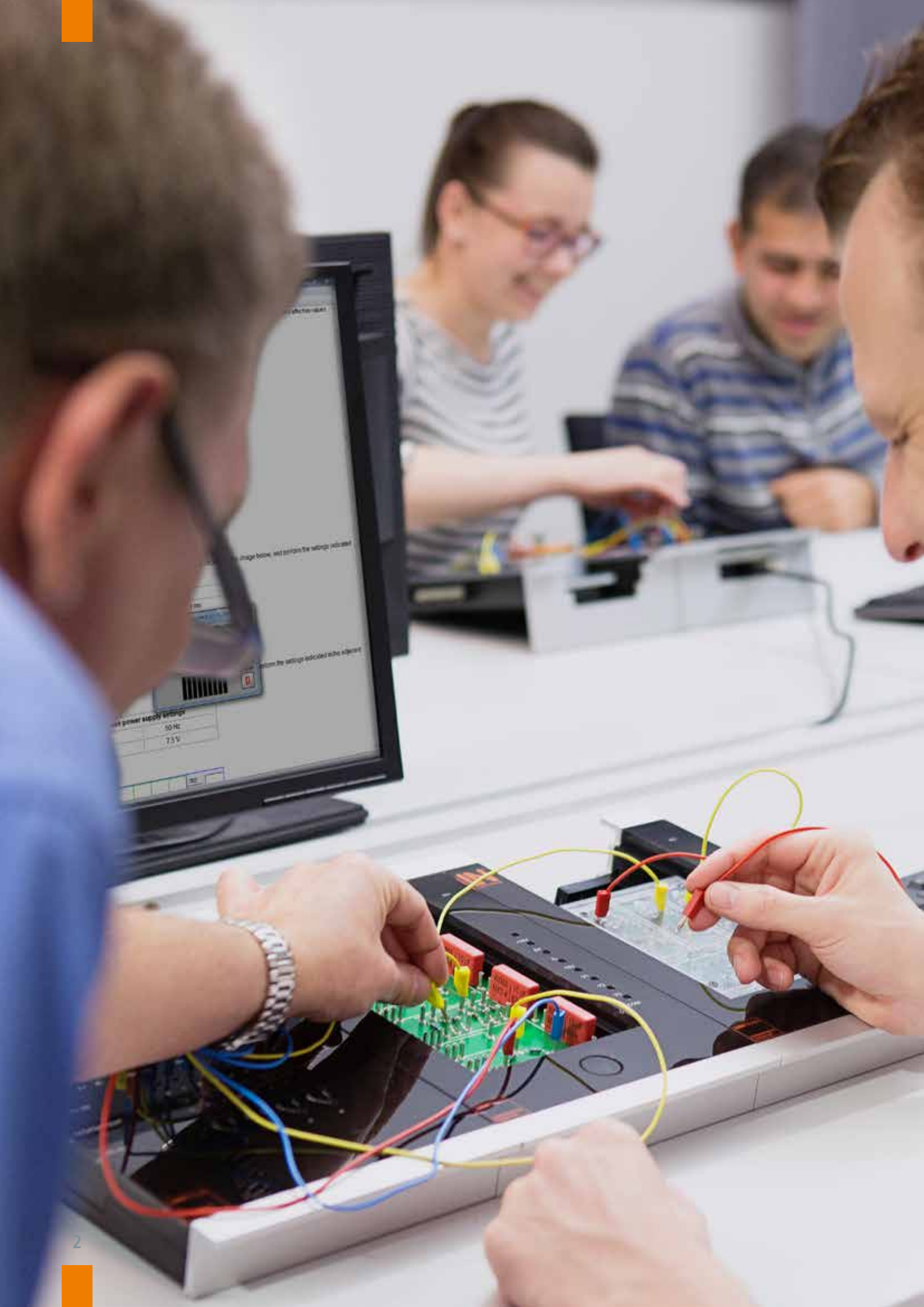




# UniTrain

Multimedia Desktop Lab  
Learning – Experimenting – Understanding





## Contents

Knowledge and practical skills	4
Blended learning	6
UniTrain: Motivated learning with a method	8
More than a training system	10
An entire lab in a single device	12
System components - ideal for experimenting	14
Complex material presented lucidly	16
LabSoft - a multimedia learning environment	18
Saving time for the essentials: LabSoft Classroom Manager	20
Everything under control at all times: Manager and Reporter	22
The right content at your finger tips: Editor and Questioner	24
Learning checks made easy: TestCreator and exercise collections	26
Courses	28
Electrical engineering	30
Electronics	32
2-mm EloTrain plus-in system	34
Digital-/microcomputer technology	36
Installation engineering	38
Power engineering	39
Power electronics & electric machines	40
Telecommunications	42
Measurement technology	46
Closed-loop control	47
Automation technology	48
Process technology	49
Pneumatics / Hydraulics	49
Mechatronics	50
Automotive technology	52
Accessories	56







Jörg Sprengel  
Product Manager, UniTrain

*„UniTrain® with its  
diversity of experimen-  
tal multimedia courses  
is unique in the field  
of technical training“*

## Knowledge and practical skills

Training with our educationally optimized systems combines acquisition of knowledge with a high level of hands-on, vocational qualifications. This turns knowledge into skill and gives rise to the practical competence required by industry and trade in professional life.

Continuously being advanced and expanded, the UniTrain system has played a leading role here for almost 15 years, and has become one of the world's largest and most versatile multimedia training systems for aspiring electrical engineers.

### 1 device with more than 120 measuring instru- ments and sources

The core is the UniTrain interface, a portable, PC-based measurement and control interface which provides the functionality of a complete electrical laboratory in a single device. Available here are more than 120 instruments and sources for measuring, controlling, programming and analysing.

### More than 130 learning programs

A combination of more than 130 learning programs with associated experimentation hardware allows all areas of electrical engineering to be explored. Besides imparting the necessary expertise, the learning programs ensure successful and safe experimentation, thereby uniting theory and practice to provide a highly efficient learning environment.

### Authoring tools and administration

The LabSoft Classroom Manager included is an extensive software package for electronic management of users and learning programs. Whether it be administering educational content and users, monitoring learning progress or independently creating exercises, courses and exams, no wish goes unfulfilled.





In the main circuit window, change the cut-off frequency to 14 V at 87 Hz. The output voltage remains set to 5 V.

Measure the output voltage and the phase angle for each frequency listed in the Table and transfer the measured values into the Table in column 4 (see 11).

Which statements are true for the circuit configuration?

- ☐ The voltage can be increased up to 50 Hz and it remains constant at higher frequencies.
- ☐ The voltage can be increased up to 87 Hz and it remains constant at higher frequencies.
- ☐ A field weakening effect can be observed above 50 Hz, which is due to the full inductor.
- ☐ A field weakening effect can be observed above 87 Hz, which is due to the full inductor.

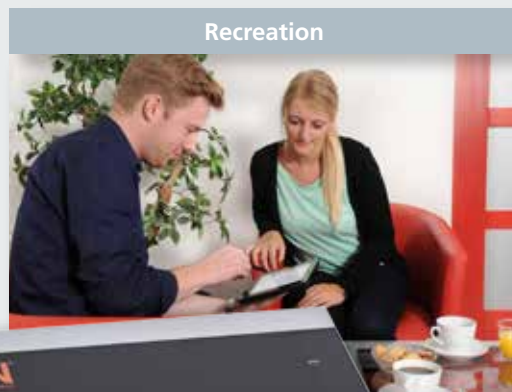
Correct

# Blended Learning

## Individual learning - the key to success

The ever growing availability of the Internet has revolutionized education in recent years. Digital learning media have established themselves to become an indispensable part of flexible and individualized training concepts.

With its open multimedia courses, the UniTrain system has pursued this approach for many years, thus enabling it to be deployed in diverse learning scenarios. The multimedia courses are closely aligned with international standards to allow their integration into numerous learning management systems.



### Your benefits

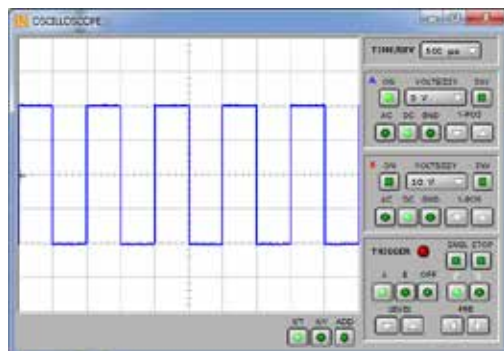
- ✓ One system – many applications
- ✓ For the classroom, laboratory, workplace and recreation
- ✓ For independent studies, laboratory internships and teaching
- ✓ Stand-alone, in a network, or as part of a learning management system (LMS)

# UniTrain – motivated learning with a method

## A single system for comprehensive technical training

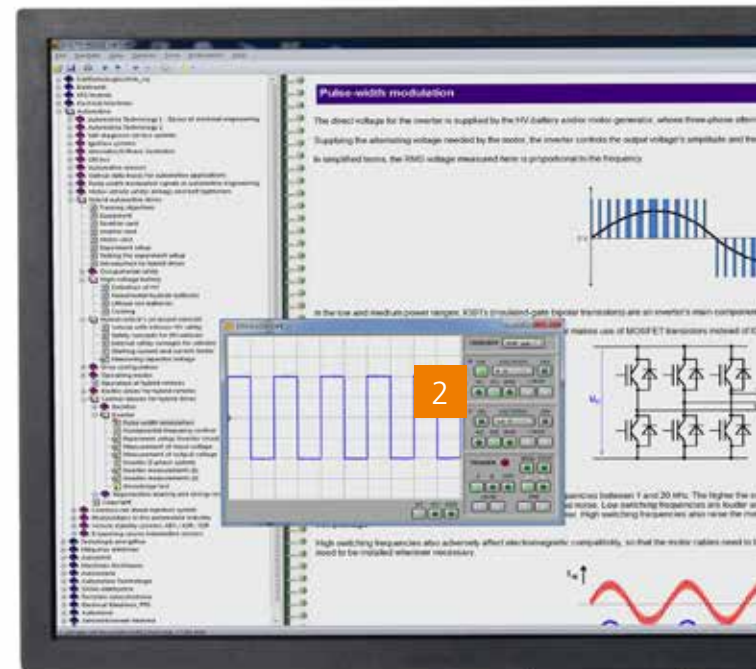
Gaining knowledge and practical skills in increasingly complex technical systems in ever shorter time cycles is the major challenge for present-day and future technical training. This challenge can be met with the help of the UniTrain system, a computer-aided, multimedia system for experimentation and training in electrical engineering and electronics.

A combination of learning programs with a fully equipped electrical laboratory in just one mobile interface enables efficient transfer of theoretical and practical skills at any place and any time.



### 2 Virtual instruments

120 virtual instruments for interface control



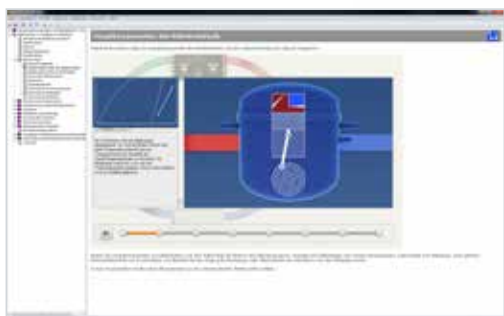
## New: Internal Wifi module

### 1 UniTrain interface

Measurement and control interface:  
Analog / digital measurement inputs and voltage sources for experiments







### 3 LabSoft course

Over 130 learning programs with experiment hardware from all areas of electrical engineering



3

### Your benefits

- ✓ Universal training system
- ✓ Mobile and useable anywhere
- ✓ Promotes individual learning
- ✓ Practical competence through practical experimentation
- ✓ High motivation through dynamic requirements
- ✓ For the entire field of electrical engineering
- ✓ Safe experimentation with safety extra-low voltages
- ✓ Combination of theory and practice in learning programs

### Product video

Convince yourself of the advantages.



3

3

4

### 4 Experimenter

Mounting of experiment cards and additional voltage outputs (three-phase)

# More than a training system

## UniTrain lab for vocational training

### 1 Presentation tools

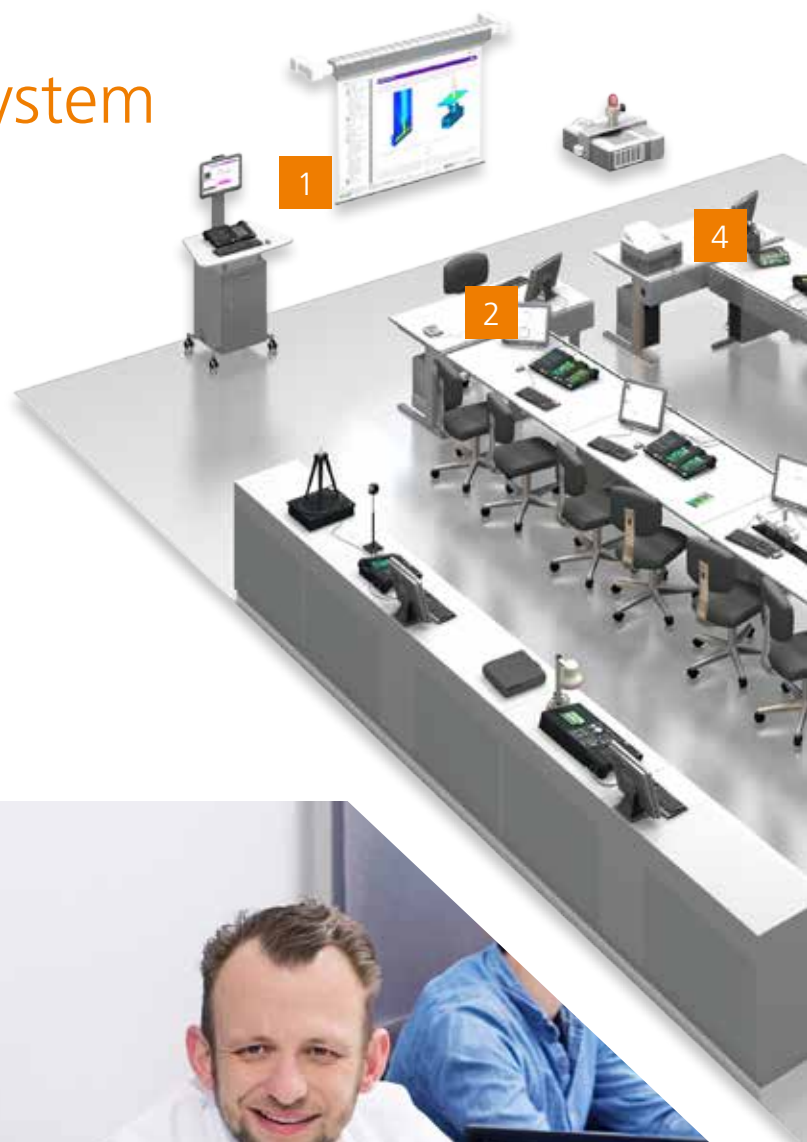
Survey what has been learned and explore complex topics and experiments, together.

### 2 Total control with Labsoft Classroom Manager

Central administration of users, groups and LabSoft courses: Check learning progress, edit courses, create own courses and exams.

### 3 LabSoft courses

Conduct LabSoft courses with the help of text, graphics, animations, experiments and test questions to obtain solid expertise and practical skills.







**4 Server-PC**

Store and manage learning programs and data centrally in a network.

**5 Sideboards –  
for storing courses**

Clearly arranged storage for quick retrieval.

**6 Multimedia tables**

Network connections and power supplies are concealed in ducts beneath moveable tabletops.







More than 120 instruments  
in a single device!

# An entire lab in a single device

## UniTrain interface and its instruments

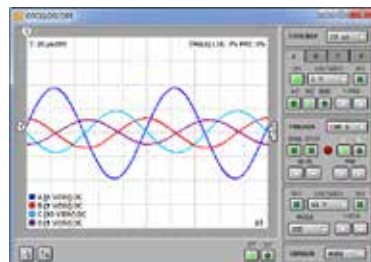
The UniTrain interface is a PC-based measurement and control interface. Its inputs and outputs are controlled via virtual instruments on a PC. More than 120 different measuring instruments and sources are available.

### Your benefits

- ✓ Mobile, handy and ready for quick use everywhere
- ✓ Universal operating concept for all instruments for faster familiarization
- ✓ Able to replace an entire range of devices
- ✓ A lab which is always at hand
- ✓ Safety ensured thanks to extra-low voltage

### 1 Measurement inputs

- Bandwidth: 10 MHz
- Sampling rate: 100 MSamples
- Measurement ranges: 100 mV to 50 V
- Oscilloscope time ranges: 100 ns – 10 s



### 2 Analog output

- -10 V to 10 V,  
DC to 5 MHz



### 3 Digital inputs /outputs

- 16 Bit, DC to 100 kHz

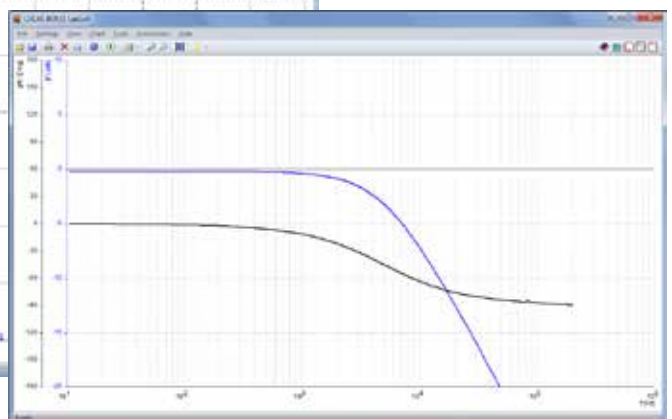
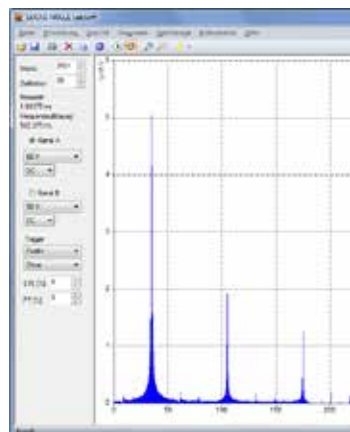
### 4 Bus connection for experiment hardware and voltage supply

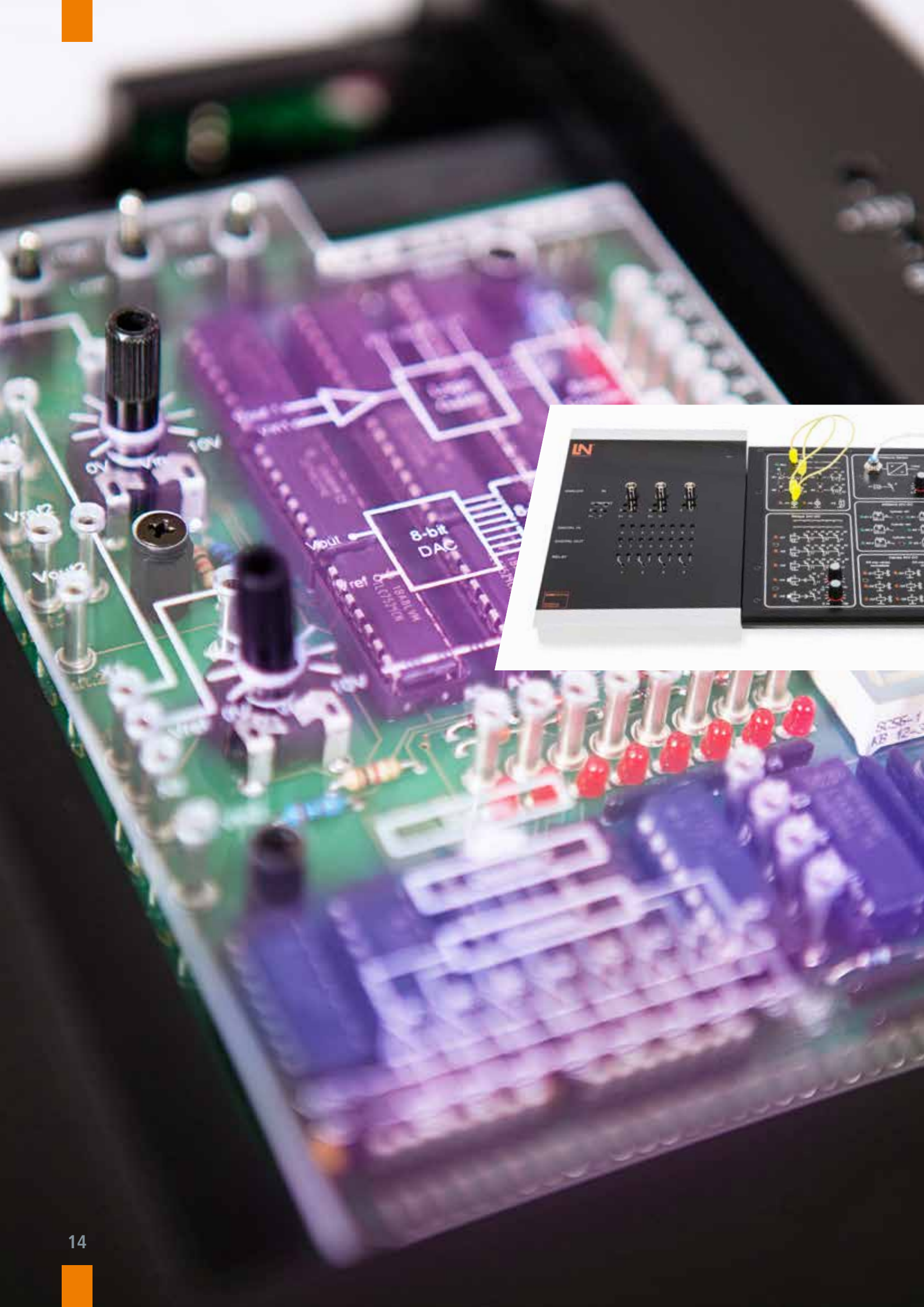
- Three-phase output  
0 - 14 V<sub>RMS</sub>, DC to 150 Hz
- Fixed voltages  
5 V, +/- 15 V



### 5 Relay connections

- 8 relays for manual  
control and automatic  
fault insertion







# System components - ideal for experimenting

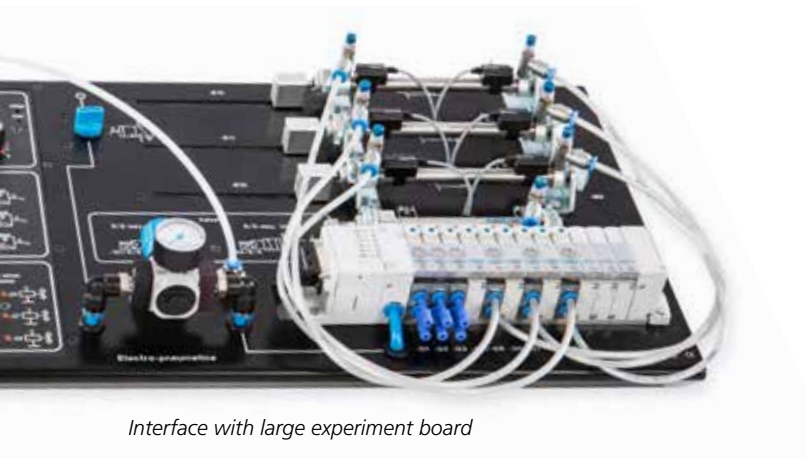
## Diverse connection options: Experimenter, boards or plug-in systems

For experimentation, the interface permits connection of diverse experiment hardware from the UniTrain courses. Electric and electronic circuits on standard, industrial European-format cards or breadboards are coupled to the interface via experimenters.

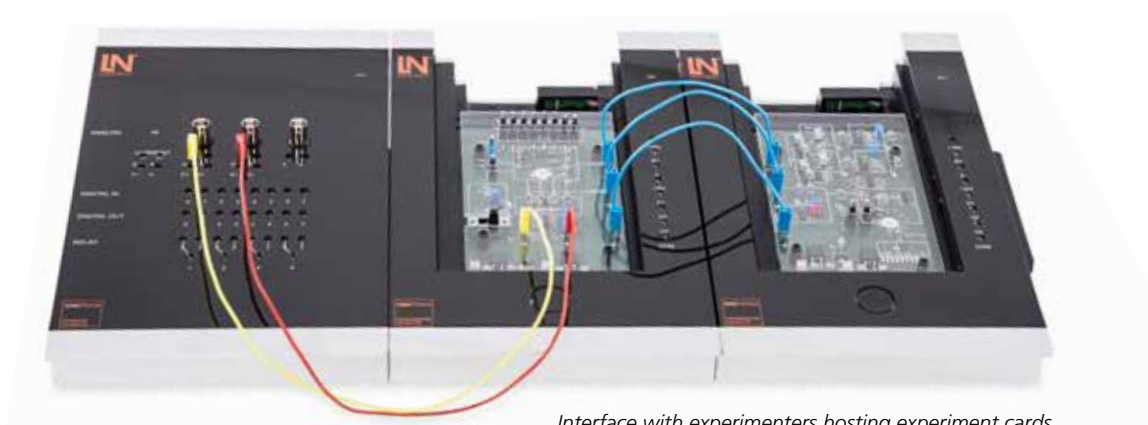
Large boards are available for circuits with large mechatronic components; the EloTrain experimenter is connected to the interface for the courses of the EloTrain plug-in system.

### Your benefits

- ✓ High flexibility
- ✓ Experiments with circuits, industrial components or plug-in modules
- ✓ Control and voltage supply via the interface
- ✓ Short setup times



*Interface with large experiment board*



*Interface with experimenters hosting experiment cards*



*Interface with EloTrain experimenter for plug-in modules*





## Complex material presented lucidly

### UniTrain courses – learning programs with matching experiment hardware

UniTrain courses combine interactive learning programs with experiment hardware that fits the content. Experimentation with real parts and industrial components reinforces acquired knowledge and imparts practical, hands-on skills. Questions for self-testing, direct feedback as well as constant alternating between theoretical and practical segments promote learning.

Animations and graphics facilitate comprehension and step-by-step understanding of experiment set-ups.

Openly structured courses in HTML provide all possible options of modifying and fine-tuning courses. In addition, courses can be supplied in all languages supported by HTML.



#### Your benefits

- ✓ More than 130 courses from the entire spectrum of electrical engineering
- ✓ Theoretical and practical competence combined in a single learning unit
- ✓ Animations, graphics, experiments, self-test questions and trouble-shooting to support learning
- ✓ Educationally oriented experimentation hardware with industrial components
- ✓ HTML-based multimedia courses
- ✓ All courses editable
- ✓ Language diversity: All HTML-languages realizable

# LabSoft – a multimedia learning environment

## Everything from a single source

LabSoft is a convenient user interface for visualizing learning programs and controlling instruments. A navigation window provides free and direct access to all course contents. The UniTrain interface is controlled via integrated virtual instruments

All measurement results and answers obtained in the course are saved automatically for each user. This permits easy tracking of the respective learning progress.

LabSoft, a system with diverse installation options: Local, networked or in combination with a learning management system.

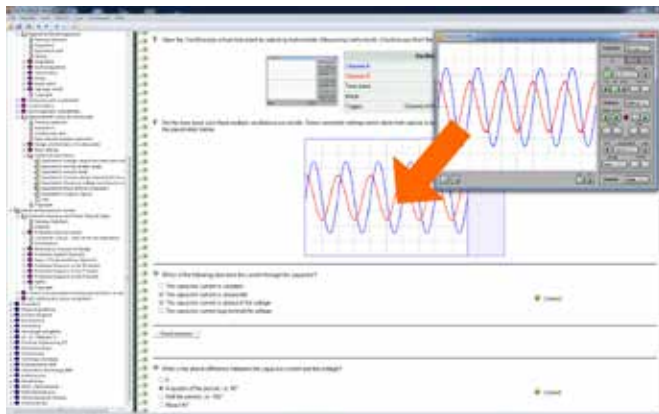
### Your benefits

- ✓ Direct access to all course content via a navigation tree
- ✓ Interface control via virtual instruments
- ✓ User-specific login and storage of results
- ✓ Storage of measurement results and measurement curves
- ✓ Operation locally, in a network, or in combination with an LMS
- ✓ Language diversity: All HTML-languages realizable

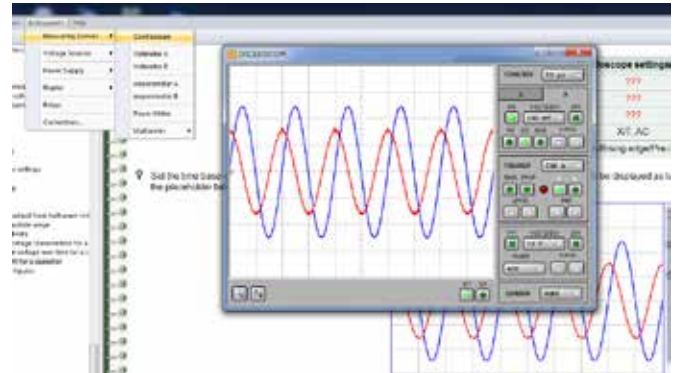




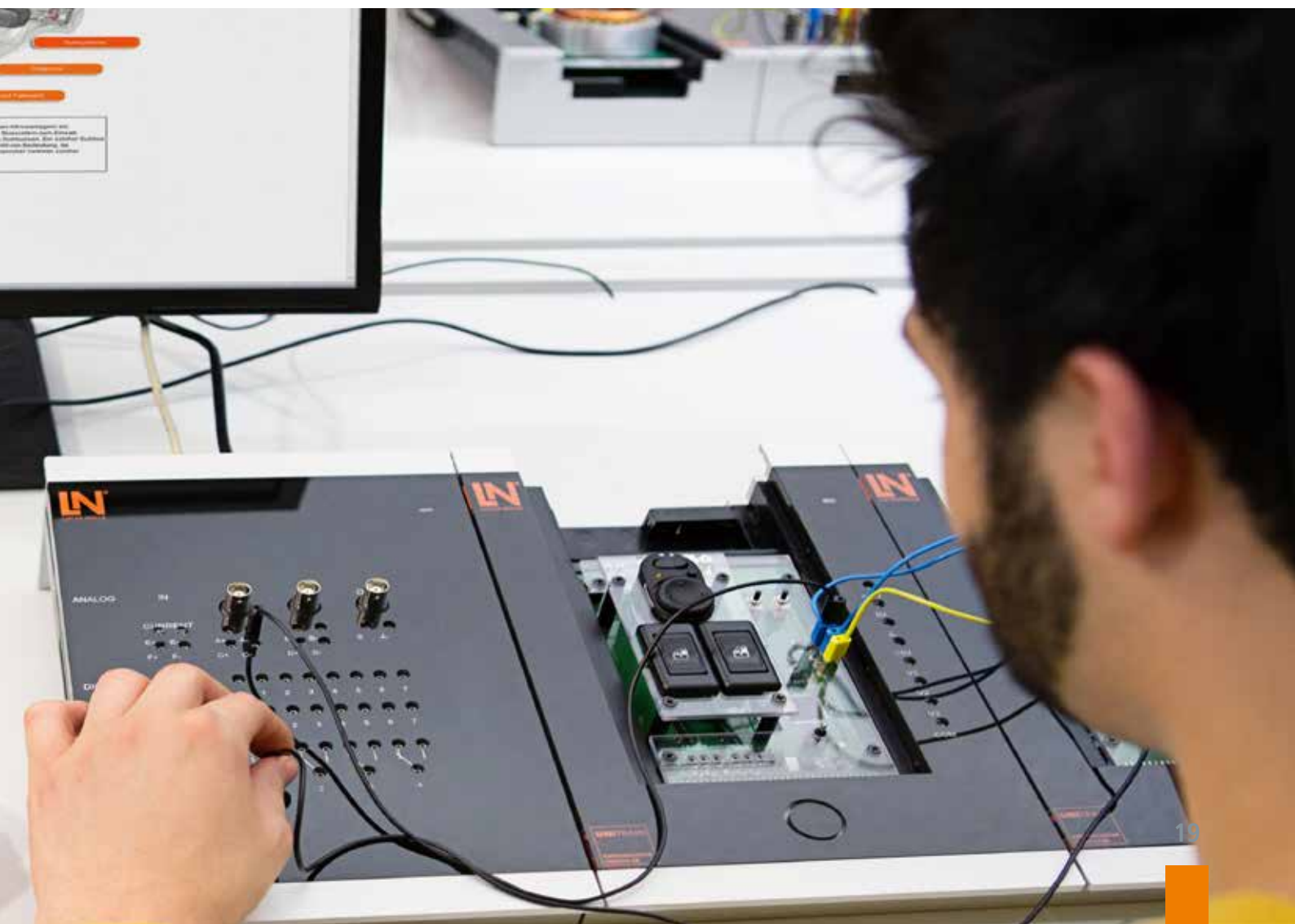
With a desktop,  
laptop or tablet PC



The navigation window provides free and direct access to all course content. Measurement results can be saved within the courses.



The UniTrain interface or other connected devices are controlled via integrated virtual instruments.



# Saving time for the essentials

## LabSoft Classroom Manager – administration, customization, testing and evaluation

LabSoft Classroom Manager is an extensive administration software for the UniTrain-system and all LabSoft courses. The Classroom Manager's programs are optimized for the related applications to facilitate daily routines.

### Your benefits

- ✓ Intuitive operation via graphic user interfaces
- ✓ Easy installation
- ✓ No need for any additional database or server systems
- ✓ Operable in the local network or Intranet







#### **Manager - minimise administrative effort**

- Everything under control: Manage students, student groups and content.
- Appropriate content at all times: Provide only the required courses for student groups.



#### **Questioner – create questions and measurement exercises**

- Knowledge tests: Create measurement exercises and quizzes for courses and exams.
- Diverse types of question: Single answer, multiple choice, filling in blanks, and more.



#### **Reporter – everything at a glance**

- Tracking learning progress: Retrieve processing statuses and test results.
- Focusing: Assessments of users, group tests and courses.



#### **TestCreator - check knowledge and skills**

- Progress checks: Compile exams and tests from sets of questions.
- Optional: Numerous, finished assignment sets with questions and measurement exercises.



#### **Editor – customize subject matter**

- Customization: Adapt courses to individual requirements.
- Innovation: Create new courses.

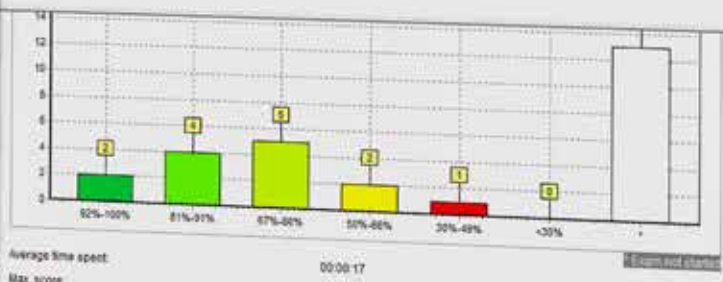




Find  
☐ Users  
☐ Courses  
☒ Exams  
☐ Groups  
☐ Group + user

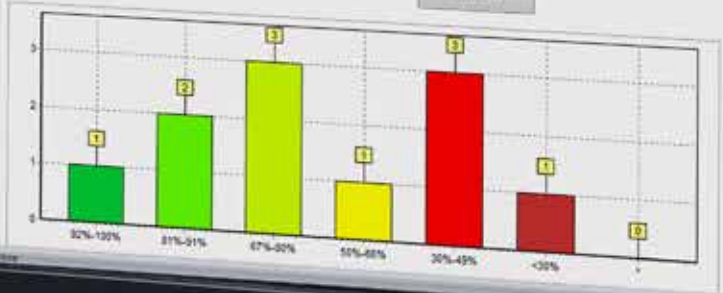
exam  
Final Test Electrical Engineering

Output  
☒ List of user groups  
☐ List of users  
  
  
  
Status  
● Exam passed  
● Exam failed



Average time spent: 00:00:17  
Max. score: 30  
Average score: 11

User group: reporttest  
Group members: 11  
Status: ●





# Everything under control at all times

## Manager and Reporter –

electronic aids for preparation and follow-up

### Manager

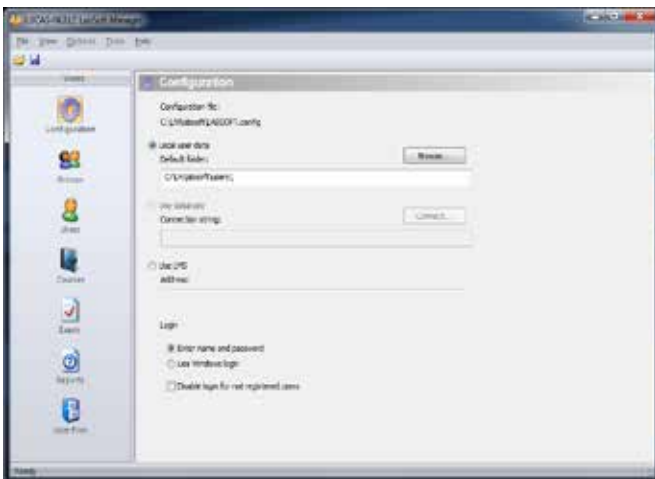


Make your life easier and utilize the benefits of managing students and courses electronically. This saves time and paper.

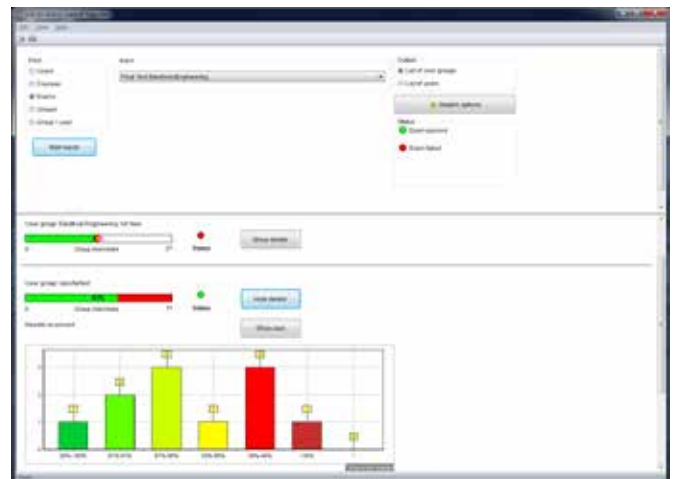
### Reporter



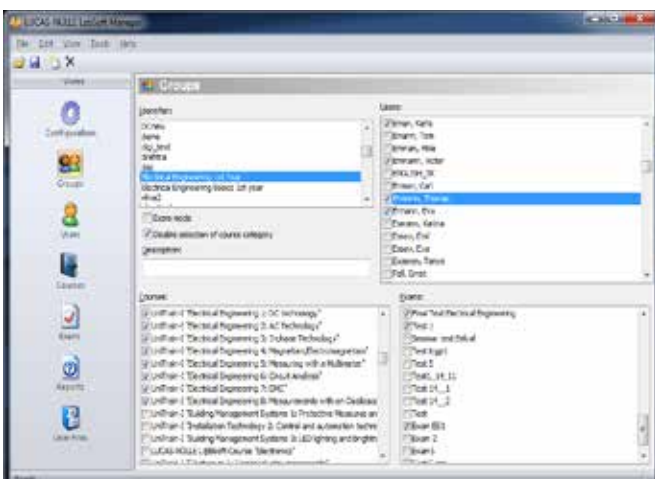
Retrieve learning progress and test results with the LabSoft Reporter. Clearly arranged selection functions lead to quick evaluation results.



Window configuration: Basic settings for LabSoft installation



Assessment of group exam results



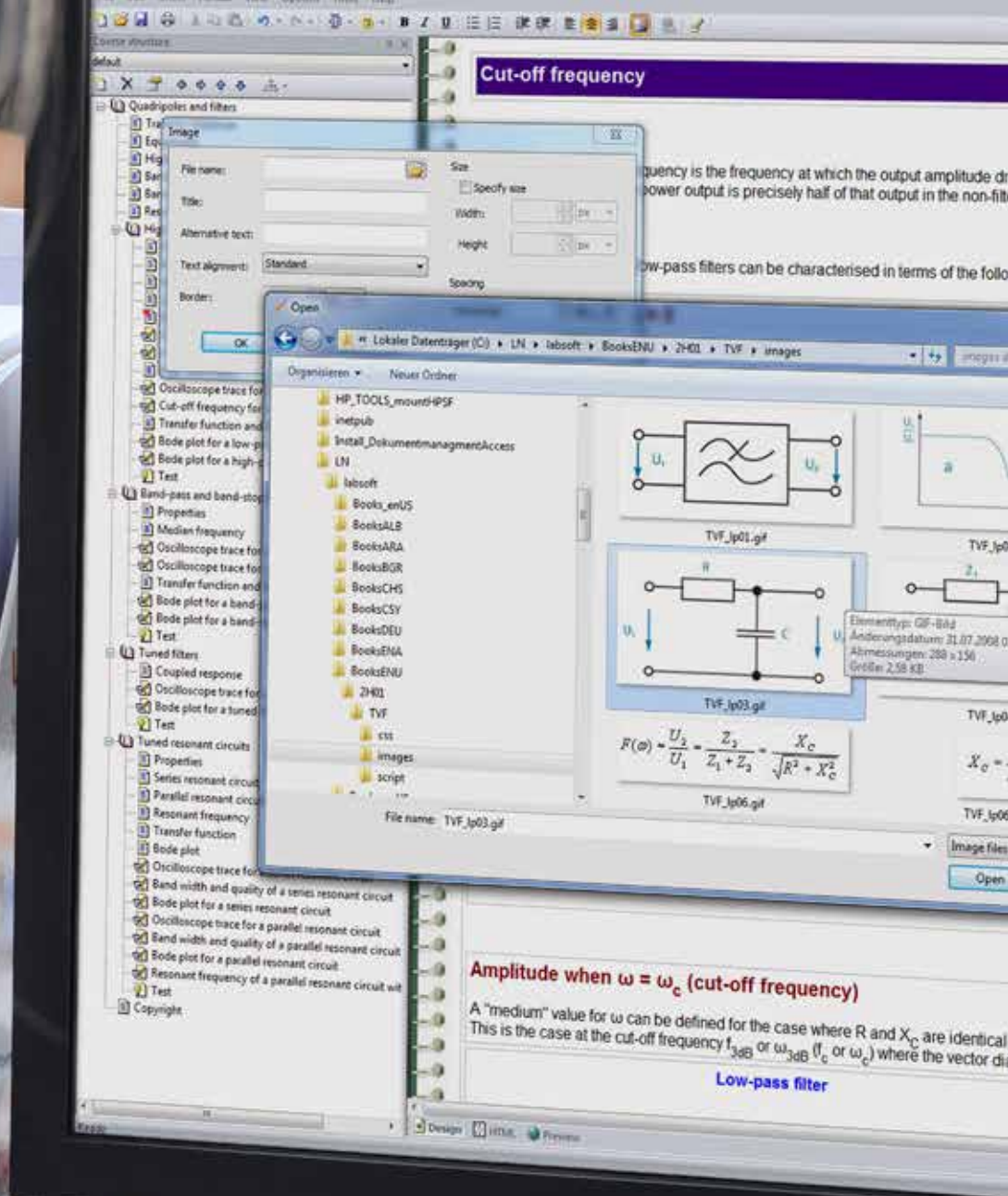
Window groups: Define groups comprising selected users and subject matter

### Your benefits

- ✓ Electronic assessment of learning progress
- ✓ Graphic presentation of processing status
- ✓ Representation of individual or group results
- ✓ Assessments of courses and tests
- ✓ Extensive search functions quickly leading to the desired assessments

### Your benefits

- ✓ Administration of the entire LabSoft installation
- ✓ Unlimited number of users and courses (learning programs)
- ✓ Creation and admin. of users and subject matter
- ✓ Creation and administration of student groups





# The right content at your finger tips

## Editor and Questioner –

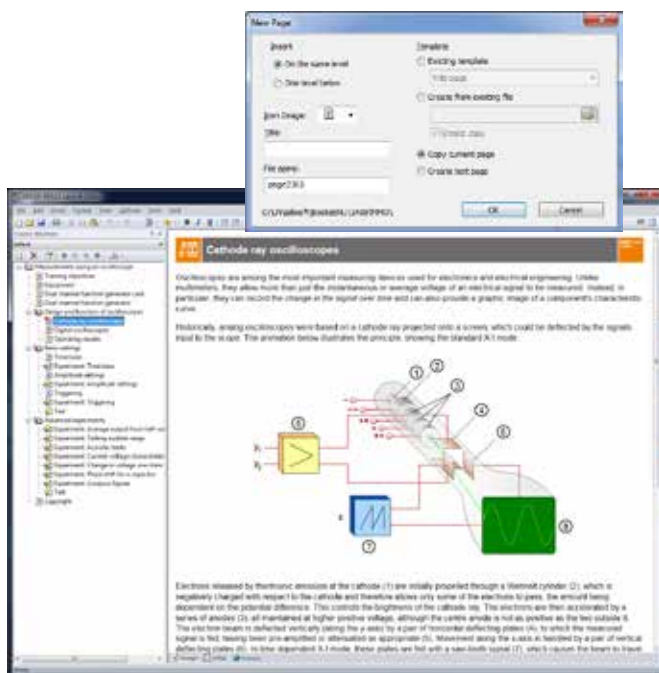
Course customization: Independently create courses and exercises

### Editor



Use the LabSoft editor to tailor your LabSoft courses to students' current needs. Create your own questions, experiments, measurement exercises and courses, which then become immediately available to students.

The Editor's numerous wizards and an extensive help function facilitate course creation.



New pages can be added to a course with just a few mouse clicks. Various different options for addition are available.

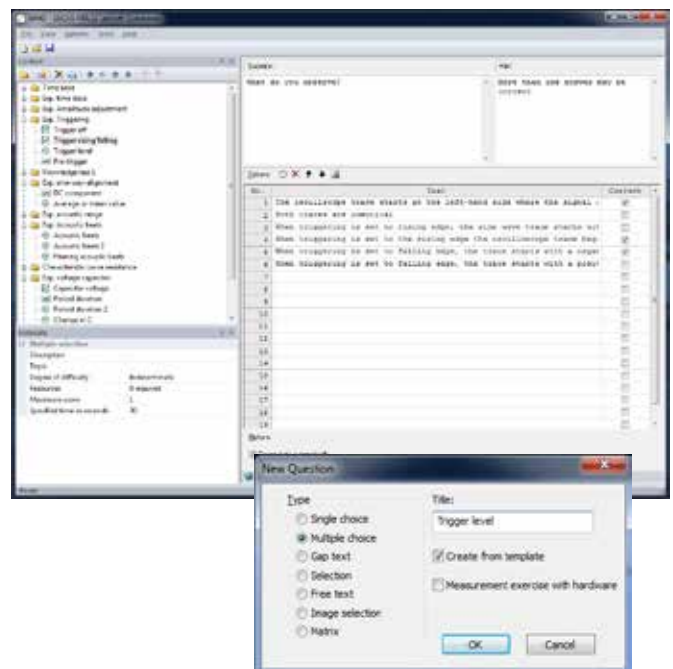
### Your benefits

- ✓ Editing and adaptation of existent courses
- ✓ Independent creation and editing of new courses
- ✓ Import of individual pages or chapters
- ✓ Preview of created pages in editing mode (wysiwyg)
- ✓ Automatic provision of newly created courses in LabSoft

### Questioner



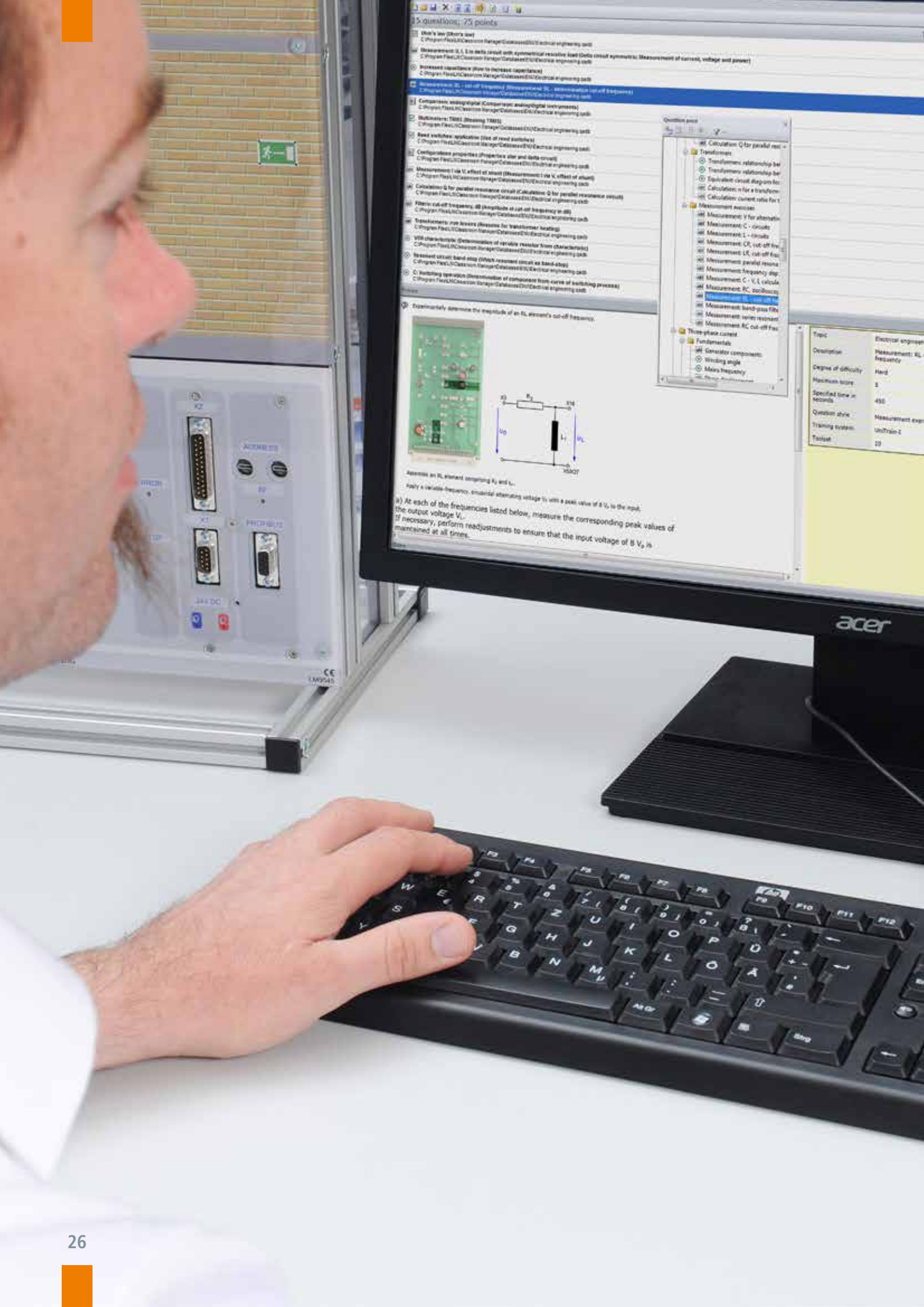
The LabSoft questioner offers many types of question for configuring quizzes, measurement exercises and exam problems. The exercises and questions can be used for courses as well as tests.



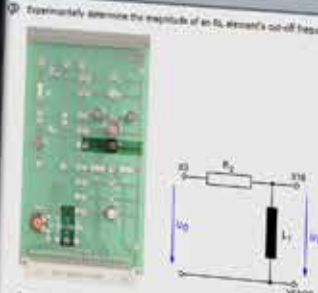
Single-choice question: Question and answer options are formulated, and the correct answers are subsequently determined with a mouse click.

### Your benefits

- ✓ Simple creation of interactive exercises and questions
- ✓ Availability of diverse question types
- ✓ Freely selectable tolerance ranges for measurement exercises
- ✓ Use of questions for exams as well as learning programs



- 5 questions; 75 points
- Question 1 (10 points)
  - Question 2 (10 points)
  - Question 3 (10 points)
  - Question 4 (10 points)
  - Question 5 (10 points)
- Question 1: Calculation of the parallel resonance frequency  $f_0$  for a parallel resonance circuit.
- Question 2: Calculation of the parallel resonance frequency  $f_0$  for a parallel resonance circuit.
- Question 3: Calculation of the parallel resonance frequency  $f_0$  for a parallel resonance circuit.
- Question 4: Calculation of the parallel resonance frequency  $f_0$  for a parallel resonance circuit.
- Question 5: Calculation of the parallel resonance frequency  $f_0$  for a parallel resonance circuit.



Approximate the RL network comprising  $R_1$  and  $L_1$ .

Apply a variable-frequency, sinusoidal alternating voltage  $U_0$  with a peak value of 8 V<sub>0</sub> to the input.

a) At each of the frequencies listed below, measure the corresponding peak values of the output voltage  $U_1$ . If necessary, perform readjustments to ensure that the input voltage of 8 V<sub>0</sub> is maintained at all times.

Topic	Electrical engineering
Description	Measurement: RL frequency
Degree of difficulty	Hard
Maximum score	5
Specified time in seconds	450
Question style	Measurement experiment
Training system	uniTrain 2
Toolset	10



# Learning checks made easy

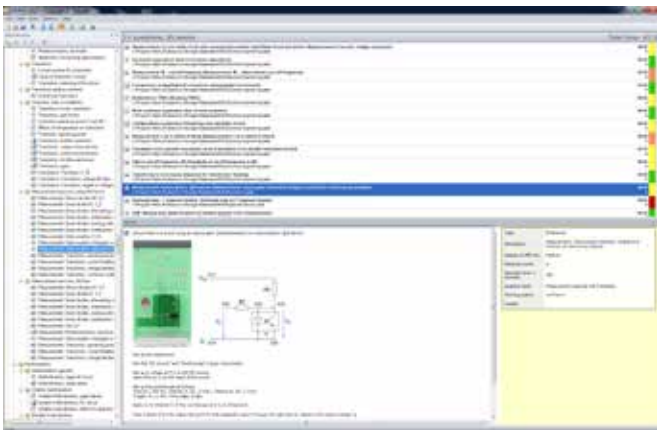
## TestCreator –

create exams with theoretical questions and practical exercises

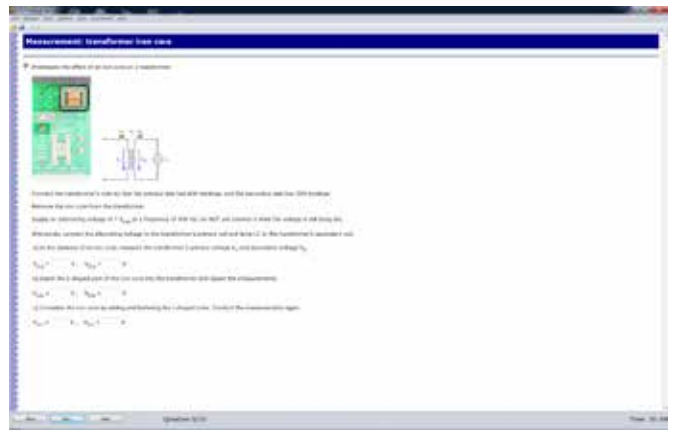
### TestCreator



Create tests in the TestCreator quickly and easily with just a few mouse clicks. For this, use questions created independently in the questioner, or finished exercise collections containing questions and measurements to review acquired knowledge and practical skills. The exercise collections regarding various topics are available separately and can be combined as desired in the TestCreator.



Selection of exam problems via drag-and-drop



Test conduction in LabSoft

### Your benefits

- ✓ Creation of electronic exams with just a few mouse clicks
- ✓ Review of acquired knowledge and practical skills
- ✓ Manual or automatic exam creation
- ✓ Availability of numerous optional assignment collections
- ✓ Question pool extensible at all times



Exercise collections with prepared assignments

Experimenting –  
Learning – Understanding



A fresh breeze  
for your lab –

with the „Renewable  
Energies“ training system  
from Lucas-Nülle.

lucasnuelle.com

unifrain-1.com





# Our course program

- Electrical engineering
- Electronics
- 2-mm plug-in system
- Digital and microcomputer technology
- Installation engineering
- Power engineering
- Power electronics
- Electrical machines
- Telecommunications
- Measurement and control technology
- Automation
- Pneumatics, hydraulics
- Process technology
- Mechatronics
- Automotive technology



# Courses on electrical engineering

## CO4204-4D

### DC technology

- Electricity, electric charge, electric fields
- Current, voltage and resistance in DC circuits
- Ohm's and Kirchhoff's laws
- Parallel and series connections of resistors
- Coils and capacitors
- Recording of characteristics and trouble-shooting
- Course duration: approx. 8 h

## CO4204-4F

### AC technology

- AC variables; sinusoidal and periodic signals
- Capacitance, inductance, reactance
- Phase shift and frequency response of RL and RC combinations
- Active, reactive and apparent power
- Resonant circuits
- Transformers
- Course duration: approx. 8 h

## SO4204-4H

### Three-phase technology

- Star and delta circuits
- Phase-to-phase/line-to-line voltages and currents
- Resistive and capacitive loads
- Symmetric and asymmetric loads
- Phase shift and power
- Compensation currents in neutral conductors
- Course duration: approx. 4 h

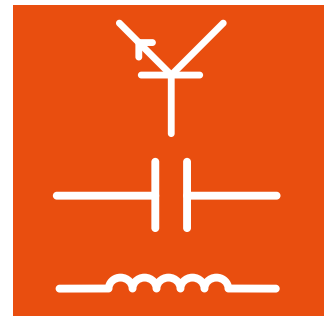
## CO4204-4A

### Magnetism/ electromagnetism

- Magnetism, electromagnetism, magnetic materials
- Magnetic poles, magnetic fields, field intensity and lines, hysteresis
- Magnetic field of a coil
- Magnetic induction, Lorentz force, induction law
- Coil, transformer, relay, Hall sensor, reed switch
- Course duration: approx. 4 h







#### SO4204-4B

##### Measurements with a multimeter

- Multimeter controls
- Potential dangers during measurements of electric circuits
- Measuring voltage, current, resistance and diodes
- Measurement range adjustment and error sources
- Determining ratings of unknown components
- Course duration: approx. 3 h

#### SO4204-4C

##### Electrical network analysis

- Kirchhoff's equations for resistor networks
- Network analysis
- Analysis methods: Star-delta conversion, superposition theorem
- Network simplification: Equivalent current and voltage sources
- Mesh current method and node potential analysis
- Course duration: approx. 5 h

#### CO4204-4K

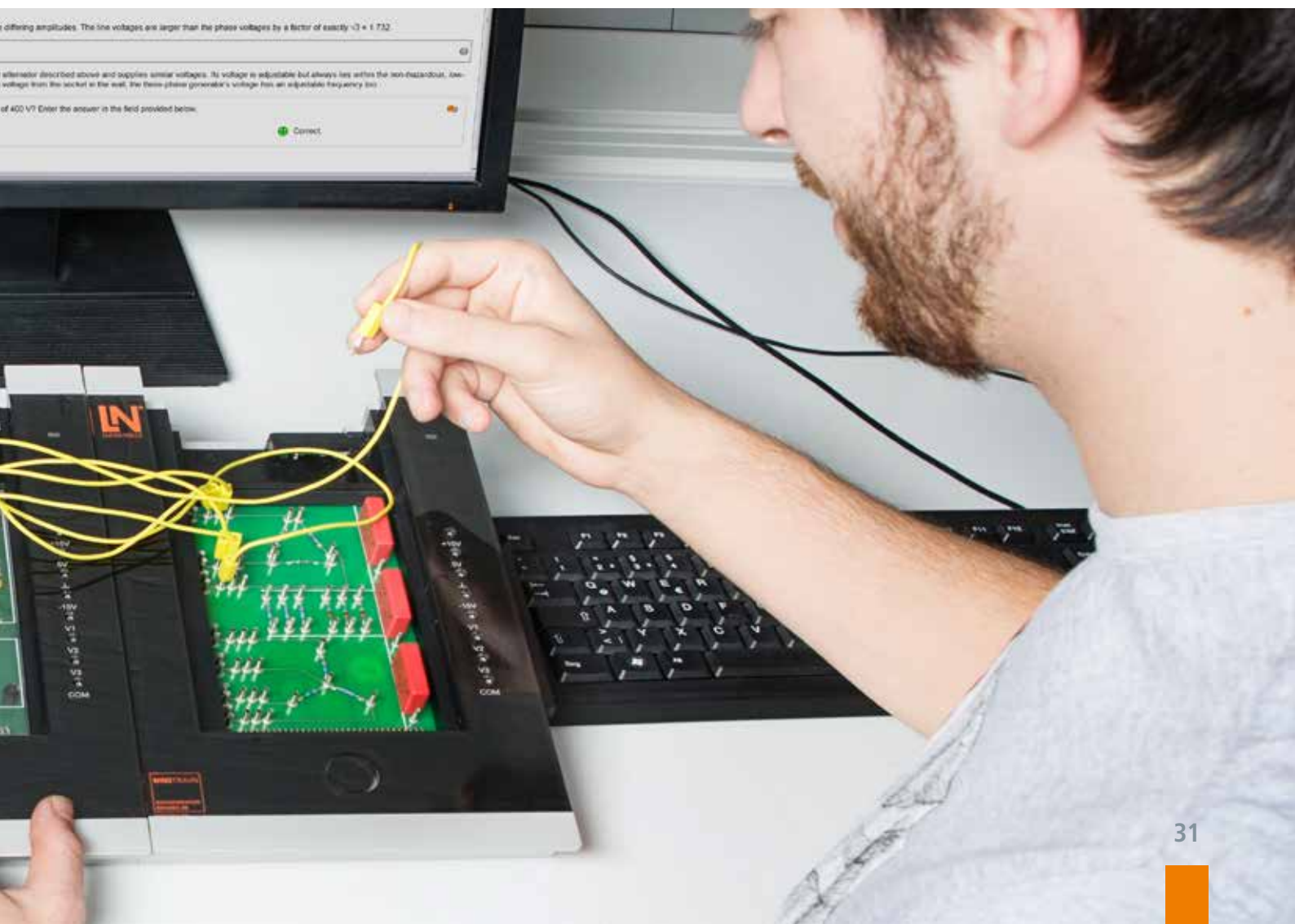
##### Electromagnetic compatibility (EMC)

- EMC concepts and coupling effects
- Standards and guidelines
- Measuring galvanic, capacitive and inductive coupling between tracks
- Improving interference resistance and EMC characteristics
- Course duration: approx. 4 h

#### SO4204-4L

##### Measurements with an oscilloscope

- Oscilloscope: Design and functionality
- Settings and operating modes
- Measuring direct and alternating voltages
- Trigger functions and modes (x/t, x/y)
- Measuring Lissajous figures
- Determining component characteristics
- Course duration: approx. 3 h



# Courses on electronics

## CO4204-5A

### Semiconductor components

- Semiconductor materials: Properties and functionality
- Doping, P-N junction
- Diode, Z-diode: Functionality, characteristics, behaviour
- LED, phototransistor, fork-type light barrier, switching characteristics
- Transistor: Basic circuits, characteristics, operating points
- Trouble-shooting
- Course duration: approx. 8 h

## CO4204-5D

### Transistor multivibrators

- Design and functionality of multivibrators
- Astable, monostable and bistable (flip-flop) multivibrators
- Input/output signals and dynamic response
- Changes in input wiring
- Response to pulsed and square-wave signals
- Trouble-shooting
- Course duration: approx. 4 h

## CO4204-5H

### Transistor and amplifier technology

- Data sheets: Determining characteristic fields and parameters
- Operating point adjustment
- Amplifier circuits and classes; Darlington amplifier, push-pull amplifier
- Single and multi-staged amplifiers
- Differential amplifiers and constant current sources
- Trouble-shooting
- Course duration: approx. 8 h

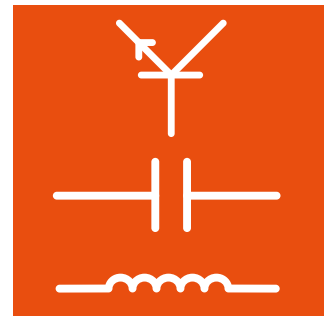
## CO4204-5K

### Field-effect transistors

- FET: Design, functionality, applications
- N- and P-channel types
- Source and drain circuits
- DC and AC negative feedback
- Trouble-shooting
- Course duration: approx. 1.5 h







#### CO4204-5M

##### Operational amplifiers

- Basic circuits; characteristic and limiting values
- Inverting and non-inverting op-amps
- Adder, subtractor, integral-action and derivative-action circuits
- Comparator and Schmitt trigger
- Precision-voltage and constant-current sources
- Active filters
- Trouble-shooting
- Course duration: approx. 5.5 h

#### SO4204-5P

##### Power semiconductors

- Design and functionality of thyristors, triacs, MOSFETs and IGBTs
- Conducting and non-conducting response
- Load and transmission response
- Threshold voltage and control power
- Course duration: approx. 2 h

#### SO4204-5R

##### Power supply circuits

- Half-wave and bridge rectifiers
- Smoothing circuit and load response
- Voltage multiplier circuit, load response, ripple
- Transistor voltage controller
- Load response and control quality of voltage regulators
- Trouble-shooting
- Course duration: approx. 5.5 h

#### SO4204-5S

##### Switched-mode power supplies

- Design and functionality of switched-mode power supplies
- Adjustment range and load dependency of step-down regulators
- Adjustment range and load dependency of step-up regulators
- Signal waveform measurements
- Course duration: approx. 2 h

#### SO4204-5U

##### Circuit design using NI Multisim

- Designing a PWM-controlled LED light mixer
- Assessing and selecting alternative solution strategies
- Computing component values and selecting components
- Sketching circuits
- Designing and simulating circuits in NI Multisim
- Assembling circuits on the breadboard; testing the circuits and comparing their results with simulations
- Course duration: approx. 8 h

#### SO4204-5V

##### PCB layout with NI Ultiboard

- Printed circuit boards: Manufacturing processes and standards
- Imperial and metric units of measurement
- Importing circuit files
- Positioning components, creating footprints
- Routes, through-connections and wire jumpers
- Creating Gerber files
- Course duration: approx. 8 h

# Courses on the 2-mm EloTrain plug-in system

## SO4206-1A

### DC technology

- Assembling electric circuits
- Using ammeters and voltmeters
- Ohm's law, series and parallel connection of resistors
- Voltage divider with and without loads
- Voltage dependent resistors
- Capacitors in DC circuits, relay circuits
- Course duration: approx. 8 h

## SO4206-1B

### AC and three-phase technology

- Characteristics of alternating current
- Resistor, capacitor and coil in an AC circuit
- Series and parallel connections of RC and RLC
- Transformer with and without loads
- Three-phase network: Star and delta circuit with symmetric/asymmetric loads
- Course duration: approx. 8 h

## SO4206-1C

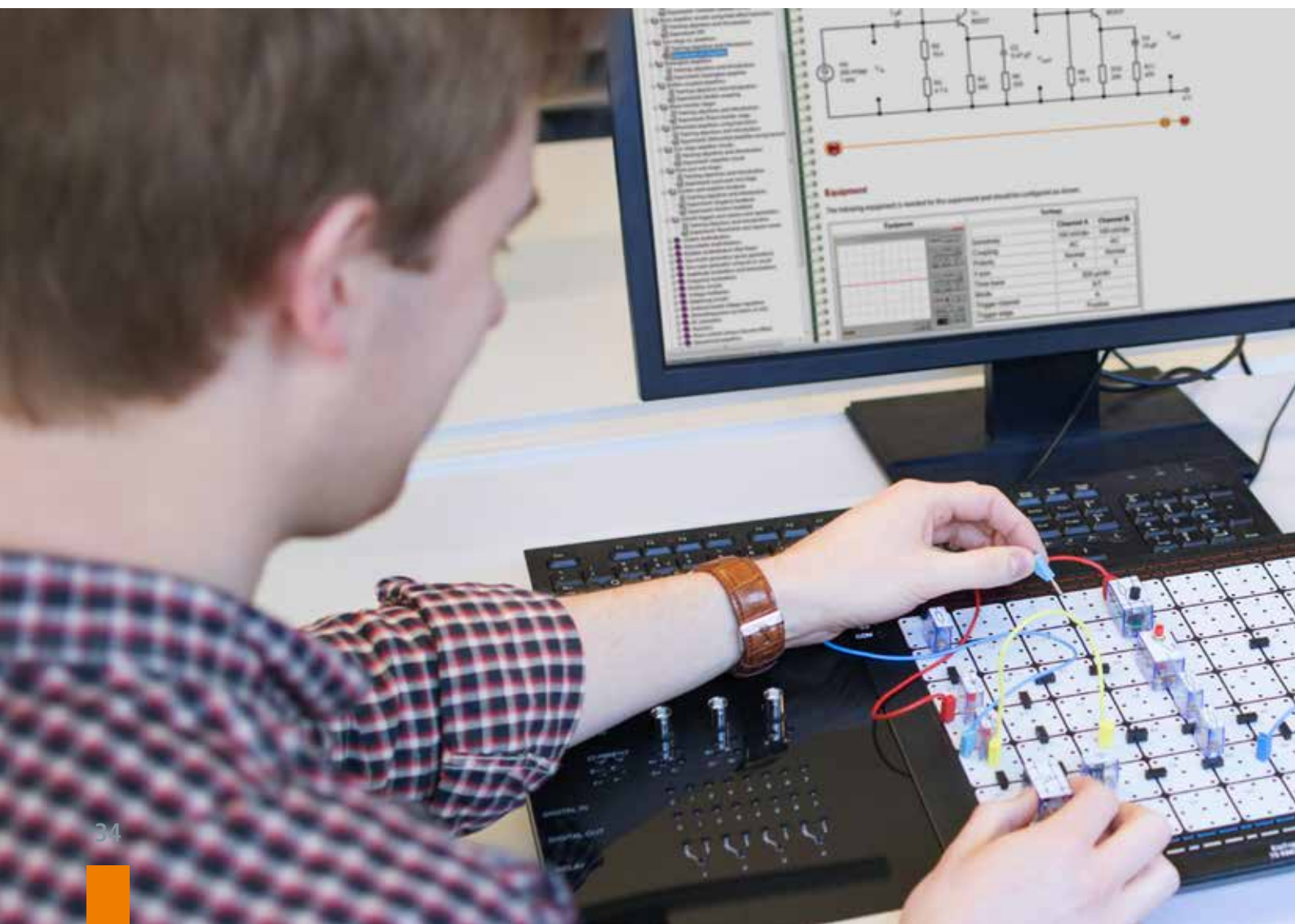
### Semiconductor components

- Fundamentals of semiconductors and doping
- Diode, LED, Zener diode
- Half-wave and bridge rectifiers
- Transistor: DC and AC response, characteristics
- Emitter, collector and base circuits
- Power semiconductors: JFET, MOSFET, thyristor, diac, triac
- Course duration: approx. 7 h

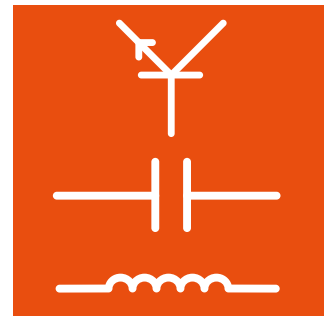
## SO4206-1D

### Basic electronic circuits

- Amplifier circuits with bipolar transistors, FETs and op-amps
- Two-stage, Darlington and coupled emitter amplifiers
- Differential amplifier
- Signal generators, Schmitt trigger, multivibrators
- Rectifier, voltage regulator
- Phase control using thyristors and triacs
- Course duration: approx. 10 h







#### SO4206-1E

##### Optoelectronics

- Light-emitting diodes: Parameters, characteristics, control
- Infrared LED, photo-detector, photodiode, phototransistor
- Signal transmission using photodiodes and phototransistors
- Optocoupler, optical fibres
- Course duration: approx. 3 h

#### SO4206-1F

##### Introduction to digital technology

- Number systems
- Basic logic functions
- Antivalence (XOR) and equivalence (XNOR)
- Half adders, full adders, subtracting circuits
- Code conversion
- RS flip-flop, D flip-flop, JK flip-flop, JK master-slave flip-flop
- Flip-flop applications
- Course duration: approx. 6 h

#### SO4206-1G

##### Sequential circuits

- Display of binary numbers on LEDs and LED displays
- Asynchronous 4-bit counter, synchronous counter, decimal counter
- Counters for special codes, divider circuits, registers and shift registers
- Serial and parallel data transmission
- Multiplexers and demultiplexers
- Course duration: approx. 6 h



# Courses on digital-/microcomputer technology

## SO4204-6A

### Gates and flip-flops

- Number systems, calculations with binary numbers
- Basic logic circuits
- Truth tables, symbols, switching equations and timing diagrams
- Boolean functions and laws
- Minimization of logic circuits using Karnaugh maps
- JK flip-flop, counter circuit
- Trouble-shooting
- Course duration: approx. 5 h

## SO4204-6C

### Sequential circuits

- Design and functionality of flip-flops and registers
- Shift registers with serial and parallel outputs
- Design and functionality of counters and dividers
- Design and assembly of counters and shift-register circuits
- Binary-coded up and down counters
- Trouble-shooting
- Course duration: approx. 5 h

## SO4204-6E

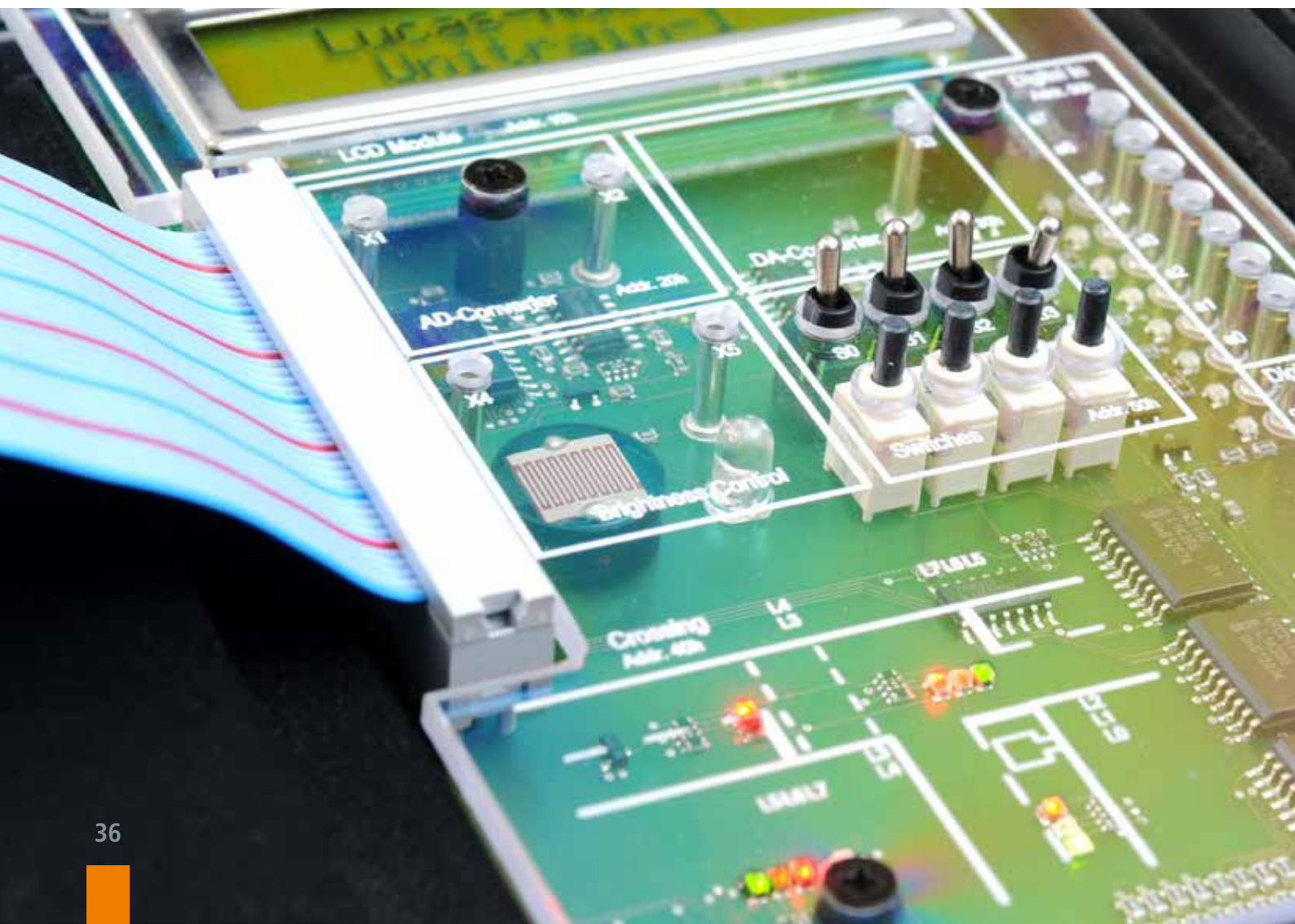
### Application circuits

- Binary addition and subtraction
- Functionality of binary half and full adders
- 4-bit full adder with parallel / serial output
- Design and functionality of multiplexers and demultiplexers
- Functionality of data and address buses
- Measurements of multiplexer/demultiplexer circuits
- Trouble-shooting
- Course duration: approx. 3 h

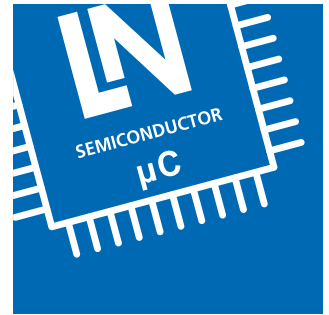
## SO4204-6B

### Converter circuits

- Converter parameters: Resolution, linearity, speed
- D/A converter with an R/2R network and weighted resistors
- Sampling, sampling theorem, signal reconstruction, aliasing
- A/D converter with counting method, single/dual-slope ADC and sigma-delta ADC
- Measurement of internal signals
- V/f and f/V converters
- Trouble-shooting
- Course duration: approx. 5 h







#### SO4204-6H

##### **Fundamentals of computer technology**

- Microcontroller architecture
- Microprocessor components (ALU, registers, stack, command decoder, program counter)
- Design and instruction set of an Intel 8085
- Memory system and buses
- Read-out of signals on address, control and data buses
- Program routines, linear and branched programs
- Course duration: approx. 5 h

#### SO4204-6J

##### **Applications and programming**

- Writing assembler programs
- Designing input programs
- Programming counters, loops and subroutines, interrupts and alphanumeric output
- Error analysis, debugging
- Programming and analyzing traffic light control
- Creating programs for processing of analog variables and serial data transmission
- Course duration: approx. 8 h

#### SO4206-9A

##### **Microcontroller PIC16F887 (Assembler programming)**

- Structure and functionality of a PIC16F887
- Instruction set and program flow
- Registers and addressing
- Programming with the IDE
- Timer and interrupts
- Creating sample programs: External clock source, monoflop, timer-controlled light sequence
- Course duration: approx. 8 h

#### SO4206-9B

##### **Programming 32-bit ARM Cortex M3 microcontrollers (C programming)**

- Introduction to C programming for embedded systems
- Cortex M3 architecture and programming model
- Commissioning a ColDE
- Programming and debugging
- Projects: Reading in external signals, interrupt with signal output, A/D conversion, I2C LCD display
- Course duration: approx. 8 h

#### SO4206-9C

##### **Digital signal processing using ARM Cortex M3 (C programming)**

- System components for digital signal processing
- Digital transfer functions: Digital voltage divider and amplifier
- Digital signal synthesis: Sine, sawtooth and square-wave generator
- Discrete and fast Fourier transformation
- LTI systems
- Design of FIR and IIR filters
- Digital sound effects
- Course duration: approx. 6 h

#### SO4206-9E

##### **FPGA: Circuit design using VHDL**

- Introduction to programmable logic
- Design and functionality of an FPGA
- Design flow with VHDL
- Familiarization with the Lattice IDE
- Independent circuit design
- FPGA configuration
- Course duration: approx. 16 h

# Courses on installation engineering



## SO4204-4M

### Safety measures and power network types

- Design of various mains systems (TN, TT, IT)
- Protection against contact
- Protection by isolation and safety extra-low voltage
- Protection against excess and residual-leakage currents
- Protective earth resistance, insulation resistance measurement, RCD test, earthing electrode, loop resistance measurement
- Course duration: approx. 10 h

## SO4204-4N

### Control systems/contactors circuitry

- Familiarization with control components
- Planning control projects
- Functionality checks with circuit simulators
- Function testing and troubleshooting in control projects
- 25 control projects
- Course duration: approx. 25 h

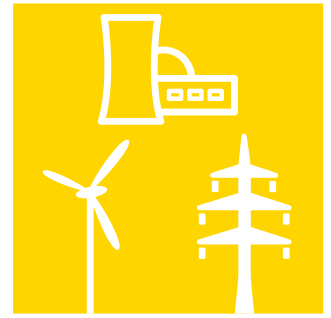
## CO4204-4P

### LED lighting and colour detection

- Familiarization with different types of LED
- Brightness control for various LEDs using pulse width modulation (PWM)
- Recording of characteristics and measurement of brightness
- Additive mixing of colours and setting of colour temperature
- Colour detection and reproduction
- Course duration: approx. 10 h



# Courses on power engineering



## CO4204-3A

### Photovoltaics

- Operating principle and function of a solar cell
- Meaning of the terms „solar radiation“ and „solar constant“
- Solar cell: Series and parallel connections
- Recording a solar module's characteristics, dependence on temperature, irradiance and angle of incidence
- Storage of energy in a solar cell
- Insular network with solar cells
- Course duration: approx. 4.5 h

## SO4204-3B

### Transient processes in AC and DC networks

- Switching processes in power supply networks
- Hazards of switching processes in power supply networks
- Current and voltage response when powering up a DC / AC circuit
- The effect of loads (R, L, C)
- Switch-on and switch-off times
- Signal characteristic measurements
- Course duration: approx. 3.5 h

## SO4204-3C

### Fuel cell technology

- Operating principle and function of a fuel cell
- Recording a fuel cell's characteristic
- Faraday's 1st and 2nd laws
- Faraday / energy efficiency and power of a fuel cell
- Series and parallel connections of fuel cells
- Operating principle and function of an electrolyser
- Characteristic of an electrolyser
- Course duration: approx. 4.5 h





# Courses on power electronics & electrical machines

CO4204-7N

## Line-commutated power converters

- Functionality and control of power semiconductors
- Single-phase and three-phase rectifiers
- Converter circuits: control and operating characteristics
- Single-phase and three-phase AC power controllers
- Analysis of power in converter circuits
- FFT analysis
- Course duration: approx. 5 h

CO4204-7M

## Self-commutated power converters

- PWM for generating variable direct and alternating voltages
- Load response, control and operating characteristics
- Measurements: Amplitude and signal modulation by converters
- Three-phase converter
- Block commutation, sine, super-sine and space-vector modulation
- Harmonic analysis with FFT
- Course duration: approx. 5 h

CO4204-7P

## Frequency converter drives

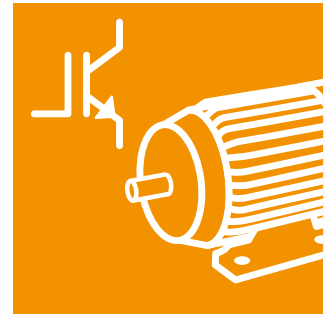
- Design and functionality of frequency converters
- DC link voltage
- V/f characteristic and boost
- Operating 3-phase motors with frequency converters, 87-Hz technology
- Design and functionality of brake choppers
- Analysis of current, voltage and power
- Course duration: approx. 5 h

CO4204-7Q

## Active power factor correction

- Areas of applications and reasons for using power factor correction
- Design and functionality of an active power factor correction circuit
- Comparison with conventional bridge rectifier circuits
- Analysis of current, voltage and power
- Analysis of variables using FFT
- Course duration: approx. 3 h





#### CO4204-7S

##### DC machines

- Electromagnetic induction and the Lorentz force
- Design and functionality of DC machines
- Armature and excitation current / voltage / resistance
- Connection types: Series, shunt and compound
- Speed measurement, control and reversal
- Working with AC voltage, braking
- Temperature monitoring
- Course duration: approx. 5.5h

#### CO4204-7T

##### Asynchronous machines

- Design and functionality of rotating field machines
- Electromagnetic induction, magnetic field, torque
- Asynchronous machine, capacitor motor, squirrel cage rotor
- Star and delta circuit line, phase, rotor current and voltage
- Nominal data and characteristics
- Temperature measurement
- Trouble-shooting
- Course duration: approx. 5.5 h

#### CO4204-7U

##### Synchronous and slip ring machines

- Design and functionality of synchronous, slip-ring and reluctance machines
- Rotating magnetic field in rotating field machines
- Circuit diagram, terminal chart, type plate and nominal data
- Speed adjustment, operating behaviour, generator mode
- Measurements: Current, voltage start-up, speed,  $\cos \varphi$
- Course duration: approx. 5 h

#### CO4204-7W

##### Stepper motors

- Design, function and applications of stepper motors
- Permanent-magnet, reluctance, and hybrid-stepper motors
- Unipolar / bipolar control
- Full-step and half-step mode
- Step angle, maximum operating and start frequencies
- Half- and full-step operation, direction reversal, current control
- Absolute / relative positioning
- Course duration: approx. 3.5 h

#### CO4204-7X

##### Linear motors

- Operating principle, functions and applications of a linear motor
- Lorentz force and „induced voltage“
- Designs of linear motors
- Advantages and disadvantages in comparison to rotary machines
- Determining motor constants
- Absolute and relative positioning; position determination using encoders and Hall sensors
- Course duration: approx. 4.5 h

#### CO4204-7Z

##### BLDC motors

- Design, functionality and applications of BLDC motors
- Advantages and disadvantages of BLDC motors
- Power supply patterns for BLDC motors: Block and sine-wave current signals
- Rotor position detection: Hall sensors, back-emf, pole detection, resolvers and incremental sensors
- Position measurement using Hall sensors
- Current and speed control
- Course duration: approx. 5 h

#### CO4204-7Y

##### Three-phase transformers

- Principle of a transformer
- Load response of a single-phase transformer in case of one-quadrant and four-quadrant operation
- Measurement of current and voltage under load / no-load
- Transformation ratio, equivalent circuit diagram
- Three-phase transformer: Load cases with various switching groups
- Determining short-circuit voltages
- Course duration: approx. 3 h

# Courses on telecommunications

## SO4204-9A

### Quadripoles and filters

- Transmission function, phase response, filter cut-off frequency
- High-pass and low-pass filters in a Bode diagram
- Bandwidth and median frequency of band-pass filters
- Series and parallel resonant circuits
- Parallel resonant circuit with capacitance diode tuning
- Course duration: approx. 5 h

## SO4204-9B

### Active filter with operational amplifiers

- High-pass, low-pass, band-pass and band-stop
- Filter order, slope, phase shift
- Cut-off frequency, ripple, attenuation
- Filter approximations: Bessel, Butterworth and Tschebyscheff filters
- Measurements in the time and frequency domains
- Course duration: approx. 5 h

## SO4204-9G

### Coaxial lines

- Resistance / capacitance / inductance per unit length, characteristic impedance
- Measurements with a Wheatstone, Wien and Maxwell bridge
- Determining a coaxial cable's characteristic impedance
- Reflections in a coaxial cable depending on termination
- Reflection-free cable termination
- Course duration: approx. 2 h

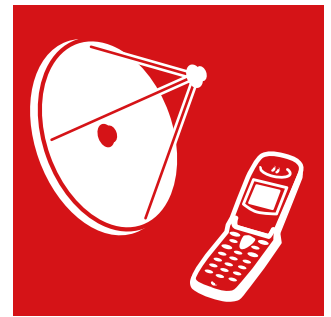
## CO4205-4E

### Signal transmission via optical fibres 650 nm / 820 nm

- Converting electrical signals into optical signals
- Characteristic and frequency response of transmitter diodes
- Modulation methods
- Transmission path with various wavelengths
- Step index and graded index fibres
- Optical waveguide configuration
- Signal recovery, bandwidth, attenuation, splices
- Course duration: approx. 4 h







#### SO4204-9F

##### Four-wire lines

- Applications and characteristic line values
- Measuring line parameters at various frequencies
- Characteristic impedance and propagation rate
- Pulse transmission and transit times
- Measurements using FFT
- Cross-talk and coupling
- Course duration: approx. 4 h

#### SO4204-9J

##### PAM, PCM and delta modulation

- Principle of PAM/PCM/delta modulation
- Shannon's sampling theorem
- Quantization, companding according to a-Law and  $\mu$ -law
- Transmission characteristics and signal waveform measurements
- Line codes: AMI, HDB3 and modified AMI
- Clock recovery, phase jitter, optimal filtering, anti-aliasing
- Course duration: approx. 4 h

#### SO4204-9K

##### Pulse modulation methods: PTM

- Principle of PWM /PPM modulation and demodulation
- Signal waveform at PWM/PPM outputs
- Signals output by PWM/PPM demodulators
- PWM transmission bandwidth
- Measurement of a PPM demodulator's internal signals
- Advantages / disadvantages of PWM / PPM
- Course duration: approx. 2 h

#### SO4204-9L

##### ASK, PSK, (Q)PSK modulation

- Transmission of digital signals via analog lines, ASK, FSK
- Spectrum of an ASK / FSK modulated signal
- Data transmission rate and required bandwidth in the case of ASK/FSK
- Demodulation of FSK signals
- Principle of PSK (DPSK) and QPSK (DQPSK) modulation
- Baud rates, dibits, transmission rate
- Course duration: approx. 2.5 h

#### SO4204-9M

##### AM/FM modulation / demodulation

- Principle of AM/FM
- AM: DSB and SSB modulation
- AM: Modulation trapezoid, modulation depth, residual carrier, phase shift
- Demodulation of AM/FM modulated signals
- FM: „Instantaneous frequency“, frequency amplitude, modulation index
- Ratio and phase detectors
- Course duration: approx. 3 h

#### SO4204-9N

##### Transmission and receiving technology

- Design and functionality of Hartley and Colpitts oscillators
- Modulation depth, frequency response
- AM transmitter / receiver
- Direct and superhet receivers
- AGC and AFC
- Signal-to-image ratio, adjacent channel selectivity
- Filter curves
- Medium-wave AM single-stage superhet receiver with full-range tuning
- Course duration: approx. 4.5 h

#### SO4204-9S

##### Data acquisition using RFID

- Areas of application and design of RFID systems
- Operating frequencies, properties and range
- Energy link, data transmission and anti-collision procedure
- Transponder designs, read/write operations
- Analysis of RFID messages according to ISO15693
- Course duration: approx. 4 h

# Courses on telecommunications

CO4205-4E

## Network technology

- Network standards, topologies and structures
- OSI layer model
- Structure and components of an Ethernet network
- Assembling and testing client-server and peer-to-peer computer networks
- The Internet protocol TCP/ IP, differences between IPv4 and IPv6
- Addressing, network masks, sub-networks
- Course duration: approx. 3.5 h

SO4204-9R

## Network technology: Client integration

- Integrating a network adapter into a PC
- Configuring a network adapter (Windows 7)
- Integration into existing networks, function checks
- DHCP, name detection in Windows networks (host file, lmhost file, WINS)
- Use of services (http, ftp), releases
- Course duration: approx. 3.0 h

SO4204-9T

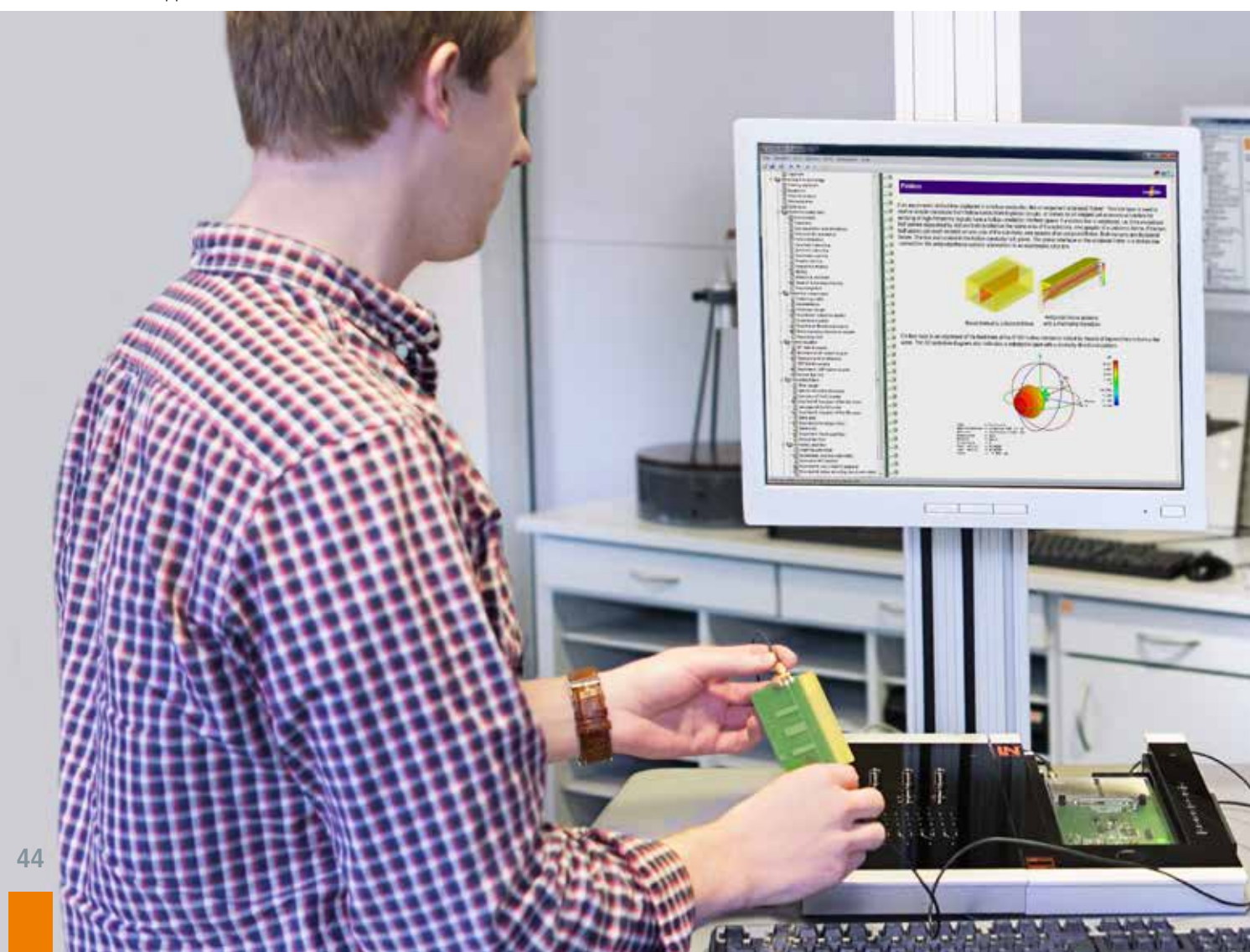
## Fundamentals of antenna technology

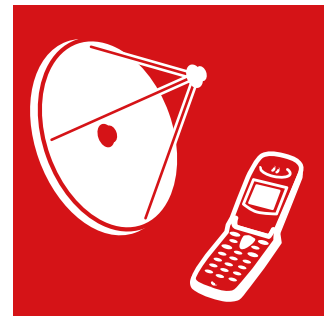
- Characteristic parameters of electromagnetic waves
- Physics of transmitting and receiving
- Dipole, Yagi, helix, patch and microstrip antennae
- Radiation in the near / far fields
- Polarization, antenna gain, impedance, symmetrization
- Measurement of directional diagrams for various antennae
- Course duration: approx. 8 h

SO4204-9Z

## Complex antenna systems

- Patch, horn, slot, dielectric, microstrip and parabolic antennae
- Formation and measurement of directional diagrams
- Group antennae and arrays
- Phase relationships in the case of group antennae
- Reflection in radio transmission links??
- Secondary radiation
- Passive radar transponder
- Course duration: approx. 16 h





SO4204-9U

### Fundamentals of microwave technology

- Characteristic parameters of electromagnetic waves
- Line variables, wave propagation in waveguides
- Gunn oscillator and LNC receiver
- Current-voltage characteristic
- Standing waves, short circuit, reflection and matching, standing-wave ratio
- Dielectrics in waveguides
- Course duration: approx. 4.5 h

SO4204-9V

### Waveguide components

- Wave propagation in a waveguide
- Waveguide elements for changing directions: Rotary coupling, E-plane and H-plane bends
- Attenuator, phase shifter, ferrite valve
- Attenuation and reflection of coupling elements
- Modulation and demodulation
- Smith chart: Determining impedance and reflection factor
- Course duration: approx. 8 h

SO4204-9Y

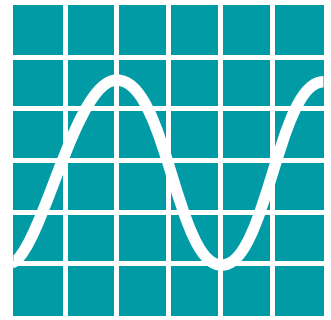
### Microstrip technology

- Characteristic line parameters and transfer function
- Scattering parameters and scattering matrix
- Transfer functions: Wilkinson divider and directional coupler
- Filter design
- 3rd and 5th order low-pass filters, band-pass, band-stop
- Microwave amplifiers: MMIC and FET amplifiers
- Reflection / standing wave ratio
- Course duration: approx. 8 h





# Courses on measurement technology



## SO4204-8A

### Electrical variables

- Functional principles of measuring instruments: Deflection and bridge methods
- Digital and analog methods
- Moving iron, moving coil and electrodynamic instruments
- Extended measuring ranges for current / voltage measurement
- Measuring effective, apparent and reactive power
- Measuring power factors, electrical work and frequency
- Course duration: approx. 5 h

## SO4204-8B

### Non-electrical variables: Temp./pressure/force

- Influence of measurement circuits
- Linearization of characteristics
- Temperature: NTC, Pt 100, KTY, thermocouple
- Pressure: Piezo-electric, inductive and resistive sensors, absolute and differential sensors
- Force: Strain gauges on a bending bar and torsion rod
- Course duration: approx. 7.5 h

## SO4204-8C

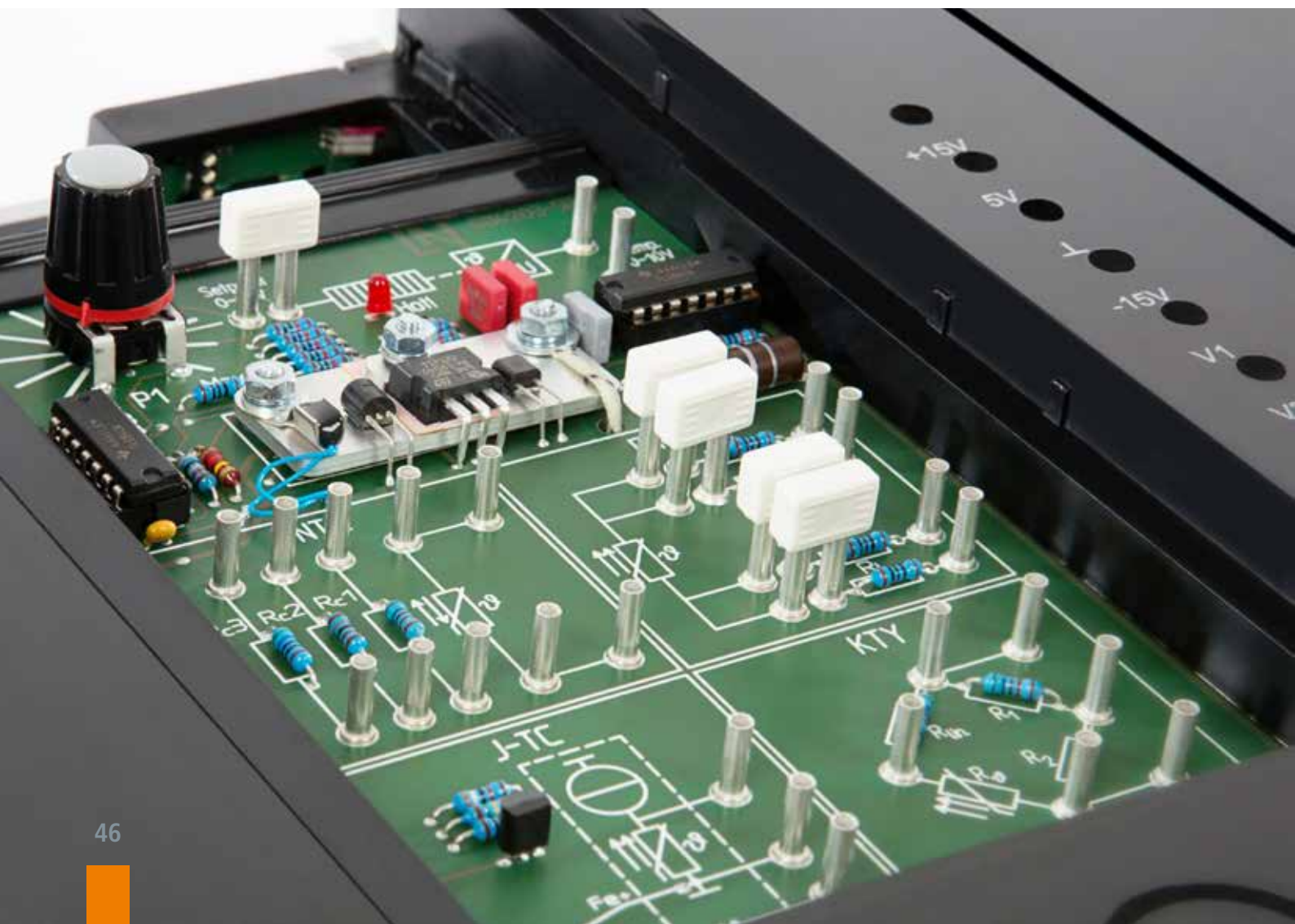
### Non-electrical variables: Displacement/angle/speed

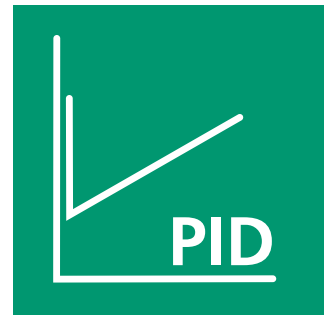
- Measuring displacement with inductive and capacitive sensors
- Displacement measurement incremental, binary and Grey code encoders
- Position measurement on rotating shafts: Optical encoder, Hall sensors, resolver
- Angular measurement with a resolver
- Determining motor speed using Hall sensors
- Course duration: approx. 6 h

## SO4204-8D

### RLC measurements

- Measurement principle of bridge circuits
- Measuring resistance and impedance using a Wheatstone bridge
- Measuring inductance using a Maxwell-Wien bridge
- Measuring capacitance using a Wien bridge
- RLC measurements using the impedance measurement technique
- Course duration: approx. 3 h





# Courses on closed-loop control

CO4204-8J

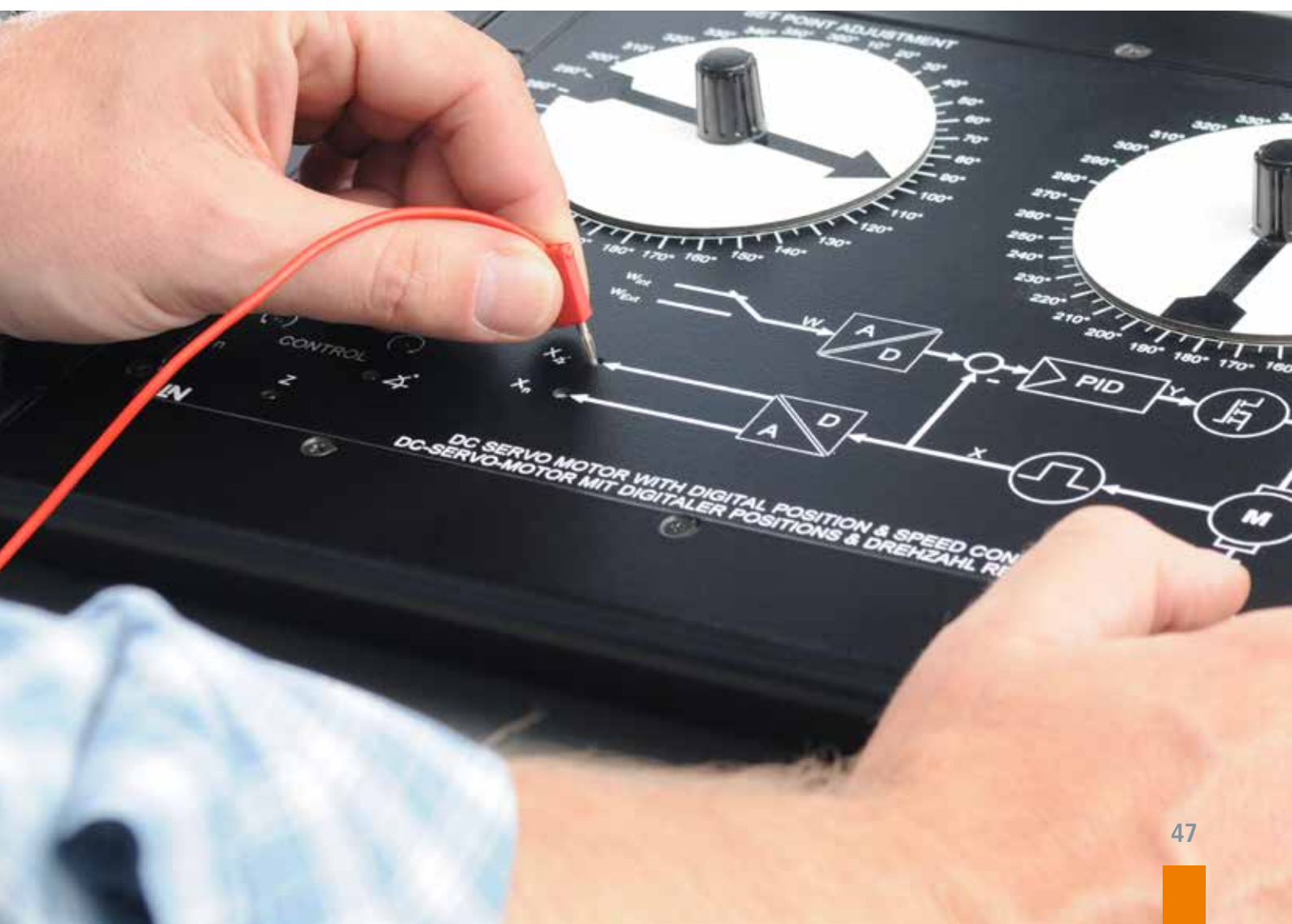
## Practical introduction to control technology

- Open-loop and closed-loop control
- Continuous and discontinuous controllers
- Temperature, speed, light, filling-level and flow rate control
- System characteristics and disturbance response
- Parametrization and optimization
- Recording step responses
- Investigating a closed control loop
- Course duration: approx. 6 h

SO4204-8H

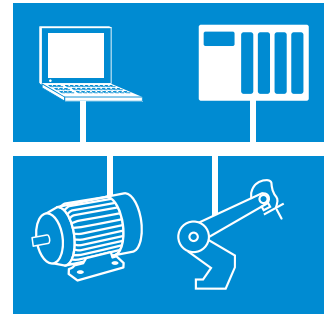
## Servo motor technology

- Angular and speed control
- Positions and speed detection by means of an incremental encoder
- Control characteristic, dead time, transient response, system deviation and control oscillation
- Step response and time constant
- Operation using various controller types
- Investigating a servo drive's response to load variations
- Course duration: approx. 4 h





# Courses on automation technology



## SO4204-8N

### PLC and bus technology

- PLC design, functionality and commissioning
- Program sequence, addressing and analog value processing
- Planning an automation system
- Programming with IL/ST editors according to IEC 1131
- Setting up PROFIBUS networks
- Transmission and fault analysis
- Connecting devices, GSD
- Course duration: approx. 10 h

## SO4204-8T

### PLC model: Lift

- Manual motor control
- Sensor signal detection
- Lift control for two storeys
- Lift control for three storeys
- Lift control with door opening/closure
- Programming emergency-stop functions
- Course duration: approx. 4 h

## SO4204-3P

### Basics of robot technology

- Industrial robots: Types and tasks
- Programming of movements: Movement types, coordinate systems, speed and acceleration
- Movements in joint and cart mode
- Combining a robot, PLC and conveyor belt in a robot cell
- Programming loading and unloading operations
- Course duration: approx. 8 h

## SO4204-8U

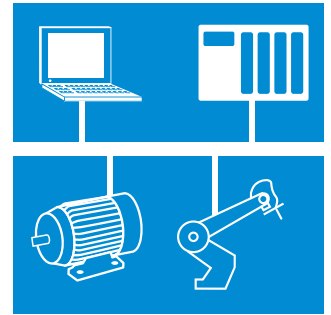
### Sensors used in automation

- Operating principle and functionality of industrial sensors
- Inductive, capacitive, optical and magnetic-field sensors
- Influence of various material samples on sensor response
- Measurement of sensing distances, hysteresis, limiting values and switching frequencies
- Reduction factor
- Course duration: approx. 4 h





# Courses on process technology



## SO4204-3E

### IPA1 Compact station

- Design and commissioning of a process plant
- Selecting and connecting different sensors
- Measurement: Filling level, flow rate, pressure and temperature
- Automatic control of filling level, flow rate and pressure
- Analyzing, designing and optimizing control loops
- Maintenance and servicing
- Course duration: approx. 8 h

## SO4204-3F

### IPA2 Mixing station

- Design and commissioning of a process plant
- Piping and instrumentation (P&I) diagram
- System sensors and actuators
- Formulation control, filling-level calculation
- PLC programming: Mixing, pumping out, cleaning, filling of dye reservoirs
- Maintenance and servicing
- Course duration: approx. 4.5 h

## SO4204-3G

### IPA3 Filling station

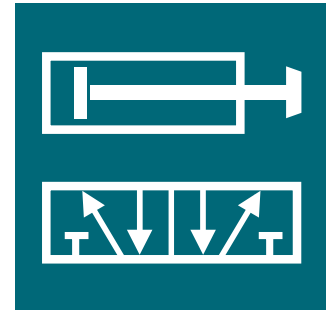
- Design and commissioning of a process plant
- Selecting and connecting different sensors
- Designing open-loop and closed-loop programs
- PLC programming: Filling, cleaning and emptying reservoirs, filling bottles
- Course duration: approx. 4.5 h

## SO4204-3H

### IPA4 Corking station

- Design, commissioning and monitoring of a process plant
- Sensor connection
- Designing open-loop and closed-loop programs
- PLC programming: Belt control, bottle cap mounting
- Maintenance and servicing
- Course duration: approx. 4.5 h

# Courses on pneumatics/hydraulics



## SO4204-8V

### Pneumatics / electro-pneumatics

- Fundamentals
- Pneumatic and electrical circuit diagrams, single- and double-action cylinders, directional valves
- Holding element control, command variable control
- Displacement- and time-dependent control
- Displacement-time diagrams
- Sequence control, hard-wired control, programmable control
- Course duration: approx. 8 h

## SO4204-8Y

### Hydraulics / electro-hydraulics

- Fundamentals
- Hydraulic and electrical circuit diagrams, single- and double-action cylinders
- Forward feed control, start (inhibit) interlock with intermediate stopping
- Pressure-dependent and time-dependent control
- Mechanical / electrical interlock of pushbutton contacts
- Rapid forward-feed/traverse control
- Displacement-time diagrams
- Course duration: approx. 8 h

# Courses on mechatronics

SO4204-8K

## **Transfer system with DC drive**

- Assembling, adjusting and testing mechanical components
- Speed and direction control
- Sequence control using a PLC
- Movement in inching mode
- Automatic transport of a workpiece carrier with holding time
- Programming movement sequences with end-limit switches
- Slip monitoring
- Course duration: approx. 5 h

SO4204-8L

## **Transfer system with three-phase drive**

- Assembling, adjusting and testing mechanical components
- Speed and direction control
- Sequence control using a PLC
- Movement in inching mode
- Automatic transport of a workpiece carrier with holding time
- Programming movement sequences with end-limit switches
- Slip monitoring
- Course duration: approx. 5 h

SO4204-8M

## **Sorting sub-system**

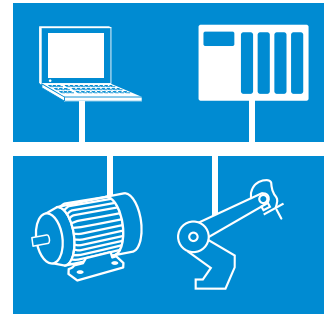
- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning a sorting unit for bottom sections
- Defining a process sequence for loading a workpiece carrier
- Programming a production sequence in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8O

## **Assembly sub-system**

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning an assembly robot for top sections
- Defining a process sequence for workpiece assembly
- Programming a flasher component and a stop cylinder
- Programming a production sequence in manual and automatic modes
- Course duration: approx. 4 h





#### SO4204-8P

##### Processing sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning an automatic processing unit
- Defining a process sequence for workpiece processing
- Programming a flasher component and a pressing cylinder
- Programming a production sequence in manual and automatic modes
- Course duration: approx. 4 h

#### SO4204-8Q

##### Testing sub-system

- Assembling, adjusting and testing pneumatic cylinders, and valves
- Optical, inductive, capacitive and magnetic test sensors
- Defining a process sequence for simple workpiece testing
- Programming a flasher component and a stop cylinder
- Programming a testing sequence in manual and automatic modes
- Course duration: approx. 4 h

#### SO4204-8R

##### Handling sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Vacuum generator and vacuum suction device with sensors
- Commissioning and controlling a pneumatic handling unit
- Defining a process sequence for workpiece sorting
- Programming a sorting sequence in manual and automatic modes
- Course duration: approx. 4 h

#### SO4204-8S

##### Storage sub-system

- Commissioning and controlling a pneumatic linear unit
- Rack level positioning with the aid of incremental sensors
- Defining a process sequence for a high rack storage system
- Programming a pulse counter
- Programming a complete warehousing procedure in manual and automatic modes
- Course duration: approx. 4 h

#### SO4204-8W

##### Routing sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning and controlling a linear unit
- Defining a process sequence
- Programming a routing sequence in manual and automatic modes
- Course duration: approx. 4 h

#### SO4204-8X

##### Buffering sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning a buffer unit
- Defining a process sequence
- Programming the production sequence in manual and automatic modes
- Course duration: approx. 4 h

#### SO4204-8Z

##### Production line

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Defining a process sequence
- Applying the principles of control technology
- Working with various actuators and sensors
- PROFIBUS project planning and commissioning
- Linking of multiple individual systems to create a totally integrated system
- Course duration: approx. 6 h



# Courses on automotive technology

SO4204-7A

## DC and AC circuits in motor vehicles

- Current, voltage and resistance
- Electric circuit with a lamp, measurements with a voltmeter and ammeter
- Ohm's and Kirchhoff's laws
- Resistor circuits
- Voltage divider, potentiometer, bridge circuits
- LDR, NTC, PTC, VDR
- Trouble-shooting
- Course duration: approx. 5.5 h

SO4204-7B

## Electronics and digital technology in vehicles

- Designs and functions of diodes and Z-diodes
- Basic transistor circuits
- Transistor as a switch and amplifier
- Basic logic circuits
- Truth tables, symbols, logic equations
- Boolean functions and laws
- Trouble-shooting
- Course duration: approx. 9.5 h

SO4206-1J

## Automotive electrics / electronics with a plug-in system

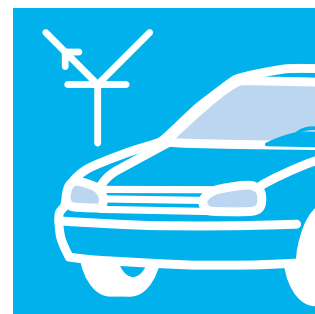
- Circuit assembly with a 2-mm plug-in system
- Current, voltage and resistance
- Ohm's law, resistor circuits
- Voltage divider, potentiometer, bridge circuits
- Variable resistors, capacitors and coils
- Typical automotive applications
- Course duration: approx. 5.5 h

SO4205-1G

## Fundamentals of automotive electrics

- Direct and alternating voltages, pulse-width modulated signals
- Current, resistance, Ohm's law
- Series, parallel and mixed resistor circuits
- Circuit analysis: Brake light, instrument lighting, heating fan, horn
- Fault diagnosis: Interrupted circuit, short circuit, defective components
- Course duration: approx. 5 h





SO4204-7J

### Pulse-width modulated signals

- Principle of pulse-width modulation (PWM)
- Automotive applications of PWM
- Power matching with PWM
- Measuring key PWM signal parameters: Frequency, amplitude, duty cycle, pulse-width, edge and signal shapes
- Control and operating circuits
- Diagnosing PWM-controlled components
- Course duration: approx. 2.5 h

SO4204-7D

### Three-phase generator (alternator)

- Electromagnetism
- Single-phase and three-phase generators, rectifiers
- Automotive electric circuits, charge control light, battery charging
- Electromagnetic and electronic voltage regulators
- Dependency of alternator voltage on motor speed and load condition
- Trouble-shooting
- Course duration: approx. 7.5 h

SO4204-7F

### Sensors in motor vehicles

- Induction, Hall effect, piezo-effect
- Speed measurement with inductive and Hall sensors
- Throttle valve switch, throttle valve potentiometer
- Air-flow measurement with hot-wire and hot-film sensors, pressure measurement in the intake manifold
- Detecting ignition timing with a knock sensor
- Temperature measurement with NTC and PTC sensors
- Course duration: approx. 10 h

SO4204-7C

### Pulse generation and ignition systems

- Ignition systems: contact-controlled, transistor-controlled, electronically controlled
- Setting the ignition-firing and dwell angles, ignition maps
- Centrifugal-force and vacuum pressure adjustment
- Generation and distribution of high voltage
- Hall and inductive sensors
- Measuring ignition voltage signal waveforms
- Course duration: approx. 8 h

SO4204-6X

### Common rail diesel injection system

- Design and function of a common rail system
- Injection response: Pilot, main and post injection
- Design and control of solenoid-valve and piezo injectors
- High-pressure generation and control
- Regeneration of soot particle filters, zero-fuel correction
- Course duration: approx. 6 h

SO4204-6W

### Traction control systems, ABS / ASR / ESP

- Driving safety and physics
- ABS: System overview, control loops, functionality
- Effects of typical faults on an ABS braking system
- ASR: Function and system structure, investigating typical control situations
- ESP: Purpose and mode of operation, response to various driving manoeuvres, control loops
- Trouble-shooting
- Course duration: approx. 6 h

SO4204-6Z

### Airbag, belt tensioners and crash response

- Active and passive safety in motor vehicles
- Purpose and function of airbags and belt tensioners
- Ignition capsule, safety switch, acceleration sensor, seat occupancy detection
- Typical crash situations
- Fault management in airbag systems
- Trouble-shooting
- Course duration: approx. 8 h

SO4204-7G

### Autoshop communications with RFID

- Communication with customers: Making appointments, providing service advice, filling out repair shop orders
- RFID technology: System components, operating frequencies, data and power transmission
- Reading and writing transponder data
- Data collisions on data buses
- RFID applications in vehicles
- Course duration: approx. 7 h

# Courses on automotive technology

SO4204-7E

## LIN bus

- Topology and components of a LIN bus system in a motor vehicle
- LIN bus: Voltage levels, addressing, master/ slave principle
- Analysis of LIN messages using LIN monitor and oscilloscope
- Editing and sending LIN messages using a PC
- Trouble-shooting
- Course duration: approx. 8 h

SO4204-7K

## CAN bus

- Topology and components of a CAN bus in a motor vehicle
- Low-speed and high-speed CAN
- Electrical properties, data rate
- Addressing and arbitration
- Analyzing CAN messages with a CAN monitor and oscilloscope
- Interpreting CAN messages
- Editing and sending CAN messages using a PC
- Trouble-shooting
- Course duration: approx. 7 h

SO4204-7H

## Optical data buses for automotive applications

- Optical bus systems in motor vehicles
- Fundamentals of a MOST bus
- MOST ring, protocol, control units, ring interruption diagnosis
- Design of optical fibre systems in motor vehicles
- Optical characteristics of light (refraction, reflection, attenuation)
- Measurement (electrical and optical) of optical fibres
- Course duration: approx. 6 h

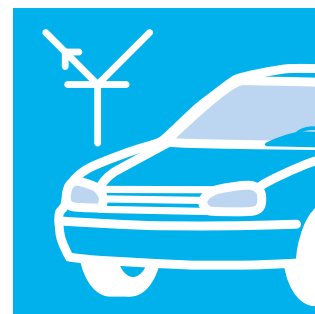
SO4204-6Y

## FlexRay

- Structure of a FlexRay node
- Signal generation with symmetric data transfer
- Description of the data link layer
- Analysis of the FlexRay at the bit level
- Measuring bus signals and bus resistance to interference
- Trouble-shooting
- Course duration: approx. 10 h







#### SO4204-6G

##### Comfort systems and keyless entry

- Central locking: Mechanical, infrared, radio and self-triggering
- Keyless entry and locking
- Teaching-in and setting comfort systems in vehicles
- Communication between a vehicle and its keyless entry device
- Retrofitting a keyless system
- Course duration: approx. 7 h

#### CO4205-1K

##### DC-DC step-up converters in hybrid and electric vehicles

- Fundamentals of DC-DC converters
- Function and design of a DC-DC step-up converter
- Circuit variants of DC-DC step-up converters
- Reading out fault memory with a diagnostic tester
- Selection of repair actions as specified by manufacturers
- Investigation using measuring instruments

#### SO4204-6L

##### DC-AC conversion in motor vehicles

- Electromagnetic induction and Lorenz force, "right-hand" rule
- Current and voltage; Ohm's law
- Pulse-width modulation (PWM)
- PWM voltage and current
- Generating alternating voltages via PWM
- Course duration: approx. 3 h

#### SO4204-6V

##### Hybrid drives in automobiles

- Working safety in the case of hybrid vehicles
- Serial/parallel hybrid system, dual-mode hybrids
- Electric drives for hybrid vehicles
- Control components for hybrid drives
- On-board networks for hybrid vehicles
- Energy recovery
- Energy and force transmission
- Course duration: approx. 8 h

#### SO4204-6M

##### Fuel cells

- Fuel cell technology for automobiles
- Tank and filling procedure, hazards of petrol and hydrogen
- Recording a fuel cell's characteristic
- Electrolysis (Faraday's first and second laws)
- Series and parallel connection of fuel cells
- Investigation of fuel cell power
- Course duration: approx. 4.5 h

#### SO4204-6N

##### Solar technology in vehicles

- Solar cell's functionality and operating principle
- Meaning of the terms „solar radiation“ and „solar constant“
- Recording a solar module's characteristics
- Temperature, radiation intensity and angle of incidence
- Energy storage in a rechargeable solar battery
- Isolated (offgrid) network with solar batteries
- Course duration: approx. 4.5 h

#### CO4205-1J

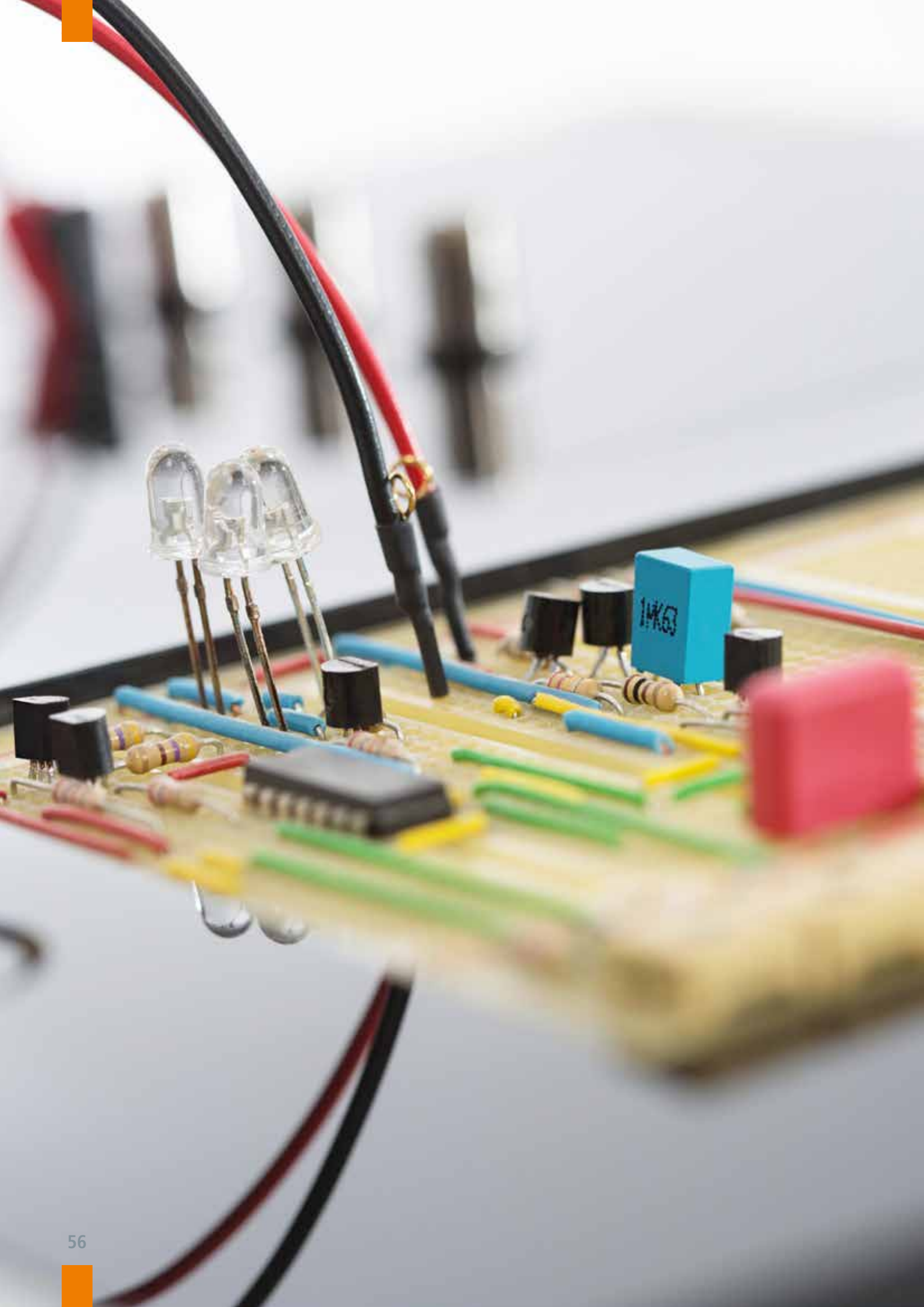
##### Battery disconnect unit in hybrid and electric vehicles

- Fundamentals of battery disconnect units
- Principle of operation and electric circuit of a battery disconnect unit
- Selection of repair actions as specified by manufacturers
- Working with spare part numbers
- Investigation using measuring instruments
- Trouble-shooting

#### CO4205-1M

##### Safe handling of HV systems

- Safety fundamentals for handling high-voltage electric vehicles
- Creating repair shop job orders
- Diagnostic functions
- Investigation by means of measurements
- Effects of common faults (faults can be switched on / off)



# Ideally equipped with the right accessories

## Practical solutions for everyday life

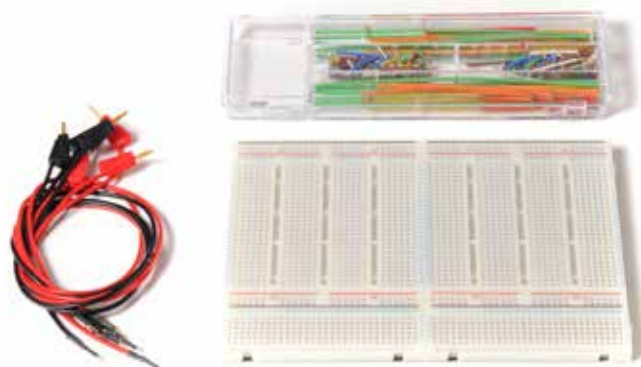
Practical accessories expand the UniTrain system's range of applications. A rugged case is available for frequent transport or storage of the system. Integrate a multimeter into the UniTrain system or utilize the breadboard to quickly build and test smaller circuits.

### Your benefits

- ✓ Simple transport
- ✓ Practical storage
- ✓ Control via tablet PC
- ✓ Additional measurement options



*Experimenter for mounting experiment cards, multimeters and breadboards, and supplying additional experiment voltages.*



*Breadboard for circuit configuration with wired components*



*Case for storing and transporting an entire system*

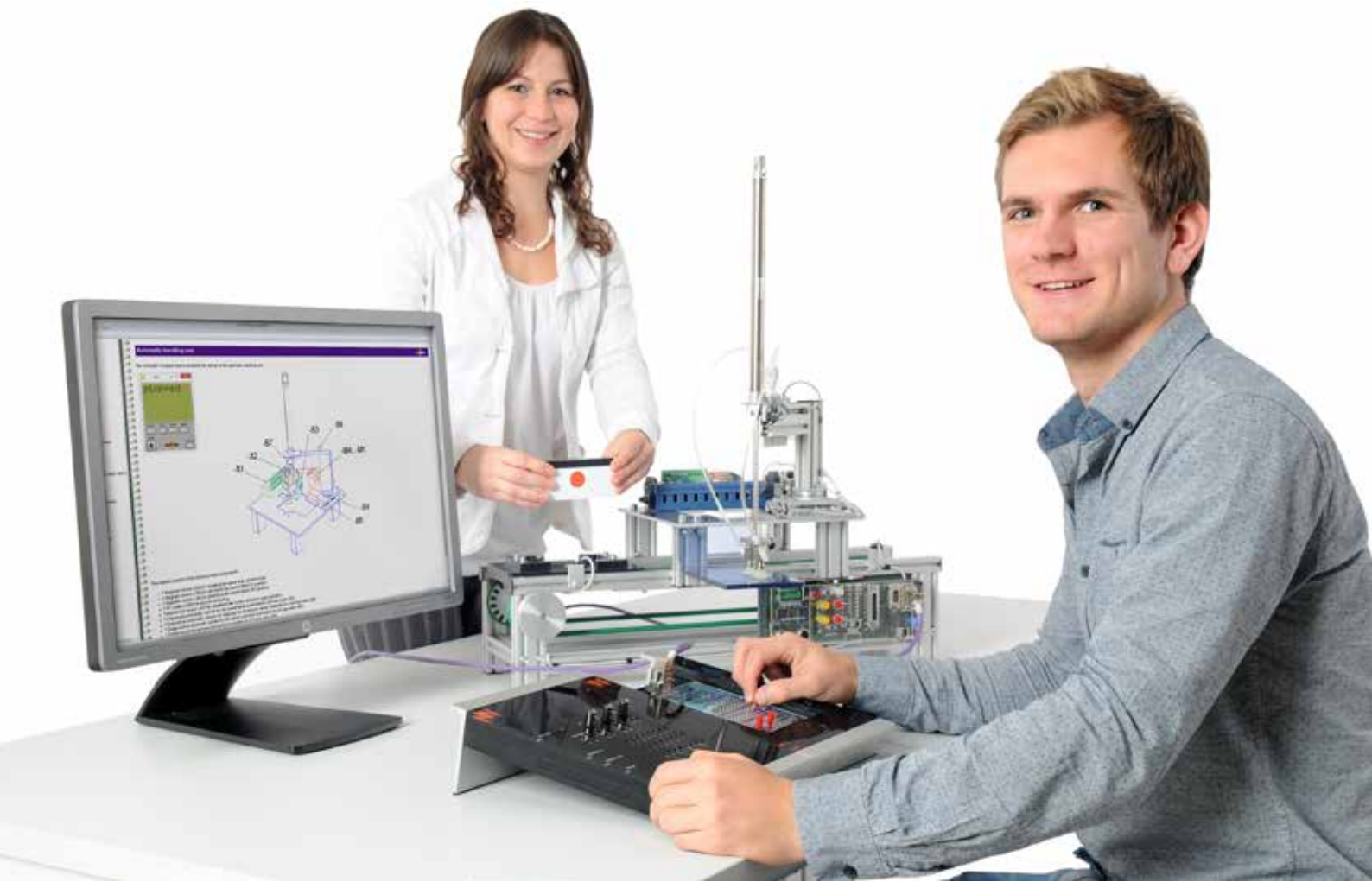


*Multimeter with optical data interface for display via a virtual instrument on a PC*



# Decisive product advantages

... ensure long-term customer satisfaction



**Christoph Hartwig, Professor at the Institute of Mechatronics of the Faculty of Mechanical Engineering at Ostfalia University uses the UniTrain system for basic education in electrical engineering and drive technology.**

*"Independent experimentation with the UniTrain-system facilitates introduction of our students to electrical engineering and electronic circuit technology. The learning programs allow subject matter imparted to students during lectures to be recapitulated and implemented directly as part of laboratory practice."*

*"Of special importance to us is the ability to create our own learning programs and lab experiments for the UniTrain. This is achieved easily and comfortably with the LabSoft Classroom Manager."*

# The whole is more than the sum of its parts

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Microcontrollers



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Automation technology



Power electronics,  
electrical machines,  
drive technology



Instrumentation



Automotive technology



Fundamentals of electrical  
engineering & electronics



Metal technology



Lab systems

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## Find out for yourself.

Product videos and demo program with examples from the UniTrain courses





# Everything at a glance

UniTrain course and equipment overview



## Course and Equipment Overview

Power electronics	Communications technology	Measurement technology	Automation	Mechatronics
<b>Commutated power converters</b> SO4-7M <b>2</b>	<b>Quadripoles and filters</b> SO4204-9A <b>1</b>	<b>Measurement of electric values</b> V/I/P/cos-phi/f SO4204-8A <b>2</b>	<b>Compact automation, PLC and bus technology</b> SO4204-8N <b>3</b>	<b>Transfer system with DC drive</b> SO4204-8K
<b>Commutated power converters, active</b> SO4-7N <b>2</b>	<b>Active filters with operational amplifiers</b> SO4204-9B <b>1</b>	<b>Measurement of non-electric values</b> Temp./pressure/force SO4204-8B <b>2</b>	<b>PLC model lift application</b> SO4204-8T <b>1</b>	<b>Transfer system with three-phase drive</b> SO4204-8L
<b>Frequency converter drives</b> SO4-7P <b>3</b> Drives SO4204-7M and SO4204-7T	<b>Coaxial cables</b> SO4204-9G <b>1</b>	<b>Measurement of non-electric values</b> Displacement/angle/speed SO4204-8C <b>2</b>	<b>Sensors for automation</b> SO4204-8U	<b>Sorting sub-system</b> SO4204-8M
<b>Power factor correction (PFC)</b> SO4-7Q <b>1</b>	<b>Fibre optics</b> SO4204-9E <b>2</b>	<b>RLC measurements</b> SO4204-8D <b>2</b>	<b>Process technology:</b> IPA 1 Compact station SO4204-3E <b>2</b>	<b>Assembly sub-system</b> SO4204-8O
	<b>4-wire lines</b> SO4204-9F <b>1</b>		<b>Process technology:</b> IPA 2 Mixing station SO4204-3F <b>3</b>	<b>Process sub-system</b> SO4204-8P
	<b>Pulse modulation methods</b> PAM/PCM/Delta SO4204-9J <b>3</b>	<b>Automatic control technology</b> 	<b>Process technology:</b> IPA 3 Filling station SO4204-3G <b>1</b>	<b>Testing sub-system</b> SO4204-8Q
<b>Electrical machines</b>	<b>Pulse modulation methods, PTM</b> SO4204-9K <b>1</b>	<b>Practical introduction to closed-loop control</b> SO4204-8E <b>2</b>	<b>Process technology:</b> IPA 4 Corking station SO4204-3H <b>1</b>	<b>Handling sub-system</b> SO4204-8R
<b>Asynchronous machines</b> SO4-7S <b>1</b>	<b>Modem methods ASK, FSK, PSK</b> SO4204-9L <b>2</b>	<b>Analysis of control loops</b> SO4204-8F <b>2</b>		<b>Storage sub-system</b> SO4204-8S
<b>Synchronous and ring machines</b> SO4-7U <b>1</b>	<b>AM/FM Modulation/Demodulation</b> SO4204-9M <b>2</b>	<b>Supplement to SO4204-8F</b> <b>Controller design &amp; optimisation</b> SO4204-8G <b>2</b>	<b>Pneumatics/hydraulics</b> 	<b>Routing sub-system</b> SO4204-8W
<b>Per motor</b> SO4-7V <b>1</b>	<b>AM transmission and receiving technology</b> SO4204-9N <b>3</b>	<b>Supplement to SO4204-8G</b> <b>Software WINFACT</b> SO6001-SQ	<b>Pneumatics/electropneumatics</b> SO4204-8V	<b>Buffering sub-system</b> SO4204-8X
<b>Servo motor</b> SO4-7X <b>1</b>	<b>Data acquisition using RFID</b> SO4204-9S <b>2</b>	<b>Servo motor technology</b> SO4204-8H	<b>Hydraulics/electrohydraulics</b> SO4205-8A	<b>Production line</b> SO4204-8Z
<b>Three-phase transformer</b> SO4-7Y <b>1</b>	<b>Network technology TCP/IP</b> SO4204-9Q <b>2</b>			
<b>Linear/servo motors</b> SO4-7Z <b>1</b>	<b>Supplement to SO4204-9Q</b> <b>Network technology: Client integration</b> SO4204-9R			
	<b>Introduction to microwave technology</b> SO4204-9U <b>1</b>			
	<b>Supplement to SO4204-9U</b> <b>Waveguide components</b> SO4204-9V			
	<b>Antenna technology</b> SO4204-9T <b>1</b>			
	<b>Supplement to SO4204-9T</b> <b>Complex antenna systems</b> SO4204-9Z			
	<b>Microstrip technology</b> SO4204-9Y <b>1</b>			

Ref.-No. K-U0-1118-GB  
UniTrain  
03/16 GB (Printed in Germany)  
Subject to technical changes.

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