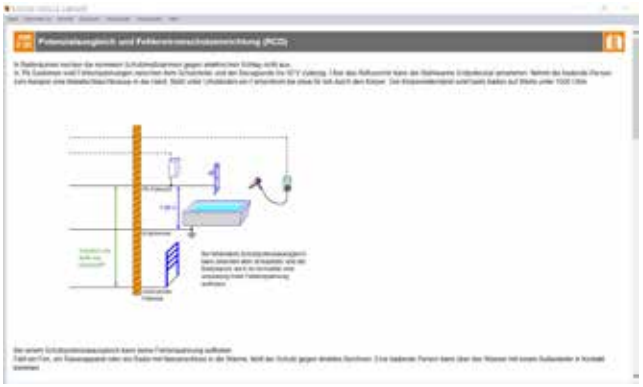
Circuits for Lighting and Appliances

The wiring installation training system for lighting and appliance circuits deals with planning, implementation and testing of common installation circuits. The system models the wiring installation for a complete building. The inter-meshing of theory and practice elements means that this module ideally meets the demands for vocational training presented by the new shaping of electrical careers. Software activates real faults which are typical in installations, such as short circuits, faulty protective earth conductors, weak points in the insulation and damaged appliances. It is the task of students to identify and rectify such faults.



Customer job orders determine the working and business procedures on the job. They exemplify the practical relevance to professional careers. Working through complex, joined-up projects, with a customer job order forming the basis, requires focussed thinking, as well as personal responsibility and action. This means students gain skills, team capability, customer-oriented outlook and also take responsibility for their own learning.





Topic

EBT 1, 2, 5, 9

EGT 1, 2, 5, 9

Training contents

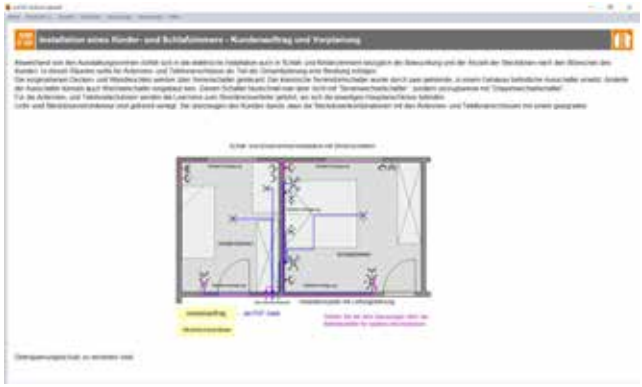
- Planning of a full electrical installation for a residence
- Research and preparation for customer consultations
- Testing economy of various circuits
- Compiling lists of equipment
- Calculation of costs for sub-projects and full installations
- Contract completion and execution of installation work
- Initial testing of an electrical installation in compliance with DIN VDE 0100-600
- Hand-over and instruction of customers about the installed systems
- Installation of many varied applications
- Protective measures against electric shock
- Testing of residual current protective devices (RCDs)
- Lightning and excess voltage protection
- Measurements in compliance with DIN/VDE standards
- Documentation, hand-over, test report and customer instruction

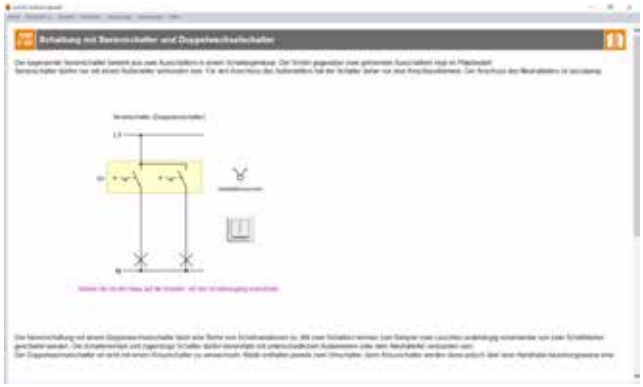
Installation Practice

Building Power Feed and (Sub-)Distribution Boxes

Whereas the other wiring installation training systems focus on investigating existing installations or identifying and rectifying faults specifically introduced using the fault simulation capability, this project puts the learning of hands-on skills in the forefront. The students learn in a realistic way how they should plan, implement and test installations by themselves.

The learning project is primarily concerned with teaching such hands-on skills against the background of implementing a customer job order. Various types of installation and wiring which are common in practice also form part ofthe training content, as do measurements, testing and reporting.





Topic

EBT 1, 2, 5

EGT 1, 2, 5

Contents

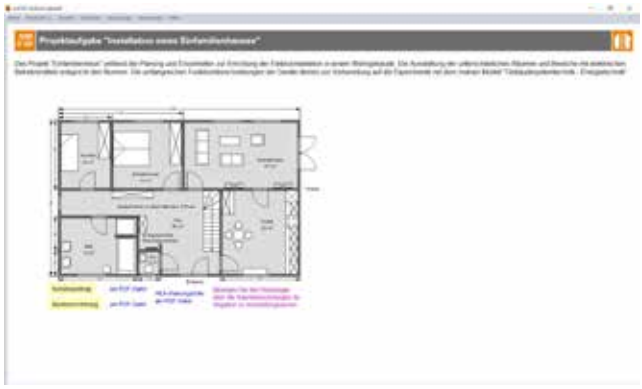
- Planning and installation of a building power feed
- Completing a customer contract
- Devising working procedures for installation of a primary distribution box (consumer unit)
- Familiarisation with various components of the electrical power feed to a building
- Use of and compliance with standards, guidelines
- Installation and wiring of various components
- Learning professional skills for working with original components
- Measurement and testing of installed systems
- Compilation of test reports in compliance with DIN/VDE standards

Installation Practice

Installation of Components Embedded in Plaster

In addition to planning work, it is necessary to choose, from the many different components and resources available, the ones which are right for the job at hand. The installation is carried out both on the front panel using components designed to be embedded in the wall and plastered over, as well as on a perforated grid on the rear with equipment to be installed on top of the plaster. All installation circuits come together at the distribution box (consumer unit).

Dealing with planning documentation, plus planning of time and work are at the focus of this project. Students will carry out the installation using various wiring methods, in compliance with standards and in keeping with the job order. They will then test the circuitry according to VDE regulations and hand over the system to the customer, in addition to giving appropriate instruction to them.



Topic

EBT 1, 2, 5

EGT 1, 2, 5

Contents

- Planning and installation of a building power feed
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- Use of and compliance with standards, guidelines
- Installation and wiring of various components
- Learning professional skills for working with original components
- Measurement and testing of installed systems
- Compilation of test reports in compliance with DIN/VDE standards

Installation Practice

Building Wiring Installation

Example of one learning project: The stairway of a multi-storey building under construction is to be lit with multiple lights and provided with a stairway lighting circuit controlled by time-delay relays. On each floor there should be a push button switch, while the cellar is to have fluorescent tube lighting rather than standard lights. In addition, the basement floor is to have two socket outlets which can be switched on or off from different locations.

Topic

EBT 1, 2, 5

EGT 1, 2, 5

Training contents

- Practice in stripping wires
- On-off circuit (for tube installation)
- Pulsed operation, latching relay circuit with socket outlet
- Functions and implementation of automatic circuit breakers
- Wiring methods using components embedded in plaster or fitted on top with loose cables or wiring conduits
- Testing and commissioning of circuits in accordance with installation plans or circuit diagrams
- Implementation of circuits using conduits or loose cable installation for fluorescent lights
- On-off and dual light and ballast circuits for fluorescent light plus socket outlet
- Tandem circuit for fluorescent lights plus socket outlet
- Bending wires and making eyelets along with wiring exercises
- Sequence, multi-way and intermediate lighting circuits with socket outlet
- Stairway lighting timer circuit with time-delay relay

Building Power Feed Systems (Service Entry Points)

Example of one learning project: A power feed distribution box with an electricity meter is to be installed in a new building. Particular attention needs to be paid to compliance with applicable regulations. Protection is to be provided by means of fuses, automatic circuit breakers and RCDs.

Topic

EBT 1, 2, 5

EGT 1, 2, 5

Training contents

- Installation, assembly and wiring of a meter cabinet with a sub-distribution box
- Installation of an electricity meter
- Installation of RCDs, circuit breakers, etc.
- Practice in stripping wires
- Wiring methods for installations fitted on top of the plaster using loose cables or conduits
- Functions and implementation of automatic circuit breakers
- Installation of various earthing systems for the power feed to a building


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Building Automation/Smart Homes

68 Bus/radio systems

72 Smart homes

78 Interfaces/gateways

Bus/radio systems

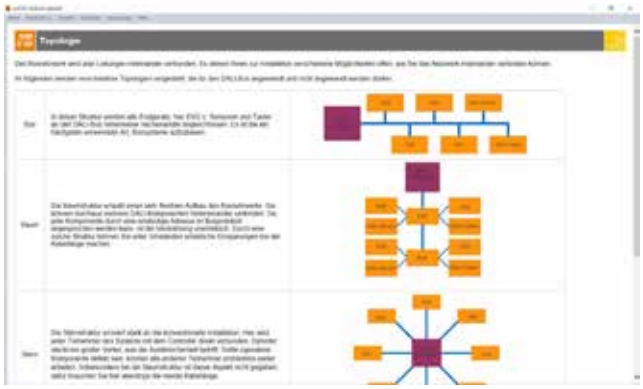
DALI and EnOcean

Simply turning lights on and off is not enough in this day and age. Modern lighting systems use open- and closed-loop control to operate lights in a way that saves energy, meets specific needs and provides the utmost degree of comfort.

This course shows how intelligent lighting management works using the DALI bus and EnOcean radio systems.

Various sub-projects are implemented in order to see how a lighting system meeting various requirements is assembled and installed. By using sensors and setting up lighting scenarios, the lights are controlled as needed with individual customisation.

The training panel includes a controller, sensors, extender and buttons. It stands out for its optional programming capability, requiring no PC or a hierarchical bus system. Full configuration of the bus-controlled lighting system can be handled entirely by means of the display integrated into the controller with the help of a push-button rotary switch.



Topic

EBT 2, 9, 11

EGT 2, 9, 11

Training contents

- Knowledge of various bus systems
- Fundamental knowledge of function, design and parameter setting for a DALI system
- Operating principle and incorporation of sensors
- Creation of lighting scenarios
- Operating principle and implementation of EnOcean
- Diagnostics using ammeters/voltmeters and oscilloscopes

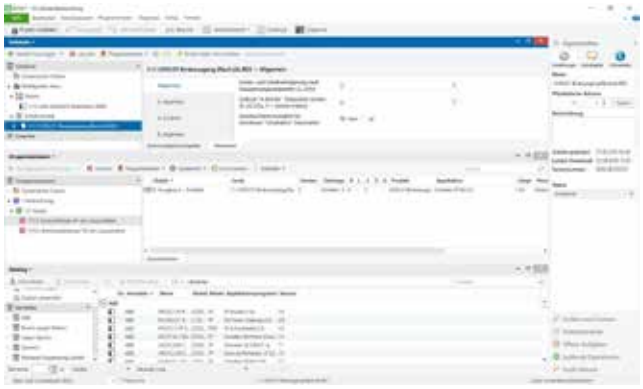
Bus/radio systems

KNX

KNX is the name of a field bus system for intelligent networking of modern residential and commercial wiring installations, which has become established throughout the world. KNX can be used to control heating, lighting, blinds, ventilation and security equipment regardless of their manufacture in a way that is fully appropriate to needs.

This training panel is equipped with commercially available actuators and sensors for a KNX bus, making it possible to carry out all the experiments on control of lights, dimming and blinds. A simulation of a room forms the basis for a project-oriented depiction of the applications.

The accompanying LabSoft course on building automation using KNX conveys all the technical content. In combination with the hardware you can work step by step through handling of the KNX software ETS 5. By means of various project assignments, you learn how to define a KNX installation, how to assemble it, set it up, configure its parameters and put it into operation.



Topic

EBT 9, 11

EGT 9, 11

Training contents

- Function and use of KNX components
- How to use ETS application software
- Assembly, parameter setting and commissioning of a KNX system
- Restructuring of an existing KNX system
- Installing lighting for a kitchen
- Central function
- Dimming
- Blinds

Smart Homes

Smart homes involve interconnection of all the electrical equipment in a residence. Controlled via a central controller and programmed accordingly, you can use a PC, a tablet computer or a smartphone to operate appliances in the home via the network. Incorporation of devices into the system, parameter setting, programming, control and indication of status are all handled by a familiar display module. By means of rules and scenarios it is possible to combine equipment and automate operating sequences.

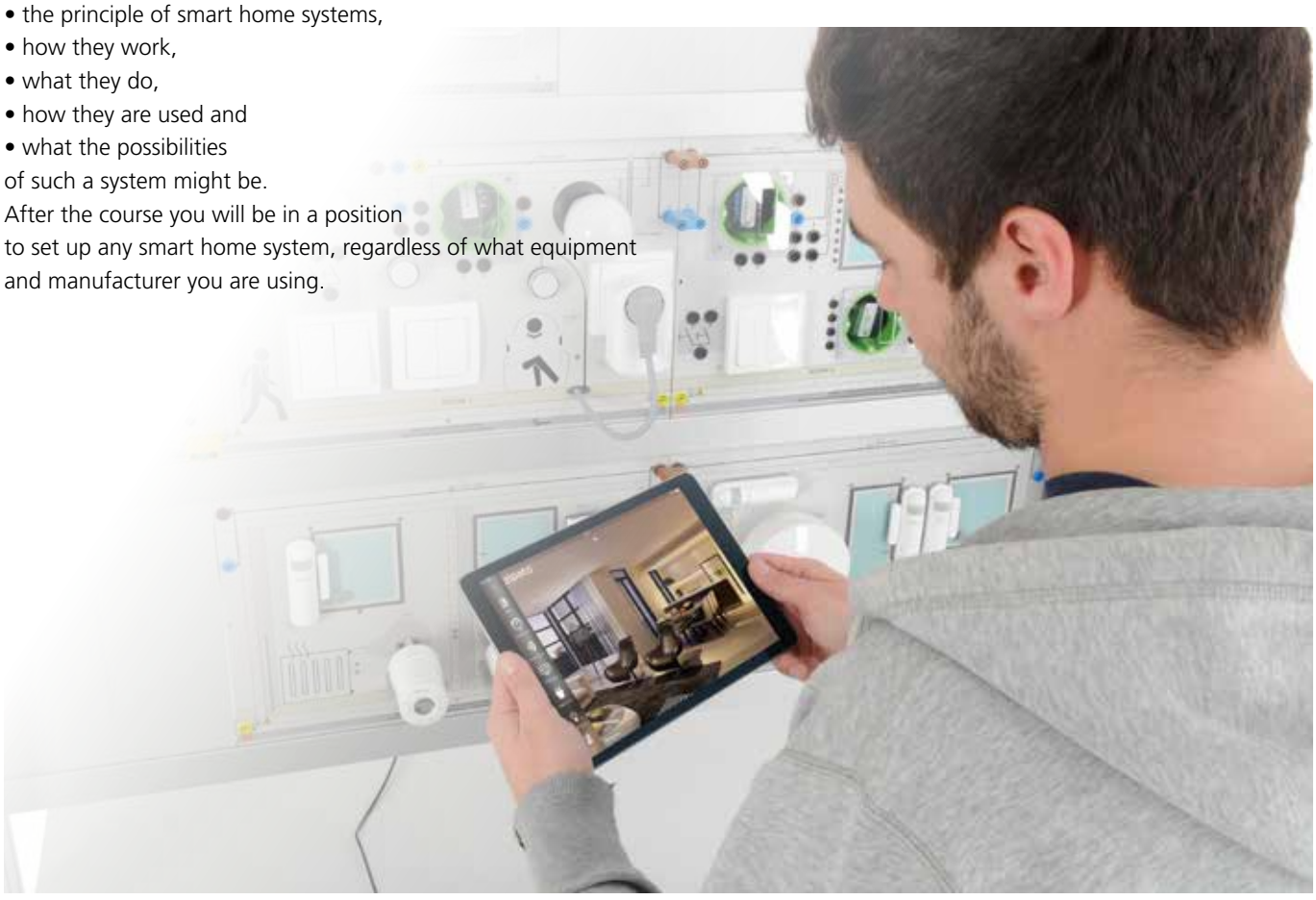
Thanks to the innovative technology, most of the devices can handle multiple functions. For example, an actuator might not just perform switching but display the current consumption as well.

Sensors might not register motion alone, but temperature and brightness too. Actuators and sensors are usually configured by setting parameters in a software program.

Adverts promise more comfort, better well-being and more security in a smart home. It sounds simple, but is it really?
Anyone looking into the business of smart homes will soon find out that
- there are lots and lots of different systems,
- lots of manufacturers,
- and lots of systems which forbid the use of other manufacturers' products.
- you can buy smart home systems almost anywhere (electrical shops, DIY shops, discount chains and over the internet),
- but there's hardly any qualified advice anywhere.

In order for you to get a better idea, we have developed a smart home training system
which explains
- the principle of smart home systems,
- how they work,
- what they do,
- how they are used and
- what the possibilities

of such a system might be.
After the course you will be in a position
to set up any smart home system, regardless of what equipment
and manufacturer you are using.



The controller for the training system is a Z-Wave controller made by Zipato. Its benefits: It means you can be flexible about how you react to the market and you can carry out a wide variety of exercises. Z-Wave is a wireless communications standard. It has been optimised for low energy consumption and security of communications. It is now used by more than 600 manufacturers and branded distributors right across the globe. Z-Wave certification guarantees that Z-Wave equipment from different manufacturers and catering for different applications will still works, together in the same, common radio network.

The Zipato controller goes even further and also enables other protocols, such as ZigBee or 433 MHz radio communication to be used. With the Zipato controller you can therefore set up a smart home network which is largely manufacturer-independent.

Zipato

Devolo

Fibaro

Danfoss

Smart Homes

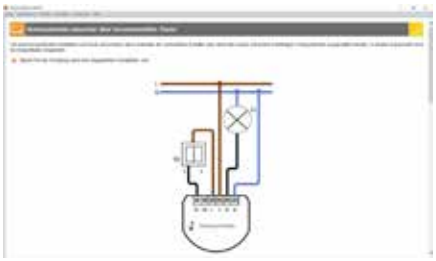
Smart Home Training System Using Radio

Our smart home training system conveys the knowledge you need to set up any smart home system regardless of manufacturer. You will gain a fundamental understanding of how to set up a network and utilise the right equipment with the right parameters. You will learn how to define automatic procedures and use applications to control all the items of equipment and visualise their operating response using tablet computers or smartphones.

The multimedia courses use many examples to guide you through the theory and practice.

The theoretical section covers all the necessary terminology which repeatedly crops up in conjunction with smart home technology:

- Network
- Controllers/actuators/sensors
- Inclusion
- Exclusion
- Scenarios/Scenes
- Apps
- etc.

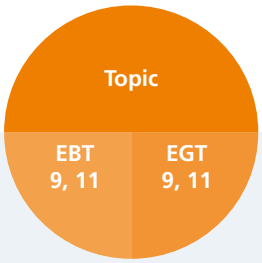


All the necessary information is provided for each experiment:

- Function and properties of equipment
- Use
- Installation
- Inclusion
- Parameter setting
- Connection to other devices
- Visualisation and monitoring

The following can be accomplished from the "My Zipato" web interface:

- Establishment of network
- Parameter setting for devices
- Creation of scenarios and rules
- Automation of procedures
- Setting of alarm system
- Definition of messages



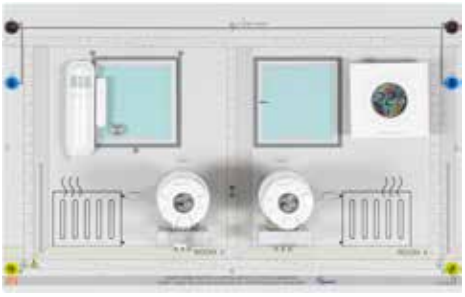
Training contents

- Fundamentals of smart home systems
- Summary of various radio systems
- Designing energy-efficient, comfortable and universally accessible homes
- Z-Wave standard
- Working with various devices (actuators, sensors) made by different manufacturers
- Structuring and implementing project work
- Versatile capabilities of smart home systems
- Set-up, parameter setting and commissioning of a smart home network

Central controller
- Functions of central controller
- Setting up a network
- Operating the application

Lighting control
- Conversion of existing lighting installations to radio control and their automation
- Inclusion of sensors (light, temperature, motion)
- Enhancement of existing lighting installations with radio components (radio switches and LEDs)
- Creation of scenarios

Control of blinds and shutters
- Installation of a shutter actuator
- Inclusion and parameter setting for a shutter actuator
- Control of roller shutters depending on time, weather and lighting conditions



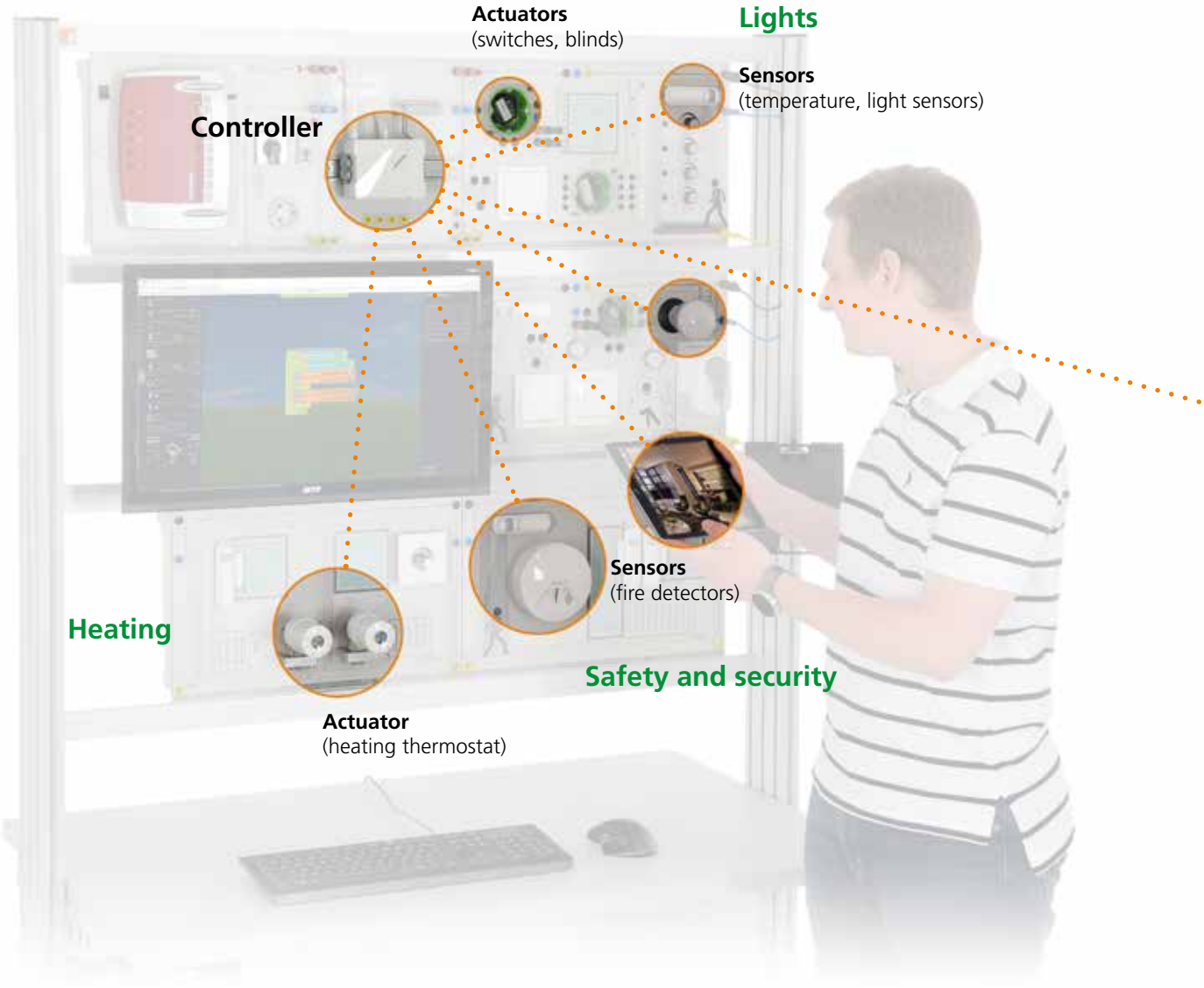
Heating
- Heating can be controlled automatically via timer or thermostat

Safety and security
- Maximum security thanks to smoke detectors, door and window contacts
- Alarms notified via messaging to tablet computers or smartphones (e-mail, SMS and similar applications)

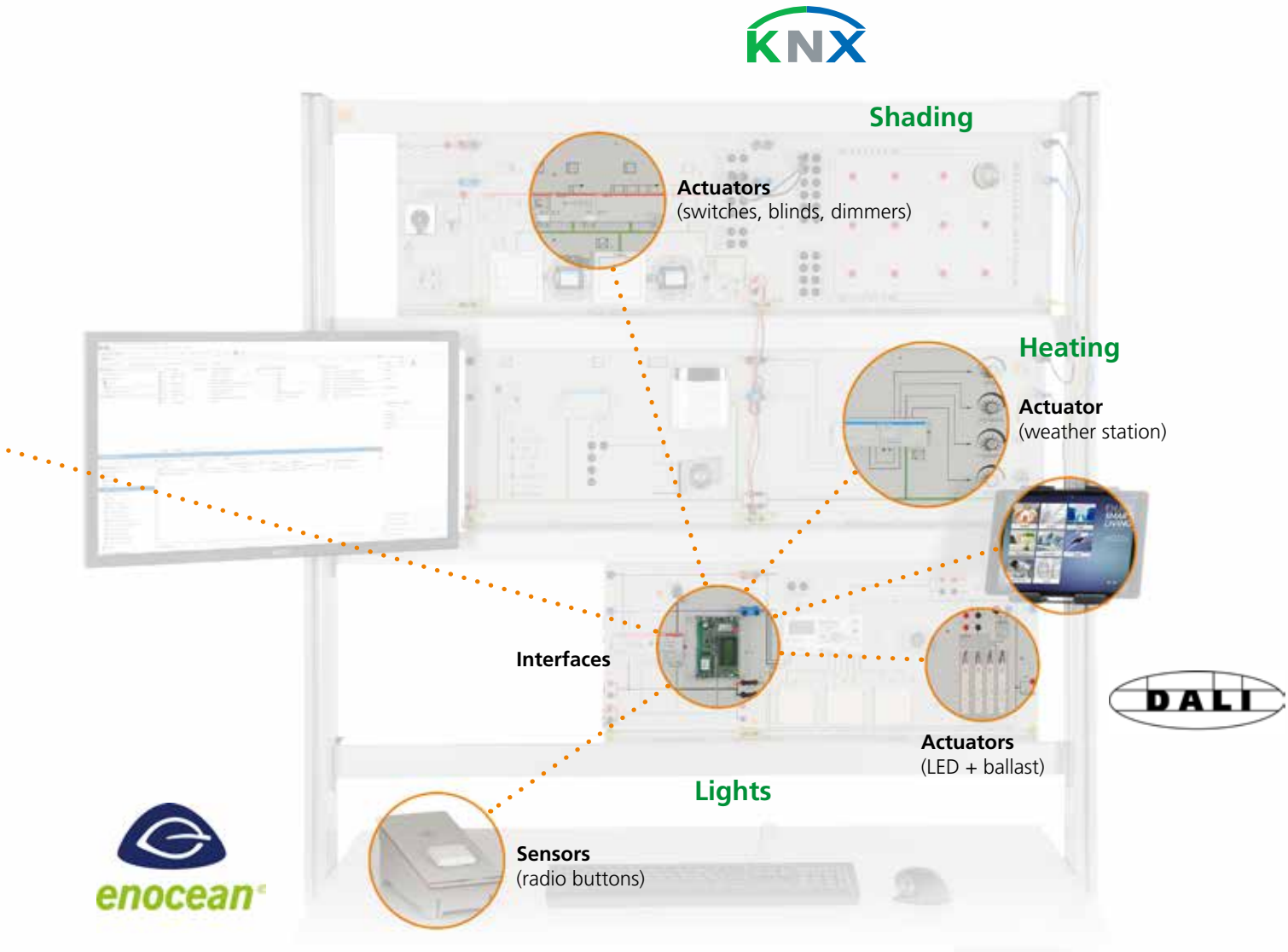
Interfaces/Gateways

Smart Home Training System Using Various Different Platforms

Interconnection, automation, central control and visualisation of all the equipment is what makes our home smart. Their interfaces and new technologies make our training systems smart, too. The modular training panel systems on the topic of smart homes can be used in flexible ways and are extensible. The interfaces make it possible to interconnect various systems into a single platform.



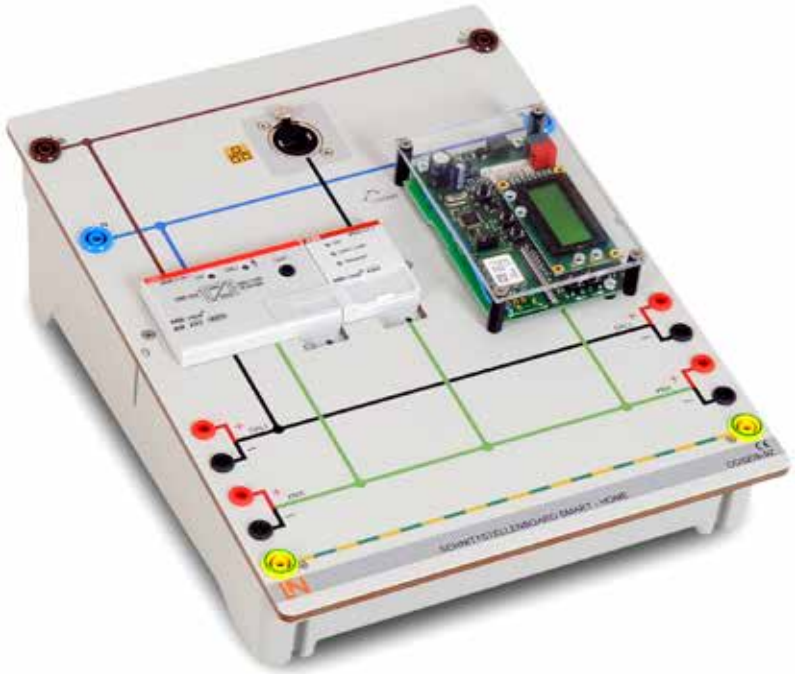
All this gives you the option to tailor training systems to your own lessons. You could start with just one system (Z-Wave, KNX, etc.) and teach how smart homes work, but then gradually add individual extensions to the growing network. Alternatively you could start with a full system from the word go.



Interfaces/Gateways

KNX / DALI / EnOcean / IP

Older buildings nowadays may have many different systems as part of their electrical installations. In addition to conventional installations there may also be such things as bus systems like KNX, DALI or even radio systems. If it is desired that these all be networked together to form a smart home installation, then gateways will be required. The course covering smart home installation using multiple system platforms demonstrates the theory and practice required to set up and visualise a smart home with multiple different underlying systems. The experiment panel has several gateways, KNX/IP, KNX/DALI and KNX/EnOcean.



Topic

EBT 9, 11

EGT 9, 11

Training contents

- Networking of multiple different systems in one smart home system
- Familiarisation with various gateways (DALI, EnOcean, KNX)
- Using external software (ABB iBus)
- Setting up a user interface with visualisation software
- Setting up a user interface on a tablet computer or smartphone

Z-Wave / KNX-IP

This supplement enables communication between the radio-controlled smart home system, Z-Wave, and a bus-based KNX system. The interface is programmed from the KNX end using ETS software. It is connected to the central smart home controller mechanically via a plug contact. Once connected, the programming can start straight away.

Topic

EBT 9, 11

EGT 9, 11

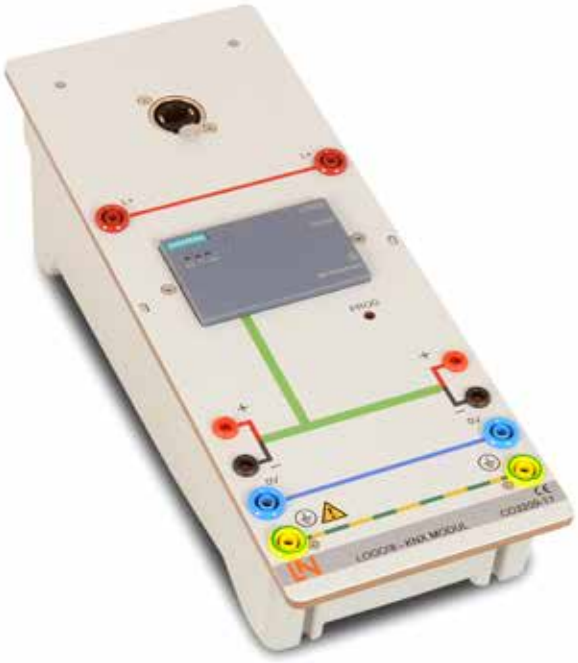
Training contents

- Interconnection of a KNX system with a Z-Wave radio system
- Inclusion and parameter setting of KNX/Z-Wave gateway into ETS 5 software
- Visualisation of KNX components via the Z-Wave interface
- Connection to DALI and EnOcean via KNX

Interfaces/Gateways

KNX / LOGO® 8

The CMK 2000 communications module is provided for communication and building automation using LOGO! 8. The communications module enables communication between a LOGO! system and any KNX devices via the KNX bus system in the building. The LOGO! system can thus be incorporated into a KNX bus installation to act as a smart controller. The CMK 2000 module converts typical PLC signals (binary or analog) into KNX packets (telegrams) to enable communication with other KNX actuators. It can also read KNX packets and convert those to signal levels suitable for LOGO! systems. This means that signals detected via standard LOGO! inputs can be efficiently mixed with signals from the KNX system (so-called telegrams) via logical functions or timer circuits. Analog signals can be monitored for thresholds or set values and setpoint variables output to LOGO! or KNX-linked actuators. This enables many applications to be covered, such as: monitoring, access control, air conditioning, lighting, provision of shade (e.g. blinds), watering of gardens or even control of pumps.



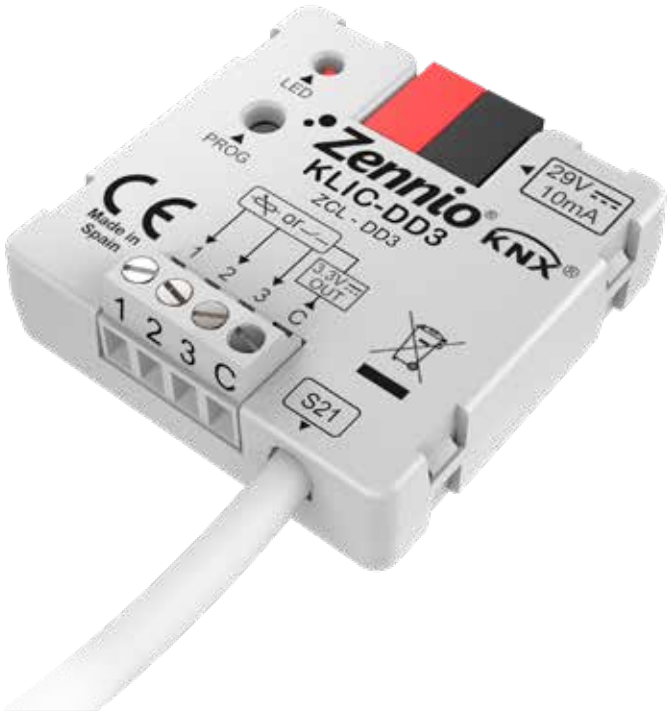
Topic	
EBT	EGT
9, 11	9, 11

Technical features

- Technical features
- Max. 24 digital inputs, 20 digital outputs, 8 analog inputs and 8 analog outputs
- Date and time can be synchronised via KNX
- In addition to digital and analog inputs and outputs it is also possible to use values processed within the programming for communication purposes in KNX.
- Dimmers and blind actuators can be controlled by a KNX system in compliant manner.
- There are 50 so-called communication objects available for project planning. Users themselves define the direction of communication and the data format.

KLICK-DD3

KNX Interface for Daikin split units. KLIC-DD3 is a bi-directional communications interface for integrating split-type air-conditioning systems manufactured by Daikin into a KNX installation. The equipment has 3 analog/digital inputs designed for the use of temperature sensors, motion sensors or floating switches/buttons/sensors as well as a logic module with 10 functions. Interface for split air-conditioning system CO3207-3A.



Topic

EBT 9, 11

EGT 9, 11

Technical features

- 3 analog/digital /inputs which can be configured as follows:
  - Binary inputs (buttons, switches/sensors)
  - Motion sensor
  - Temperature sensor
  - 10 Logical functions
  - All data saved in the event of a KNX bus failure
  - Dimensions 39 x 39 x 14 mm
  - For installation in distribution boxes, plug sockets or on the wall
  - Black boxes
  - Built-in KNX BCU
  - Complies with CE guidelines (CE mark on front of equipment)

Building Communications

84 Telecommunications networks

88 Commissioning, maintenance, troubleshooting

90 Installation practice systems

Telekommunikationsnetze

Building Communications Systems and Stairway Lighting

To round off the wiring installation for our building, this topic covers the entrance and stairway areas of detached homes or multi-flat blocks in more detail. It starts with implementation of various stairway lighting circuits and continues with simple door bell installations, till it culminates with a full two-way intra-building intercom system. The major challenge in all this is to plan the systems, including implementing suitable circuits to match the stated requirements. For this purpose, the distinction between circuits using pulsed latching relays and timer circuits or that between one-way and duplex intercom circuits needs to be experienced. In terms of the professional and practical side of the work, the challenge then lies in installing the circuitry for the multiple voltage levels in keeping with standards such that it performs faultlessly.

Topic

EBT 2, 5

EGT 2, 5

Training contents

- Door bell and door opening systems for one user
- Door bell and door opening systems for two users
- Telephone intercoms
- Electric door openers
- Telephone and voice intercoms
- Telephone and voice intercoms with door

Video and Intercom Systems

Bus-controlled video building intercom systems represent a new level of quality in intra-building communications. This kind of building communication incorporates many functions (seeing, hearing, lighting I/O, door openers, and door bells) with little wiring effort. The video building intercom can be combined with other aspects of wiring installation and communications technology to make up some extensive training projects. In order to reduce the amount of data flowing along the data lines, complex systems tend to be divided into smaller sections. In this section there is an option to redistribute the video and audio signals.

Topic

EBT	EGT
2, 9, 11	2, 9, 11

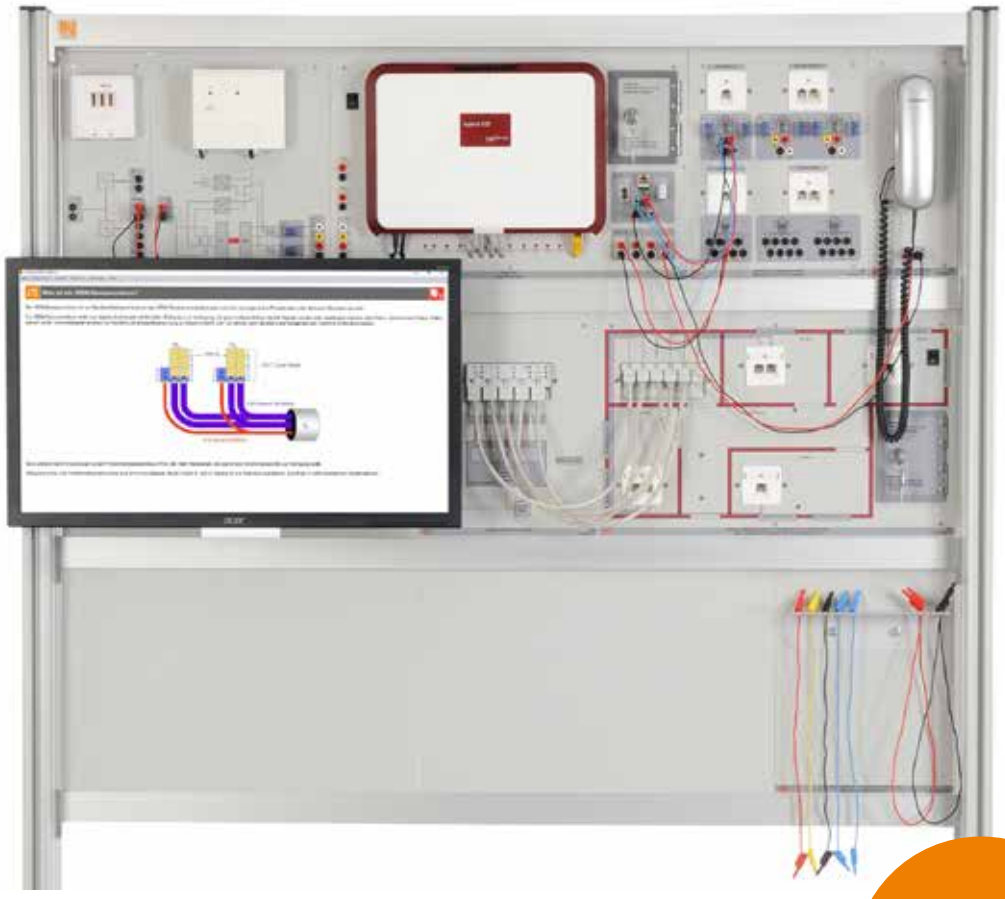
Training contents

- Installation and programming of a building intercom system using bus technology
- Intercom between apartments and front door, with voice control
- Use of various inter-building telephones
- Integration of a door opener
- Control of stairway lighting

Telecommunications

Planning and Implementation of Office Telecommunications Structures

This training system allows you to install, commission and configure a typical office telecommunications structure and also troubleshoot for faults. The equipment set can either be used stand-alone or be incorporated into an existing telephone system or local network.



Topic

EBT 4, 9, 13

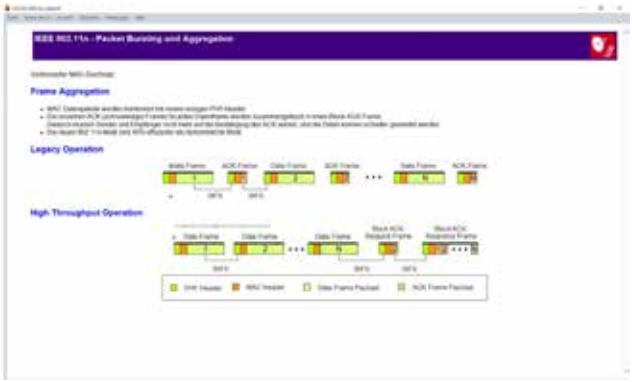
EGT 4, 9, 13

Training contents

- Installation and configuration
- Installation
- Installation and configuration of analog devices
- Installation and configuration of ISDN devices
- Installation and configuration of VoIP devices
- Troubleshooting
- Hand-over and instruction

Installation of a WiFi Network

What this practice system seeks to achieve is to train students in the skills needed for installation and ensuring security of wireless networks. This includes selection of the correct components, materials and tools for an installation, as well as knowledge of the encoding system to be implemented. One key aspect is the choice and operation of test equipment, either simple or complex, for the purpose of testing functionality and troubleshooting for faults in the communications system.



Topic

EBT 4, 9, 13

EGT 4, 9, 13

Training contents

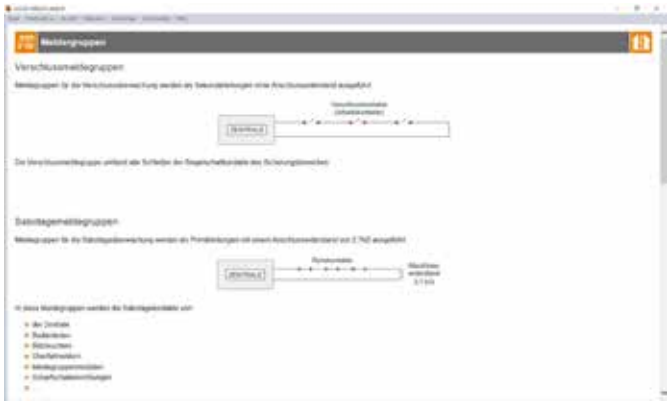
- Installation of network components
- Configuration of WiFi routers
- Use of professional tools and measuring instruments in an installation
- Practical implementation of network topology and devices

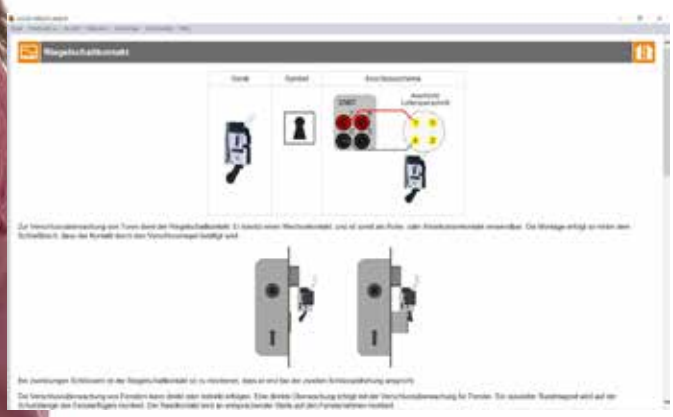
Commissioning, Maintenance, Troubleshooting

Communications Technology Using InsTrain

The wiring installation training system on communications technology is intended to cover planning, installation and testing of structured communications wiring for various applications and services. The training project is concerned with setting up a "home office". The following topics are covered in detail: telephony, internet, network wiring, TV and video. Using the fault simulation capability, assignments can be matched to the level of the trainees being taught.

Structured wiring involves planning in advance how the communications technology is to be implemented as part of the project. The communications wiring expected to be developed should be planned and implemented to be application-neutral and should take into account the needs of the final customer, the applicable standards and use state-of-the-art technology. Research into latest developments and supplying appropriate advice to the customer represent key skills that students should be learning from this model.





Topic

EBT 4, 5, 13

EGT 4, 5, 13

Training contents

- Planning of multimedia cabling
- Selection of transmission media and equipment
- Compliance with required transmission categories
- Future-proofing cable installations
- Carrying out various sorts of wiring
- Setting up a WiFi connection
- Interconnecting two PCs with polymer optical fibres
- Interconnecting the PCs via RJ45 socket (LSA)
- Fitting NTBA unit and WiFi, router, etc. into the distribution box
- Installation of a patch bay in a multimedia junction box
- Interconnection of PCs via switches and patch bays
- Feeding in a signal via a DVB-T receiver
- Installation of connector and end sockets in a segment of ducting (coax cables)
- Installation, wiring and testing of two RJ45 sockets in a segment of ducting
- Documentation, hand-over, test report and customer instruction
- Commissioning of a DSL connection

Installation Practice Systems

Installation of a Cat 5 Network

What this practice system seeks to achieve is to help students learn the skills needed for installation of networks. This includes selection of the correct components, materials and tools for an installation, as well as knowledge of the topology to be implemented. One key aspect is the choice and operation of test equipment, either simple or complex, for the purpose of testing functionality and troubleshooting for faults in the communications system.

Topic

EBT 2, 4, 5

EGT 2, 4, 5

Training contents

- Components of a network installation
- Cables, plugs and sockets, design, application and operating principle
- Use of professional tools and measuring instruments in an installation
- Practical implementation of network topology and devices

Building communications systems

Example of a learning project: A maisonette house with two family apartments is to be equipped with an intra-building communications system. This is to include a central door communication set-up and two communicating stations, one on each floor. The wiring is to be laid on top of the plasterwork in conduits.

Topic

EBT 2, 4, 5

EGT 2, 4, 5

Training contents

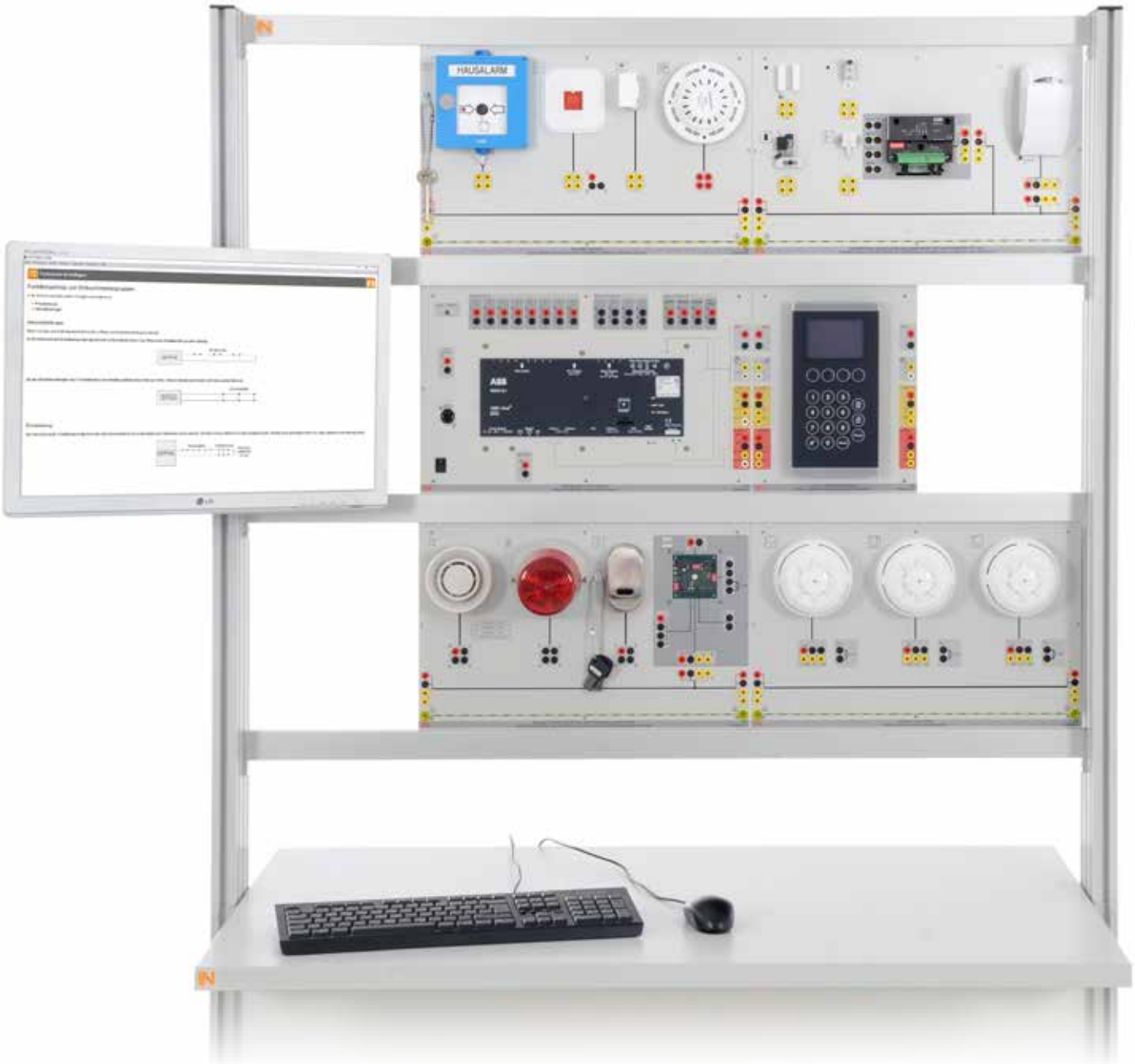
- Assembly and wiring
- Telephone intercom with door opener
- Intercom and door bell system
- Testing and commissioning of circuits using circuit diagram and installation plan
- Assembly and wiring of door and apartment intercoms with and without two-way telephone communication in accordance with circuit diagram and installation plan

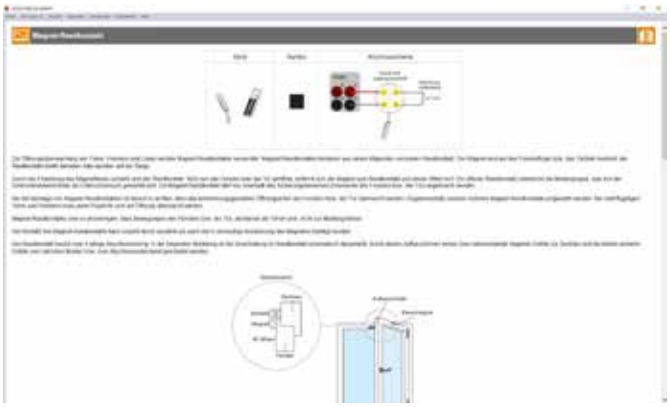
Building Security

Hazard Alarm Systems and Access Control

Hazard alarms

With the help of the hazard alarm training system, instructors can deal with the topic of burglar and fire alarm protection as a key aspect of modern building installations. The training focuses on the operating principles of sensors and how detectors, sensors, arming systems and a central control panel are networked together. The system is freely programmable and can be used for performance-related training in any number of ways. The hazard warning system consists of components typically used in practice, all of which have certification from VdS (German property insurers association).





Topic

EBT 9, 12

EGT 9, 12, 13

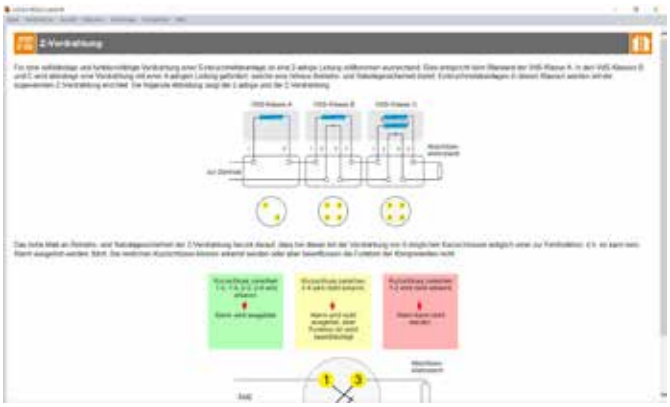
Training contents

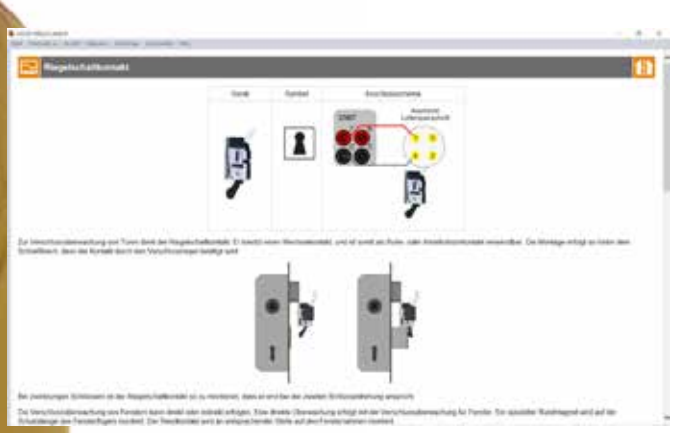
- Basic knowledge of project planning for alarm systems, burglar alarms, fire alarms and access control systems
- Physical operating principles of various sensors
- Installation of gas, water, smoke and intrusion detectors
- Configuration of conventional detector groups
- Installation of bus-compatible sensors and detectors
- Programming of the system with a PC or its own operating panel

Hazard Alarm Systems and Access Control

Project: Hazard Alarm System and Access Control

With the help of the hazard alarm training system, instructors can deal with the topic of burglar and fire alarm protection as a key aspect of modern building installations. The training focuses on the operating principles of sensors and how detectors, sensors, arming systems and a central control panel are networked together. The system is freely programmable and can be used for performance-related training in any number of ways. The hazard warning system consists of components typically used in practice, all of which have VdS certification.





Topic

EBT 9, 12, 13

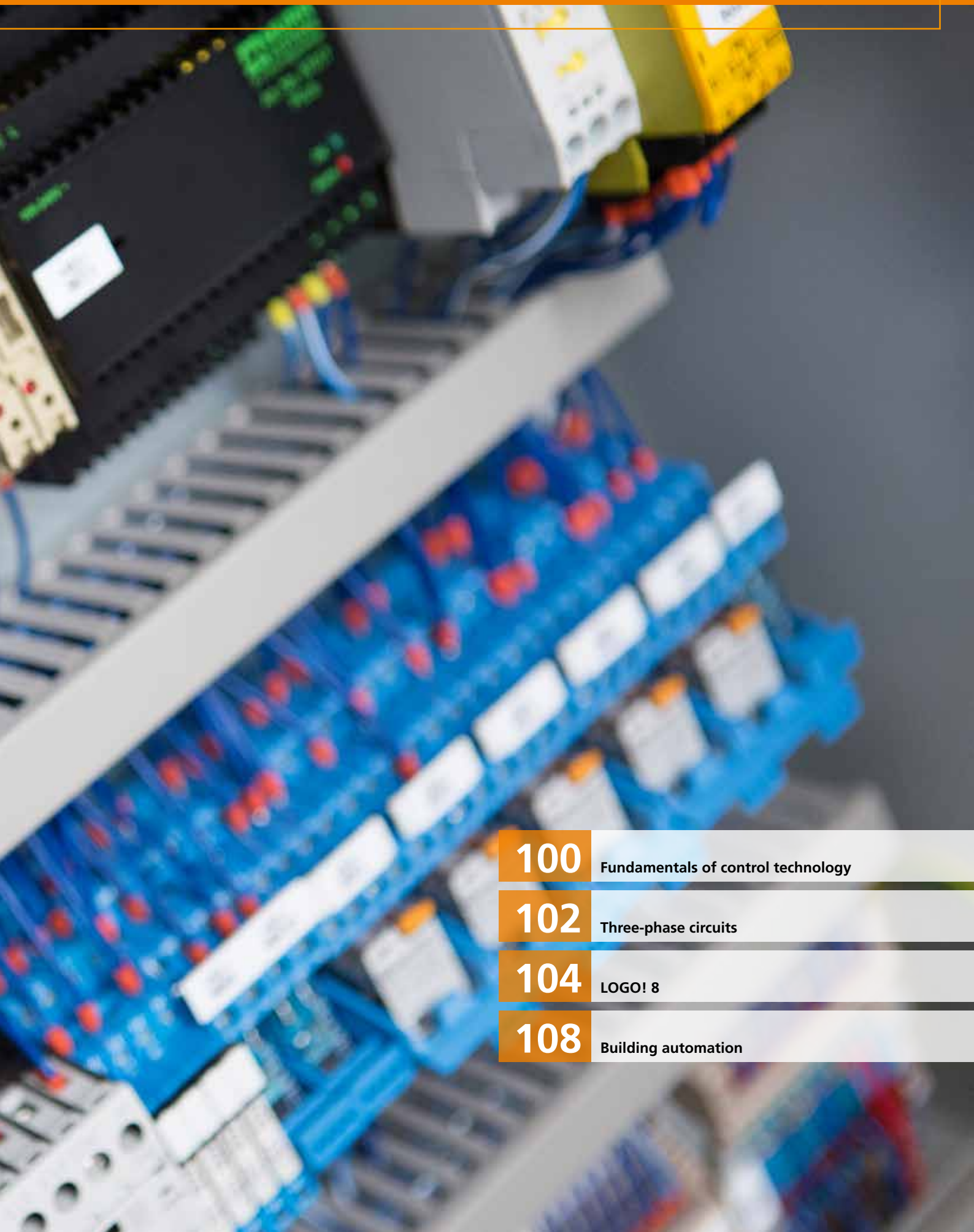
EGT 2, 4, 5

Training contents

- Basic knowledge of project planning for alarm systems, burglar alarms, fire alarms and access control
- Physical operating principles of various sensors
- Installation of gas, water, smoke and intrusion detectors
- Configuration of conventional detector groups
- Installation of bus-compatible sensors and detectors
- Programming of the system with a PC or its own operating panel


+S1-
1201
+S1-
1202
LOGO!
SIEMENS
RUN/STOP
LAN

Industrial Wiring Installation



100 Fundamentals of control technology

102 Three-phase circuits

104 LOGO! 8

108 Building automation

Fundamentals of Control Technology

Protective Circuitry

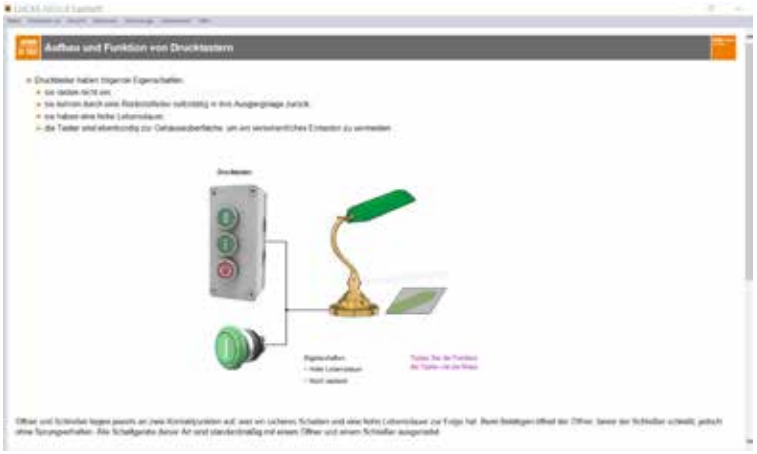
Here trainees can learn some systematic and structured working with some simple aspects of control systems. Use of safety extra-low voltage means students can experiment on their own. All the control implementations are carried out using examples closely based on authentic practice.

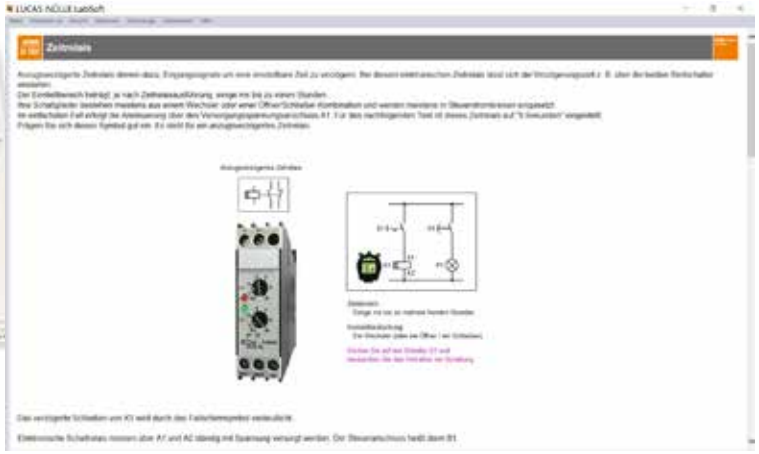
Topic

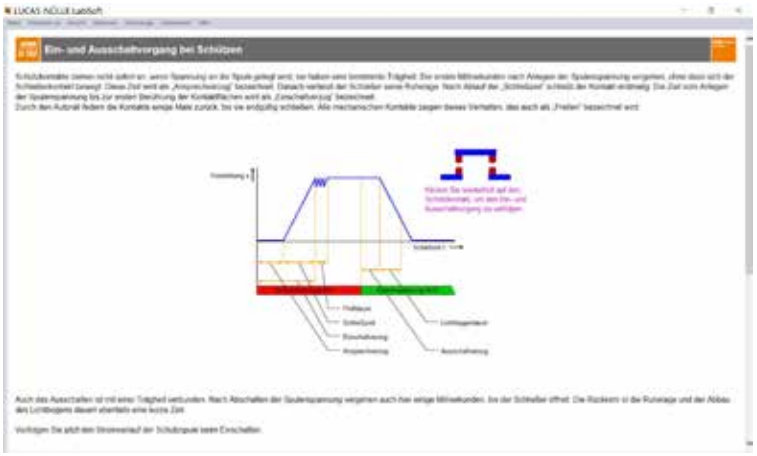
EBT 3 | EGT 3

Training contents

- Familiarisation with components used in control technology
- Planning of control projects
- Checking function with a circuit simulator
- Functions testing and fault finding in control projects
- Latching and interlocking circuits
- Circuits for controlling speed of rotation and reversal of direction
- Various types of star-delta circuit
- Time-dependent control
- Complex sequence control systems


Aufbau und Funktion von Drucktastern


Zeitrelais


Ein- und Ausschaltvorgang bei Schützen

Three-Phase Circuits

Manual switching of three-phase circuits

Multi-pole consumers up to a certain power classification can be switched on and off directly in a three-phase circuit. There is specific switching equipment for this, which needs to be employed according to the purpose of the application. The development of the circuits, plus the correct choice of switching elements and equipment represent the key focus of this training segment. The training topics include, for example, star-delta circuits, star-delta reversal circuits or switching of polarity.

Topic	
EBT	EGT
3, 8	3, 8

Training contents

- Manual switching of three-phase circuits
- Turning off a three-phase induction motor with a squirrel-cage rotor
- Star-delta circuit for a three-phase induction motor with a squirrel-cage rotor
- Star-delta circuit for a three-phase induction motor with a squirrel-cage rotor
- Reversing polarity with a Dahlander three-phase induction motor
- Reversing polarity of a three-phase induction motor with two separate windings

Three-Phase Protection and Systems Circuitry

As of a certain power classification it is no longer possible to switch three-phase loads on and off directly. For this reason, such loads are turned on and off indirectly by means widely different types of contactor circuits. Development of control systems and setting up systems with function monitoring form the key aspects of the training. By means of the supplementary sets it is possible to work up extra, more complex control requirements. The supplementary machine set includes all the necessary machines and equipment to make up the circuits for directly and indirectly controlling motors in three-phase circuits and perform tests on them.

Topic

EBT	EGT
3, 7, 8	3, 7, 8

Training contents

- Creation of circuit diagrams
- Latching protective circuitry
- Pull-on and pull-off time-delay relays
- Reversible contactor control with interlocking
- Configuration of motor protection relays as per the motor's rating plate
- End-point control using mechanical end-limit switches plus reversal of direction
- Project planning, construction and commissioning of complex control systems
- Operating principle and pin assignments
- Function testing and fault finding
- Connecting three-phase motors
- Pulsed contactor circuits
- Star-delta circuits
- Protective and safety functions

LOGO! 8

Programmable Miniature Control Systems Using "LOGO!"

The universal LOGO! board is equipped with both LOGO! 8 and a DM8 supplementary module. This means that all the basic circuits for topic area 4 can be implemented. The LOGO! 8 system has an IP interface. The universal board is connected to mains voltage via its plug and a built-in power unit provides all the voltages necessary for the subsequent components. The board can be supplemented with extra, supplementary components. The inputs can be operated by switches, push-buttons or by external signals. Outputs are floating switch contacts. The universal LOGO! board is also available in a different version, which is additionally equipped with an AM2 module.

Topic

EBT 3, 7, 8, 11

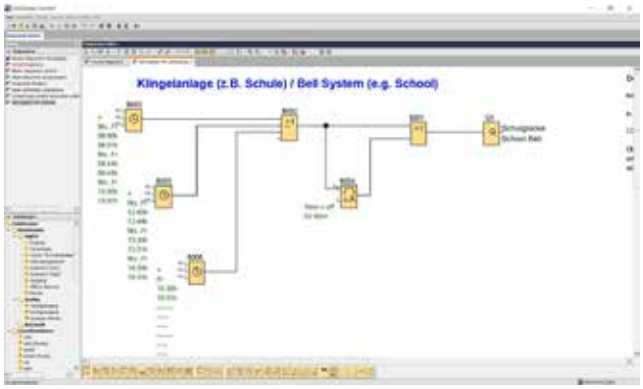
EGT 3, 7, 8

Training contents

- Connection of logic modules
- Implementation of circuit diagrams in function block diagrams
- Programming of basic functions
- Programming of special functions
- More complex control requirements
- Testing of functions

LOGO!® Soft Comfort

LOGO! Soft Comfort is the software with which project planning for Logo! 8 can be carried out quickly and easily. Switching programs are coded step by step and can besimulated and tested offline with the help of a PC. Program segments which frequently repeat can be set up as macro routines. This considerably reduces the time needed for project planning. Functions can be selected via drag & drop and incorporated into programs usingfunction block and ladder diagrams as well. LOGO! Soft Comfort is suitably documented and has online help.



LOGO! 8 CMK 2000 KNX module with IP interface

By means of the Logo! CMK2000 communications module the present range of Logo! 8 logic modules can be incorporated into the KNX building management bus system. Logo! 8, which is designed for small automation solutions, can now be used in combination with the new building automation communications module, for various purposes, such as monitoring, access control, air conditioning, lighting, blinds and shutters, watering the garden or control of pumps. The KNX module Logo! CMK 2000 communicates with Logo! 8 via Ethernet. It passes the information (data) from sensors associated with KNX bus devices on to the logic module, where it is further processed by means of logic functions. Logo! control instructions are then sent via the communications module on to KNX actuators.

LOGO!® display

LOGO! TDE is an external text display module for the LOGO! 8 product range. It has built-in operating and diagnostic functions, which make it easy to modify parameters and carry out fault finding.

LOGO! 8

Project: Control of an IMS®Conveyor Belt Using "LOGO!®"

Hard-wired logic control utilising contactor circuits is ideally suitable in particular for smaller projects controlling an IMS® conveyor belt. Projects which use LOGO!® also fit in well and supplement the range of possible control systems. Our advisers and consultants would be happy to supply you with the necessary information.

Topic

EBT 3, 7, 8, 11

EGT 3, 7, 8

Training contents

- **Contactor circuits**
  - Conventional, hard-wired control technology
  - Introduction by means of some simple assignments
  - Possible extensions to create extensive control projects
  - Preparation and migration of control projects into programmed control technology
- **LOGO!®**
  - First steps in programmed control routines
  - Combination and extension of existing control set-ups
  - Use of LOGO!® Soft Comfort
  - Includes multimedia self-learning course

Project: Control of a Sliding Door via LOGO!®

Typical application examples for the LOGO!® logic modules include various control arrangements for ventilators, gates, blinds and conveyor belts, escalators, sliding and rolling shutter doors or revolving doors. By means of project work, the knowledge of programming miniature control systems can be put into practice, providing tangible experience of the benefits offered by such modern technology.

Topic

EBT	EGT
3, 7, 8, 11	3, 7, 8

Training contents

- Connection of logic modules
- Implementation of job requirements in function block diagrams
- Programming of more complex control requirements for an application
- Processing signals in a system
- Testing of functions

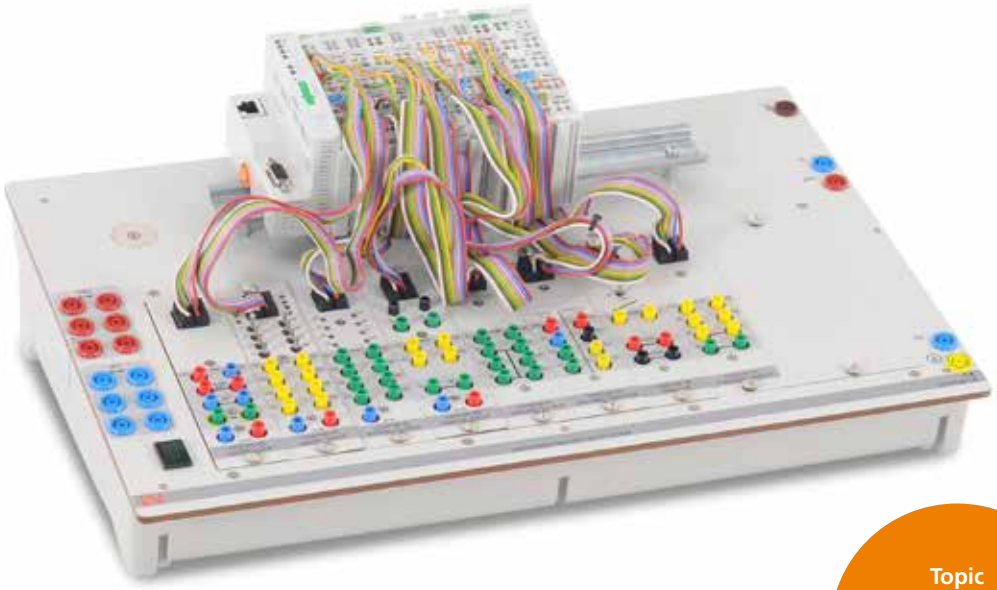
Building Automation

Building Automation

What can be done on a small scale in smart homes can also be achieved for large projects using building automation. It is no longer enough to simply control lighting, blinds and heating. It is also necessary to handle large air conditioning systems, lifts or management of load in large kitchens. The philosophy behind all this is the same, but the implementation requires knowledge of wiring installations and automation.

Combining the electrical wiring of buildings with automation equipment is the very objective of this training package. Unlike the case of industrial automation, building automation involves many different communications buses being coupled together. For this reason we have selected an automation system in which it is not only peripherals (inputs and outputs, analog or digital) which can be freely combined, but also the 'intelligent', components (controllers, BACnet, IP, KNX) and their interfaces. This is the only way we can ensure that existing components too (KNX, DALI etc.) can be combined with higher-level bus systems in an educational programme.

This topic area should not be regarded as separate from any others. Indeed it is very closely linked to the topics of smart homes, control technology and small-scale miniature control systems.



Topic

EBT 3, 7, 9, 11

EGT 3, 7, 9, 11

Training contents

- Programming of various field bus controllers
- Measurement of energy consumption and load management
- Optimisation of lighting installations
- Inclusion of various sensors for control of heating, lighting and air conditioning
- Modification of building automation for changed requirements

LON-Bus

The abbreviation LON® stands for Local Operating Network and is the name of a field bus standard which is primarily used in the sphere of building automation. It is an open standard defined as ISO/IEC 14908 and under the name LonWorks® it is accessible to any company operating in the market.

Topic

EBT 3, 7, 9

EGT 3, 7, 9

Technical data

The board includes all the key components needed for a single LON workstation.

Components:

- 2 Programmable LON controllers
- 6 Digital inputs, 24 V, for UP controllers
- 2 Digital outputs, 24 V, for UP controllers
- 4 Digital inputs, 24 V
- 4 Digital outputs, 24 V
- 2 Digital outputs, 230 V
- 2 Analog inputs, 0 ... 1 V
- 2 Analog outputs, 0 ... 10 V, 2 Loads, 230 V
- 2 Switches, 230 V, 1 power supply, 24 V/2 A
- 2 Analog power supplies, 0 ... 10 V
- Nominal voltage: 85 .... 264 V
- Frequency: 47 … 64 Hz
- Inputs/outputs: 2-mm and 4-mm safety sockets
- Weight: 3.5 kg

Renewable Energies/Environmental Protection

112 Photovoltaics

116 Energy storage

118 Electric vehicles

Photovoltaic

Sunny Outlook with the Photovoltaics Course

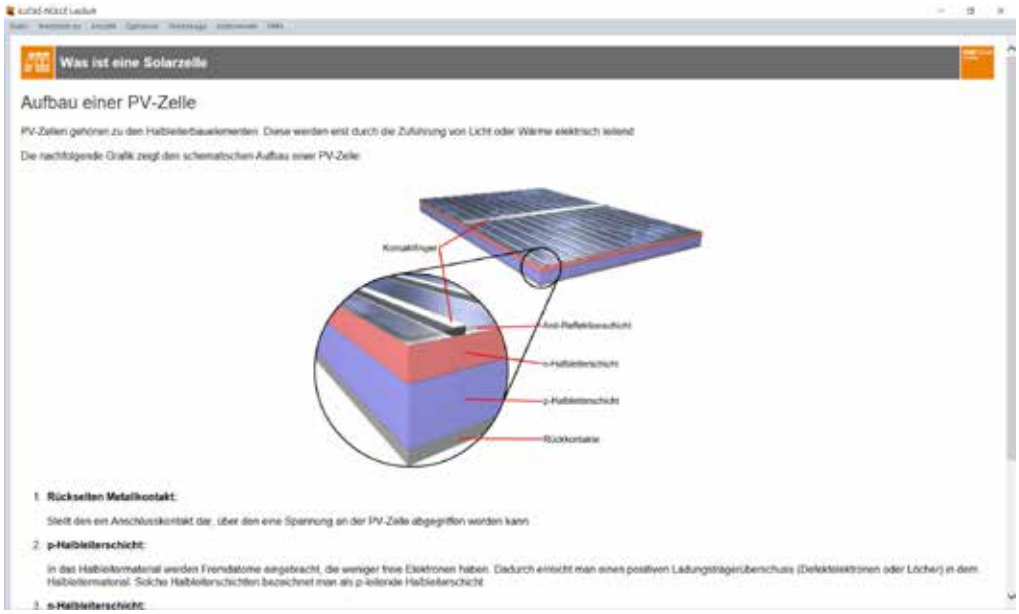
In these times of rapidly increasing energy costs and heightened awareness of the environment, photovoltaics represent a very interesting alternative to conventional ways of generating energy. In the photovoltaics course you can not only learn about the fundamentals of solar cells and carry out investigations on them, you can also simulate photovoltaic systems in both direct and storage modes.

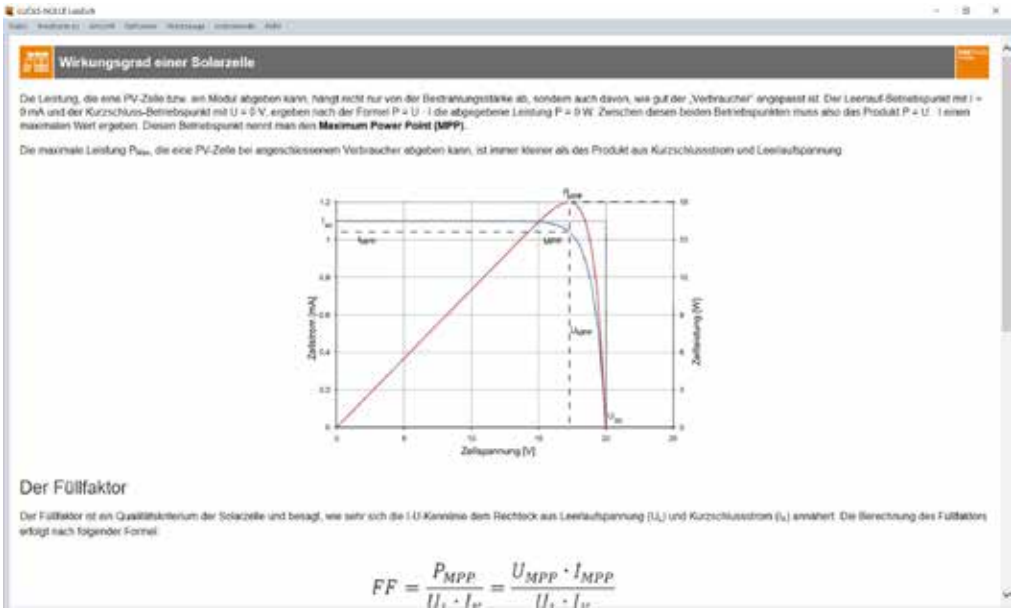
Topic

EBT	EGT
10, 12, 13	10, 12, 13

Training contents

- Familiarisation with the operating principle and working of solar cells
- Recording characteristics for a solar module
- Explanation of how current and voltage of a solar module depend on temperature, radiation (light) intensity and angle of incidence
- Familiarisation with series, parallel and other ways of connecting solar cells
- Familiarisation with various ways solar cells are manufactured
- Various types of solar cell will be discussed
- Design of a rechargeable solar battery
- Various types of solar power generation systems
- Set-up of a stand-alone network with a solar battery


Was ist eine Solarzelle
Aufbau einer PV-Zelle
PV-Zellen gehören zu den Halbleiterbauelementen. Diese werden erst durch die Zuführung von Licht oder Wärme elektrisch leitend.
Die nachfolgende Grafik zeigt den schematischen Aufbau einer PV-Zelle:
Kontaktfinger
Anti-Reflektionsschicht
n-Halbleiterschicht
p-Halbleiterschicht
Rückkontakte
1. Rückseiten Metallkontakt:
Stellt den ein Anschlusskontakt dar, über den eine Spannung an der PV-Zelle abgegriffen werden kann.
2. p-Halbleiterschicht:
In das Halbleitermaterial werden Fremdatome eingebracht, die weniger freie Elektronen haben. Dadurch entsteht man einen positiven Ladungsträgerüberschuss (Defektelektronen oder Löcher) in dem Halbleitermaterial. Solche Halbleiterschichten bezeichnet man als p-leitende Halbleiterschicht.
3. n-Halbleiterschicht:


Wirkungsgrad einer Solarzelle
Die Leistung, die eine PV-Zelle bzw. ein Modul abgeben kann, hängt nicht nur von der Bestrahlungsstärke ab, sondern auch davon, wie gut der „Verbraucher" angepasst ist. Der Leerlauf-Betriebspunkt mit I = 0 mA und der Kurzschluss-Betriebspunkt mit U = 0 V, ergeben nach der Formel P = U · I die abgegebene Leistung P = 0 W. Zwischen diesen beiden Betriebspunkten muss also das Produkt P = U · I einen maximalen Wert ergeben. Diesen Betriebspunkt nennt man den Maximum Power Point (MPP).
Die maximale Leistung P_{max}, die eine PV-Zelle bei angeschlossenem Verbraucher abgeben kann, ist immer kleiner als das Produkt aus Kurzschlussstrom und Leerlaufspannung.
Zellstrom [mA]
Zellspannung [V]
Zellleistung [W]
Der Füllfaktor
Der Füllfaktor ist ein Qualitätskriterium der Solarzelle und besagt, wie sehr sich die I-U-Kennlinie dem Rechteck aus Leerlaufspannung (U_L) und Kurzschlussstrom (I_K) annähert. Die Berechnung des Füllfaktors erfolgt nach folgender Formel:
$$FF = \frac{P_{MPP}}{U_L \cdot I_K} = \frac{U_{MPP} \cdot I_{MPP}}{U_L \cdot I_K}$$

Photovoltaic

Project Work with Industrial Components

This training system enables realistic simulation of the way the sun moves across the sky. This means that, even in the absence of the sun, experiments can still be carried out, just as things are done in practice, with the help of emulators.
Teaching of background and know-how is made possible by the "Photovoltaics Advanced" multimedia course, as is the PC-supported assessment of measurement data.

Sample experiment from "Advanced Photovoltaics EPH 2"

Topic

EBT	EGT
10, 12, 13	10, 12, 13

Training contents

Investigation of solar modules
- Determining optimum alignment of solar modules
- Recording characteristics for solar modules
- Investigation of response for cells partly in shade
- Investigation of how by-pass diodes work
- Types of wiring for solar modules

Set-up of photovoltaic systems in stand-alone mode
- Installation of photovoltaic systems
- Assembly and testing of a stand-alone photovoltaic system in direct operating mode
- Assembly and testing of a stand-alone photovoltaic system in storage mode
- Assembly and testing of a stand-alone photovoltaic system for generation of 230-V AC voltage

Set-up of photovoltaic systems operating in parallel with the grid
- Installation, assembly and testing of photovoltaic system with mains feed
- Measurement of energy generated by a photovoltaic system
- Determination of efficiency for mains inverter
- Investigation of photovoltaic system response in the event of a power cut

Modern Photovoltaic Systems Operating in Parallel with Mains Grid

Assembly of photovoltaic systems operating in parallel with the mains is communicated in realistic fashion. In order to keep the electricity grid stable, various techniques have been devised, including derating of inverters and use of regulatable local transformers. Teaching of background and know- how is made possible by the "Photovoltaics Professional" multimedia course in conjunction with SCADA Power Lab software, as is the PC-supported assessment of measurement data.

Sample experiment from "Set-up of photovoltaic systems in operation parallel with mains grid" EPH 3Topic areas

Topic

EBT	EGT
10, 12, 13	10, 12, 13

Training contents

Investigation of solar modules

- Recording of changes over days and years
- Investigation of optimum alignment for solar modules (improvement of energy output)
- Recording characteristics for solar modules

Set-up of photovoltaic systems operating in parallel with the grid

- Measurement of energy generated by a photovoltaic system
- Power limiting for photovoltaic inverters (derating)
- Determination of efficiency for mains inverter
- Regulating response of mains inverter, MPP tracking
- Recording of output data using sunshine emulator
- Investigation of photovoltaic system response in the event of a power cut
- Profitability of photovoltaic systems

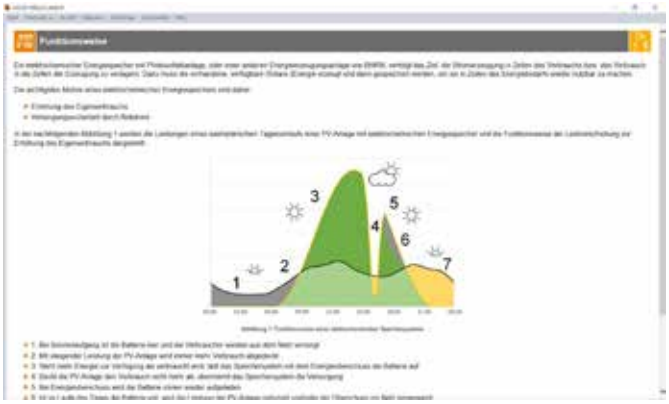
Voltage regulation for local power supply grids

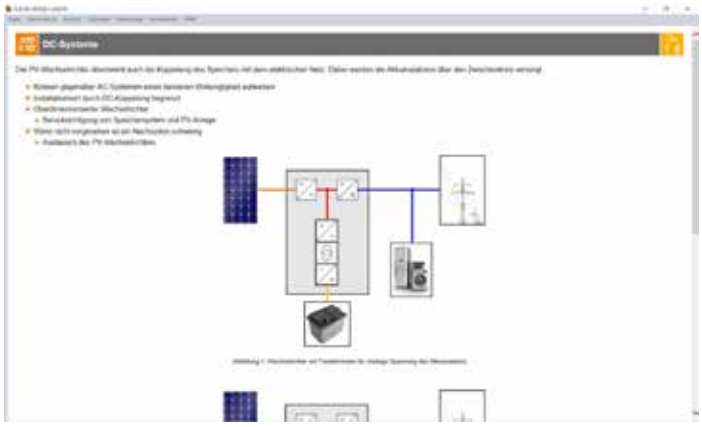
- Local supply transformer
- Power limiting for photovoltaic inverters (derating)
- Automatic regulation of voltage in local supply networks
- Integration of modern photovoltaic systems into smart grids

Battery Storage

Battery Storage

Storage systems are being used ever more frequently to supplement modern solar energy plants, in order to automatically increase local consumption by means of predictable charging. The training system consists of a battery storage system with a 3-phase mains inverter, which can feed power back to the grid as well as consuming electricity from there.





Topic

EBT 10, 12, 13

EGT 10, 12, 13

Training contents

- Assembly and installation of battery storage
- Commissioning of storage
- Interaction between photovoltaic and storage systems
- Increasing local consumption thanks to energy storage

Electric and Hybrid Vehicles

InsTrain Wall-Mounted Charging Station

The wall-mounted charging station for electric vehicles – or wall box for short– is a wiring installation system conforming to DIN EN 61439-7 for the purposes of training in electrical and automotive professions. The Instrain wall box is compact, multi-functional and supported by computer, making it the ideal aid to training in electrical installation of charging stations and teaches the electricians of tomorrow all the key topics needed for training in electrical engineering and automotive careers.

Topic

EBT	EGT
5, 10	5, 10

Training objectives

- Planning projects by yourself
- Understanding charging stations for electric vehicles
- Determining energy provision
- Understanding charging infrastructure and planning projects accordingly
- Integrating charging infrastructure into an installation
- Testing and documenting electrical systems as per VDE standards
- Setting up communication between charging infrastructure and vehicle
- Data logging

Suggested Equipment - Regardless of Manufacture

The ILA course (Interactive Lab Assistant course) supplements the training system and uses interactive experiment set-up animations to guide students through the topic of testing protective measures for charging infrastructure. It provides you with an extensive experiment platform. Questions with a feedback function and assessment logic make it possible to keep a check on the progress of your trainees.

Basic equipment set EGT 8

SE2671-1P
Wall box

LM8559
Test box

LM8556
VDE tester

Power feed to house and garage

EGT 1
Building power feed

SE2671-1P
Wall box

LM8559
Test box

LM8556
VDE tester

Power feed to house and garage with electric vehicle connected

EGT 1
Building power feed

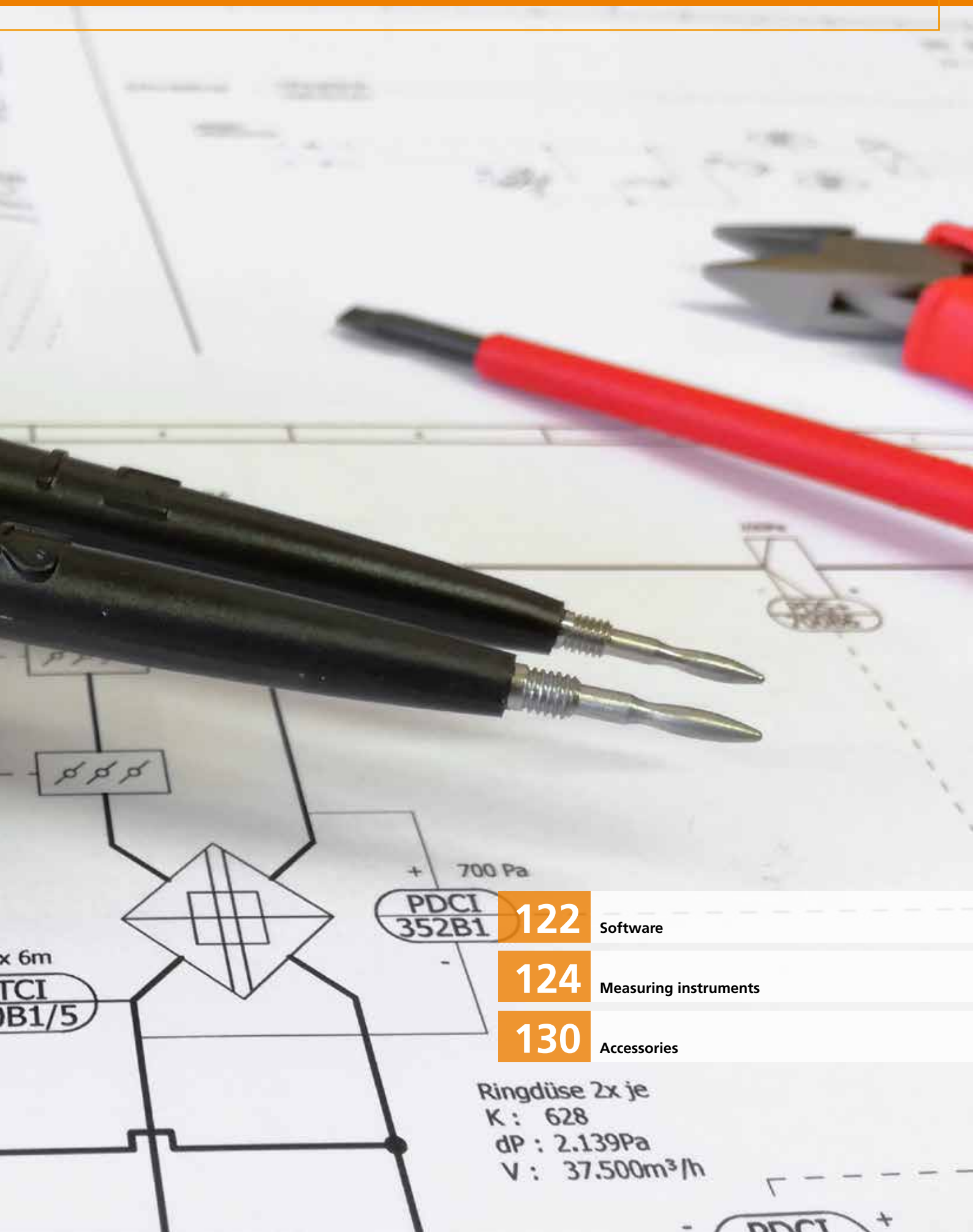
SE2671-1P
Wall box

CO3221-6K
CarTrain

LM8556
VDE tester


410M6+7
Ringdüse 2x je
K : 627
dP : 1.733Pa
V : 33.750m³/h

Supplementary Sets



122 Software

124 Measuring instruments

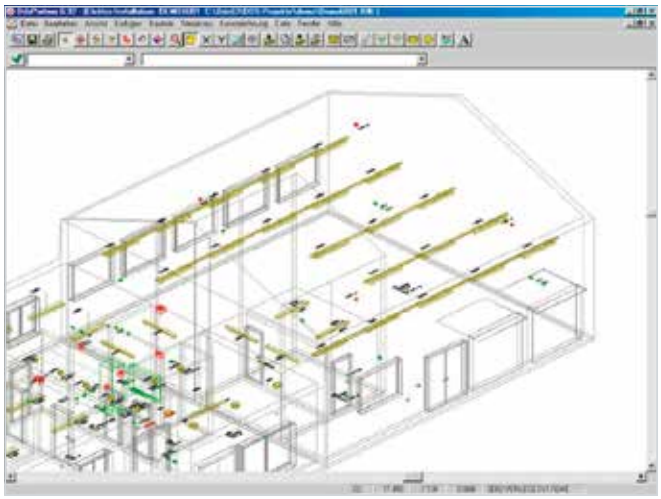
130 Accessories

Software

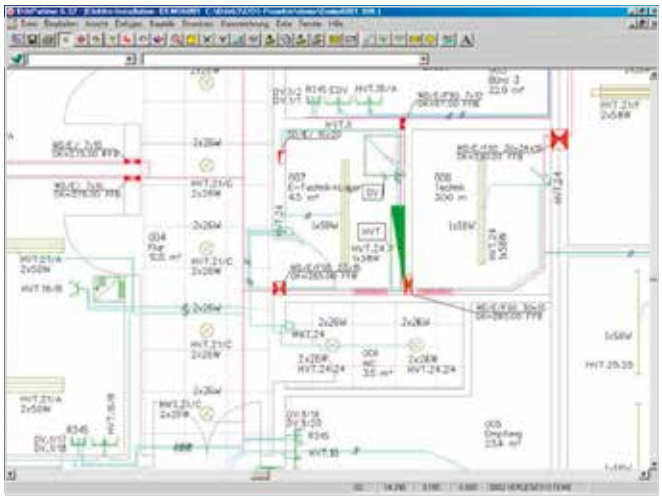
DDS Planning Software

Planning software for wiring installations in buildings fulfils the need of making it easy for users to devise plans which do not depend on specific manufacturers, to manage databases and provide end users with a clear and understandable planning concept. Interfaces to measuring instruments, manufacturer databases and graphic files from other planning systems should be easy to incorporate into an implementation without great difficulty.

For the purposes of education, though, it is also necessary for the planning software to be learnable quickly and to lead to rapid success even for small projects.



Floor plan 2-D/ 3-D



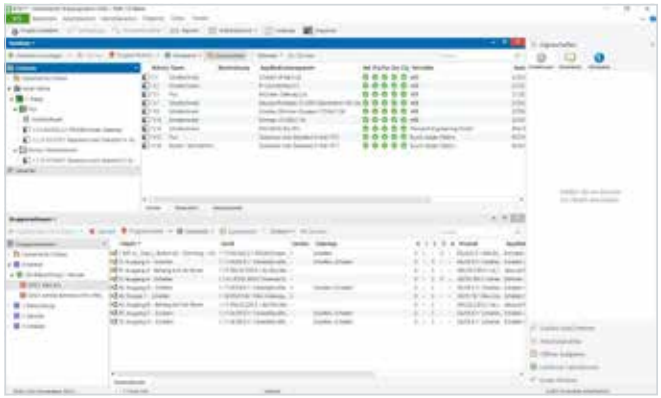
Installation plan 2-D/ 3-D

Specifications

- Setting up a conceptual model of a building in 3D (Building Information Modelling - BIM)
- "Smart building" - IFC data exchange format
- Versatile compilation of floor plan and building structure
- Intelligence of components with built-in object recognition
- Security system used as a tool for monitoring and documentation
- Manufacturer-independent conception, electrical installation, plumbing, heating, air conditioning etc.
- Estimating functions - built-in professional expertise
- Visualisation options
- Multi-user principle for network operation
- Educationally designed help function

ETS 5 Lite

If you want to set up a KNX bus, then you need ETS. ETS stands for Engineering Tool Software. This software is now available in its 5th generation and it is manufacturer-independent. ETS can be used to plan and configure smart building management and wiring installations based on a KNX system.



Specifications

- Support for all current 32-bit and 64-bit Windows® operating systems
- Use of latest Windows®2008 server components for ETS 5 database
- Import of KNX project/product data
- Switching between and searching for KNX elements, such as objects and group addresses
- Separate tree & list searches
- Separate management of KNX bus interfaces for KNX monitors and ETS 5
- Open structuring of group address with more than three levels
- Full utilisation of 16-bit group address space
- Project wizard for rapid compilation of building structures
- Online project diagnostics for analysis of installation errors
- Flexible KNX bus/group monitor with controlled plotting options and new filter and trigger conditions
- Bus load display

Measuring

PROFITEST MTECH Installation Tester

The "PROFITEST Master" range of testers provides professional electricians with universal measuring instruments at the highest technical level. The devices can be used to carry out all testing of protective system effectiveness as specified in VDE 0100 part 600 and defined in the various sections of VDE 0413. They are therefore ideally suited for authorisation and repeat tests on local electrical installations. Classified in measurement category CAT IV, the PROFITEST devices offer users maximum safety.

Features

- Voltage drop measurement
- Current measurement with Metraflex
- AMC – automatic measurement lead compensation using four-wire sensing
- All measurements conforming to VDE 0100 part 600/IEC 60364.6.61/EN 61557
- RCD testing with continuously rising ramp
- 1-mA varistor triggering test with insulation measuring voltage up to 1000 V
- Two-pole measurements with plug attachment or interchangeable 2-pole/3-pole adapter
- Measurement of RINS with rising voltage
- Connection of RFID or bar-code scanner
- Includes ETC software

Additional functions of LM8556:

- Loop measurement with tripping RCDs (with pre-magnetisation)
- DC testing for type B RCDs
- Selective earth measurement

PROFITEST PRIME Installation Tester

Tester for testing effectiveness of protective systems in electrical installations according to standards VDE 0100-600, machines and systems according to VDE 0113-1, low-voltage switching combinations according to VDE 0660-600-1, photovoltaics according to VDE 0126-23 and electricity charging stations according to VDE 0122-1.

Features

- Wide-range measuring instrument for all AC, DC and three-phase networks with voltages up to 1000 V and frequencies between 15.4 and 420 Hz
- Low-voltage measurements for protective earth and equipotential bonding conductors with 200 mA current and automatic polarity reversal plus 25 A current
- Insulation measurement for up to 1000 V with rising ramp
- Measurement of internal impedance of grid and fault loop impedance with high test currents at up to 690 V AC/800 V DC without triggering RCDs of type A or type B
- Testing of RCDs of types A, AC, F, B, B+, EV, MI, G/R, SRCDs, PRCDs
- Combined RCD testing with continuously rising ramp, tripping time, trip current
- Testing of RCMs and IMDs
- Measurement of leakage and differential currents
- Measurement of temperature and humidity
- Voltage measurement up to 1000 V AC /DC
- Operation from mains or battery (the latter with restricted functionality)
- Bluetooth and USB ports
- Push-print function – transmission of measured value after successful measurement

Measuring

METRATESTER 5+ Equipment Tester

This tester is designed for testing and measurement of repaired or modified equipment. The device under test is plugged into the test socket of the tester for this purpose. The quick-clamp safety sockets are connected in parallel with the test socket and allow measurements to be made on equipment with no earthed plugs or on hard-wired equipment. To test that there is no voltage present on touchable conductive components and to measure load current, the device under test is connected to the mains socket of the tester.
The handy device has a compact plastic case with fold-out carrying handle. The mains lead and measurement lead are fixed in place. The mains lead can be wound around a fitting on the rear of the case and the measuring lead fits into its own built-in compartment. The variables to be measured are selected via a rotary switch.

Features

Testing safety of electrical components in accordance with DIN VDE 0701-0702: 2008 via measurements of:

- Protective earth resistance
- Insulation resistance
- Contact current (ensuring absence of voltage by measuring current)
- Current in protective earth conductor (using equivalent leakage current/differential current methods)
- Mains voltage
- Load current

SECUTEST BASE VDE 0701-0702 Equipment Tester

Tester with standard-compliant test procedures for testing electrical safety of equipment after repair and as part of repeat testing (DGUV regulation 3, MPBetreibV). The Secutest BASE tester offers all the measurement and testing functions needed to test protective systems for electrical appliances - using both pre-defined and also optional programmable test sequences which are required in accordance with VDE 0701-0702, IEC/EN 62353 (VDE 0751) and IEC/EN 60974-4 (VDE 0544-4) test standards. Tester with standard-compliant test procedures for testing electrical safety of equipment after repair and as part of repeat testing (DGUV regulation 3, MPBetreibV). The Secutest BASE tester offers all the measurement and testing functions needed to test protective systems for electrical appliances - using both pre-defined and also optional programmable test sequences which are required in accordance with VDE 0701-0702, IEC/EN 62353 (VDE 0751) and IEC/EN 60974-4 (VDE 0544-4) test standards.

Features

- Protective earth resistance
- Insulation resistance measurement
- Measurement of leakage current: Protective earth current, appliance leakage current, contact current, patient leakage current
- Leakage current from application components using equivalent (alternative) method, direct method and differential method
- Voltage measurement: Contact voltage, SELV, PELV voltage
- PRCD trigger time
- Function test (U, I, P, S, LF, f)
- Conductor tests: Continuity, shorts, polarity (swapping of wires)
- Temperature measurement (for Pt-100/Pt-1000 thermocouple sensors

Measuring

PROFIsafe 400 Continuity Tester

The PROFIsafe is a two-pole voltage tester conforming to EN/IEC 61243-3 (VDE 0682 part 401) with an LED display. Using the PROFIsafe you can measure DC and AC voltages in the range from 12 to 400 V.
In addition, tests of polarity, phase and direction of rotating can be undertaken and continuity tests for up to 500 k as well. The energy for the extra functions (continuity/rotating field/phase) is supplied by a lithium rechargeable battery which is charged via a high-performance solar cell, even under poor lighting conditions. No other battery is required. The tester's built-in energy source is not required for voltage measurements. Thanks to its high protection classification (IP 65), the PROFIsafe tester can even be used when it is raining.

Features

- Voltage testing
- Phase testing
- Polarity testing
- Display of rotating field direction
- Continuity testing
- Tough casing, safe to use even in damp conditions, protection class IP 65
- Easy to use, VDE-GS tested
- Equipment in CAT IV measurement category

Multimeter Range

Universal lab multimeter and temperature measuring instrument range with patented automatic socket interlock and infra-red data interface, for high-quality, universal measurement and registration of data in education, power supply engineering, process engineering etc. Direct transmission of data to the UniTrain system is made possible by means of an infra-red data interface.

LM2322: METRAHIT TEACH

LM2330: Basic

LM2331: TRMS meter with capacitance, frequency and dB measurement

Features

- 3¾ to 4¾ digit multimeter
- Measurement category CATII - 1000 V
- Coupling to UniTrain system via infra-red data interface
- Various measuring ranges for voltage, current and resistance depending on application
- Special ranges: Temperature measurement in °C using PT100/1000 thermocouples
- Continuity and diode test
- Automatic range selection plus battery shut-off, min./max. and data-hold functions
- High-current fuse for mA range at nominal voltage of 1000 V
- LM2330 and LM2331: Display with bar chart and background lighting
- Includes: Rubber wallet, measurement leads, spare fuse, 9 V battery, calibration certificate
- Automatic socket lock

Accessories

Tool Case

This tool case is made of leather and includes a document pocket and shoulder straps as well as being especially equipped for the needs of trainees. Edges are reinforced with aluminium protectors and a tough galvanised steel tray is included in the base. The front and rear of the case can be folded out separately. The case can also be locked.

Equipment set

- 1 Set of telephone pliers, straight ended
- 1 Set of combination pliers
- 1 Side cutter
- 1 Set of stripping pliers
- 2 Workshop screwdrivers
- 2 Cross-head screwdrivers
- 4 Electricians' screwdrivers
- 1 VDE voltage tester
- 1 Cable knife
- 1 Jokari cable knife
- 1 PUK pocket saw
- 1 Electricians' hammer
- 1 Stone hammer
- 1 Carpenter's hammer
- 1 Mallet
- 1 Painters' trowel
- 1 Plaster tray
- 1 Paintbrush

Tool Trolley

This tool trolley makes the perfect supplement to your training workshop. The tools included make it possible for you to achieve the best results in any application situation. Thanks to the high quality of all components, you can work in a relaxed and professional way.

ST8090-1B

ST8090-1F

ST8090-1D

ST8090-1H

Equipment set

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- 1 Paintbrush

Topic Areas

134 Electronics engineers for application engineering

136 Power supply and wiring installation electricians

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