LUCAS-NÜLLE

UniTrain-I
Multimedia Desktop Lab

Learning. Experimenting. Understanding!
Anywhere, anytime.

UniTrain SYSTEM

2nd Edition

Table of Contents

UniTrain-I - the Mobile Lab Combining Theory and Practice

Learning. Experimenting. Understanding! Comprehensive, Simple, Safe

The UniTrain-I system is a powerful experiment and training platform for computer-based vocational and advanced professional training in the areas of electrical engineering and electronics.

UniTrain-I combines theory and practice resulting in a highly efficient and effective learning environment with multimedia diversity.

Blended learning is making its way into vocational and advanced professional training and education

The situation now:

There are massive changes underway in vocational training and education

- The useful time span for knowledge is constantly shortening
- Budgets are being cut
- Standards and demands are on the rise
- Continuous learning is becoming mandatory

The consequences:

- Traditional training and education materials no longer suffice
- Instead, these traditional materials are being supplemented by computer-based training methods and learning networks
- All of these various methods can be combined at will
- Allowing for optimum adaptation to individual learning situations
- Learning can take place anywhere, anytime
- Free access to course content via databases and networks
- Online administration by tutors

Blended Learning with UniTrain-I

The Mobile Electronics Lab for Flexible Training

The UniTrain-I from Lucas-Nülle is the electrical engineering and electronics lab which can be customised to fit any training and education concept. Simply configure your training and education concept in line with the following aspects:

Media	Methods	Persons	Location	Time
• Practical experiments • Animations • e-learning • Network or stand-alone	• Standard class work • Practical, hands-on lab work • Self-study	• Individual instruction • Group instruction • Class networking	• At school • At home • At the workplace	• Completely irrespective of time

UniTrain-I Combines Practical Experiments with Theoretical Knowledge.

For the instructor or tutor:
This means the system can be configured freely in line with individual training concepts

For the students:
This means an opportunity to acquire exhaustive knowledge and gain long-lasting know-how while still having fun

UniTrain-I
The configurable system customised to fit your professional training concept

UniTrain-I Hardware

System Components for Optimal Experimentation

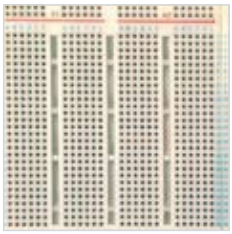
The primary components of the system are the UniTrain-I interface and the UniTrain-I experimenters which are connected to the interface.

UniTrain-I interface

- 32-bit processor
- Measurement data memory
- USB interface
- Integrated virtual instruments save you the cost of expensive external measuring instruments
- 2 analogue differential inputs
  - Band width 4 MHz
  - Time range 1 µs to 10 s
  - Trigger with adjustable level, pre-trigger and single-shot
  - Sampling rate 40 Msamples/s
  - Meas. range 100 mV to 50 V
  - Storage function, 2 x 32 Kbytes
- 16 digital input and outputs
  - TTL/CMOS technology, 16-bit
  - DC up to 100 kHz
- Analogue output
  - Output voltage
  - 10 V to +10 V
  - DC frequency up to 1 MHz
  - Any programmable curve shape desired (8,000 sampling points)
  - 8 relays
- Fixed voltages +/-15 V/5 V
- Variable three-phase supply
- LabView driver

UniTrain-I experimenter

- Accommodates UniTrain-I experiment cards
- Simple interchange of experiment cards at the press of a button
- Accommodates an external multimeter, read out of measurement readings via IrDa port is also possible
- Supplies voltage to experiment cards
- Includes UniTrain-I bus output for connection to additional experimenters



UniTrain-I accessories

- UniTrain-I multimeter with IrDa port
- Aluminium case to transport entire system
- Hard shell case to accommodate up to 24 experiment cards

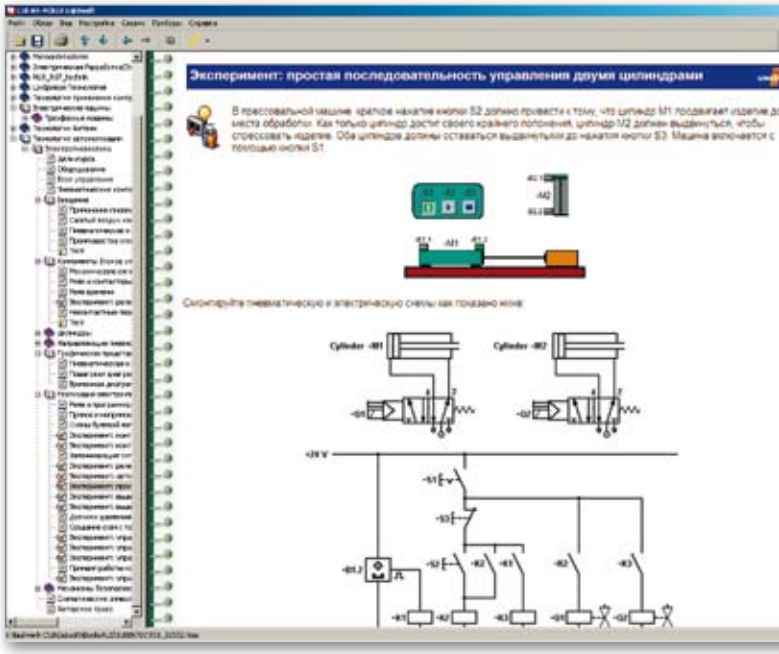
UniTrain-I Software

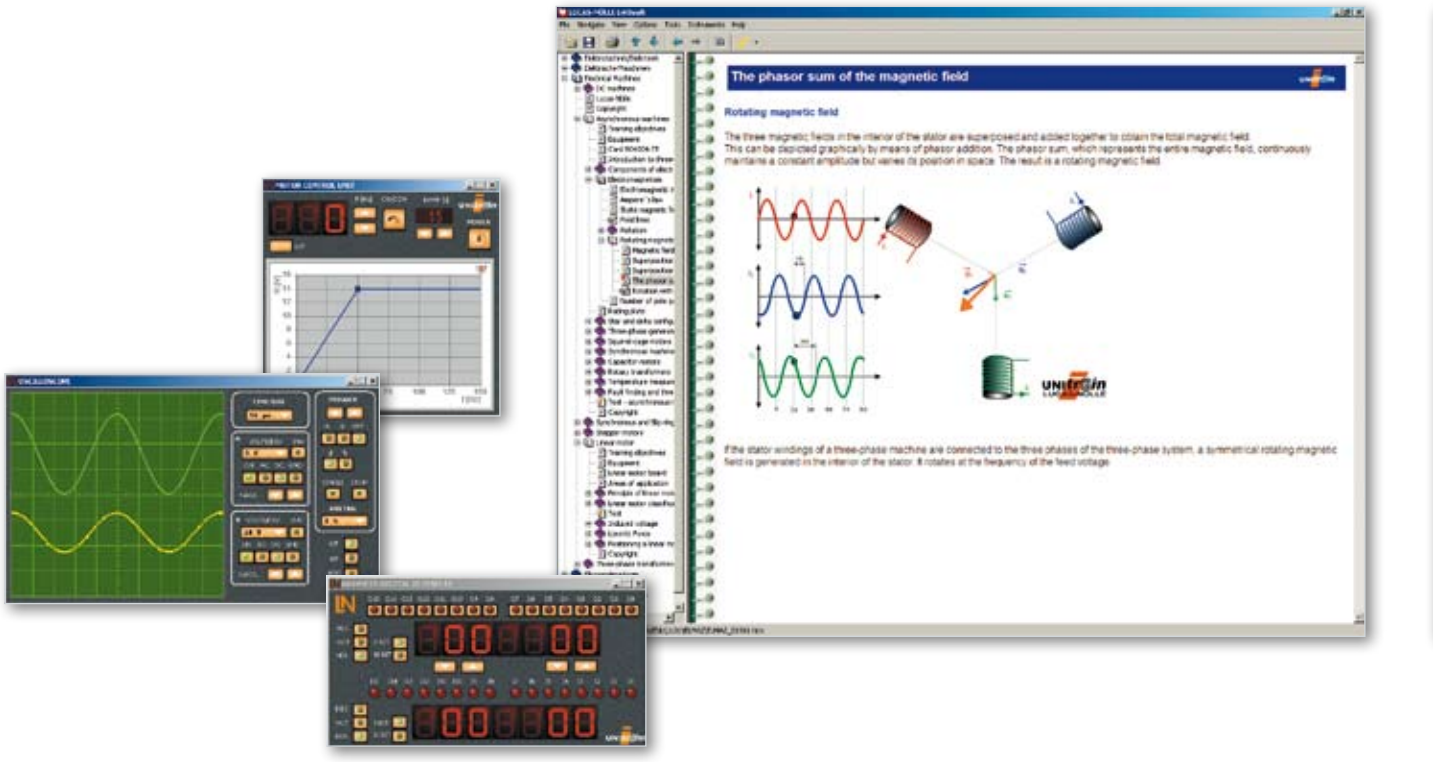
Open Experimenting Platform with Access to All Kinds of Courses and Instruments

LabSoft

LabSoft is the user interface needed to operate UniTrain-I, an open experimenting platform which permits access to all of the UniTrain-I laboratory media:

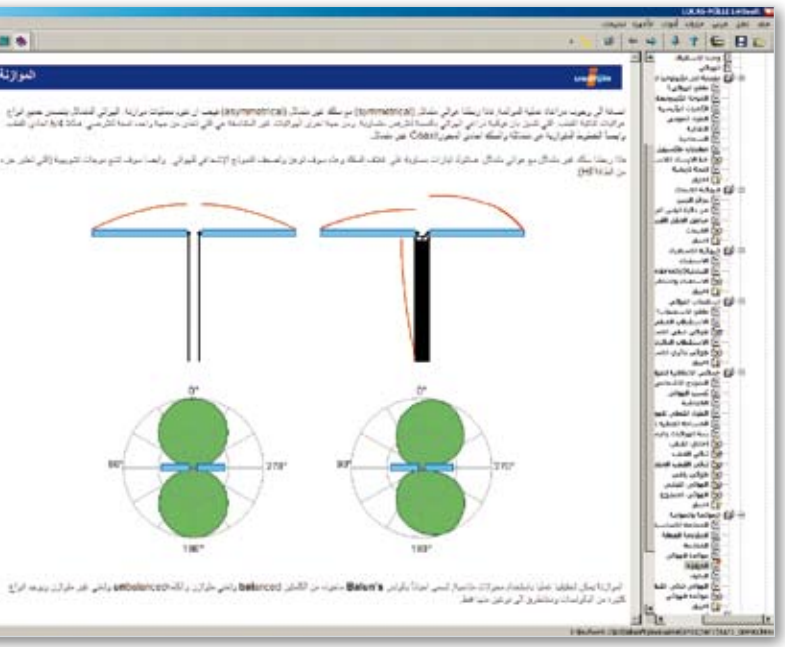
- Navigation window with tree structure for display and direct selection of all UniTrain-I courses
- Conducts experiments including documentation, evaluation and storage of the measurement results
- Virtual instruments for real-time measurement
  - Voltmeter, ammeter, multimeter
  - Dual-channel storage oscilloscope
  - Function, pulse and waveform generator
  - Three-way AC/DC power supply
  - Three-phase power supply
- Circuit design and simulation software





LabSoft in a network

LabSoft supports both local installation on a user PC as well as installation on a central server allowing for intranet or internet accessibility. In order to facilitate integration into learning management systems, international standards were adhered to and complied with during the development of LabSoft.



UniTrain-I courses

- HTML-based multimedia courses
- All courses in languages supported in HTML
- Animations and graphics designed to support learning
- Theory and lab experiments in a single training unit
- Results are documented
- Questions check knowledge level and depth

LabSoft Classroom Manager

Making Teaching Easier:
Create Courses, Monitor Results, Administer Data

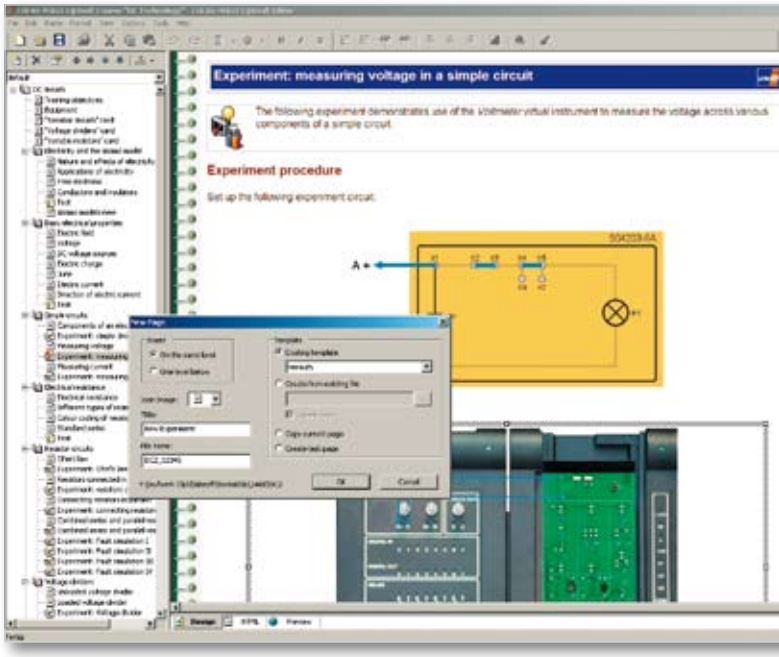
The LabSoft Classroom Manager is an extensive administration program designed especially for the UniTrain-I system and all its LabSoft courses.

Classroom Manager is comprised of the following program components:

LabSoft Reporter:
Designed to monitor learning progress and generate statistics

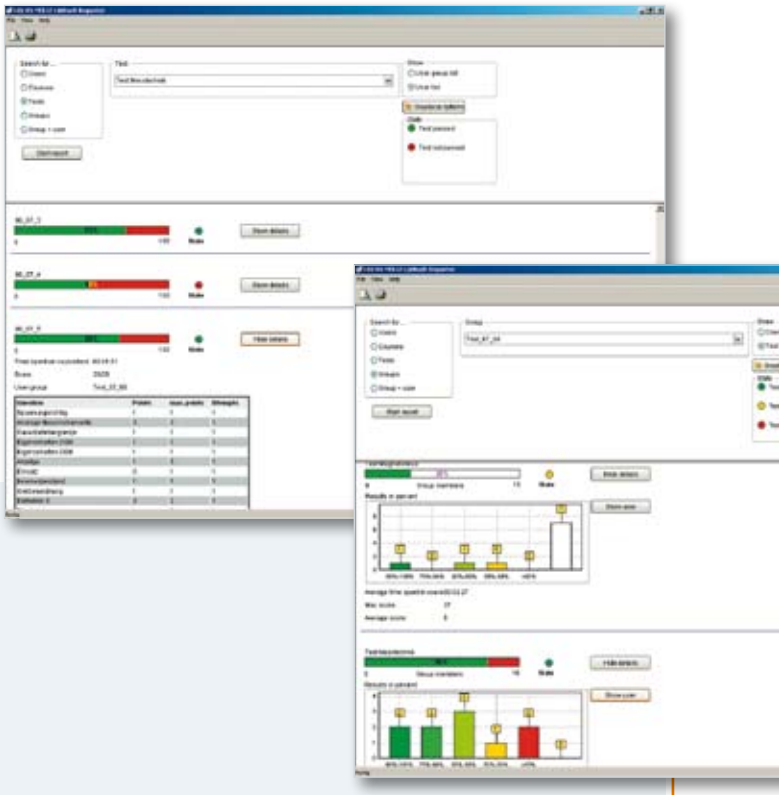
LabSoft Editor:
Designed for the creation and editing of courses and tests

LabSoft Manager:
Designed to supervise students and manage courses in LabSoft



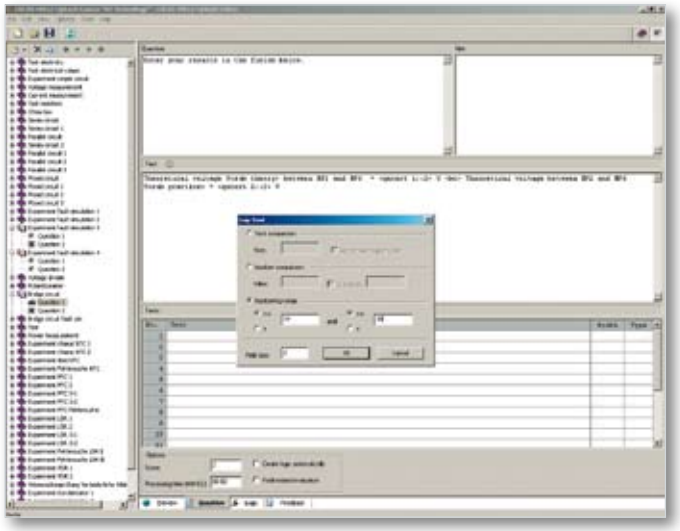
LabSoft Reporter:

- Electronic evaluation of students' learning progress
- Graphic representation of results
- Graphic depiction of individual and group results
- Assessments for courses, tests, individual students or classes
- Extensive search functions for students, classes, courses or tests



Your benefits

- Intuitive graphic interface for easy use
- Simple installation
- Usable in local networks or on stand-alone workstations
- Requires no additional database software
- Access protection via USB dongle

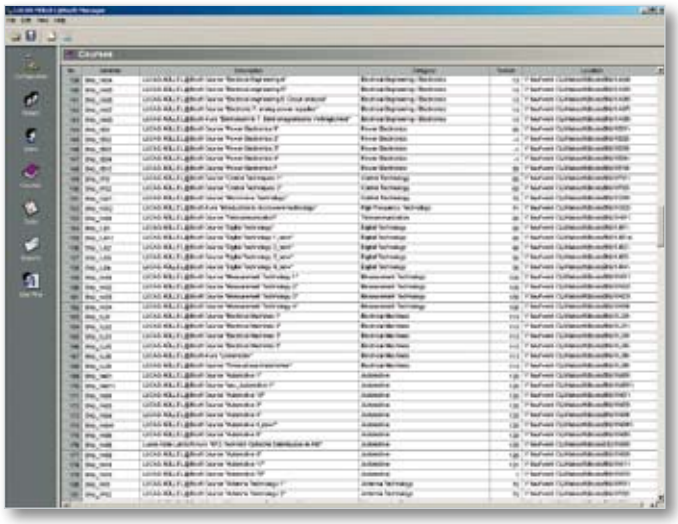


LabSoft Editor:

- HTML editor permitting easy editing of LabSoft courses and tests
- WYSIWYG and HTML views plus page preview
- Help for drafting courses and pages
- Editing of navigation tree per mouse click
- Format templates for various page styles
- Integrated tool facilitating compilation of exercises and questions for electronic tests
- Various question types: including selection of single or multiple answers, filling in the blanks and answer matching

LabSoft Manager:

- Administration of LabSoft installation
- Management of any number of students and courses
- Creation and editing of courses and tests in LabSoft
- Creation and editing of users and groups
- Assignment of course work or tests in a class



Article no.: SO2001-5A, consisting of:

1 x CD-ROM with installation software
1 x USB dongle

More Than a Training System

The UniTrain-I Laboratory – the Total Solution

Server PC:
Centrally administered training software and data

Presentation tools:
Work through complex topics and experiments or summarize entire lessons jointly with the whole class

Everything under control with the LabSoft Classroom Manager:
Manage individual users, groups and courses, check progress levels, edit existing courses and create your own course material

Workstations:
Well-structured course software uses text, graphics, animations, experiments and test questions to provide solid training and expertise

Sideboards to store courses:
Well stored, easy-to-find

Multimedia desks:
Network connections and power supplies disappear inside channels located under sliding desktops

Electrical Power Engineering

Photovoltaics

Transient Processes in DC and AC Networks

Fuel Cell Technology

UniTrain-I system

- Comprehensive, portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in one package

UniTrain-I interface with USB

- Oscilloscope with 2 analog differential inputs
- Sampling rate of 40 Msamples/s
- 9 measuring ranges from 100 mV - 50 V
- 22 time ranges from 1 µs - 10 s
- 16 digital inputs/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Receptacle for experiment cards
- Experiment power supply of ±15 V, 400 mA
- Experiment power supply of 5 V, 1 A
- Variable direct or three-phase current, 0 - 20 V, 1 A
- IrDa interface for multimeters
- Serial interface for additional experiment cards

Integrated measuring equipment and power supplies

- Function generators, ammeters, voltmeters
- 2-channel storage oscilloscope
- Solar meter
- Transient analyzer
- X-Y recorder
- … and many other instruments

LabSoft training and experiment software

- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Independent navigation
- Documentation of measurement results
- Knowledge test

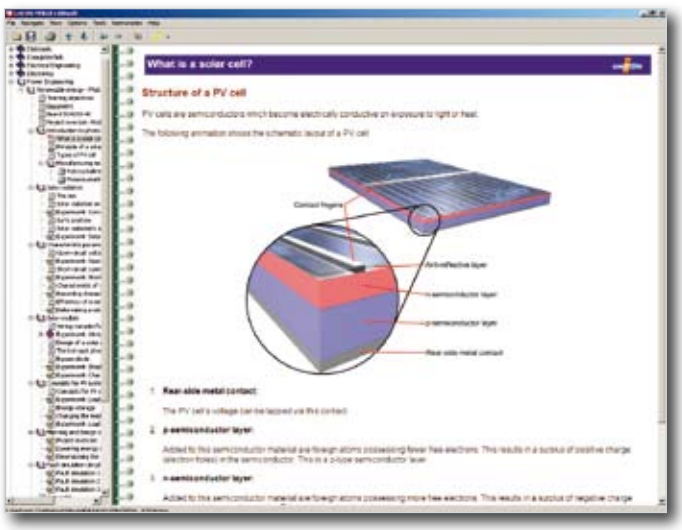
Photovoltaics

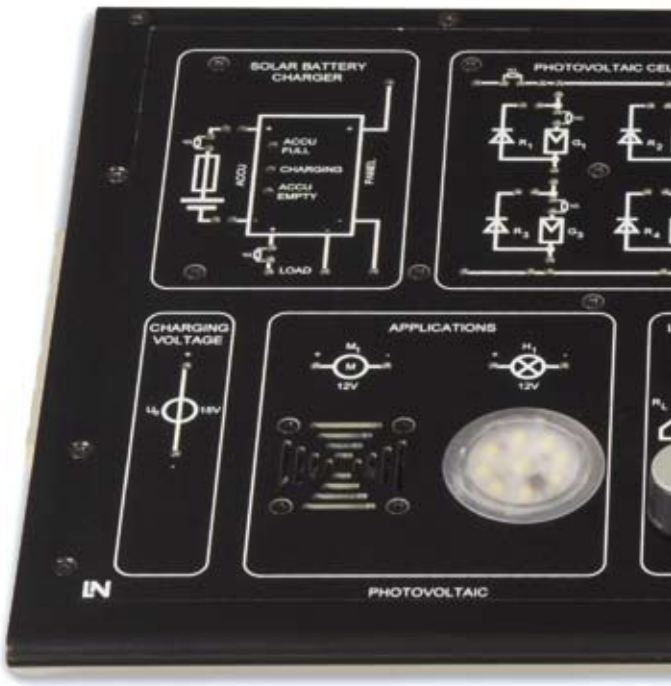
Solar Radiation
Function and Efficiency of Solar Cells
PV System Concepts

Depletion of fossil energy resources and increasing global warming have lead to a re-thinking of energy production techniques. Electricity generation from renewable energy such as wind and solar radiation is an ever more important, high-growth sector.

Training contents

- Introduction to the design and function of solar cells
- Basic concepts related to solar radiation
- Measurement of open-circuit voltage and short-circuit current
- Operation of solar cells connected in series and parallel
- Determining a solar cell's efficiency
- Investigating a solar facility's operation in direct and storage mode





Article no.: SO4204-3A, consisting of

1 x CD with "Photovoltaics" course
1 x Experiment board "Photovoltaics"

Optional:
Article no.: SO4203-2V
Aluminium carry case for the experiment board

Transient Processes in DC and AC Networks

Switching Operations
Various Loads Comprising R, L, and C
Transient Recorder

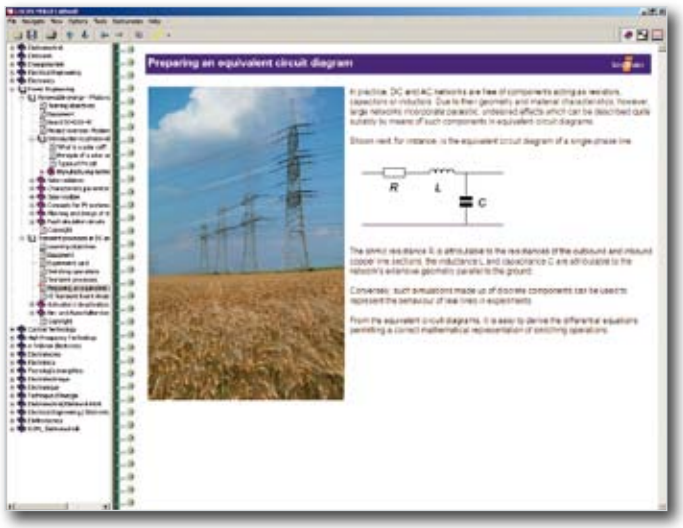
Switching operations in power distribution networks can lead to critical operating conditions or even grid failure in extreme cases. A knowledge of current and voltage conditions at the instant of switching helps avoid malfunctions.

Training contents

- Description of an electrical line's simple, equivalent circuit diagram
- Measurement of current and voltage characteristics during switching operations
- Investigating turn-on and turn-off processes during a supply of direct and alternating voltages
- Investigating turn-on and turn-off processes under various loads comprising R, RL, RC and RLC

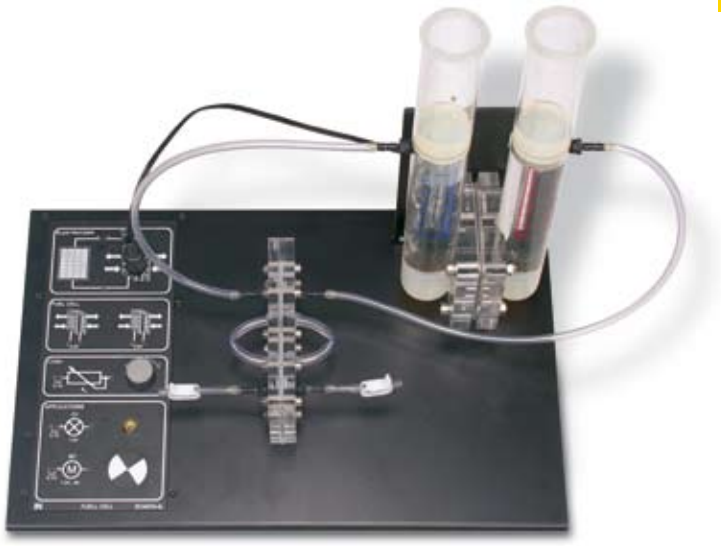
Article no.: SO4204-3B, consisting of

1 x CD with "Transient processes in DC and AC networks" course
1 x Experiment card "RLC line simulation"



Fuel Cell Technology

Faraday's Laws
V-I Characteristics
Electrolyser



Besides wind and solar energy, fuel cells are a further, clean energy source of the future. Though its breakthrough is still prevented by unresolved issues concerning the handling of the hydrogen necessary for operation, this technology holds a lot of potential for the future.

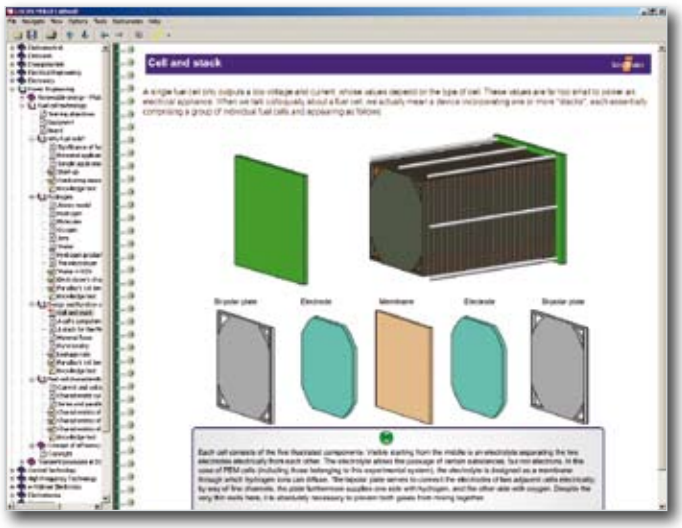
Training contents

- Introduction to the design and function of fuel cells
- Recording of characteristics
- Description of the chemical processes occurring during electrolysis
- Determining a fuel cell's efficiency
- Investigating series and parallel connections of fuel cells
- Recording an electrolyser's V-I characteristic

Article no.: SO4204-3C, consisting of

1 x CD with "Fuel cell technology" course
1 x Experiment board "Fuel cells"

Optional:
Article no.: SO4203-2V
Aluminium carry case for the experiment board



Electrical Machines

DC Machines

AC Machines

Asynchronous Machines

Synchronous Machines

Linear Motors

Stepper Motors

Electronically Commutated Brushless DC (BLDC) Motors

Learning and experiment software

- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Tests of knowledge

Integrated power supply

- Safety ensured by safety extra-low voltage
- Short-circuit proof
- Variable three-phase power supply 14 V/24 V, 1 A, 0 ... 150 Hz
- Variable DC power supply -24 V ... 24 V, 1 A

Integrated measuring instruments

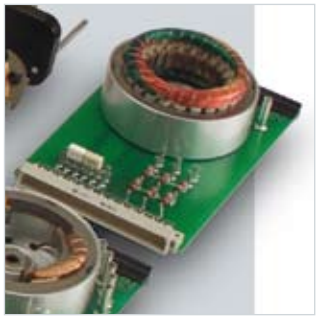
- Multimeter, oscilloscope, etc.
- Measurement of line and phase variables
- Speed measurement using a stroboscope
- Displays with virtual instruments

Rotors

- 7 different rotors
- Interchangeable without the use of tools
- Rotor windings connected via 2-mm sockets
- Quick tensioning screw for optional accessories

Control unit, relays

- Computer-controlled fault simulation
- Automated processes
- Parameter setting via virtual control units
- External/internal connection via UniTrain-I bus



Stators

- Open design – replacing cutaways
- Coloured stator windings
- Interchangeably connectable, open winding ends
- Monitoring by temperature sensor

DC Machines

Shunt-wound Machines
Series-wound Machines
Compound-wound Machines
Universal Machines

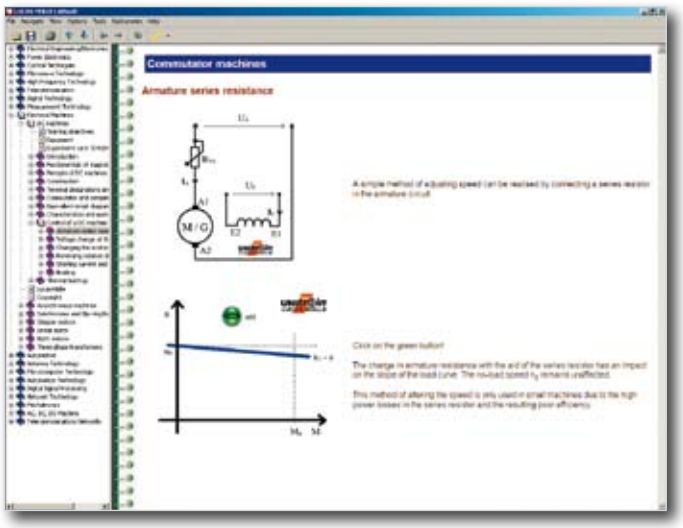
Although DC machines are becoming less and less popular in industrial practice, they still represent an introduction to the topic of electrical machines.

Training contents

- Connection of a DC machine
- Start-up experiments
- Setting neutral zone
- Investigation of field-weakening response
- Introduction to methods of open-loop speed control
- Experiments on generator and braking operation

Article no.: SO4204-7S, consisting of

1 x CD with "DC machines" course
1 x Experiment card "DC machines"
1 x Rotor
1 x LED stroboscope



Three-phase Transformer

Models

Connection Types

Load Response

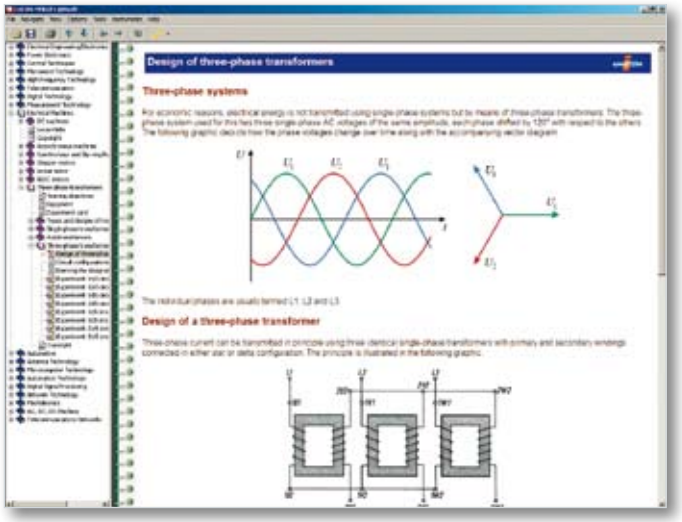
Transformers are electrical machines used to transform AC or three-phase voltages into voltages that are higher or lower. Three-phase transformers are particularly important in the area of electrical power transmission.

Training contents

- Introduction to the principle of transformers and their equivalent circuit diagrams
- Investigating load response of single-phase transformers in single- and four-quadrant operation
- Recording current and voltage with and without load
- Investigation of transformation ratio
- Investigation of various loads with various vector groups
- Investigation of various vector groups with unbalanced loads
- Determining short-circuit voltage

Article no.: SO4204-7Y, consisting of

1 x CD with "Three-phase transformer" course
1 x Experiment card "Three-phase transformer"



Asynchronous Machines

Squirrel-cage Rotors
Permanent Magnet Motors
Capacitor Motors
Short-circuit Rotors
Variable Transformers

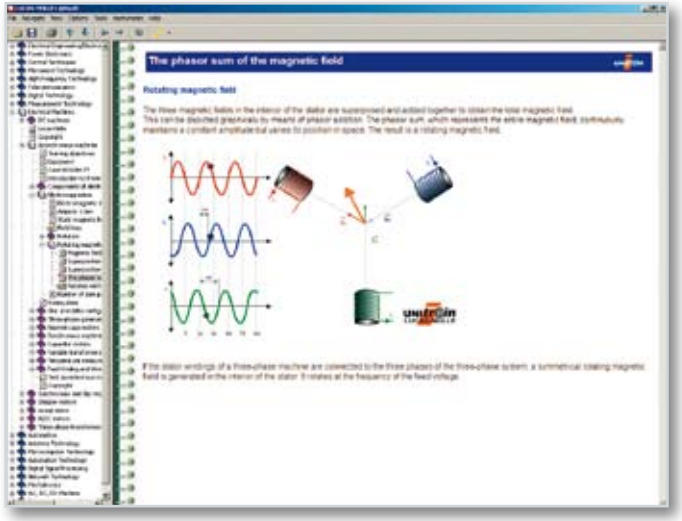
Due to their enormous popularity, asynchronous machines are extremely important, and this is certainly the case when training electrical engineers.

Training contents

- Generation of static and rotating magnetic fields
- Voltage and current measurements on a stator
- Connection of a stator in star and delta configuration
- Differences between various rotor types
- Response during start up and field weakening
- Fault simulation

Article no.: SO4204-7T, consisting of

1 x CD with "Asynchronous machines" course
1 x Experiment card "Asynchronous machines"
3 x Rotors



Synchronous Machine

Slip-ring Rotor Machines
Synchronous Machines
Reluctance Motors

Reluctance machines are the motors of the future. Nowadays three-phase machines with synchronous and slip-ring rotors are extremely widespread and popular.

Training contents

- Explanation of the technology and its practical applications
- Derivation of the physics needed to understand the machine
- Starting machines with starter resistors as well as variable frequency
- Controlling speed
- Various experiments on the following aspects:
  - Motors with slip-ring rotor
  - Effects of open or connected rotor windings
  - Effect of varying exciter voltage

Article no.: SO4204-7U, consisting of

1 x CD with "Synchronous and slip-ring rotor machine" course
1 x Experiment card "Stator"
3 x Rotors
1 x LED stroboscope

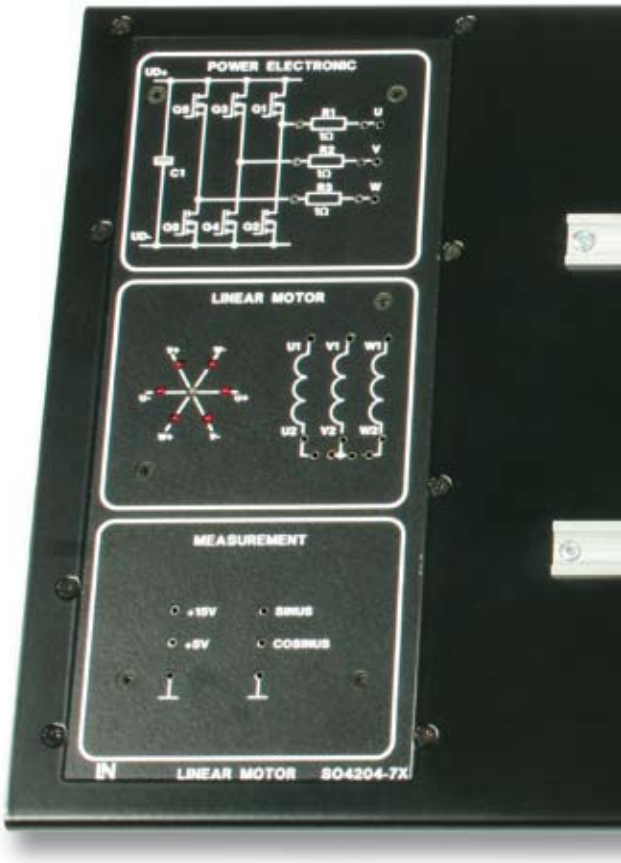
Linear Motor

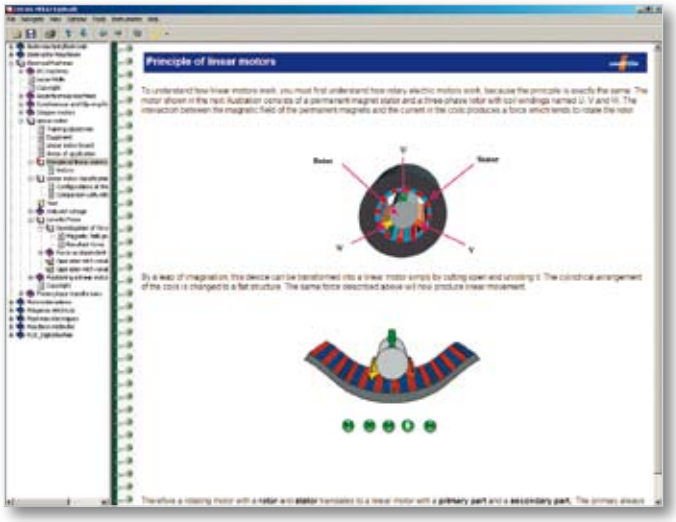
Function
Applications
Positioning

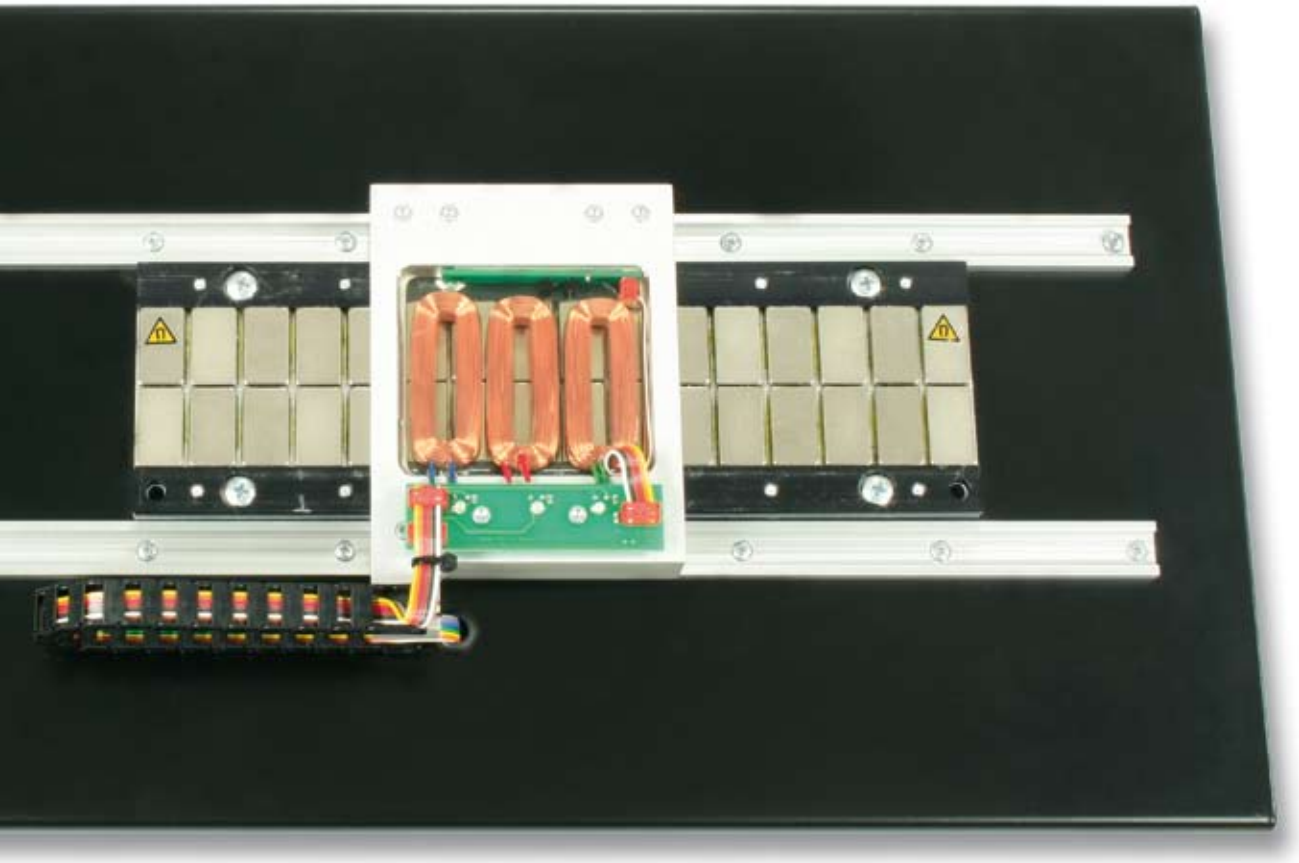
Linear motors are extremely effective for any application that requires linear motion. They are being used more and more also in modern automation applications.

Training contents

- Design, function and operating response of linear motors
- Meaning of the terms "Lorentz force" and "induced voltage"
- Areas of application for linear motors
- Various types of linear motor
- Advantages and disadvantages of linear motors compared to rotating machines
- Determining motor constants
- Positioning with a linear motor
- Methods of determining position (encoders, Hall sensors)
- Difference between absolute and relative positioning
- Determining position with the aid of analogue Hall sensors







Article no.: SO4204-7X, consisting of

1 x CD with "Linear motor" course
1 x Experiment board "Linear motor"

Optional:
Article no.: SO4203-2V

Aluminium carry case for experiment board

Stepper Motor

Models

Operating Principle

Positioning

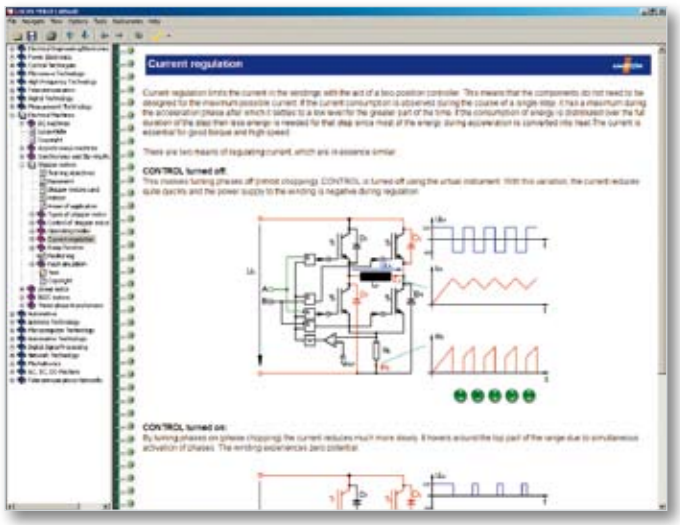
Stepper motors make for a low-cost solution to positioning requirements. They are thus produced in large numbers and deployed in a multitude of products.

Training contents

- Demonstration of the theoretical background behind stepper motor technology using animations and experiments
- Including controlling principles
- Illustration of the differences between two current-limiting procedures
- Limitations of stepper motors
- Complex positioning assignments

Article no.: SO4204-7W, consisting of

1 x CD with "Stepper motor" course
1 x Experiment card "Stepper motor"



BLDC Motor

Function
Position Detection
Automatic Control

Brushless direct current (BLDC) motors are being used in various areas and applications. BLDC motors operate like synchronous motors.

Training contents

- Design and function of a motor and control electronics
- Investigation of a sensor system
- Investigation of a motor's power circuitry
- Design of torque- and speed-controlled drives
- BLDC motor as a servo motor

Article no.: SO4204-7Z, consisting of

1 x CD with "BLDC motor" course
1 x Experiment card "BLDC motor"

Power Electronics

Line-commutated Converters

Self-commutated Converters

Frequency Converters

Power Factor Correction (PFC)

UniTrain-I system

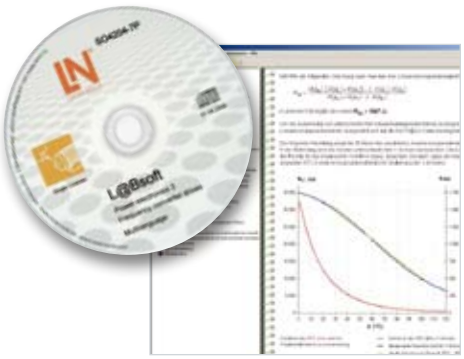
- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msamples/s
- 9 measuring ranges 100 mV - 50 V
- 22 time ranges 1 µs - 10 s
- 16 digital inputs/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Accommodates experiment cards
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards



LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of experiment results
- Tests

Integrated measuring equipment and power supplies

- Multimeters, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- Three-way AC/DC power supply
- Three-phase power supply
- ... and many other instruments

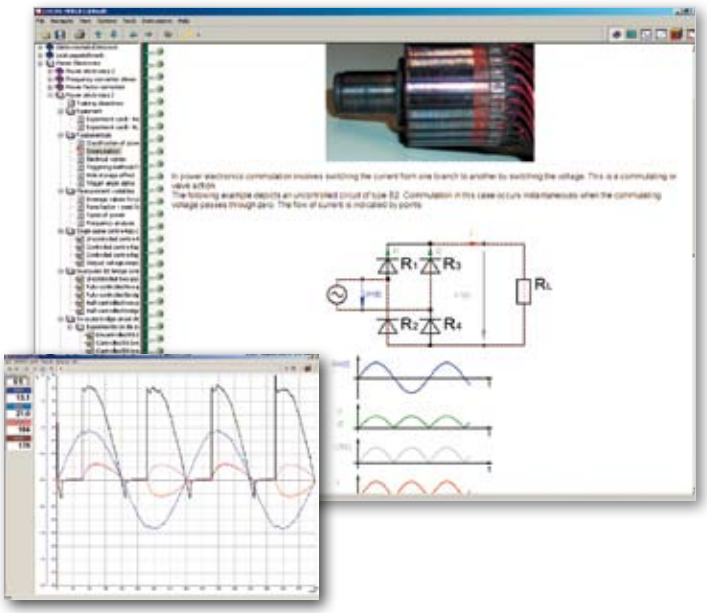
Line-commutated Power Converters

Uncontrolled Rectifiers
Controlled Rectifiers
AC Controllers/Three-phase Controllers

Having become an integral part of our daily lives, power electronics is what makes it possible to have modern dimmers for halogen lights, variable-speed drills and adjustable electric heating, to quote a few examples. For this purpose power semiconductors like diodes, thyristors and power transistors are used.

Training contents

- Measurable variables in power electronics
- Power semiconductors and their control
- Design and operation of single-phase and three-phase rectifiers
- Recording operating characteristics of uncontrolled converter circuits
- Recording control and operating characteristics for semi-controllable converter circuits
- Fully controllable converter circuits
- Recording of control and operating characteristics for single-phase and three-phase AC power controllers
- Measurement and analysis of the performance of converter circuits
- Analysis of variables using FFT



Article no.: SO4204-7N, consisting of

1 x CD with "Line-commutated power converters" course
1 x Experiment card "Line-commutated converter"
1 x Experiment card "Load line-commutated converter"

Self-commutated Power Converters

PWM
Single-quadrant and 4-quadrant Controllers
Single- and Three-phase Power Inverters

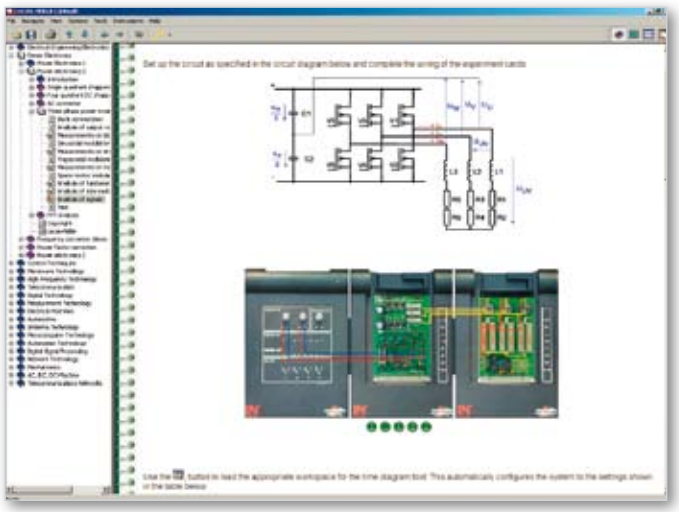
The number of variable-speed drives on modern machines is increasing steadily due to rising technological demands and the advent of advanced, economical converters. Today, these converters make use of pulse-width modulation (PWM).

Training contentss

- PWM for the generation of variable DC and AC voltage
- Investigation of load response in single- and four-quadrant operation
- Recording of control and operating characteristics in single- and four-quadrant operating modes
- Measurements of signal characteristics of power inverters during amplitude and signal modulation
- Design and function of three-phase power inverters
- Block commutation, sine, super-sine and space vector modulation for the generation of three-phase voltages
- Analysis of the various modulation methods based on signal waveform measurements
- Comparison of various modulation methods using Fourier analysis (FFT)

Article no.: SO4204-7M, consisting of

1 x CD with "Self-commutated power converters" course
1 x Experiment card "Self-commutated converter"
1 x Experiment card "Load self-commutated converter"



Frequency Converter Drives

Intermediate Circuit
Inverters
Speed Adjustment

Frequency converters permit low-loss and continuous adjustment of the speed of asynchronous three-phase motors. Besides serving to control and protect motors, these devices also perform process automation functions nowadays.

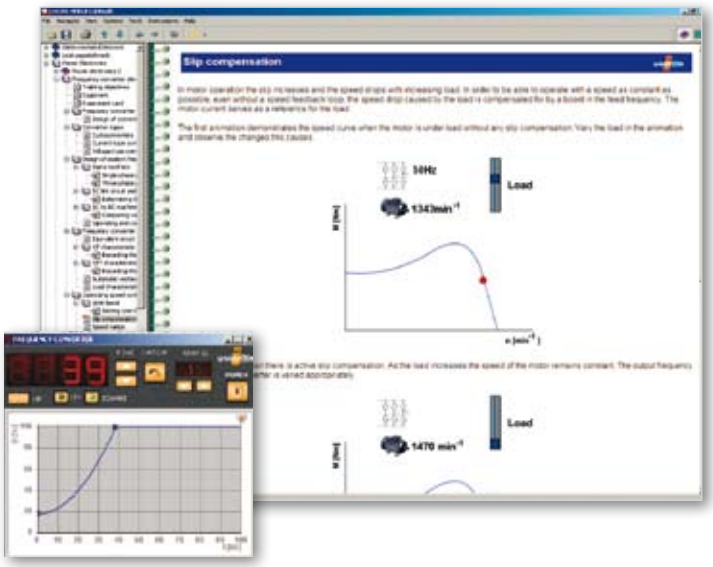
Training contents

- Classification of frequency converters
- Design of modern frequency converters
- Generation of intermediate circuit voltage
- Recording V/f characteristics and boost
- Need for speed ramps
- Operation of three-phase motors in conjunction with frequency converters
- Design and function of brake choppers
- Optimisation of speed-controlled drives
- Introduction to so-called "87-Hz technology"
- Recording and analysis of currents, voltages and power levels

Article no.: SO4204-7P, consisting of

1 x CD with "Frequency converter drives" course
1 x Experiment card "Intermediate circuit for frequency converters"

The following courses are required in addition:
SO4204-7M Power electronics 2 – "Self-commutated power converters"
SO4204-7T Electrical machines 2 – "Asynchronous machines"



Active Power Factor Correction

Active PFC
Automatic Control
Fourier Analysis

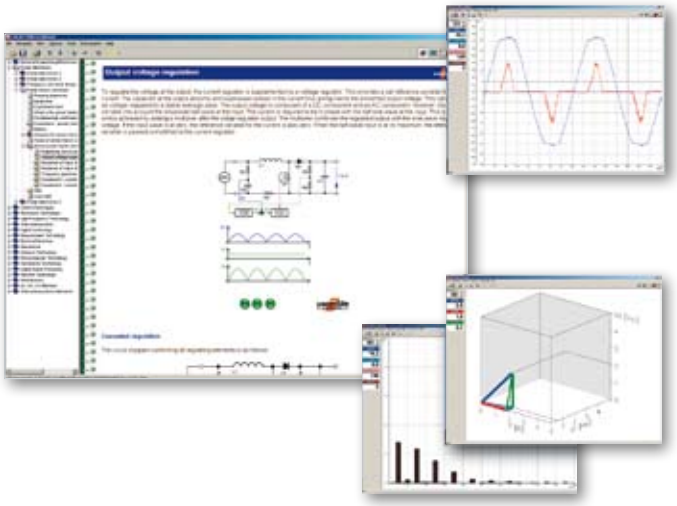
Nowadays every power supply built into a computer is equipped with a power factor correction circuit (PFC). The reason for this is the existence of a Europe-wide standard requiring that, as of a certain power classification, any consumer drawing current from the mains in such a way that the current consumption is not linearly proportional to the voltage characteristic must be equipped with a power factor correction circuit.

Training contents

- Reasons for using power factor correction circuits
- How power factor correction works
- Areas of application for power factor correction
- Active and passive power factor correction
- Design and function of an active power factor correction circuit
- Comparison with conventional bridge rectifier circuits
- Recording and analysis of currents, voltages and power levels
- Analysis of variables involved using FFT

Article no.: SO4204-7Q, consisting of

1 x CD with "Active power factor correction (PFC)" course
1 x Experiment card "Power factor correction (PFC)"



Electrical Engineering

Direct Current

Alternating Current

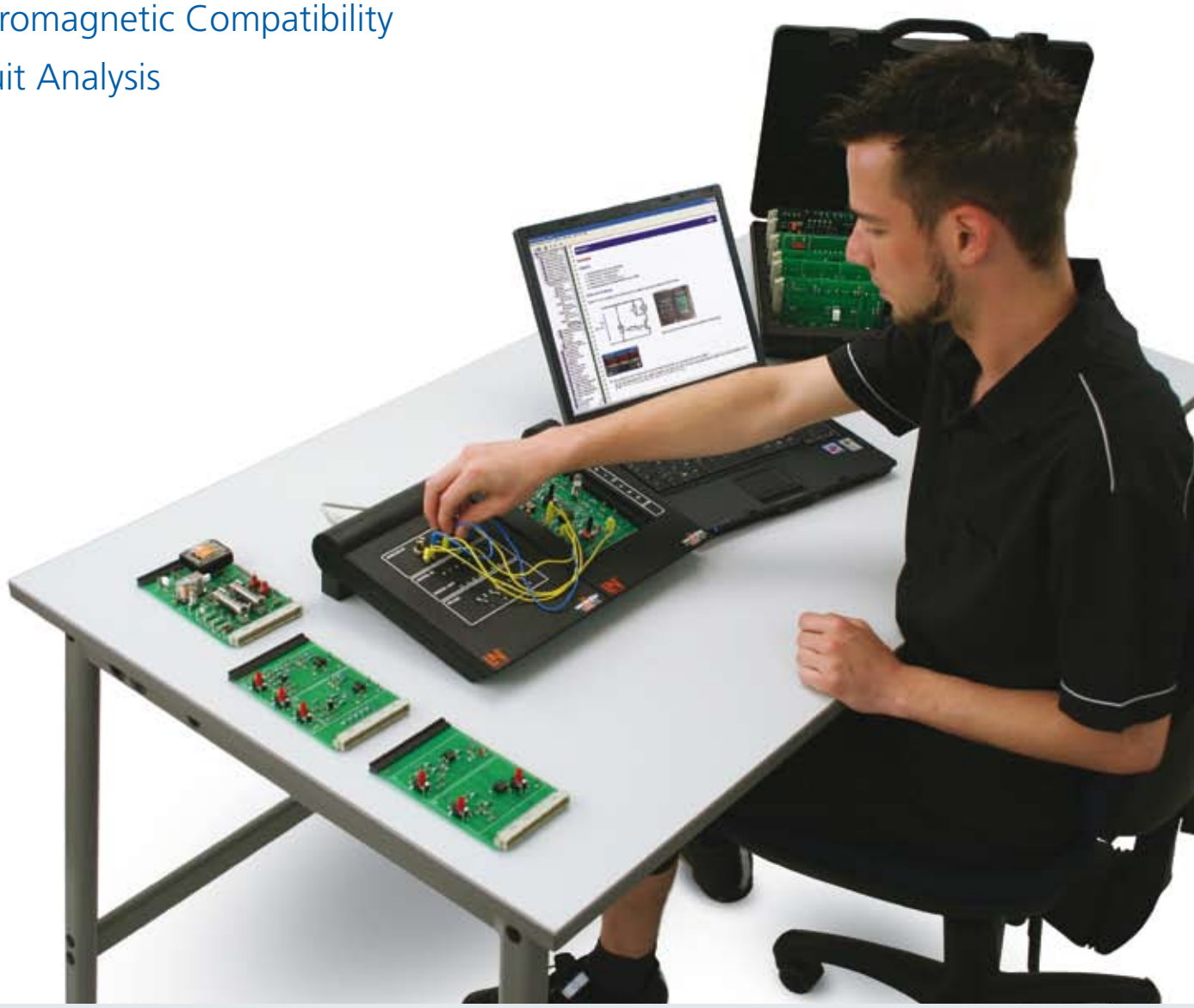
Three-phase Current

Measurement Using a Multimeter

Magnetism

Electromagnetic Compatibility

Circuit Analysis



UniTrain-I system

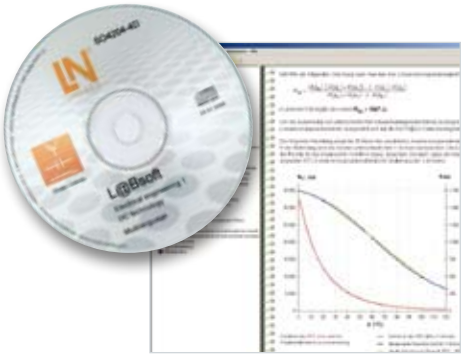
- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msamples/s
- 9 measuring ranges 100 mV - 50 V
- 22 time ranges 1 µs - 10 s
- 16 digital inputs/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Accommodates experiment cards
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeters
- Additional serial interface for cards



LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Flexible navigation
- Documentation of experiment results
- Tests

Integrated measuring equipment and power supplies

- Multimeters, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- Three-way AC/DC power supply
- Three-phase power supply
- ... and many other instruments

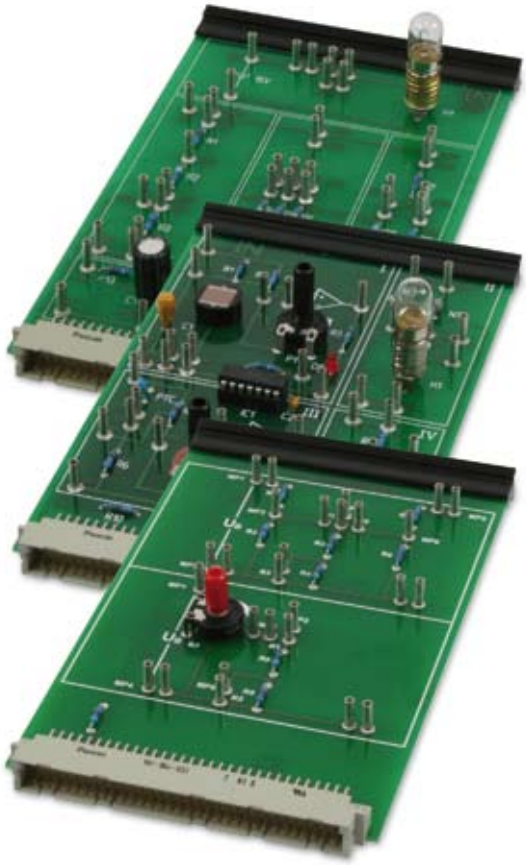
DC Technology

Current
Voltage
Resistance

Acquire a practical knowledge of voltage, current and resistance – the fundamentals of electrical engineering. The course clearly explains the basic laws of electrical engineering by means of numerous experiments that are easy to understand and are illustrated by animations and text.

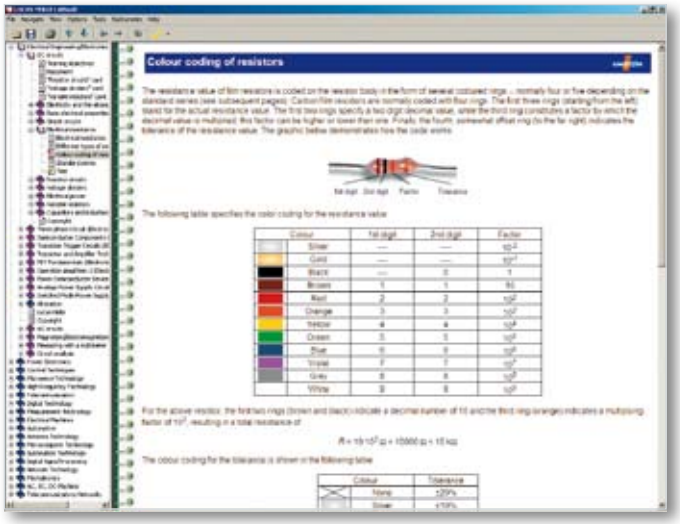
Training contents

- Basic terminology: electric charge, electric field, current, voltage, resistance and power
- Using power supplies and measuring instruments
- Experimental demonstration of Ohm's law and Kirchhoff's laws
- Measurements involving series and parallel resistor circuits and voltage dividers
- Recording of characteristics for variable resistors (LDR, NTC, PTC, VDR)
- Investigation of coils and capacitors in DC circuits
- Fault simulation



Article no.: SO4204-4D, consisting of

1 x CD with "DC technology" courses
1 x Experiment card "Resistor circuits"
1 x Experiment card "Voltage dividers"
1 x Experiment card "Variable resistors"



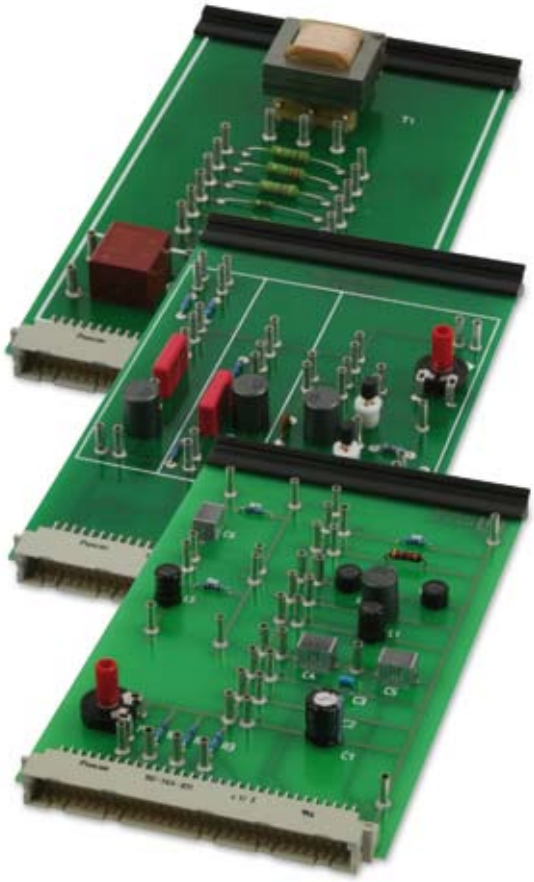
AC Technology

Inductance
Capacitance
Oscillating Circuits/Transformers

How do coils and capacitors respond to alternating current? What is an oscillating circuit and how does a transformer work?

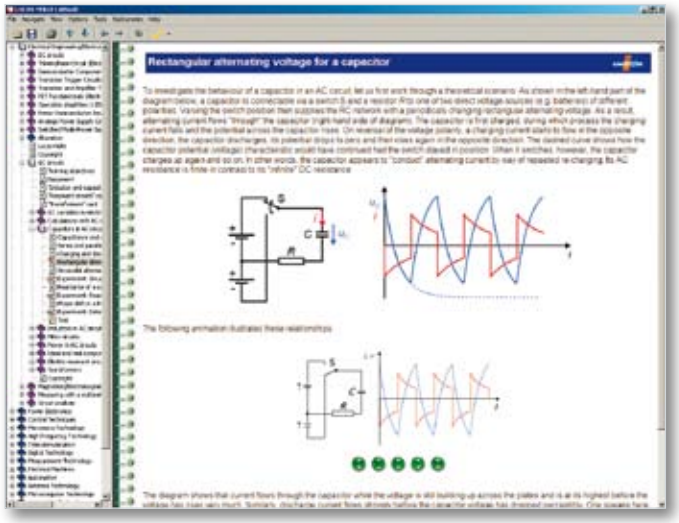
Training contents

- Characteristics for periodic or sine-wave signals
- Use of vector diagrams
- Experimental determination of reactance for coils and capacitors
- Explanation of active, reactive and apparent power
- Frequency response of simple filter circuits
- Electrical resonant circuits: resonance, quality, band width and cut-off frequencies
- Measurement of frequency response for series and parallel resonant circuits
- Measurements with and without load or with short circuit
- Frequency response of transformers and repeaters
- Fault simulation



Article no.: SO4204-4F, consisting of

1 x CD with "AC technology" course
1 x Experiment card "Inductors and capacitors"
1 x Experiment card "Oscillating circuits"
1 x Experiment card "Transformers"



Three-phase Technology

Star and Delta Circuits
Three-phase Current Generators

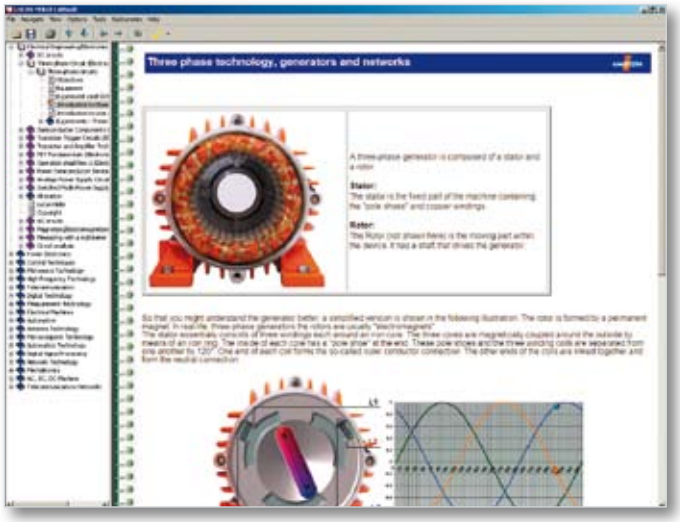
Three-phase current plays a vital role in energy and drive technology, more specifically in the generation and transmission of electrical energy, and operation of powerful industrial machines.

Training contents

- Measurement of phase-to-phase and line-to-line properties
- Experimental determination of laws relating to phase-to-phase and line-to-line properties
- Resistive and capacitive loads in star (Y) and delta circuits
- Phase shift between phase-to-phase and line-to-line properties
- Measurement of equalising current in neutral conductors
- Effect of breaks in a neutral conductor
- Current and voltage measurement under balanced and unbalanced loads
- Power measurement for a three-phase load

Article no.: SO4204-4H, consisting of

1 x CD with "Three-phase technology" course
1 x Experiment card "Three-phase circuits"
1 x Experiment card "Three-channel oscilloscope"



Conducting Measurements with a Multimeter

Current Measurement
Voltage Measurement
Measurements on Resistors and Diodes

This course teaches proper and safe measurement using conventional multimeters by means of numerous measurement exercises and animated illustrations.

Training contents

- Introduction to multimeter controls
- Hazards when measuring electrical circuitry
- Measurement of DC and AC voltage using a multimeter
- Measurement of DC and AC current using a multimeter
- Measurements on resistors and diodes
- Zero calibration and continuity testing
- Setting measuring ranges
- Possible sources of measurement errors
- Identification of unknown components in a circuit by means of voltage and current measurement

Article no.: SO4204-4B, consisting of

1 x CD with "Conducting measurements with a multimeter"course
1 x Experiment card "Test components"
1 x Multimeter "Multi 13S"

Magnetism/Electromagnetism

Magnetic Fields
Induction
Circuit Components

Magnetism and electricity are closely interlinked, many electrical components making use of the effects of electromagnetism.

Training contents

- Magnetism: magnetic poles, magnetic field, field lines and field strength
- Hard and soft magnetic materials, hysteresis
- Investigation of magnetic field around a current carrying conductor
- Investigation of magnetic field around a coil (containing air, or a ferrite core)
- Electromagnetic induction and the Lorentz force
- Design and function of a transformer
- Investigation of a transformer under various loads
- Design and function of electromagnetic components: relays, reed switches, Hall switches
- Investigation of applied circuits

Article no.: SO4204-4A, consisting of

1 x CD with "Magnetism" course
1 x Experiment card "Magnetism and electromagnetism"

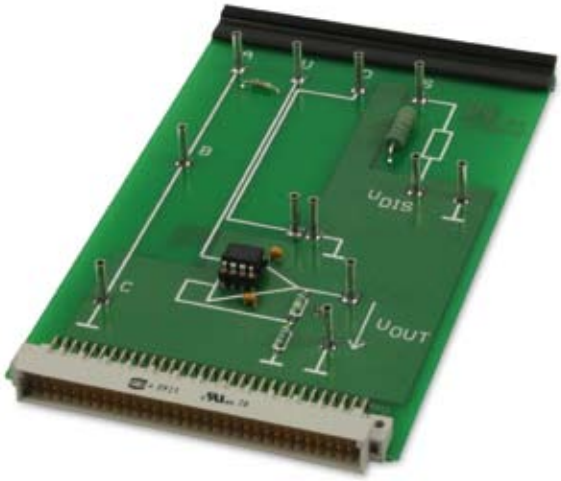
Electromagnetic Compatibility

Coupling Effects
Immunity to Interference
Standards

The various aspects of electromagnetic compatibility play a major role in the development and fault analysis of circuits. These aspects include coupling effects within the circuit itself as well as external or internal sources of interference.

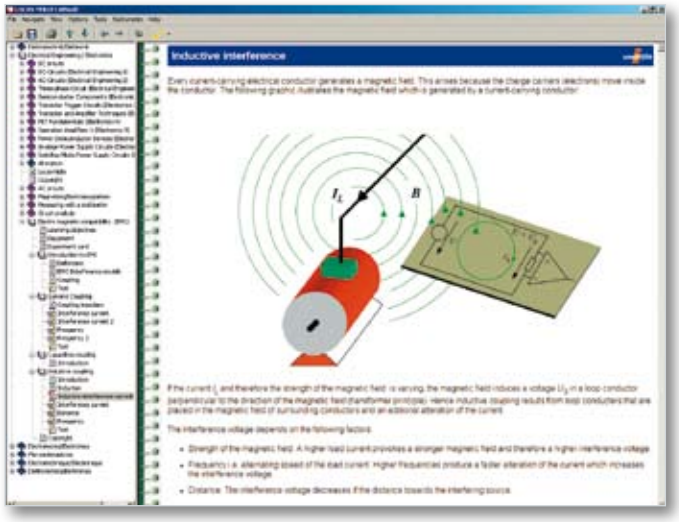
Training contents

- The meaning of electromagnetic compatibility (EMC)
- Description of electromagnetic coupling effects
- Natural and man-made sources of electromagnetic interference
- European EMC standards and guidelines
- Investigation of galvanic coupling between parallel tracks
- Investigation of capacitive coupling between parallel tracks
- Investigation of inductive coupling between parallel tracks
- Ways of improving electromagnetic compatibility of a circuit
- Ways of improving a circuit's immunity to interference



Article no.: SO4204-4K, consisting of

1 x CD with "Electromagnetic compatibility" course
1 x Experiment card for "Electromagnetic compatibility"



Electrical Network Analysis

Rearrangement of Component Networks
Equivalent Sources
Superposition Principle

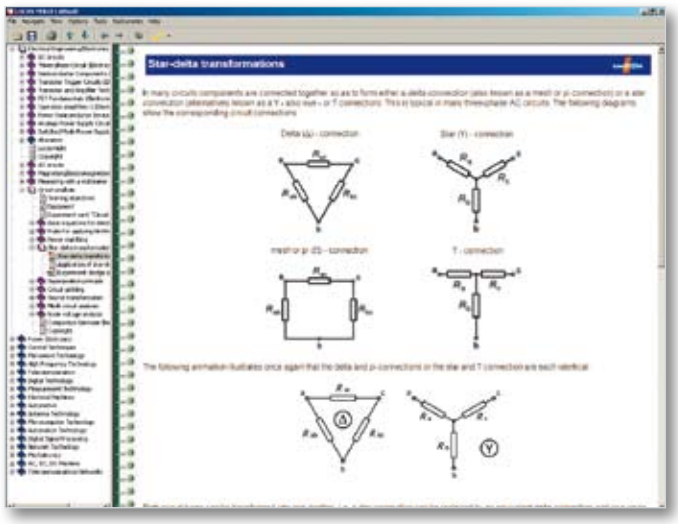
Even though various wide-ranging tools for circuit analysis exist in this day and age, the efficient use of such tools still requires a fundamental knowledge of circuit analysis techniques. This course introduces a variety of analytical methods for determining the distribution of voltage and current even in quite complex circuits and subjects them to experimental investigation.

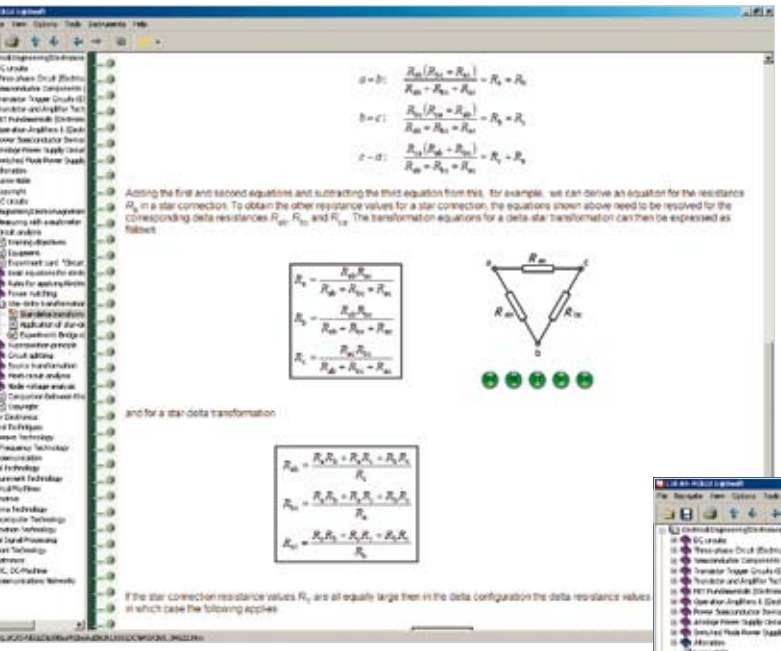
Training contents

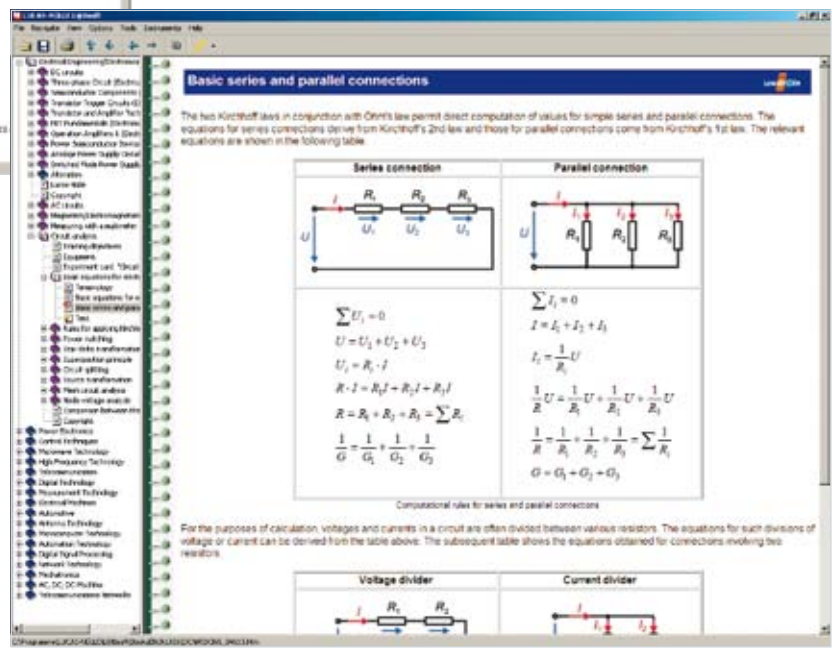
- Use of Kirchhoff's laws for resistor networks
- Analysis of resistor combinations using Kirchhoff's laws
- Power matching for resistor combinations
- Star-delta modification
- Superposition principle
- Equivalent circuits for current and voltage sources
- Simplification of a resistor network with 2 sources using Millman's theorem
- Conversion of equivalent voltage source to current source
- Mesh (loop) analysis and nodal analysis

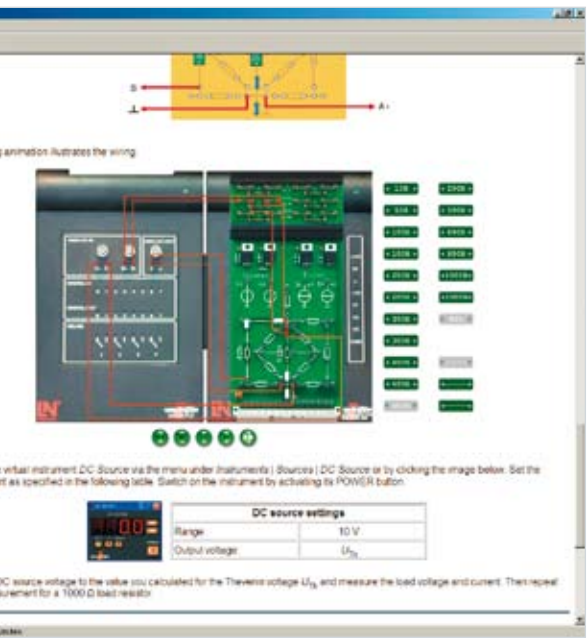
Article no.: SO4204-4C, consisting of

1 x CD with "Electrical network analysis" course
1 x Experiment card "Circuit analysis"
1 x Circuit board with pluggable resistors






Basic series and parallel connections
Series connection
Parallel connection
Voltage divider
Current divider


DC source settings
Range
10 V
Output voltage

Electronics

Semiconductor Components

Transistor Circuits

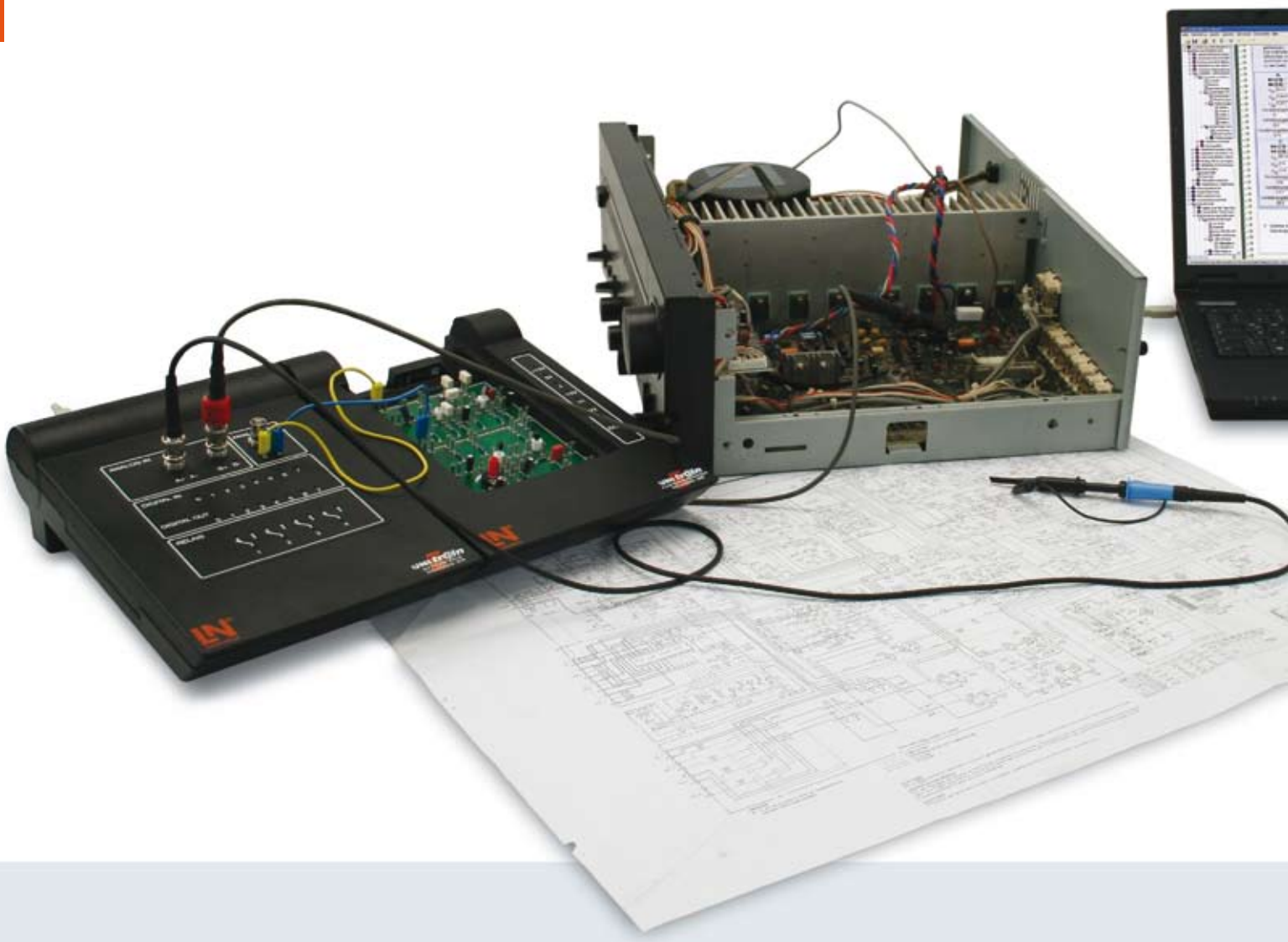
Operational Amplifiers

Power Semiconductors

Power Supplies

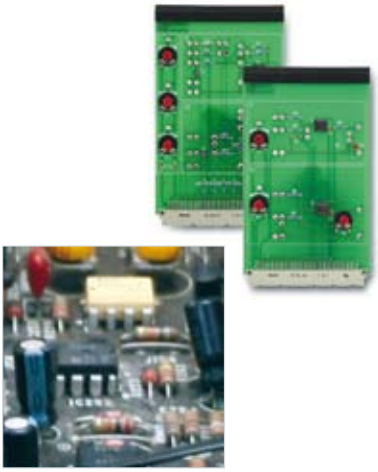
Circuit design

PCB Layout

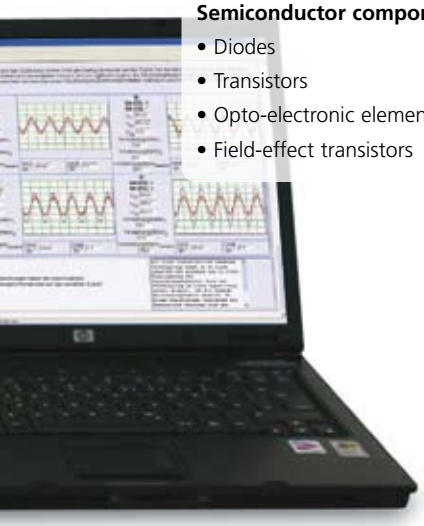


Semiconductor components
- Diodes
- Transistors
- Opto-electronic elements
- Field-effect transistors

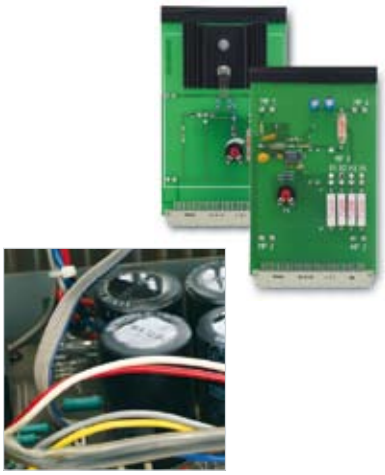
Transistor circuits
- Multi-stage amplifiers
- Differential amplifiers
- Power sources
- Multivibrator circuits



Operational amplifiers
- Inverted and non-inverted mode
- Adders
- Comparators
- Schmitt triggers



Power semiconductors
- TRIACs
- MOSFETs
- IGBTs
- Thyristors



Power supply circuits
- Rectifiers
- Filter circuits
- Voltage regulators
- Voltage multipliers

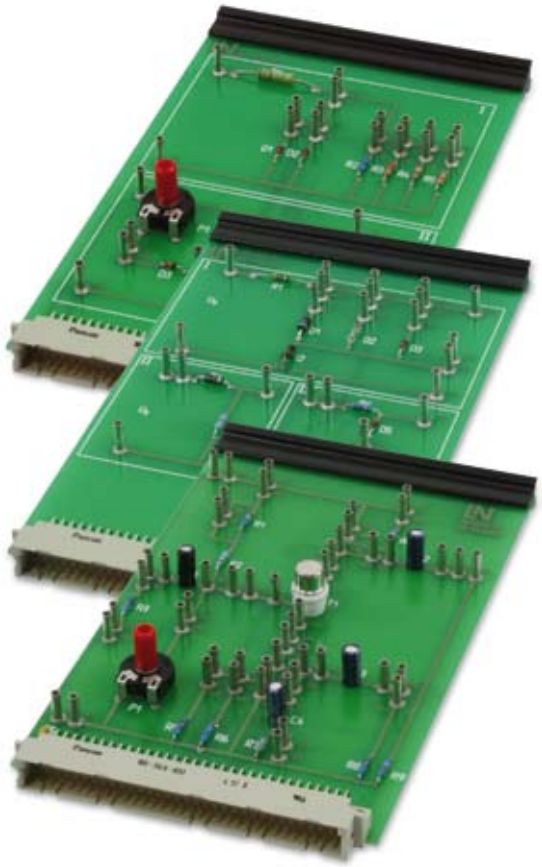
Semiconductor Components

Diodes
Transistors
Opto-electronic Elements

A knowledge of the properties and functions of electronic components serves as a basis for understanding and analysing electronic and integrated circuits.

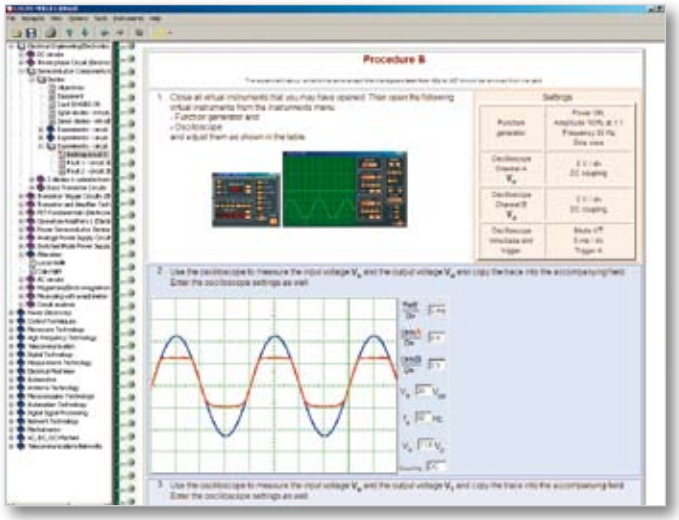
Training contents

- Designs, properties and characteristic parameters of diodes
- Valve and rectifying capabilities of diodes
- Recording static and dynamic characteristics of various diodes
- Determining various properties of germanium, silicon and Zener diodes
- Zener diodes in limiter or stabiliser circuits
- Properties and characteristic of an LED
- Investigation of switching properties and characteristics of photodiodes
- Investigation of a light barrier circuit
- Basic transistor circuits using bipolar transistors
- Setting the operating point of a transistor circuit
- Fault simulation



Article no.: SO4204-5A, consisting of

1 x CD with "Electronics" courses
1 x Experiment card "Diodes"
1 x Experiment card "Zener diodes and opto-electronic elements"
1 x Experiment card "Basic transistor circuits"



Field-effect Transistors

Source/Drain-follower Circuits

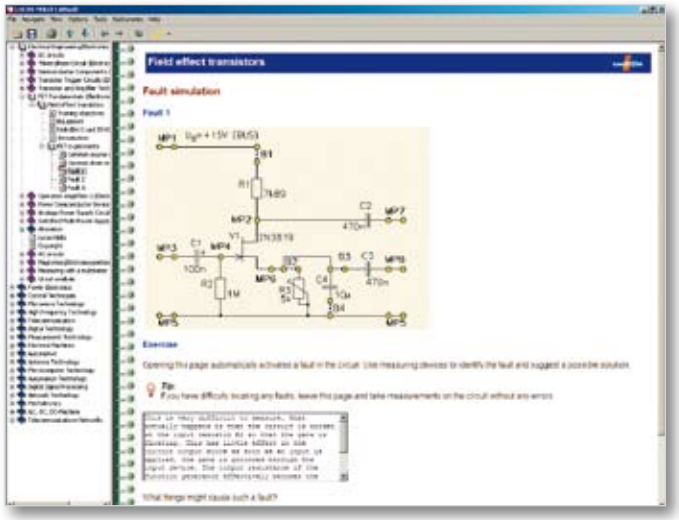
Field-effect transistors (FET) are increasingly replacing bipolar transistors. Produced more easily and cheaply than bipolar transistors, FETs also consume less power and give rise to less heat losses. Accordingly, FETs play a predominant role in integrated circuits and power electronics.

Training contents

- Design and function of an FET
- FET terminals: source, drain, gate
- Explanation of the terminology n-channel and p-channel
- Determining the gain of an FET in source and drain follower circuits
- Investigation of an FET with negative feedback in AC or DC circuits
- Comparison with the electrical properties of circuits with bipolar transistors or FETs
- Fault simulation

Article no.: SO4204-5K, consisting of

1 x CD with "Electronics" courses
1 x Experiment card "Field-effect transistors"



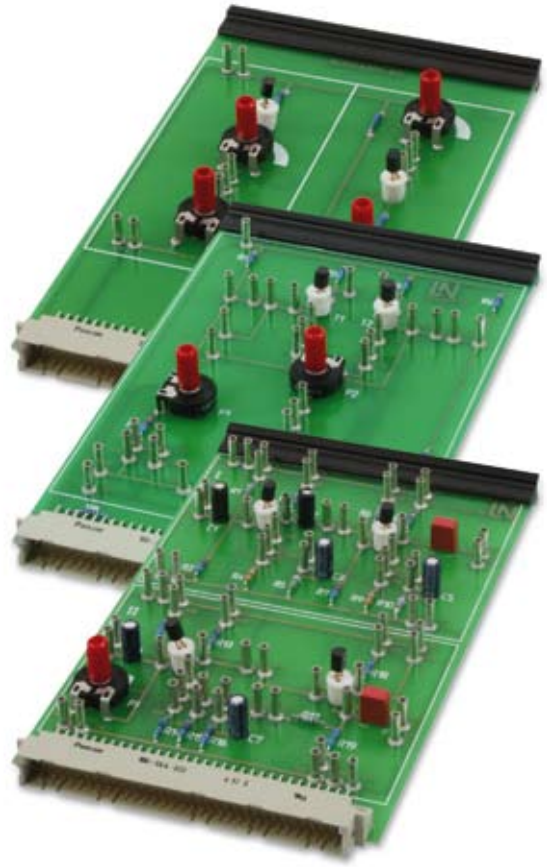
Transistor and Amplifier Technology

Multi-stage Amplifiers
Differential Amplifiers
Power Sources

Amplifier circuits are used in almost every electronic device. They are employed wherever signals with low amplitudes need to be boosted, in transmission, instrumentation and audio/video technology.

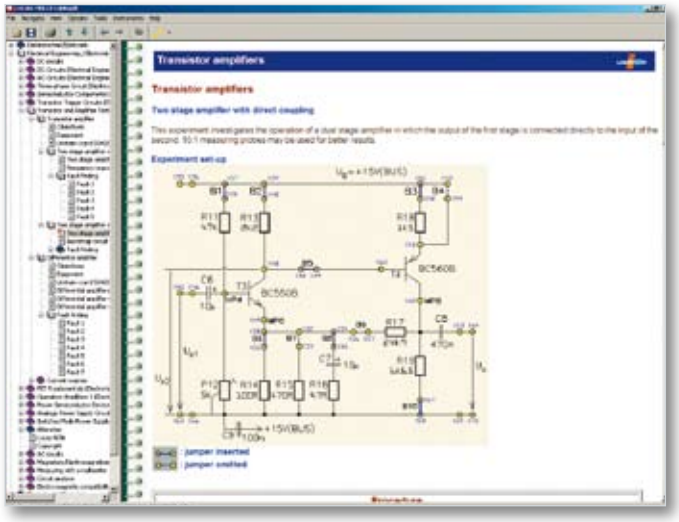
Training contents

- Measurement of voltage gain from a single amplifier stage
- Gain and frequency response of a multi-stage amplifier
- Capacitive and galvanic coupling of amplifier stages
- Function and operation of a differential amplifier
- Calibrating offset for a differential amplifier
- Response of a differential amplifier to symmetric or asymmetric voltages
- Function of a constant current source
- Investigation of load response for constant current sources using bipolar transistors or FETs
- Fault simulation



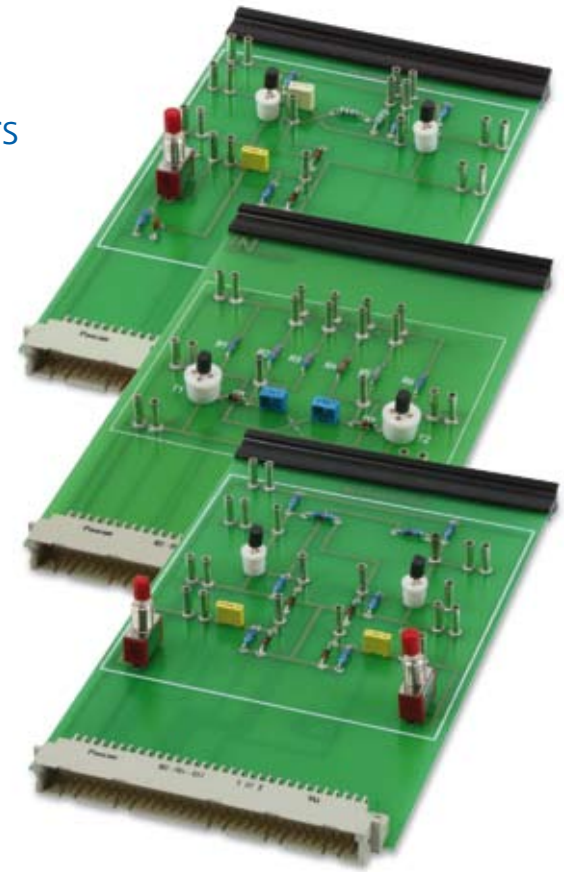
Article no.: SO4204-5H, consisting of

1 x CD with "Electronics" courses
1 x Experiment card "Multi-stage amplifier"
1 x Experiment card "Differential amplifier"
1 x Experiment card "Power sources"



Transistor Multivibrators

Multivibrators:
Astable/Bistable/Monostable Multivibrators



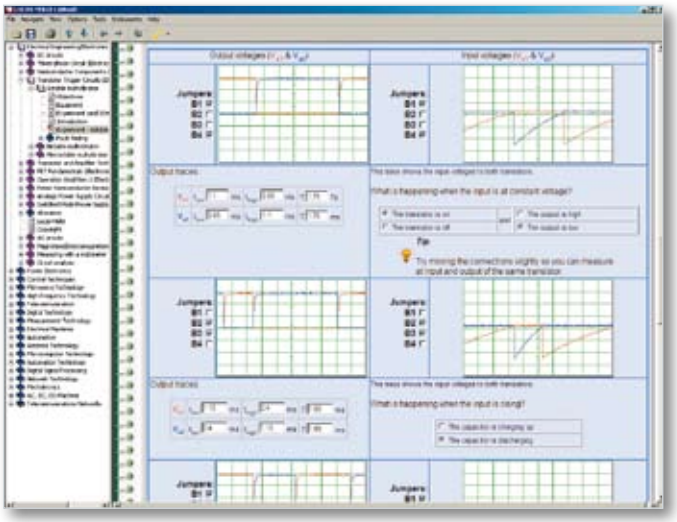
Transistor multivibrators are of paramount significance in digital technology. They serve as basic building blocks for memory modules, as well as clock and pulse generators.

Training contents

- Function of astable, bistable and monostable multivibrators
- Measurement of signal waveforms at the input and output of the circuits
- Investigation of dynamic response of multivibrators to input configurations
- Effect of various input configurations on the dynamic response of multivibrators
- Investigation of multivibrator switching response to pulsed or square-wave inputs
- Investigation of multivibrator switching response to an input produced by a key switch
- Fault simulation

Article no.: SO4204-5D, consisting of

1 x CD with "Electronics" courses
1 x Experiment card "Astable multivibrator"
1 x Experiment card "Bistable multivibrator"
1 x Experiment card "Monostable multivibrator"



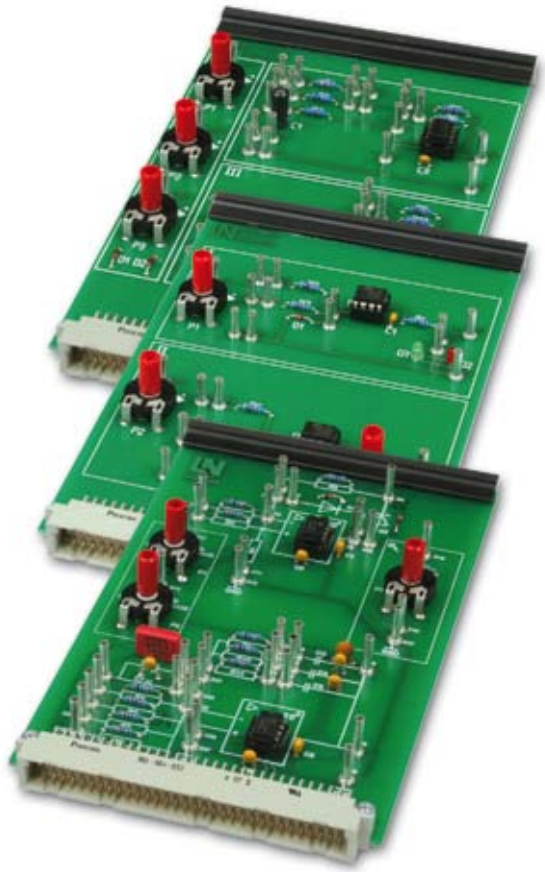
Operational Amplifiers

Basic Circuits
Precision Sources
Active Filters

Operational amplifiers have assumed a major role in analogue electronics. These highly integrated, economically manufactured, versatile components constitute an important area of training in electronics.

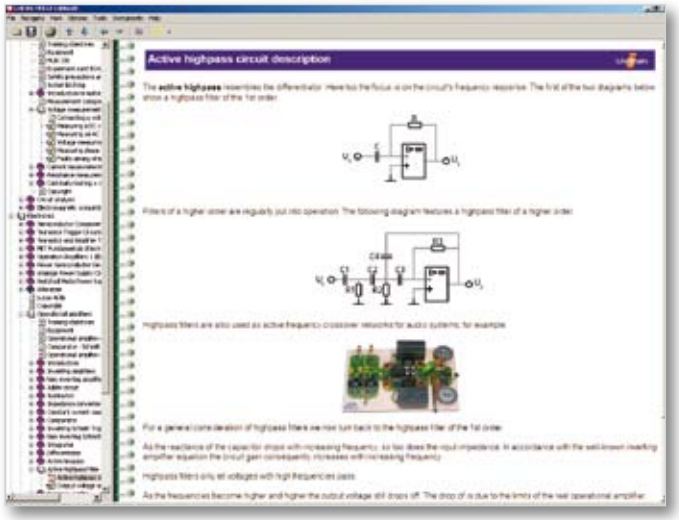
Training contents

- Design and function of operational amplifiers
- Circuit diagrams and basic circuits for operational amplifiers
- Measurement of an operational amplifier's characteristic and limiting values: Frequency response, gain
- Investigation of typical, analogue computing circuits: Adder, subtracter, integrator and differentiator
- Assembly and measurement of precision voltage sources and constant current sources
- Assembly and measurement of typical application circuits: Impedance converter, precision rectifier, comparator and Schmitt trigger
- Investigation of active filter circuits
- Troubleshooting



Article no.: SO4204-5M, consisting of

1 x CD with "Operational amplifier" course
1 x Experiment card "Operational amplifiers"
1 x Experiment card "Comparator"
1 x Experiment card "Operational amplifier applications"



Power Semiconductors

TRIACs/Thyristors
IGBTs/MOSFETs

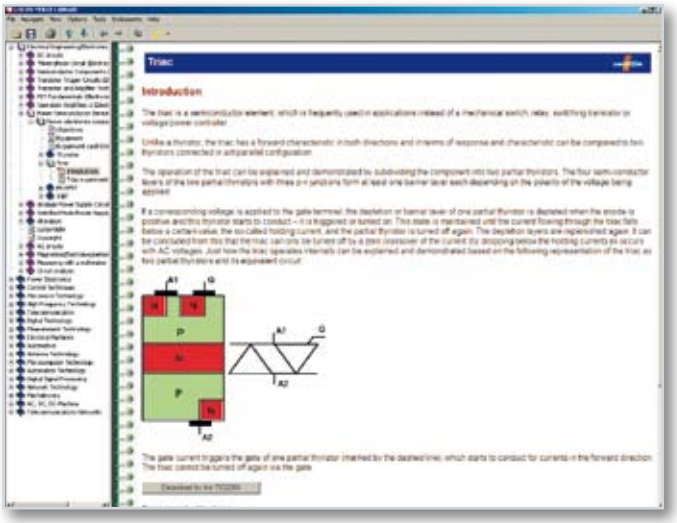
Power electronics are mainly implemented nowadays with the help of semiconductor components. Accordingly, knowledge of power semiconductors is an important prerequisite for a sound grasp of systems incorporating power electronics.

Training contents

- Design and function of thyristors
- Design and function of TRIACs
- Design and function of MOSFETs
- Design and function of IGBTs
- Thyristor circuit response: load, conducting and non-conducting states, transmission response
- TRIAC circuit response: load, conducting and non-conducting states, transmission response
- Determining threshold voltage for a MOSFET
- Investigation of switching response and driving power for a MOSFET
- Determining threshold voltage for an IGBT
- Investigation of switching response and driving power for an IGBT

Article no.: SO4204-5P, consisting of

1 x CD with "Electronics" courses
1 x Experiment card "Power semiconductors"



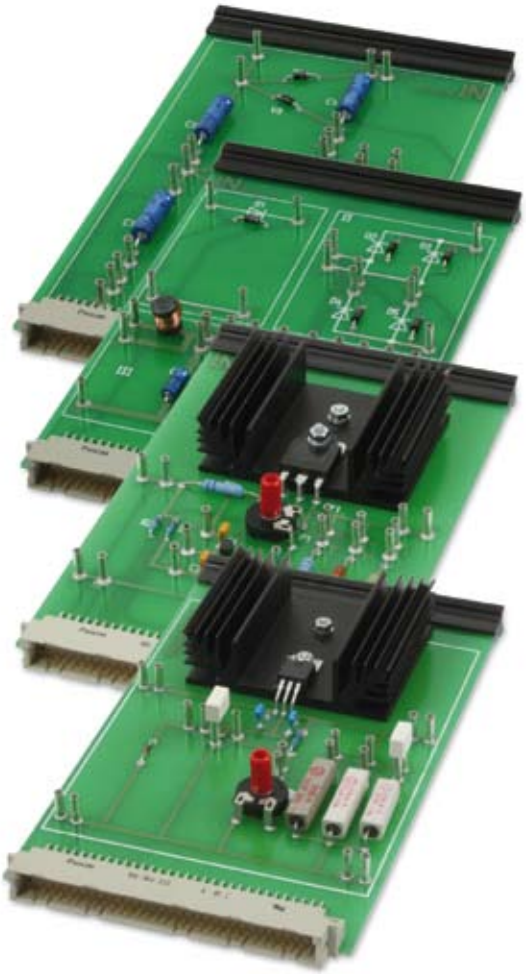
Analogue Power Supplies

Rectifiers
Voltage Regulators
Voltage Multipliers

Properly designed power supply circuits are an important prerequisite for safe and reliable operation of electronic devices.

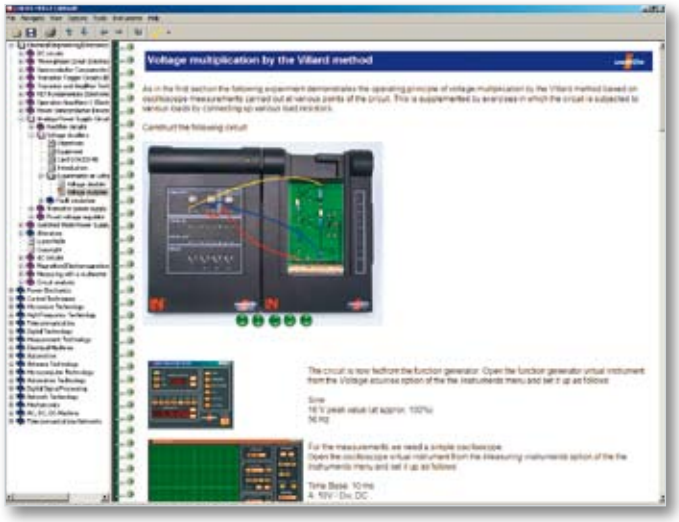
Training contents

- Half-wave and bridge rectifiers
- Mean and RMS values, form factor and ripple
- Output smoothing circuits
- Measurement of characteristic parameters for a half-wave rectifier
- Investigation of a voltage multiplier circuit with and without load
- Measurement of how ripple depends on the load
- Darlington transistors
- Fixed voltage regulator with series control transistor
- Shunt-type transistor used as a variable voltage regulator
- Static and dynamic regulating quality of transistorised voltage regulators
- Fault simulation



Article no.: SO4204-5R, consisting of

1 x CD with "Electronics" courses
1 x Experiment card "Rectifier circuits"
1 x Experiment card "Voltage multiplier"
1 x Experiment card "Transistor voltage regulator"
1 x Experiment card "Fixed voltage regulator"



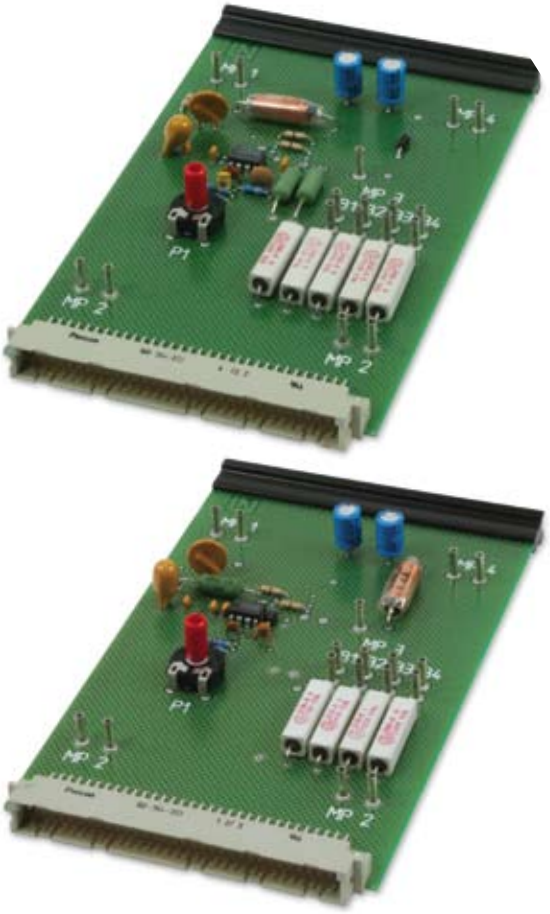
Switched-mode Power Supplies

Step-up and Step-down Converters
Setting Range
Load Response

Switched-mode power supplies are emerging as economical, low-loss alternatives to analogue power supplies.

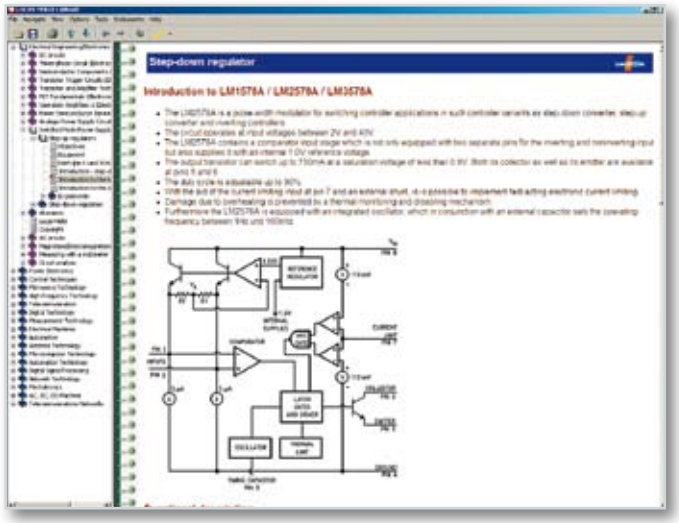
Training contents

- Design and function of switched-mode power supplies
- Measurement of setting range and load response of a step-down converter
- Analysis of a step-down converter by measurement of signal waveforms
- Measurement of setting range and load response of a step-up converter
- Analysis of a step-up converter by measurement of signal waveforms



Article no.: SO4204-5S, consisting of

1 x CD with "Electronics" courses
1 x Experiment card "Step-up converter"
1 x Experiment card "Step-down converter"



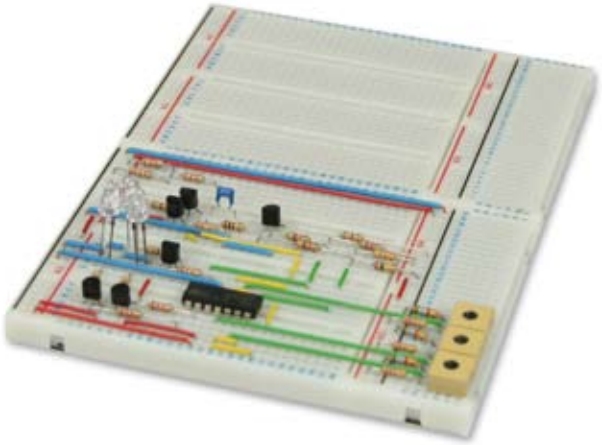
Circuit Design Using NI Multisim

Project Planning
Component Design
Circuit Simulation
Circuit Testing

The design of electronic circuitry is no longer feasible without the use of modern circuit design and simulation software programs.

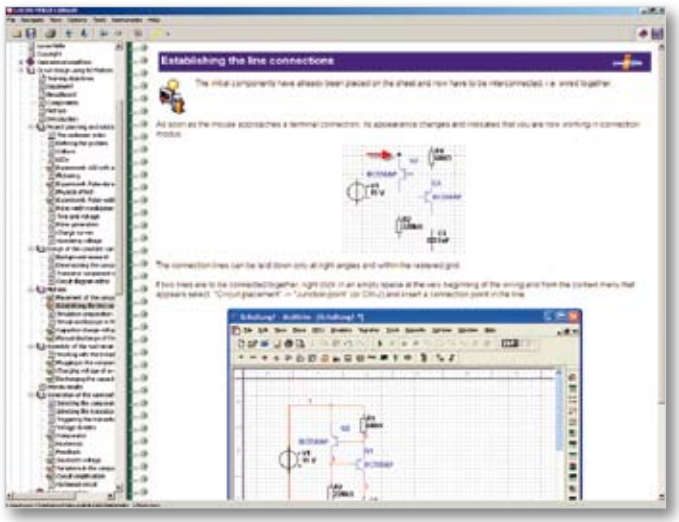
Training contents

- Design of a PWM-controlled light mixer
- Weighing alternative design solutions
- Creating a circuit diagram in NI Multisim
- Simulating circuit operation in NI Multisim
- Assembly of simulated circuit on the breadboard
- Breadboard circuit measurement and testing
- Comparison of simulated and real circuit
- Circuit evaluation and optimisation



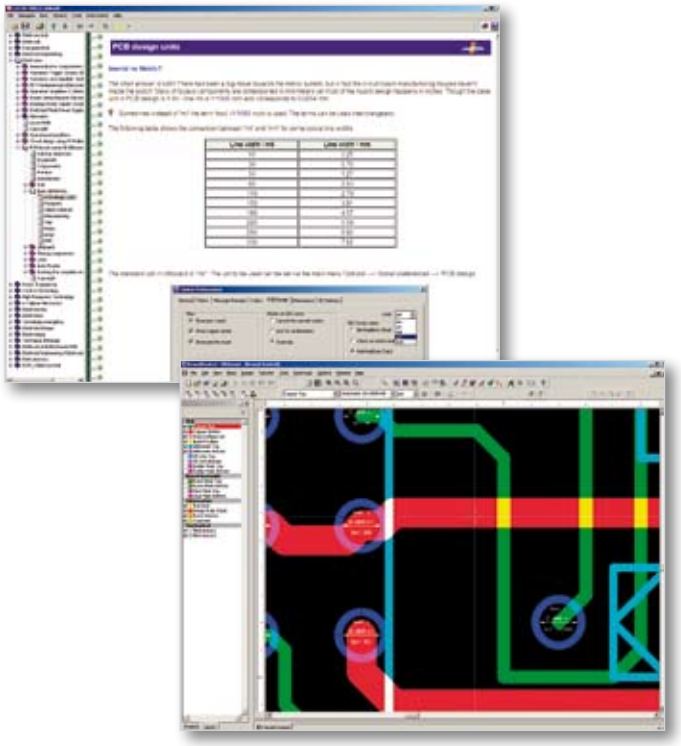
Article no.: SO4204-5U, consisting of

1 x CD with "Circuit design with NI Multisim" course
1 x Breadboard and set of cables
2 x Sets of wired components to assemble circuit
1 x NI Multisim Education Edition, single workstation license



PCB Layout with NI Ultiboard

Layout Creation
Design Rules
Optimization



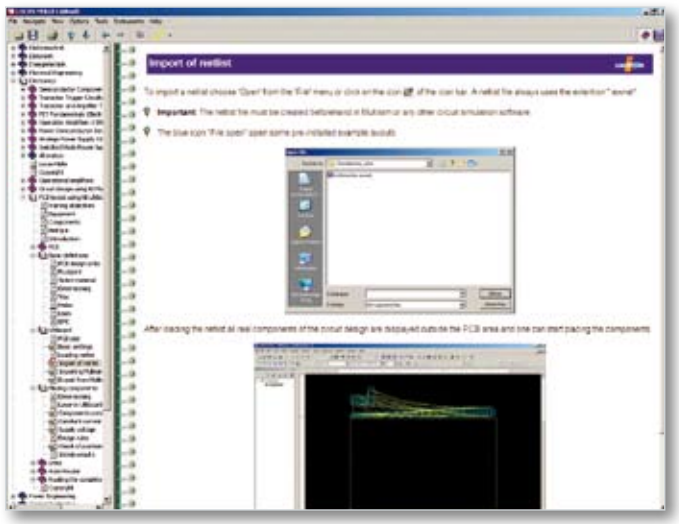
Increasing miniaturization has made layout programs indispensable for design and routing on printed circuit boards. Nevertheless, a great deal of experience and know-how is required of the person creating the layout.

Training contents

- Fundamental procedures of layout creation
- Dimensions and definitions used in the manufacture of printed circuit boards
- Specification of design rules
- Introduction to the Ultiboard program using a sample circuit
- Routing for the circuit created as part of the course titled "Circuit design with NI Multisim"
- Optimization of routing
- Preparation of Gerber data for manufacturing printed circuit boards

Article no.: SO4204-5V, consisting of

1 x CD with "PCB design with an NI Ultiboard" course
1 x NI Ultiboard single workstation license
1 x NI Multisim file implementing the circuit designed in the course SO4204-5U for application on the Ultiboard



Communication Technology

Fundamentals

Cables

Modulation Methods

Multiplexing Technology

Transmitters and Receivers

Networks

Antennae and High-frequency Technology

UniTrain-I system

- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

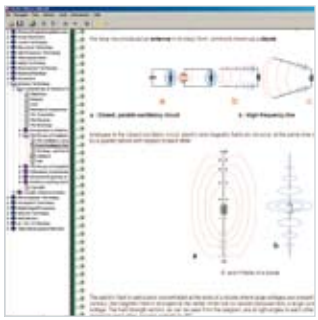
- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msamples/s
- 9 measuring ranges 100 mV - 50 V
- 22 time ranges 1 µs - 10 s
- 16 digital inputs/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Accommodates experiment cards
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards

Integrated measuring equipment and power supplies

- Multimeters, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- Level meter
- Spectrum analyser
- Bode plotter
- ... and many other instruments

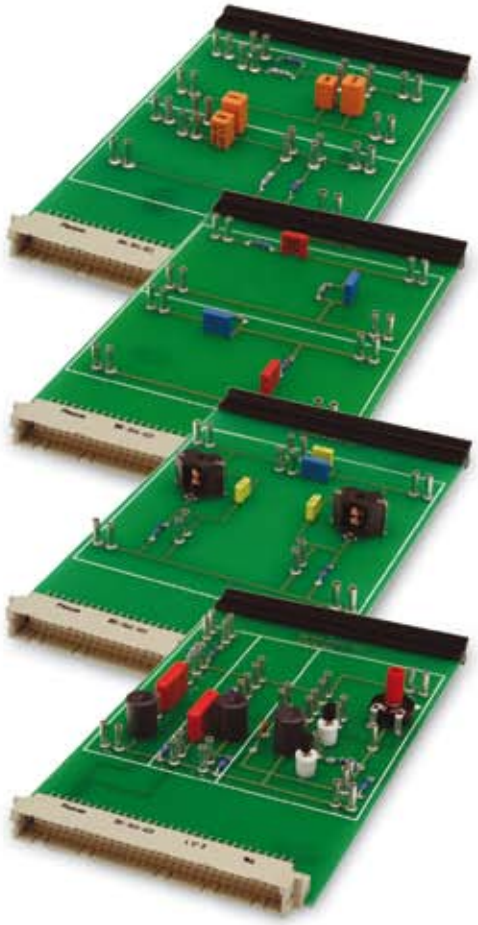


LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of experiment results
- Tests

Quadripoles and Filters

High-pass and Low-pass Filters
Band-pass and Band-stop Filters
Tuned Filters
Series and Parallel Resonant Circuits



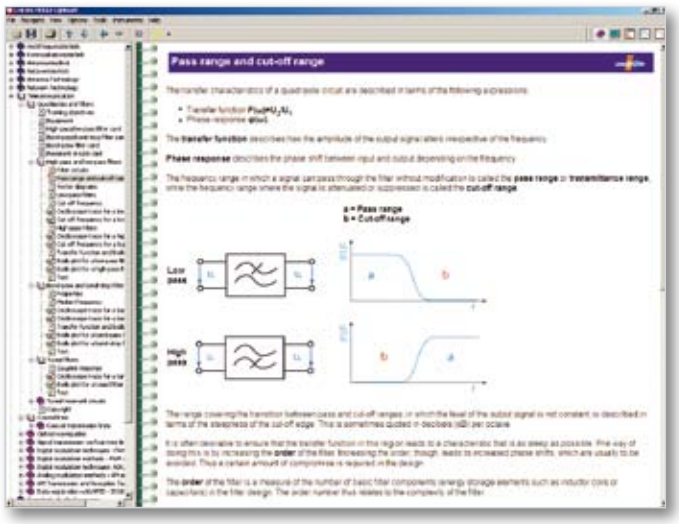
Filter circuits are used in a wide-range of applications in communications technology for suppressing or excluding unwanted frequencies from a signal. The most effective way to describe their performance is by means of the two quadripole parameters, the transfer function and the phase response.

Training contents

- Transfer function, phase response and cut-off frequencies for filters
- Representing a transfer function in the complex plane
- Determining the transfer function, phase response and cut-off frequencies for high-pass and low-pass filters by means of a Bode plot
- Determining the transfer function, band width and median frequency for a tuned filter by means of a Bode plot
- Resonant circuits: determining the transfer function, band width, quality and resonant frequency
- Analysis of resonant circuits using a Bode plot
- Investigation of a parallel resonant circuit with varicap tuning

Article no.: SO4204-9A, consisting of

1 x CD with "Quadripoles and filters" course
1 x Experiment card "High-pass and low-pass filters"
1 x Experiment card "Band-pass and band-stop filters"
1 x Experiment card "Tuned filters"
1 x Experiment card "Resonant circuits"



Coaxial Cables

Cable Characteristics
Characteristic Impedance
Matching
Reflections

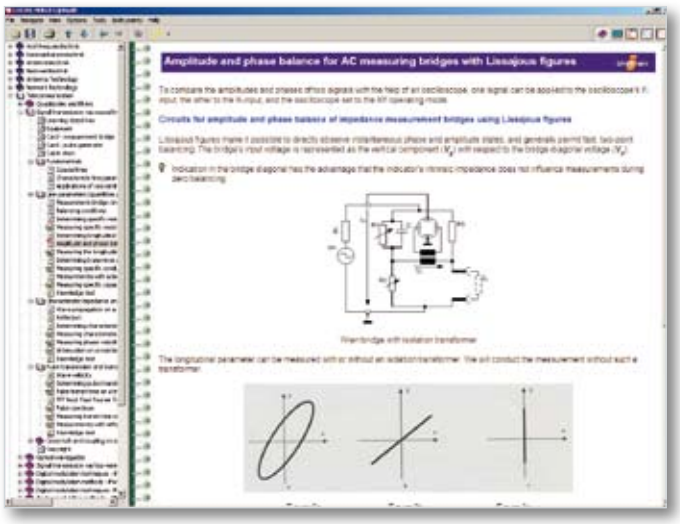
The vast majority of signals and data are transmitted via fixed media such as cables. In spite of the relative simplicity in terms of technical hardware, difficulties still crop up in practical situations, due to poor choice of conducting material or poor matching, for example.

Training contents

- Resistance per unit length, capacitance per unit length, inductance per unit length and characteristic wave impedance of a coaxial cable
- Experiments to determine the following:
  - Resistance per unit length using a Wheatstone bridge
  - Capacitance per unit length using a Wien bridge
  - Inductance per unit length using a Maxwell bridge
  - Characteristic wave impedance for a coaxial cable
- Investigation of reflections in a coaxial line due to termination
- Correct termination of a coaxial line to eliminate reflections

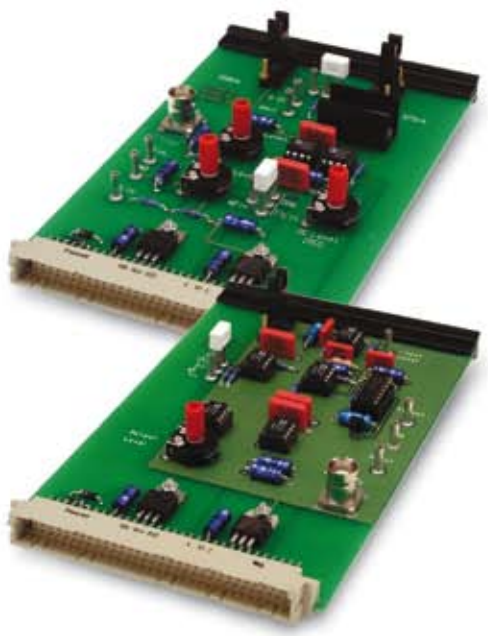
Article no.: SO4204-9D, consisting of

1 x with "Coaxial cable" course
1 x Experiment card "Measurement bridges"
1 x Experiment card "Pulse generator"
1 x Experiment module with 60 m of coaxial cable
1 x Set of plugs for coaxial cable
7 x Pluggable impedances



Fibre Optics

Optical Cabling
Optical Fibres
Attenuation



An ever-increasing flow of information calls for constantly improving transmission rates and is leading to increasing adoption of optical fibre transmission lines in industry and in communications networks.

Training contents

- Principles of optical communication
- Components used for optical communication
- Advantages and disadvantages of optical communication lines
- Characteristic and frequency response of infra-red transmitting diodes
- Modulation methods for analogue and TTL signals
- Effects of various wavelengths on the transmission response
- Configuration of an optical fibre
- Influence of receiver diodes on signal recovery
- Band width of an optical fibre line
- Effect of input capacity on band width and wavelength on attenuation
- Comparison of properties between step-index and graded-index fibres

Article no.: SO4204-9E, consisting of

1 x CD with "Optical waveguides" course
1 x Experiment card "Optical fibre transmitter"
1 x Experiment card "Optical fibre receiver"
1 x Optical fibre kit with plastic and glass fibre cables and plugs
1 x Optical gauge
1 x Set of pincers for work with optical fibres

Four-wire Lines

Line Constants
Near-end and Far-end Crosstalk
Adaptation

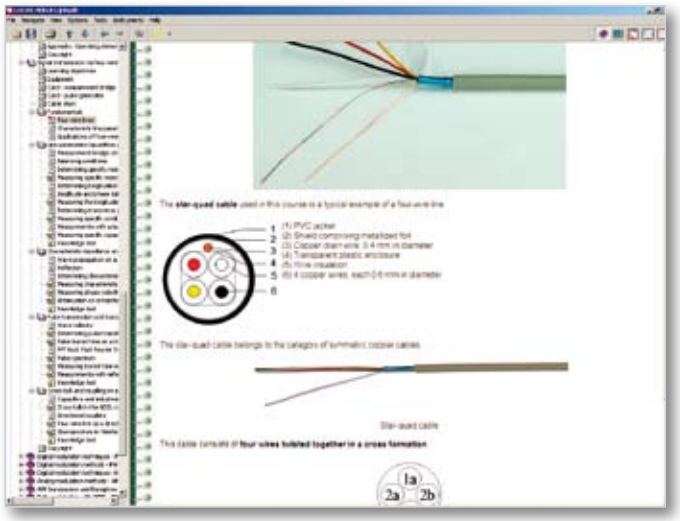
Classical two-wire and four-wire lines are still most commonly used for connecting and wiring telecommunications networks. Whether analogue or digital connections are involved, the "last mile" connecting a subscriber to a communications network normally consists of a four-wire cable.

Training contents

- Using a measurement bridge to determine the constants of a 4-wire transmission line
- Measuring the trunk lines' resistances and inductances
- The meaning of crosstalk
- Measuring the trunk lines' capacitances
- Measuring near-end and far-end crosstalk on a line
- Measuring characteristic impedance and propagation constant
- Measuring pulse transit time on wire pairs and single wires
- Measuring characteristic impedance in the audio / ISDN / ADSL frequency ranges

Article no.: SO4204-9F, consisting of

1 x CD with "Four-wire lines" course
1 x Experiment card "Measurement bridges"
1 x Experiment card "Pulse generator"
1 x Cable drum with 2 four-wire lines (100 m and 5 m long) including accessories



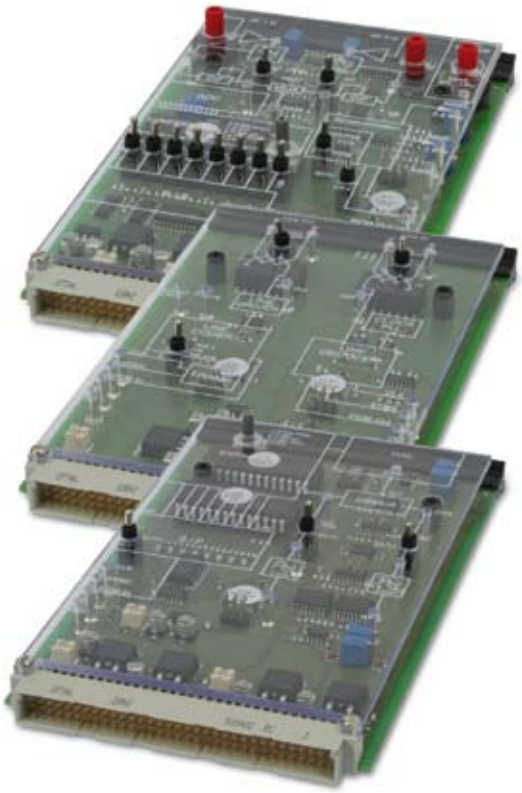
Pulse Modulation Methods

Time Multiplexing
PAM/PCM/Delta Modulation
AMI, HDB3

Transmission of digital instead of analogue data via communication channels proves advantageous in a number of ways. In addition to higher quality and interference immunity, multiplexing of multiple channels has also been a decisive criterion contributing toward the rapid rise of this technology in communication and signals engineering.

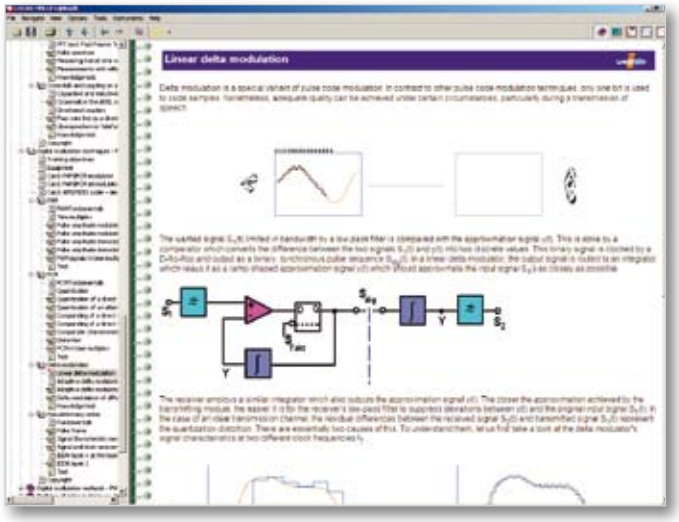
Training contents

- Function of PAM/PCM/delta modulation, PAM/PCM/Delta demodulation and time-multiplexing methods
- Shannon sampling theory
- Signal measurement with PAM/PCM/Delta modulated signals
- Optimum filtering, anti-aliasing
- Quantisation of analogue signals and determination of quantisation interval
- Companding methods using A-Law and µ-Law principle and recording of a transfer characteristic
- Line codes: signal measurement for line-coded signals, AMI, HDB3 and modified AMI
- Clock recovery, phase jitter
- ISDN layer 1: investigation of a data frame and the position and function of its bits



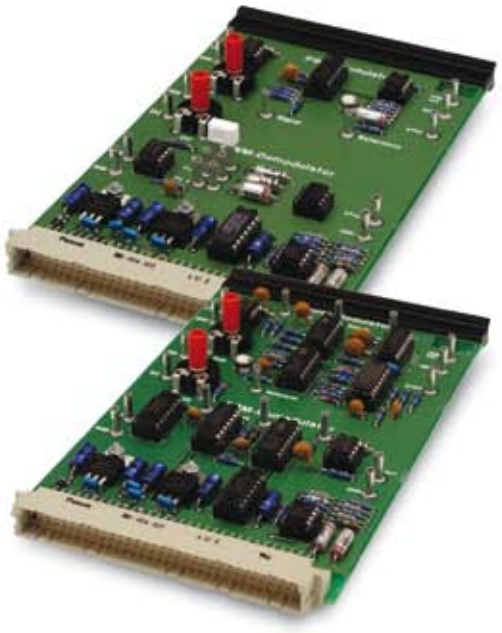
Article no.: SO4204-9J, consisting of

1 x CD with "PAM/PCM/delta modulation" course
1 x Experiment card "PAM/PCM/delta transmitter"
1 x Experiment card "AMI/HDB3 coder/decoder"
1 x Experiment card "PAM/PCM/delta receiver"



Pulse Modulation Method PTM

Pulse-width Modulation
Pulse-phase Modulation



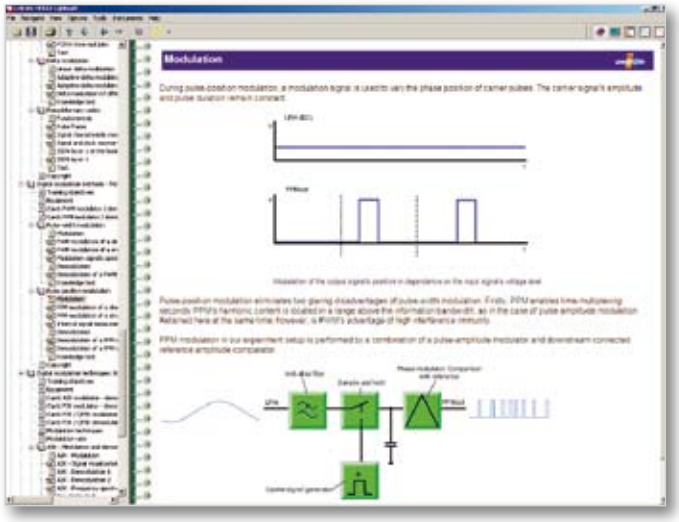
Besides pulse-code modulation, pulse-time modulation also plays a significant role in transmission technology.

Training contents

- Principles of PWM modulation and demodulation
- Recording a signal at the output of a PWM modulator
- Investigation of the output signal of a PWM demodulator, effects of band width on the input signal
- Advantages and disadvantages of PWM
- Introduction to the principle of PPM modulation and demodulation
- Recording the output signal of a PPM modulator
- Measurement of signals inside a demodulator
- Advantages and disadvantages of PWM

Article no.: SO4204-9K, consisting of

1 x CD with "Pulse-time modulation" course
1 x Experiment card "PWM modulator/demodulator"
1 x Experiment card "PPM modulator/demodulator"



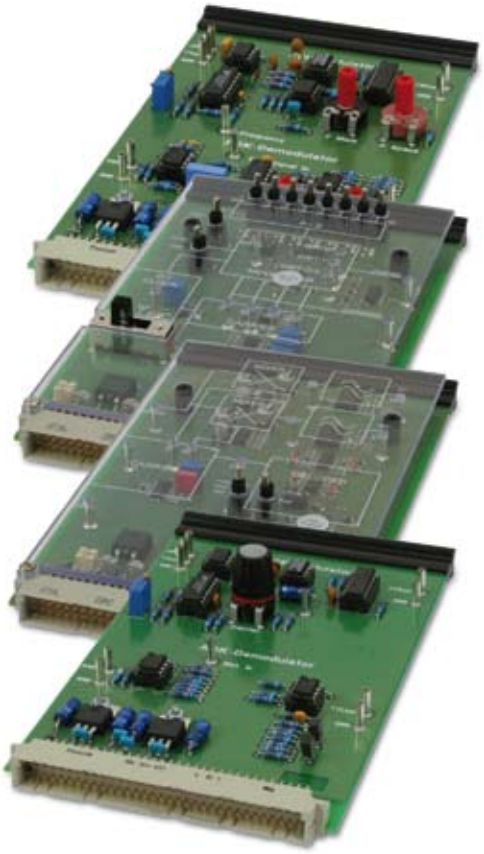
Modem Methods ASK, FSK, PSK

Amplitude Shift Keying
Frequency Shift Keying
Phase Shift Keying

If analogue channels are used to transmit digital data, the sinusoidal carrier's parameters are usually shift keyed. This transmission technique is used not only for cable modems and fax machines on a widespread basis, but also as part of modern wireless radio applications.

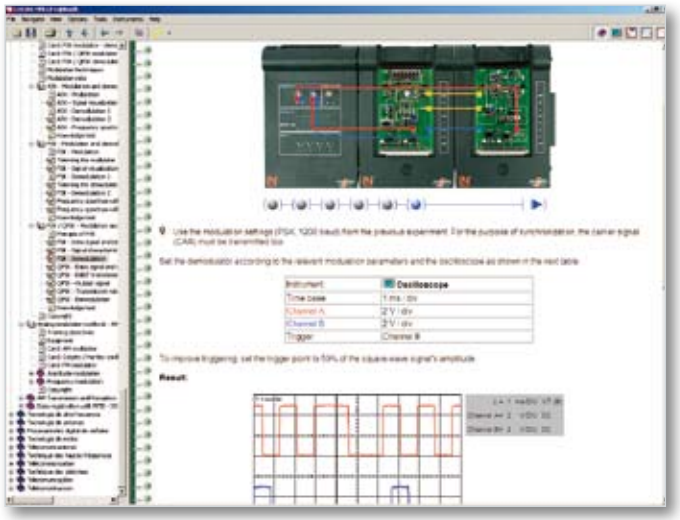
Training contents

- Principle of ASK/FSK modulation for transmitting digital signals over analogue lines
- Spectrum of an ASK modulated signal
- Link between data rate and required band width
- Investigation measuring the spectrum of an FSK modulated signal
- Demodulation of FSK signals using a PLL loop
- Principle of PSK (DPSK) modulation, generating a 2 PSK signal at various baud rates
- Principle of QPSK and DQPSK modulation
- Generation of dibits and the relationship between data rate and baud rate
- Signal measurement at the output of modulators and demodulators (ASK, FSK, (Q)PSK)



Article no.: SO4204-9L, consisting of

1 x CD with "ASK/FSK/PSK modem methods" course
1 x Experiment card "ASK modulator/demodulator"
1 x Experiment card "FSK modulator/demodulator"
1 x Experiment card "(Q)PSK modulator"
1 x Experiment card "Q)PSK demodulator"



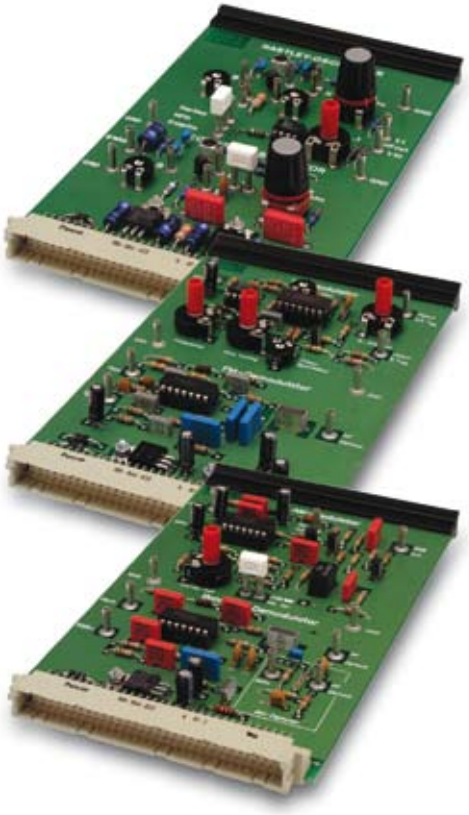
AM / FM Modulation / Demodulation

Amplitude Modulation
Double Sideband Modulation (DSB)
Single Sideband Modulation (SSB)
Frequency Modulation

AM and FM modulation are still by far the most common types of modulation for radio transmission of audio signals due to their continued use by radio broadcasters.

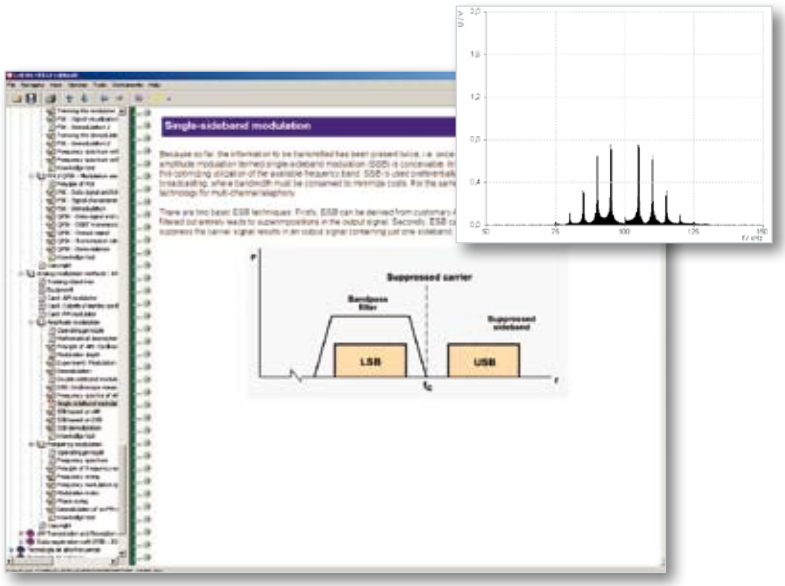
Training contents

- Illustration of the principle of amplitude modulation
- Recording of a modulation trapezium for varying degrees of modulation
- Demodulation of a signals diode detector
- Single sideband (SSB) and double sideband (DSB) modulation
- Signal recovery using an integrated dual push-pull (SSB) mixer
- Illustration of the principle of frequency modulation and demodulation
- Momentary frequency, frequency deviation and modulation index of a modulated signal
- Effect of AF amplitude and frequency
- Recovery of modulated signal with a phase demodulator



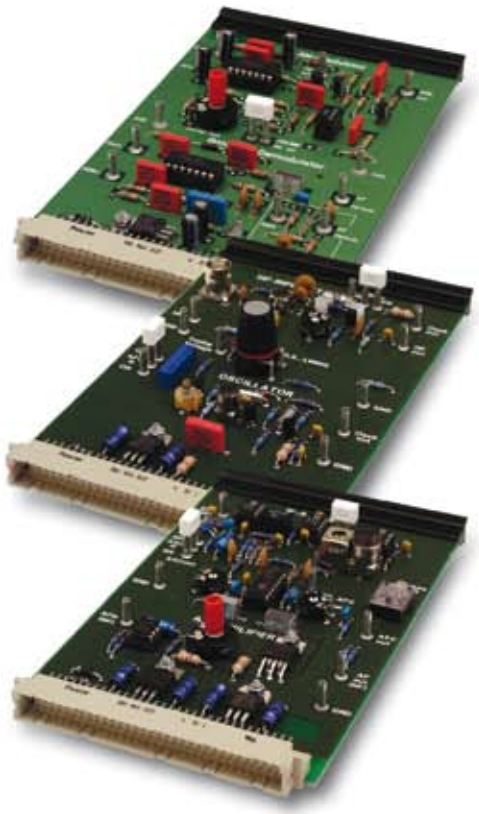
Article no.: SO4204-9M, consisting of

1 x CD with "Amplitude/frequency modulation" course
1 x Experiment card "AM modulator/demodulator"
1 x Experiment card "FM modulator/demodulator"
1 x Experiment card "Hartley/Colpitts oscillators"



AM Transmission and Receiving

Oscillators
Transmitters and Degree of Modulation
Superhet Receivers



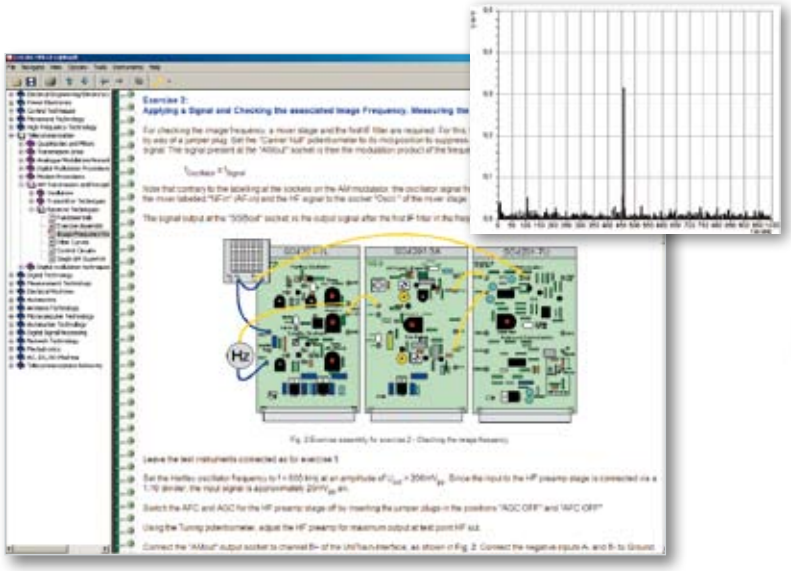
Radio transmitters and receivers continue to play a leading role in communications technology, whether as part of conventional broadcasting systems or modern, mobile data communication networks.

Training contents

- Design and function of high-frequency oscillators: Hartley and Colpitts oscillators
- Investigation of oscillation conditions (self-excitation)
- Design of an AM transmitter and receiver
- Tuned receivers and superhet receivers
- Automatic gain control (AGC) and automatic frequency control (AFC)
- Investigation of a phase discriminator
- Signal-to-image ratio (far-off selectivity) and adjacent-channel selectivity
- Determination of image frequency for superhet receivers
- Investigation of filter curves of high-frequency input stages and IF amplifiers
- Design of an AM medium-wave single-stage superhet receiver with full-range tuning

Supplementary to SO4204-9M:
Article no.: SO4204-9N, consisting of

1 x CD with "AM transmission and receiving technology" course
1 x Experiment card "AM modulator/demodulator"
1 x Experiment card "AM input stage"
1 x Experiment card "IF amplifier"



Data Acquisition Using RFID

RFID Standards
Transponders
Data Transmission

Though still a relatively young technology, RFID permitting contactless detection of objects has found a number of applications in everyday life. RFID systems are used, for instance, for access control, electronic article surveillance at department stores, and monitoring flows of goods in the logistics sector.

Training contents

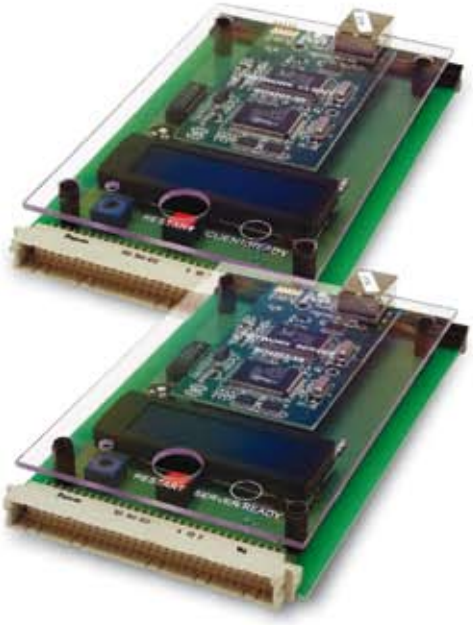
- Design and function of RFID systems
- Characteristics and ranges of various RFID systems
- Various transponder designs
- Techniques of energy transfer and data transmission
- Analysis of data coding and transmission
- Measurement-aided investigation of RFID messages in accordance with ISO15693
- Writing and reading transponder data
- RFID protocol analysis: Standard commands, flags and anti-collision procedures

Article no.: SO4204-9S, consisting of

1 x CD with "Data acquisition with RFID" course
1 x Experiment card "RFID reader"
1 x Experiment card "RFID antenna"
1 x Experiment card "Measurement transponder"
1 x "Transponder" set

Network Technology TCP/IP

Ethernet
Network Structures
Protocols
Addressing



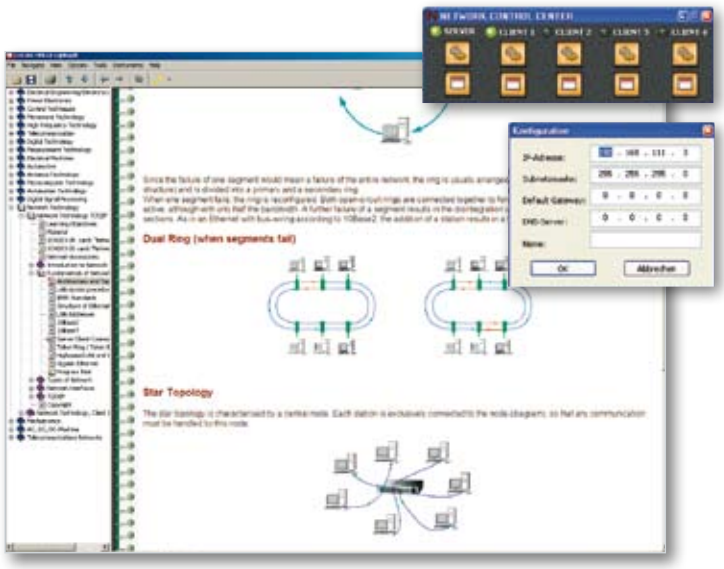
The success of the internet has given the transmission protocols associated with it a vital importance in modern network technology. Computer networks everywhere would be useless without them.

Training contents

- Network standards and differences between LAN, MAN, WAN and GAN configurations, OSI layer model
- Network interfaces and their role
- Network structures: Ethernet, token ring, token bus
- Design and components of an Ethernet network
- Principle of addressing (MAC address) in a local network
- Design and testing of computer networks with client-server or peer-to-peer structures
- Introduction to the internet family of protocols TCP/IP
- Addressing in IP, changing the network address of a computer
- Establishment of a sub-net using a sub-net mask
- Capability for integration of multiple courses or incorporation in an existing LAN

Article no.: SO4204-9Q, consisting of

1 x CD with "TCP/IP networks" course
1 x Experiment card "Network Client"
1 x Experiment card "Network Server"
1 x Network "Switch"
2 x Cat5 connector cables "Standard"
1 x Cat5 connector cable "Cross over"



Network Technology Client Integration

Network Connections
Configuration
Network Services

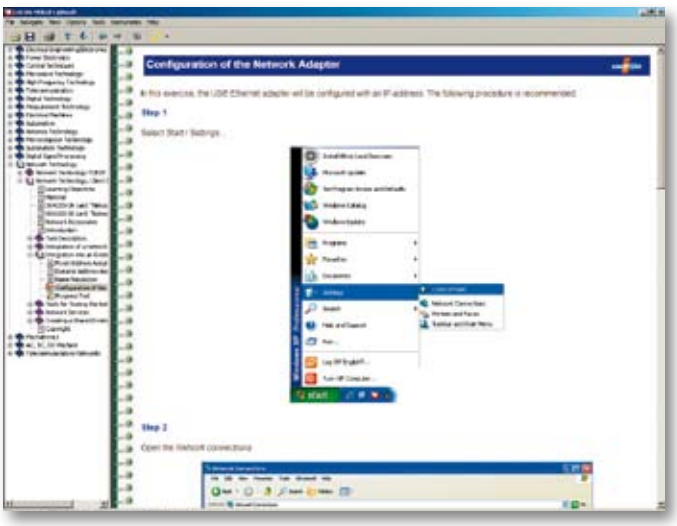
Virtually all computers are connected to a network of some kind nowadays. Connecting up a new computer therefore always involves its integration into a network and the configuration of ports and services.

Training contents

- Integration of a network adaptor into a PC
- Cables and cable connections
- Layer 1 and Manchester encoding
- Configuration of a network adapter (hardware) in the Windows XP operating system
- Configuration of a network port and the corresponding drivers
- Integration into an existing network
- Use of tools to check functionality
- DHCP
- Name resolution in Windows networks (host file, lmhost file, WINS)
- Using services (http, ftp)
- Creating shares

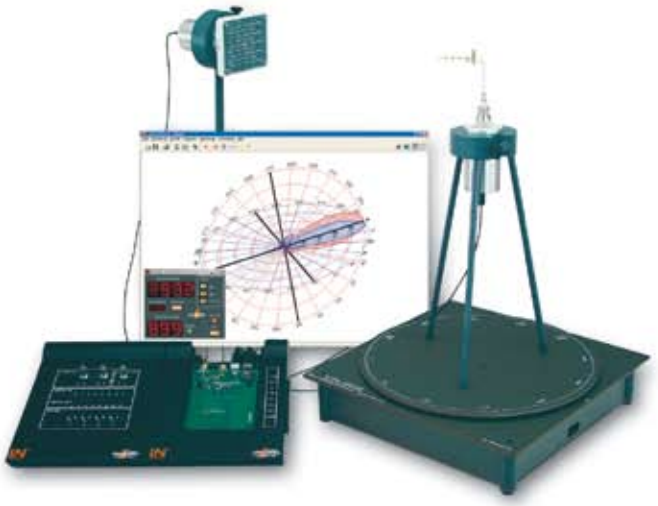
Supplementary to SO4204-9Q:
Article no.: SO4204-9R, consisting of

1 x CD with "Client Integration" course
1 x USB 2.0 Ethernet adapter
1 x Cat5 connector cable



Fundamentals of Antenna Technology

Radio Transmission
Wavelengths
Polarisation
Polar Diagrams



The modern world would be inconceivable without radio transmission and that means antennae. Broadcast radio, mobile telephony, satellite navigation and radar are just a few of the examples of these technlogies.

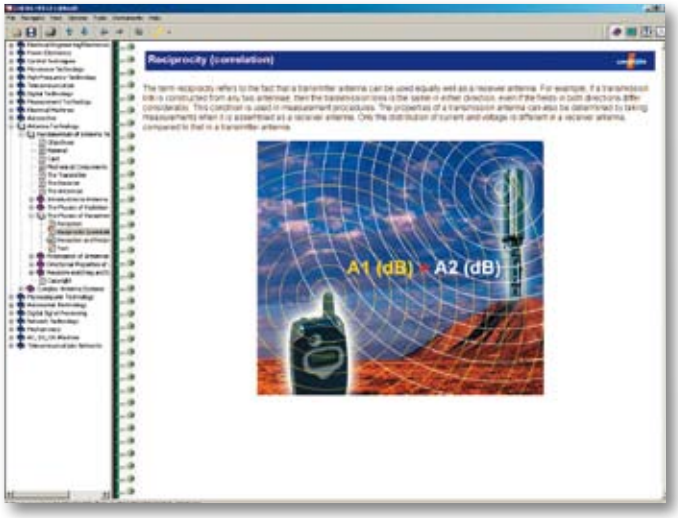
Training contents

- Antenna designs and examples.
- Physics of antennae for broadcast and reception
- Impedance and matching of antennae
- Symmetry (Balun)
- Broadcast characteristics for near-field and far-field regions
- The formation of a polar diagram
- Measurement of polar diagrams of various types of antenna
- Investigation
  - Monopole and dipole antennae
  - Yagi antennae
  - Helical antennae
  - Patch and microstrip antennae

In order to enable work to be undertaken simultaneously at multiple places in a room, three different frequency variants ranging from 8.5 GHz to 9.5 GHz are available.

Article no.: SO4204-9W, consisting of

1 x CD with "Basics of antenna technology" course
1 x X-band LNC (receiver)
1 x X-band antenna interface (selective)
1 x X-band DRO (transmitter)
1 x Stepper-motor controlled turntable
1 x Monopole
1 x Half-wave dipole
1 x Full-wave dipole
1 x Folded dipole
2 x Yagi antennae (3 elements, 6 elements)
2 x Helical antennae (right, left)
3 x Patch antennae (linear, right, left)
1 x Microstrip antenna
1 x Set of installation tools and leads



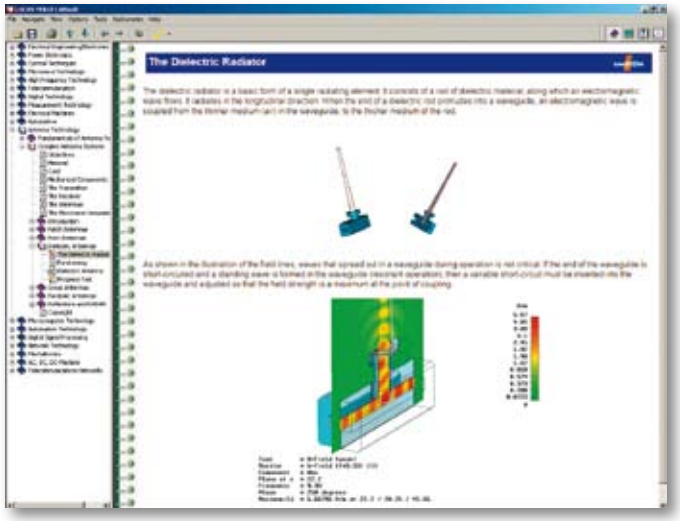
Complex Antenna Systems

Patch Antennae
Horn Antennae
Slot Antennae
Microstrip Antennae
Parabolic Antennae

Antennae are needed for the transmission and reception of radio signals. Every application has its own antennae matched to the relevant frequency ranges, the signals to be transmitted and the security of the transmission.

Training contents

- Investigation of the function of various antennae
- Formation of a polar diagram
- Measuring polar diagrams for various antennae
- Far-field conditions
- Parabolic reflectors
- Primary radiators
- Array antennae
- Phase relationships for antenna arrays
- Reflections in radio transmission links
- Secondary radiation
- Passive radar transponders, Lüneberg lenses



Supplementary to SO4204-9W:
Article no.: SO4204-9X, consisting of

1 x CD with "Complex antenna systems" course
1 x Experiment card "X-band antenna interface (broadband)"
1 x Microstrip antenna
1 x Slot antenna
1 x Dielectric antenna
1 x Configurable parabolic antenna
3 x Horn antennae (10, 15, 20 dB)
1 x Reflection disc
1 x Lüneberg lens
1 x Terminating resistor
1 x Wave-guide/coaxial adapter
1 x E-H positioner
1 x E-Band
1 x RB100 adapter
1 x Set of installation aids
1 x Aluminium carry case

Introduction to Microwave Technology

Waveguides
Line Quantities
Reflections

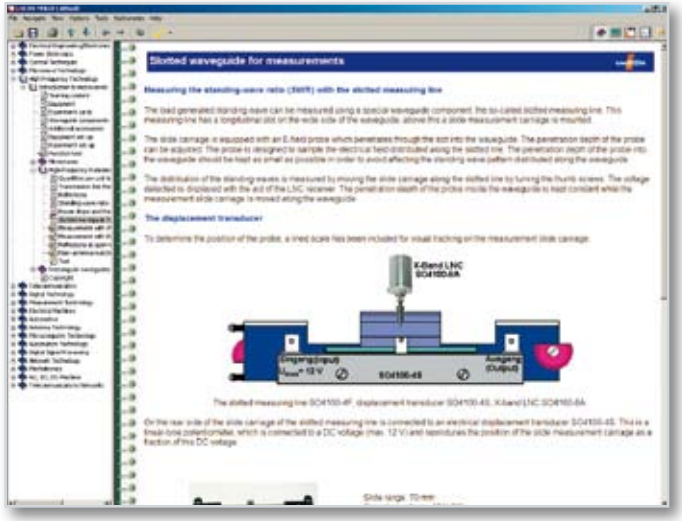
Microwaves have become very important for transmission of signals in radar technology, satellite communications and even mobile telephony. The microwaves themselves are often guided to and from transmitting and receiving antennae by means of so-called waveguides.

Training contents

- Theory of waveguides and line quantities
- Recording of current and voltage characteristics
- Slotted waveguides
- Reflection, standing wave ratios and matching
- Waveguide dimensions and operating frequencies
- Propagation of waves in waveguides
- Short circuit at one end of the waveguide, wavelengths
- Measuring the influence of dielectrics

Article no.: SO4204-9U, consisting of

1 x CD with "Introduction to microwave technology" course
1 x Experiment card "X-band measurement interface + LNC"
1 x Gunn oscillator
1 x Slotted line with displacement and measuring sensors
1 x Isolator
4 x Various waveguide terminators
3 x Dielectrics
1 x Set of installation aids, measuring leads and adapters
1 x Aluminium carry case



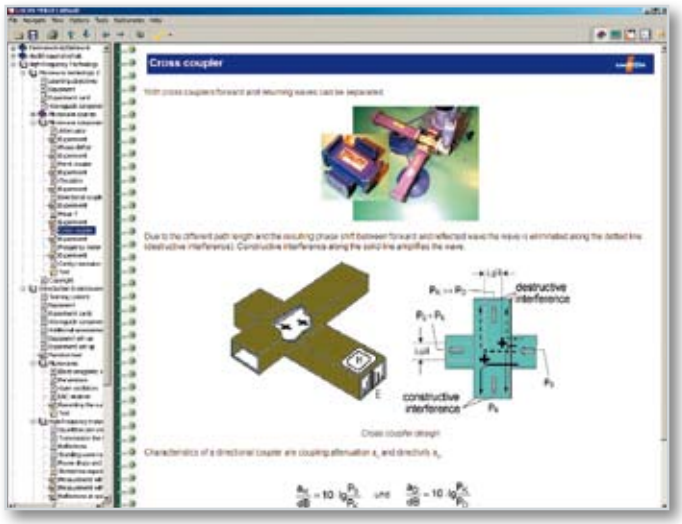
Waveguide Components

Generators
Couplers
Circulators

In order to construct complex microwave circuitry for waveguides, some specialised components are required such as couplers, circulators and branching ports. These enable the necessary functionality to be implemented.

Training contents

- Ultra-high frequency generators: Gunn oscillator, klystron, magnetron
- Characteristics of directional and cross-coupled couplers
- Reflection and attenuation response
- Differentiation of signals using circulators
- Attenuation circuits
- Impedance matching in waveguide systems
- Line branches (ports)



Supplement to SO4204-9U
Article no.: SO4204-9V, consisting of:

1 x CD with "Microwave components" course
2 x Horn antennae
1 x Parallel detector
1 x Directional and cross-coupler
1 x E-plane and H-plane bends
1 x Movable short
1 x Waveguide rotary coupling
1 x Ferrite circulator
1 x Set of adapters and terminators
1 x Set of installation aids

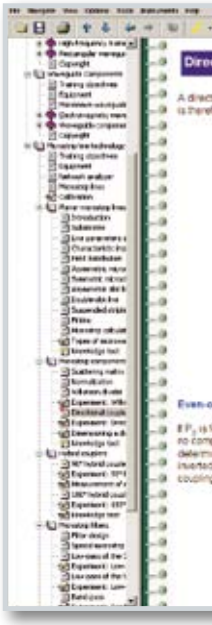
Microstrip Technology

Technology
Filter Circuits
MMIC

Manufacturing of high-frequency circuits based on semiconductors has only been made possible by microstrip technology. These planar waveguides have become established in a variety of applications over the last two decades.

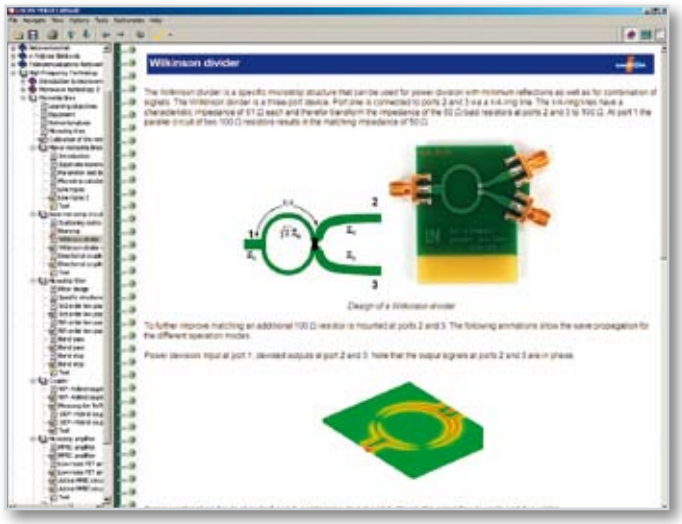
Training contents

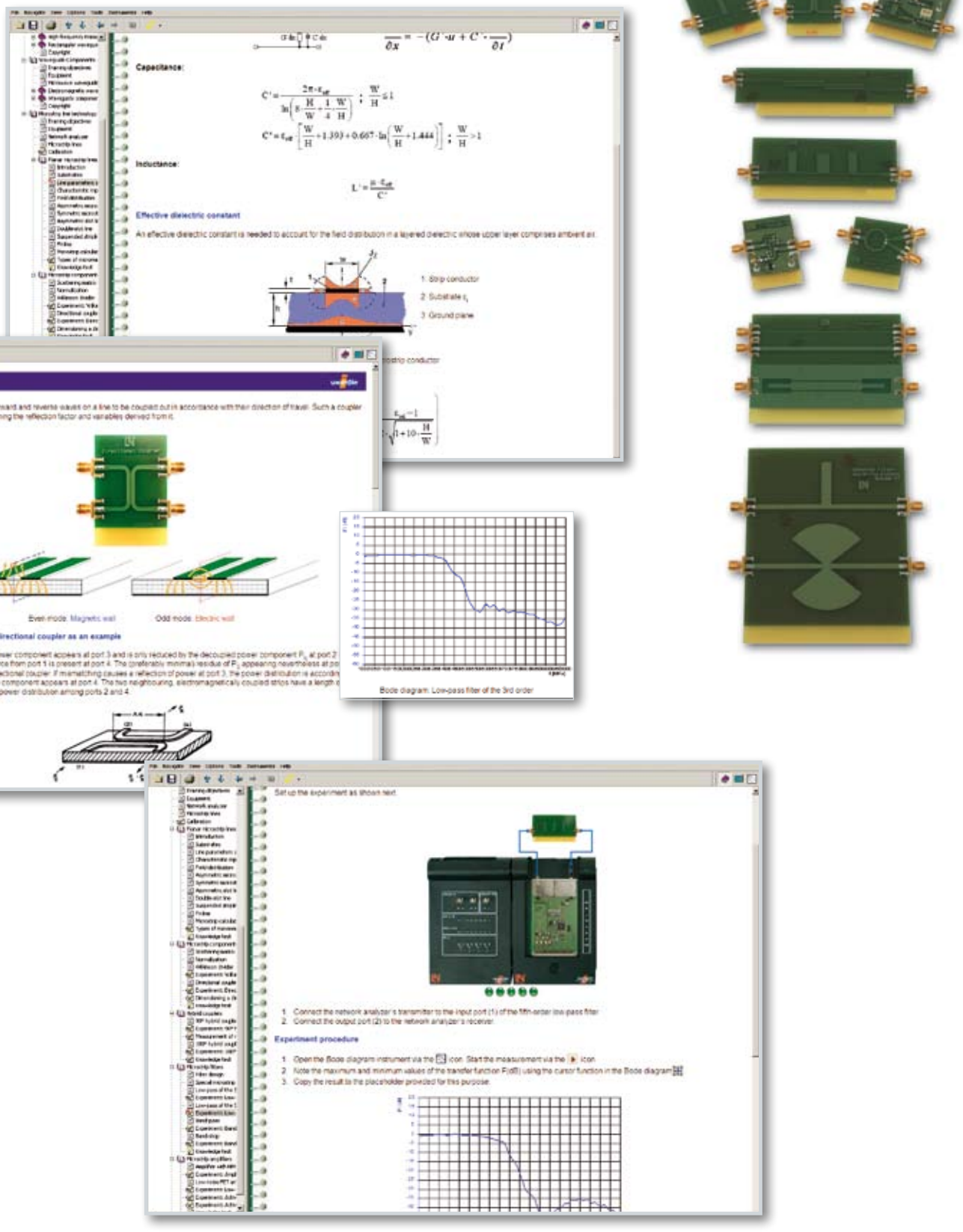
- Design of microstrip lines
- Line theory and wave propagation
- Determining the transmission characteristic: frequency response measurement from 1 up to 2 GHz
- Characterisation by means of scattering parameters
- Design and function of couplers and dividers
- Measurement-based analysis of a Wilkinson divider and hybrid couplers
- Design and function of microstrip line filters
- Analysis of filters and amplifiers
- Amplifiers used in MMIC technology



Article no.: SO4204-9Y, consisting of

1 x CD with "Microstrip lines" course
1 x Experiment card "Network analyser"
1 x Set of microstrip components
2 x SMA cables
1 x SMA connector and terminator




Capacitance:
Inductance:
Effective dielectric constant
1 Strip conductor
2 Substrate
3 Ground plane
ctional coupler
Even mode: Magnetic wall
Odd mode: Electric wall
Bode diagram: Low-pass filter of the 3rd order
Set up the experiment as shown next.
Experiment procedure

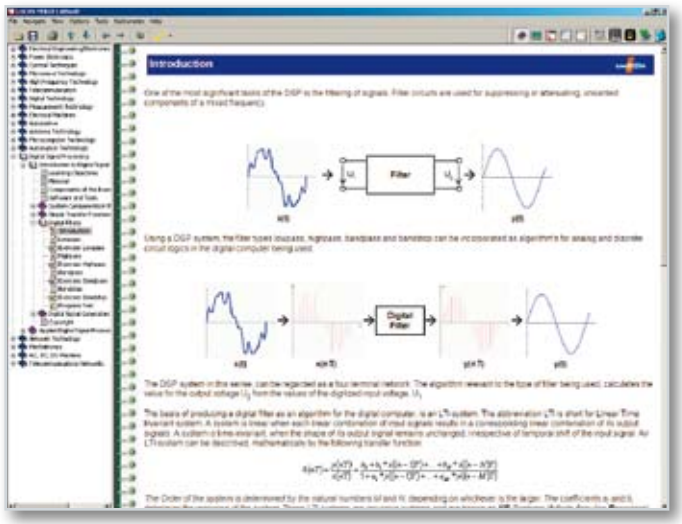
Digital Signal Processing

System Components
LTI Systems
FIR and IIR Filters
Digital Signal Generation

Due to ever more powerful and faster microprocessors the digital processing of audio and video signals has taken on paramount importance. Many applications involve methods of data reduction, filtering, signal generation as well as manipulation.

Training contents

- Design and operation of a DSP system
- Discrete transfer function
- Digital amplifier and digital voltage divider
- LTI systems
- Experiment-based investigation of digital filters
- FIR and IIR filters
- Signal generation with the aid of DSP
- Experiment-based investigation of periodic signals
- Influence of computing algorithms on signal shape



Article no.: SO4204-6P, consisting of

1 x CD with "Introduction to digital signal processing" course
1 x MCLS work platform
1 x DSP module with 32-bit ARM processor
1 x Software tool for DSP module
1 x Keypad module
1 x Serial interface

Fourier Transformation
Signal Synthesis
Filter Computation
Sound Effects

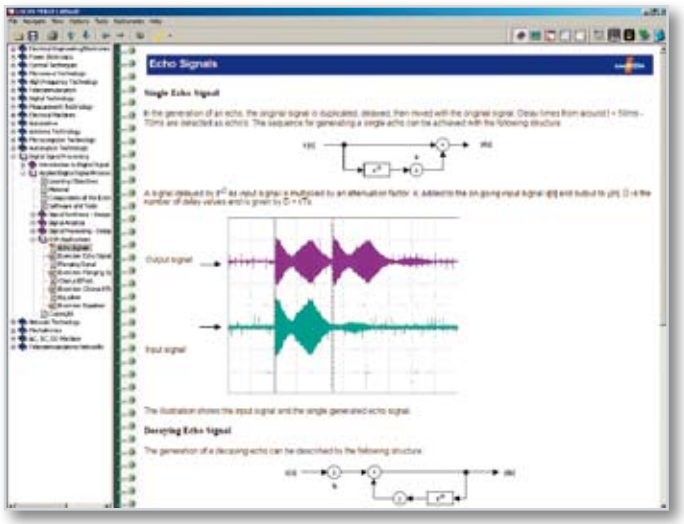
Due to digital signal processing it is now possible to use simple computational algorithms to determine the characteristics of filters and sound or visual effects accurately and precisely. Suitable software tools permit cost-efficient and flexible circuit development.

Training contents

- Synthesis of periodic signals using DSP systems
- Fourier transformation (DFT and FFT)
- Recursive and non-recursive LTI systems
- Methods on the design of digital filters
- Filter design with various characteristics: Butterworth, Tschebyscheff, Cauer
- Filter design: FIR and IIR filters
- Manual and software-assisted design
- Programming sound effects
- Digital equalizer

Supplement to SO4204-6P
Article no.: SO4204-6Q, consisting of

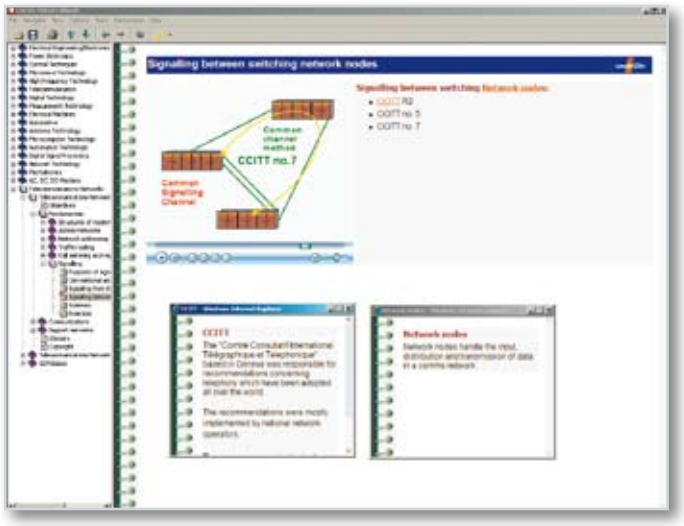
1 x CD with "Applied digital signal processing" course
1 x Stereo cinch cable
1 x Stereo headphones

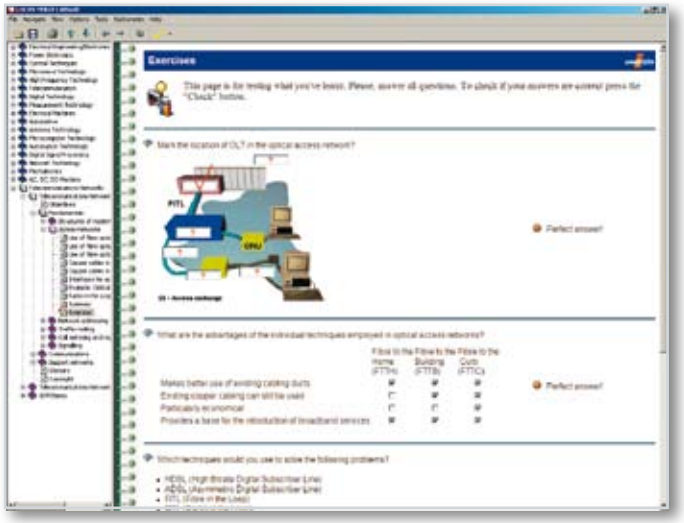


Telecommunication Networks

Network Structures
Addressing
Signalling
Network Management

We cannot even begin to imagine life without globe spanning telecommunications networks. This course provides an overview of the basic facts of modern telecommunications networks.





Training contents

- Structures of Telco networks
- Access networks
- Network addressing
- Traffic routing
- Charge metering and registration
- Signalling
- Transmission networks
- Plesiochronous Digital Hierarchy (PDH)
- Synchronous Digital Hierarchy (SDH)
- Supporting networks
- C7 signalling network
- Intelligent network (IN)
- TMN network management

Special features

- Voice output
- Languages: German, English, Russian

Article no.: SO2700-1A, consisting of

1 x CD with "Telecommunication networks 1" course

PSTN, GSM, ISDN
Broadband Networks
ATM
Network Convergence

Today modern networks are required to transmit voice, data and multimedia services with huge bandwidths. In future this will lead to the convergence of the various public networks (PSTN, PLMN).

Training contents

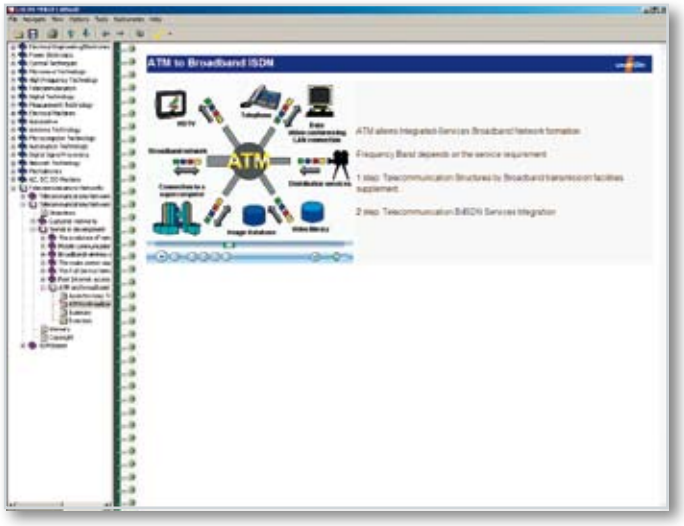
- Public Switched Telephone Network (PSTN)
- Digitalization in local exchange and long-distance trunk network
- Integrated Services Digital Network (ISDN)
- Mobile radio network (GSM)
- Metropolitan Area Network (MAN)
- The evolution of networks
- Broadband wireless access networks
- Mains power system as access network
- Full service network
- Rapid internet access via analogue telephone networks
- ATM and broadband ISDN

Special features

- Voice output
- Languages: German, English, Russian

Article no.: SO2700-1B, consisting of

1 x CD with "Telecommunication networks 2" course



ISDN

Services
Basic Access
Signalling
Terminal Equipment Connection

With the launch of ISDN it was possible to transmit the widest range of services like fax, voice, data or video telephony via a single network connection.

Training contents

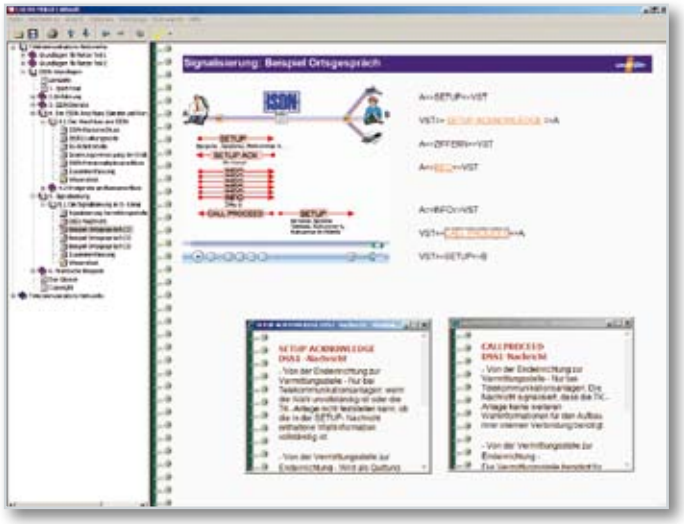
- Development up to ISDN
- ISDN services and service features
- Terminology
- Bearer services
- Teleservices
- ISDN access (equipment and configuration)
- Connection to ISDN
- Terminal equipment connected to basic access
- Signalling
- Signalling in the D-channel
- Practical examples with ISDN applications
- Telephony
- Data transmission
- Video telephony

Special features

- Voice output
- Language: German

Article no: SO2700-1C, consisting of

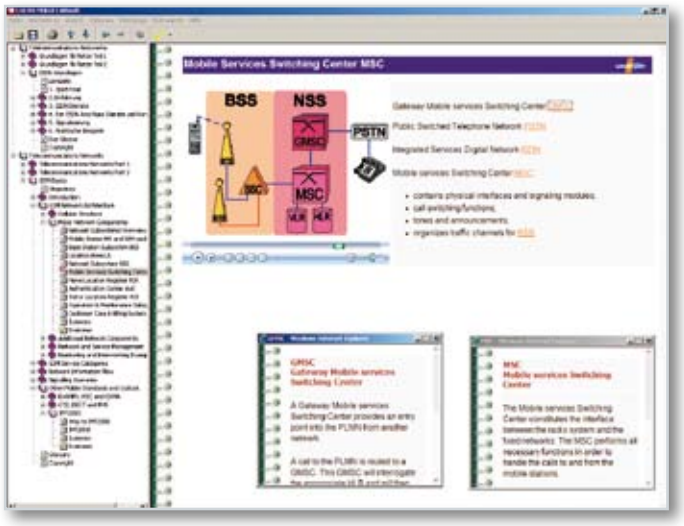
1 x CD with "ISDN" course

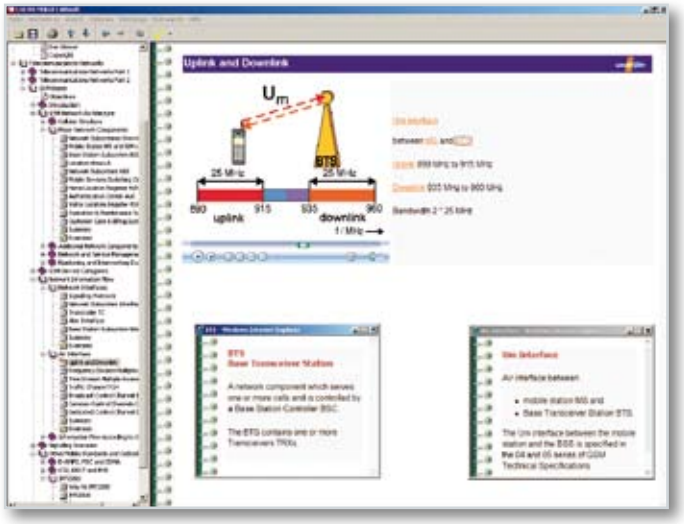


GSM Mobile Radio

Network Architecture
Network Elements
Network Protocols
Call Scenarios

Mobile radio networks make mobile communication possible to virtually anywhere in the world. The most important and most widespread standard is GSM with more than 2 billion users.





Training contents

- GSM specifications
- Service features
- GSM network architecture
- Radio cells
- Master network elements (MSC, BSC, BTS)
- Additional network elements
- Number plan
- GSM service categories
- Network interfaces and their protocols
- Signalling in relation to OSI layers 1-3
- Call scenarios (traffic cases)
  - Location update
  - Authentication and encryption
  - Mobile terminated call
  - Mobile originated call
  - Handover
- Additional mobile radio standards: D-AMPS, PDC and CDMA
- W-CDMA (UMTS)

Special features

- Voice output
- Languages: English, Russian

Article no.: SO2700-1D, consisting of

1 x CD with "GSM" course

Control Technology

Control Loop Elements

Continuous and Discontinuous Controllers

Real Controlled Systems

Closed-loop Control

Determination and Optimisation of Control Parameters

Fuzzy Control

UniTrain-I system

- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

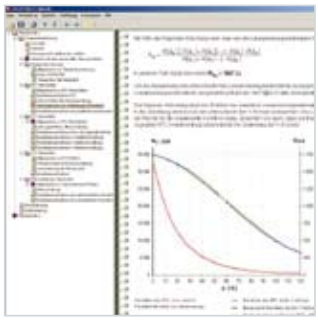
- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msamples/s
- 9 measuring ranges 100 mV - 50 V
- 22 time ranges 1 µs - 10 s
- 16 digital input/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Accommodates experiment cards
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards, LabSoft training and experiment software

Integrated measuring equipment and power supplies

- Multimeter, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- Step response and time diagram
- Bode plotter
- ... and many other instruments



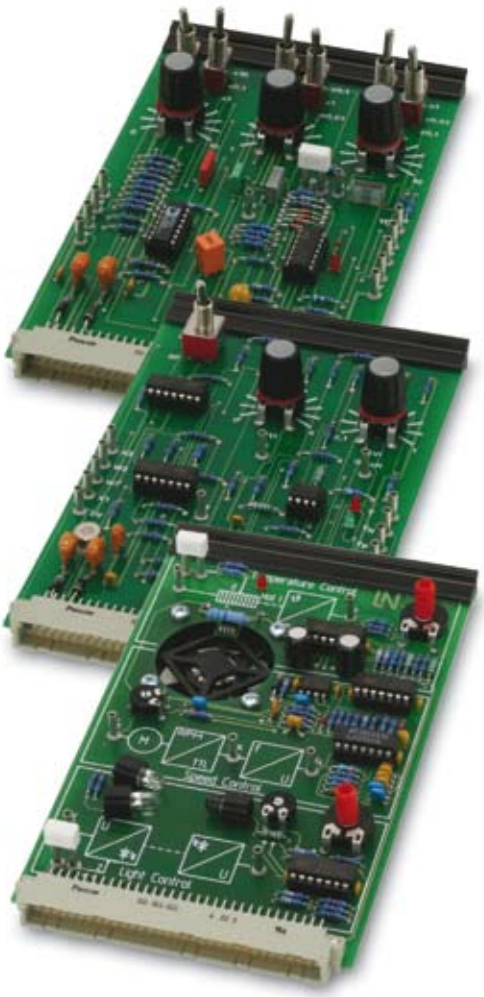
LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of experiment results
- Tests

PID

Practical Introduction to Closed-loop Control

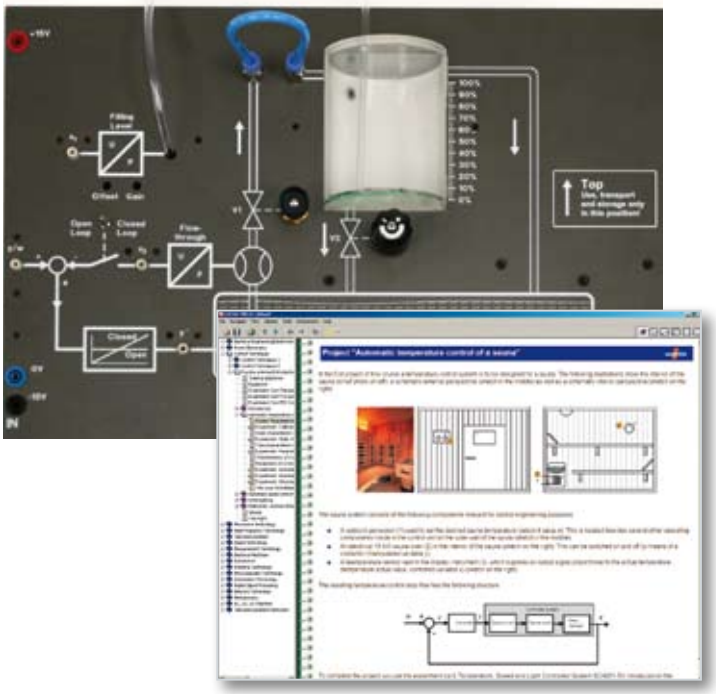
Temperature Control
Speed Control
Lighting Control
Flow Control



In our automated age, control technology has taken on a major importance in modern technical systems.

Training contents

- Effective principles of open- and closed-loop control
- Design and function of continuous and discontinuous controllers
- Practical investigation of control loops with continuous controllers
- Temperature control for a sauna using a two-position controller
- Design and optimisation of a speed controller using continuous control
- Reference and disturbance variables in a lighting control loop
- Flow control using a 2-position controller and a PI-controller (requiring optional controlled system model "Filling level" SO3620-1H)



Article no.: SO4204-8E, consisting of

1 x CD with "Practical introduction to closed-loop control" course
1 x Experiment card "2-position/3-position controllers"
1 x Experiment card "PID controller"
1 x Experiment card "Temperature, speed and lighting control"

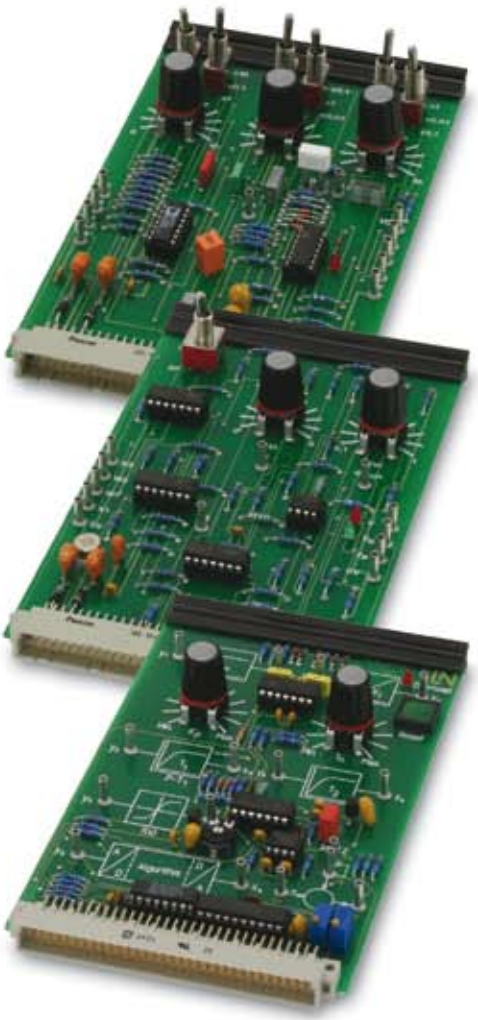
Analysis of Control Loops

Control Loop Elements
Continuous Controllers
Discontinuous Controllers
Closed-loop Control Circuits

The "Components and control loops" course carefully illustrates the principles of automatic control technology.

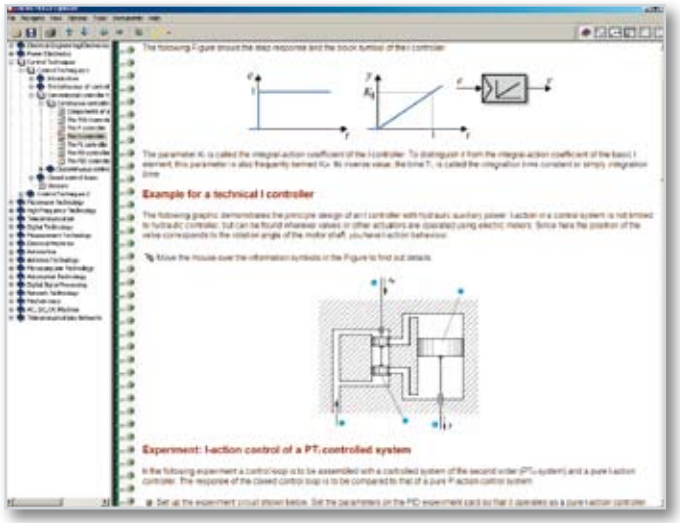
Training contents

- Using step-response diagrams to determine response and characteristics of various control elements, e.g.:
  - P-action elements
  - I-action elements
  - 2 PT1 elements
  - Non-linearity
  - Arithmetic control elements
- Determining the appropriate controller types
- Optimisation of closed control loops
- Analysis of control loops and systems using Bode plots
- Static and dynamic response of control loop elements and closed loops



Article no.: SO4204-8F, consisting of

1 x CD with "Analysis of control loops" course
1 x Experiment card "2-position/3-position controllers"
1 x Experiment card "PID controller"
1 x Experiment card "Controlled system emulation"



Controller Design & Optimisation

Real Controlled Systems
Optimisation Guidelines
Control Optimisation
Stability Analysis

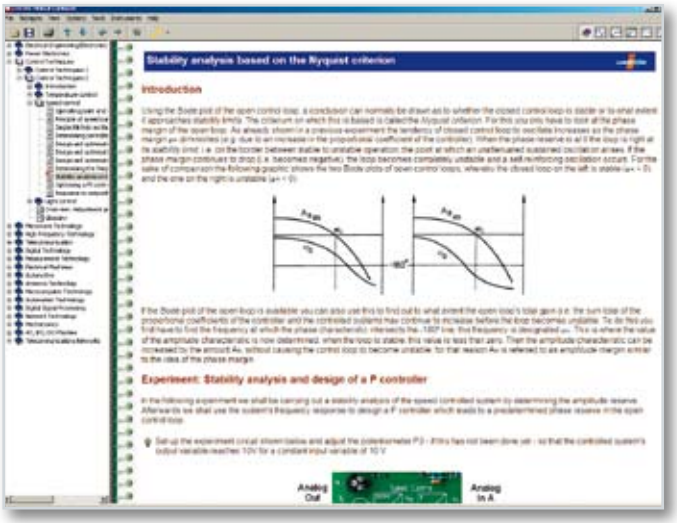
This set supplements the course "Analysis of control loops" with genuine controlled systems that illustrate more advanced aspects of automatic control technology.

Training contents

- Determining key parameters of a genuine controlled system:
  - Temperature control
  - Speed control
  - Lighting control
- Observation of systems using continuous and discontinuous controllers in a closed control loop
- Investigation of reference and disturbance response
- Design and optimisation in time and frequency domains
- Assessment of control quality and stability analysis in the frequency domain by obtaining a Bode plot or locus diagram

Supplement to SO4204-8F
Article no.: SO4204-8G, consisting of

1 x CD with "Controller Design & Optimisation" course
1 x Experiment card "Temperature, speed and light control systems"



Numeric and Fuzzy Control

Digital Control
Software Simulation
Integration into Real Control Structures

In order to control complex systems with multiple and non-linear variables, fuzzy controllers are used. Such fuzzy systems can also be integrated into the UniTrain-I system with the aid of a supplementary package.

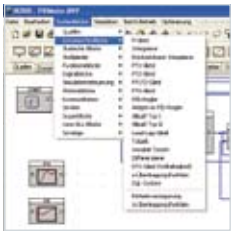
Training contents

- Analysis, synthesis and simulation of conventional control systems
- Implementation of fuzzy systems
- Real-time measurement using actual systems

Article no.: SO6001-5Q, consisting of

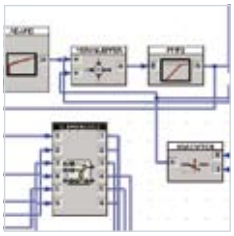
1 x CD with "WinFACT" software

Block-oriented simulation system



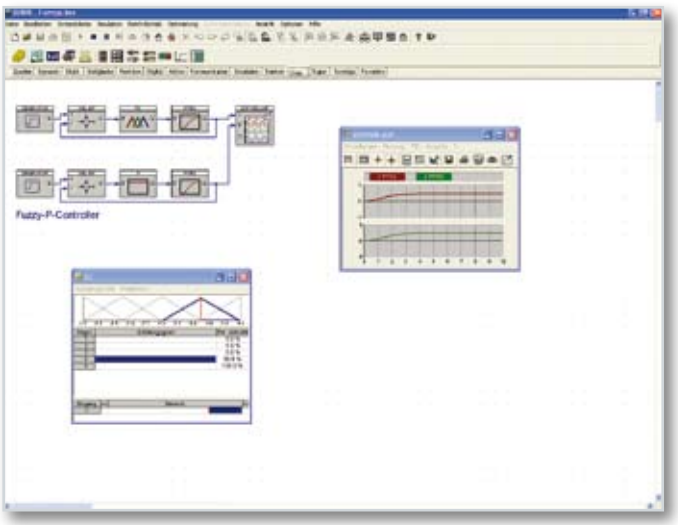
Extensive library for assembling control structures

- Signal generators
- Linear and non-linear transfer elements
- Time-discrete systems, digital technology
- Virtual instruments

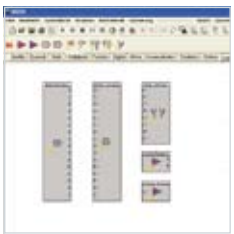


Combination of sub-systems into reusable modules

Graphics module for displaying measured data



Design of fuzzy systems



Real-time measurement using actual hardware

Instrumentation

Voltage
Current
Power
Resistance
Inductance
Capacitance
Power factor
Work
Frequency

Temperature
Pressure
Force
Torque
Displacement
Angle
Speed

UniTrain-I system

- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

- Oscilloscope with 2 analogue differential inputs
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- 9 measuring ranges 100 mV - 50 V
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- Function generator for frequencies up to 1 MHz
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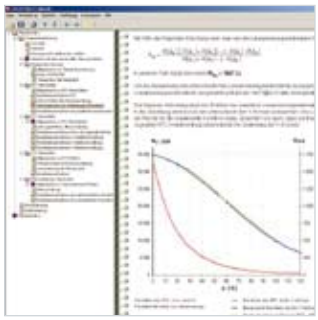
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards

Integrated measuring equipment and power supplies

- Multimeter, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- Three-way AC/DC power supply
- Three-phase power supply
- ... and many other instruments



LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of experiment results
- Tests

Measuring Electrical Variables

Current/Voltage
Power
Work
Frequency

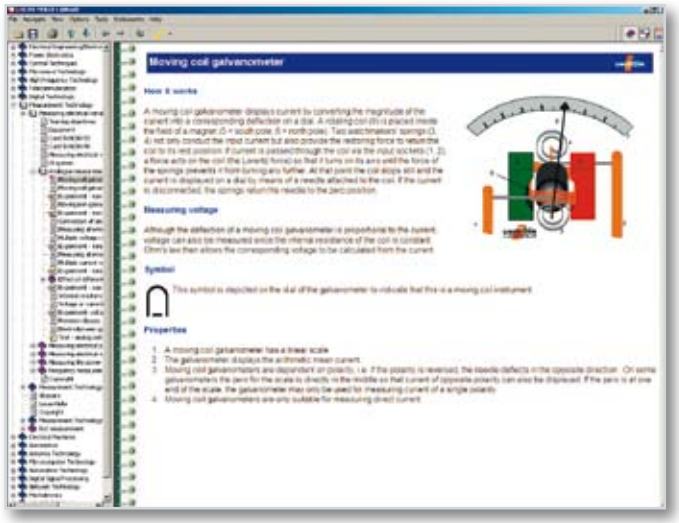
Electrical instrumentation is introduced by way of moving-coil and moving-iron galvanometers. These are used to measure voltage and current, to illustrate the effect of signal waveforms on results and to demonstrate how various measuring ranges can be covered simply by the addition of supplementary resistors.

Training contentss

- What is involved in measuring power?
- Explanation of measuring principles using a DC circuit
- Simple experiments to illustrate differences between active, reactive and apparent power measurement
- Explanation and measurement of power factor
- Measurement of power consumption and electrical work using a Ferraris counter

Article no.: SO4204-8A, consisting of

1 x CD with "Measuring electrical variables" course
1 x Experiment card "Voltage and current measurement"
1 x Experiment card "Power, cos ϕ and frequency measurement"



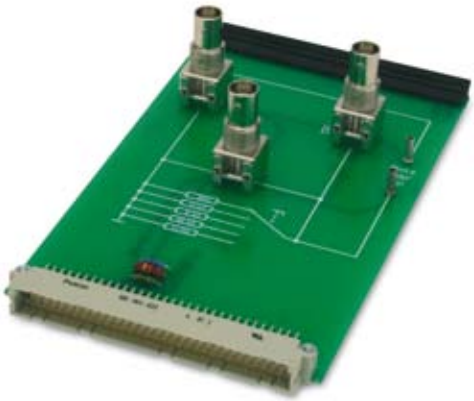
RLC Measurement

Resistance
Inductance
Capacitance

Bridges and impedance measuring methods have been used for many years in order to determine parameters of passive components such as resistors, capacitors and inductors.

Training contents

- RLC measurements using adjustable versions of the following:
  - Wheatstone bridge
  - Maxwell-Wien bridge
  - Wien bridge
- Explanation of measuring principles
- Measurement using an RLC meter
- Comparison of results



Article no.: SO4204-8D, consisting of

1 x CD with "RLC Measurement" course
1 x Experiment card "Measuring R, L, and C with bridges"
1 x Experiment card "Measuring R, L, and C using impedance techniques"
3 x Measurement leads BNC-BNC

Measuring Non-electrical Variables

Temperature

Pressure

Force

Torque

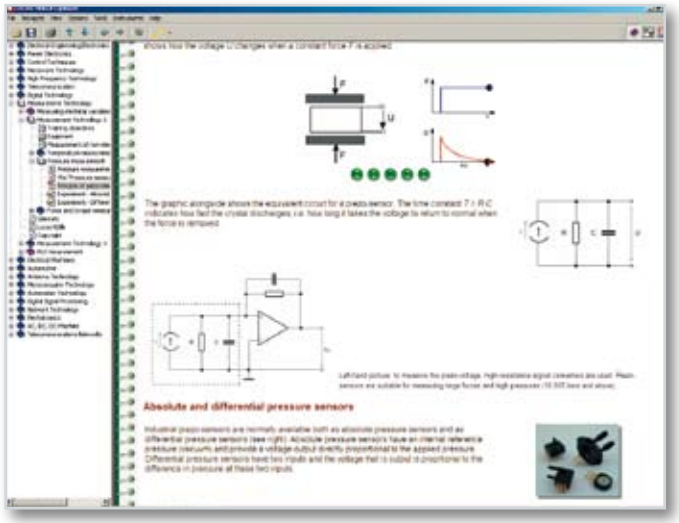
In modern industrial practice it is becoming increasingly essential to monitor, display or electronically process physical variables. This means that even non-electrical variables need to be converted into electrically meaningful variables using appropriate equipment.

Training contents

- Explanation of how measuring circuitry can affect a circuit
- Characteristics of various temperature sensors: NTC, Pt 100, KTY, thermocouples
- Pressure measurement: piezo-electric, inductive and resistive pressure sensors
- Principle for measurement of force by means of strain gauges, bending bars or torsion rod
- Recording of characteristics for various sensors
- Methods for linearising non-linear characteristics
- Possible sources of error

Article no.: SO4204-8B, consisting of

1 x CD with "Measuring non-electrical variables: temperature, pressure, force, torque" course
1 x Experiment card "Temperature measurement"
1 x Experiment card "Pressure measurement"
1 x Experiment card "Force and torque measurement"
1 x Experiment card "Measuring amplifier"
1 x Set of weights
1 x Pressure generator and gauge



Displacement
Angle
Speed

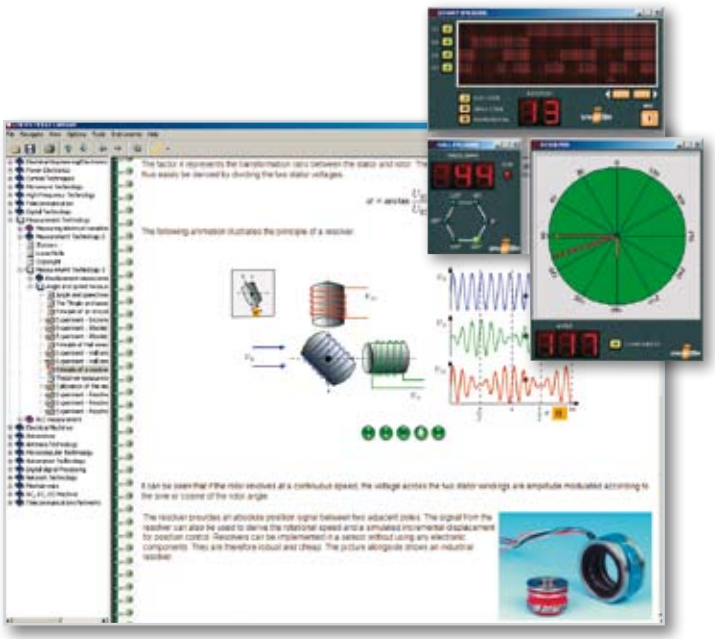
In mechatronics or drive applications in manufacturing, accurate measurement of displacement, angle and speed can be decisive in terms of dynamics, economy and quality.

Training contents

- Analogue and digital methods for measuring displacement, angle and speed
- Selection of required sensors, their operation and characteristics
- Experimental recording of characteristics
- Calibration of measuring circuits
- Experiments with inductive and capacitive sensors
- Use of optical sensors and Hall sensors for measuring position of rotating shafts
- Using incremental methods, BCD and Gray-code encoders for measuring displacement
- Investigation of a rotating shaft using a resolver

Article no.: SO4204-8C, consisting of

1 x CD with "Measuring non-electrical variables: displacement, angle, speed" course
1 x Experiment card "Inductive displacement sensor"
1 x Experiment card "Capacitive displacement sensor"
1 x Experiment card "Angle and speed measurement"
1 x Experiment card "Resolver measuring amplifier"
3 x Code discs



Digital Technology

Gates and Flip-flops

Sequential Circuits

Application Circuits

Converter Circuits

UniTrain-I system

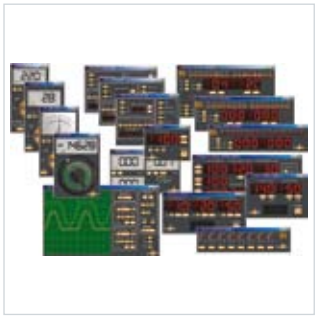
- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msamples/s
- 9 measuring ranges 100 mV - 50 V
- 22 time ranges 1 µs - 10 s
- 16 digital inputs/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I ixperimenter

- Accommodates experiment cards
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards



Integrated measuring equipment and power supplies

- Multimeters, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- 32-bit logic analyser
- Digital I/Os
- ... and many other instruments

LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of experiment results
- Tests

Gates and Flip-flops

Boolean Algebra
Logical Gates
Flip-flops

Computers and other digital devices have become an indispensable aspect of day-to-day life. Digital systems are now found wherever there is a need for data to be processed, transferred or stored, such as in the areas of communication, audio/video, measurement, automation and automotive technology.

Training contents

- Basic logic circuits
- Truth tables, symbols and timing diagrams
- Experimental demonstration of Boolean functions and laws
- Construction of basic logic circuits using NAND gates or NOR gates
- Minimisation of logic circuits using Karnaugh maps
- How flip-flops work
- JK flip-flops: static and dynamic input signals, single-clock mode
- Investigation of a counter circuit
- Fault simulation

Article no.: SO4204-6A, consisting of

1 x CD with "Gates and flip-flops" course
1 x Experiment card "Basic digital circuits"
1 x Experiment card "JK flip-flops"

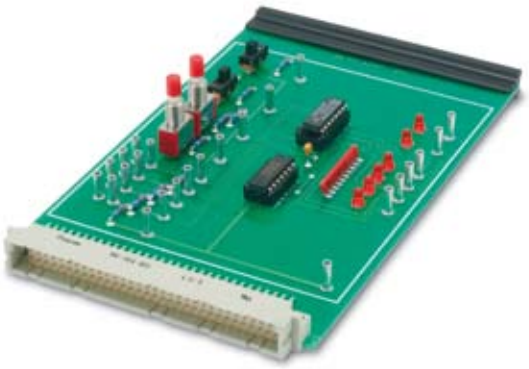
Sequential Circuits

Flip-flops
Counters
Dividers
Registers

Sequential circuits play a crucial role in computer engineering. Flip-flops and their products such as counters, registers and dividers constitute the elementary building blocks of any micro-processor.

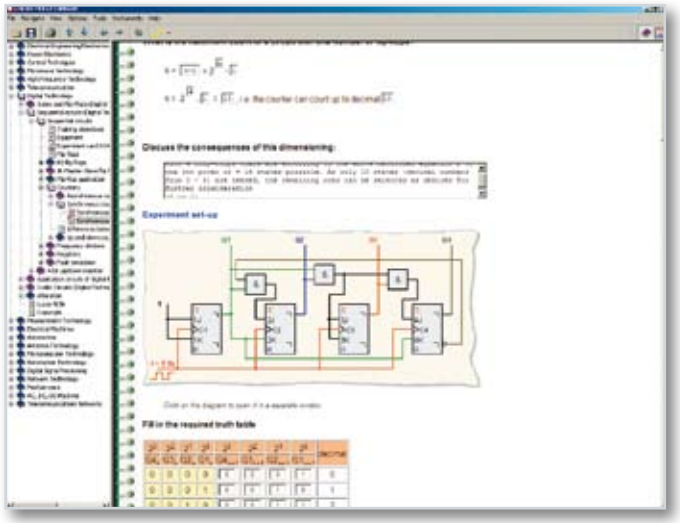
Training contents

- Design and function of flip-flops and registers
- Design, construction and testing of counters and dividers
- Design, assembly and testing of shift registers with serial or parallel output
- Measurements involving synchronous and asynchronous counters
- Design an investigation of binary-coded up and down counters
- Investigation of how debounced buttons and switches work
- Fault simulation



Article no.: SO4204-6C, consisting of

1 x CD with "Sequential circuits" course
1 x Experiment card "Sequential circuits"
1 x Experiment card "4-bit counter"



Application Circuits

Adders
Multiplexers
Demultiplexers

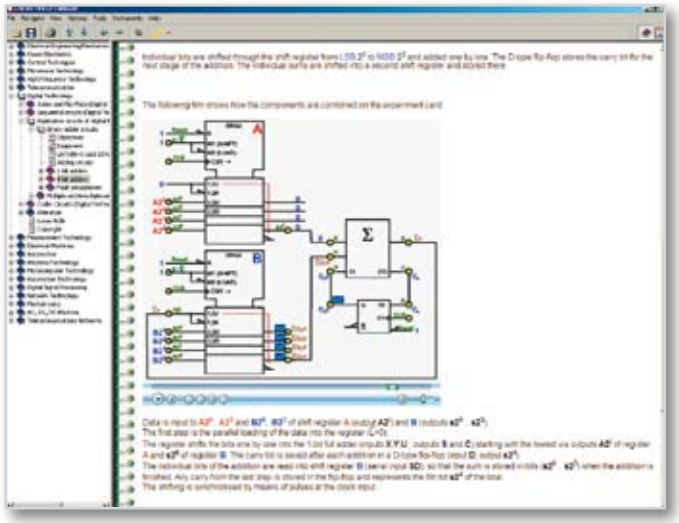
Adders and multiplexing components are also used in computer engineering. Adders form part of a microprocessor's arithmetic logic unit (ALU) while multiplexers and demultiplexers are needed to convert parallel data flows into serial ones.

Training contents

- Design and investigation of single-bit half adders and full adders
- Design and investigation of 4-bit, parallel-output full adders
- Design and investigation of 4-bit, serial-output full adder with shift register
- Design and function of multiplexers and demultiplexers
- Data and address buses
- Measurement-based investigation of multiplexer and demultiplexer circuits
- Fault simulation

Article no.: SO4204-6E, consisting of

1 x CD with "Application circuits" course
1 x Experiment card "Adders"
1 x Experiment card "Multiplexer/demultiplexer"



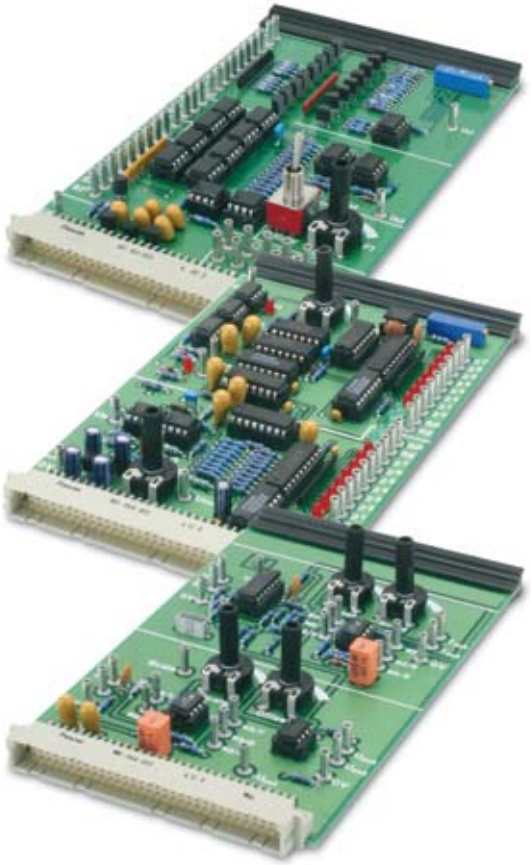
Converter Circuits

A/D – D/A Conversion
f/V – V/f Conversion

A/D and D/A converters act as interfaces between digital data processing devices like computers and their periphery. Used in nearly all areas of electrical engineering, these converters play a correspondingly important role in related training syllabuses.

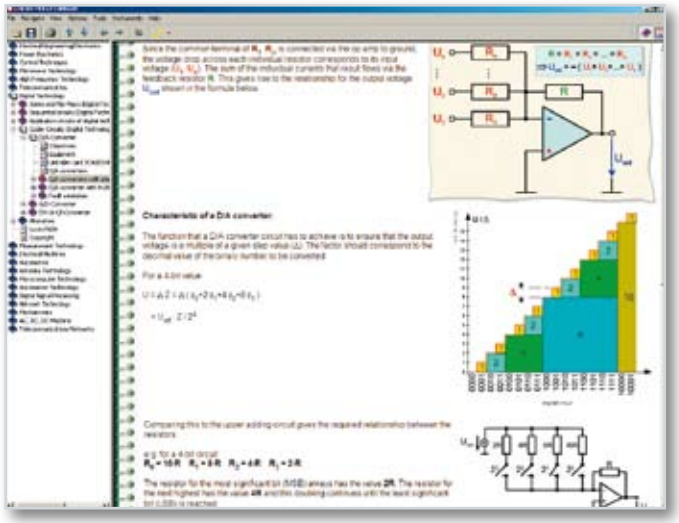
Training contents

- Design and function of D/A converters (R-2R networks, weighted resistors)
- Recording of static and dynamic characteristics for D/A converters
- Investigation of an applied D/A converter circuit
- Design and function of A/D converters (counting methods, dual-slope method)
- Design and function of V/f and f/V converters
- Recording of characteristics and measurement of internal signals
- Calibration of reference voltage for V/f and f/V converters
- Fault simulation



Article no.: SO4204-6F, consisting of

1 x CD with "Converter circuits" course
1 x Experiment card "A/D converter"
1 x Experiment card "D/A converter"
1 x Experiment card "V/f-f/V converter"



Microcomputer

Fundamentals of Computer Engineering
Applications and Programming

Experiment cards

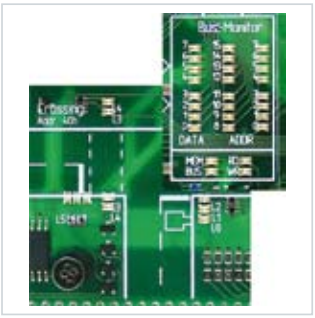
- Microcomputers and application circuits
- Plexiglass covers with screen printing
- Labelling of modules and addresses

Program editor and debugger

- Debugger: Program execution and single-step mode
- Display of program events as well as memory and register contents
- Code editor with instruction list and error display

Microcontroller

- 32-bit microcontoller
- Programming in Assembler
- Emulator for 8085 processors



Microcomputers and application circuits

- LED display of address and data buses
- Access to address and data buses
- RS 232 interface
- Programming of traffic lights, matrix displays etc.

Documentation

- User documentation
- Storage of results in the training program
- Tests with automatic evaluation

Fundamentals of Computer Engineering

CPU
Memory
Registers
Buses

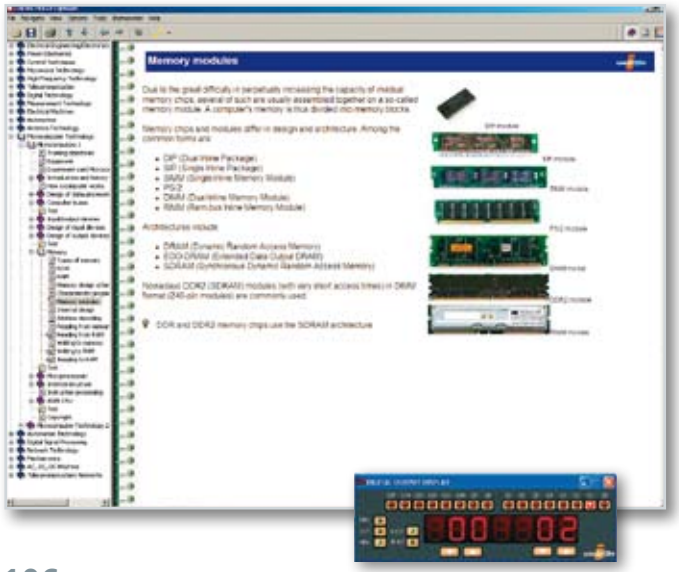
Computers have become commonplace devices and most modern electronic devices make use of microprocessors and microcontrollers. But how does a microprocessor work? What are its basic modules? How is it controlled by a program?

Training contents

- Architecture of a microcomputer
- Microprocessor components (ALU, registers, stack, instruction decoder, program counter)
- Design of the Intel 8085
- Memory in microcomputers
- Bus systems in a microcomputer
- Reading of data from address, control and data buses
- The CPU instruction set
- Tracing and analysis of individual programs
- Differences between linear and branched programs

Article no.: SO4204-6H, consisting of

1 x CD with "Fundamentals of computer engineering" course
1 x Experiment card "Microcomputer"



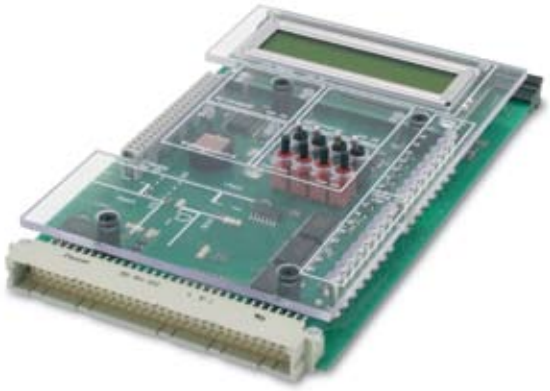
Applications and Programming

Loops
Interrupts
Subroutines

Properly structured and documented programs are necessary for the efficient use of microprocessors. Machine language is an ideal environment for learning programming techniques also employed with higher-level languages. Machine language permits a direct examination of the effects of individual program steps on hardware operation.

Training contents

- Understanding and writing assembler programs
- Investigation of program run times
- Programming counters and loops
- Programs for writing alpha-numeric characters to a display
- Programming subroutine calls and interrupts
- Programming and analysis of a traffic light controller
- Programs for serial data transfer
- Methods for tracing faults (debugging)



Supplement to SO4204-6H
Article no.: SO4204-6J, consisting of

1 x CD with “Applications and programming” course
1 x Experiment card “Microcomputer applications”
1 x 40-pole flat ribbon cable

Automation Technology

Industrial Sensors

Electropneumatics

Programmable Logic Controllers (PLC)

PLC Languages

Field-bus Systems

UniTrain-I system

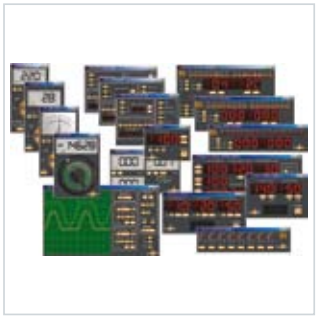
- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msamples/s
- 9 measuring ranges 100 mV - 50 V
- 22 time ranges 1 µs - 10 s
- 16 digital inputs/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Accommodates experiment cards
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards



Integrated measuring equipment and power supplies

- Multimeter, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- PROFIBUS monitor
- PROFIBUS tester
- ... and many other instruments

LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of experiment results
- Tests

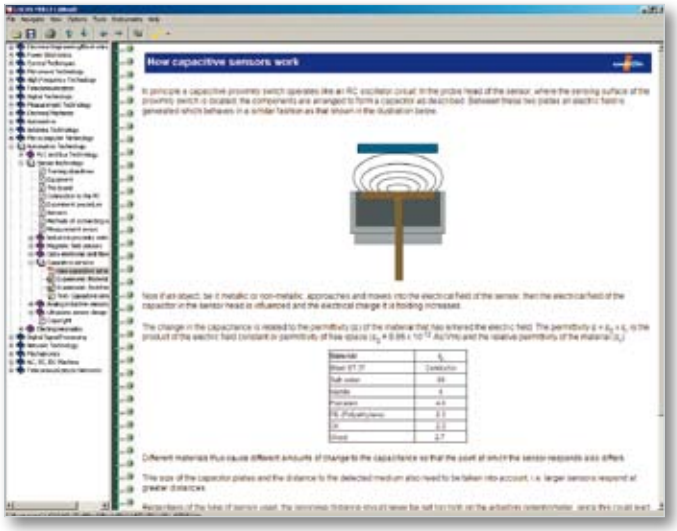
Sensors for Automation

Industrial Sensors

In order to control technical processes using programmable control systems, it is necessary to employ sensors. They convert physical measurements into electrical signals, much in the way that human senses do. This means that the topic of sensors is essential basic knowledge for any automation technician.

Training contents

- Working with capacitive and inductive proximity sensors
- Working with various sensors such as magnetic field sensors or optical sensors
- Which sensors respond to which materials?
- Determination of switching distance, hysteresis and frequency
- Computer-controlled methods for material testing



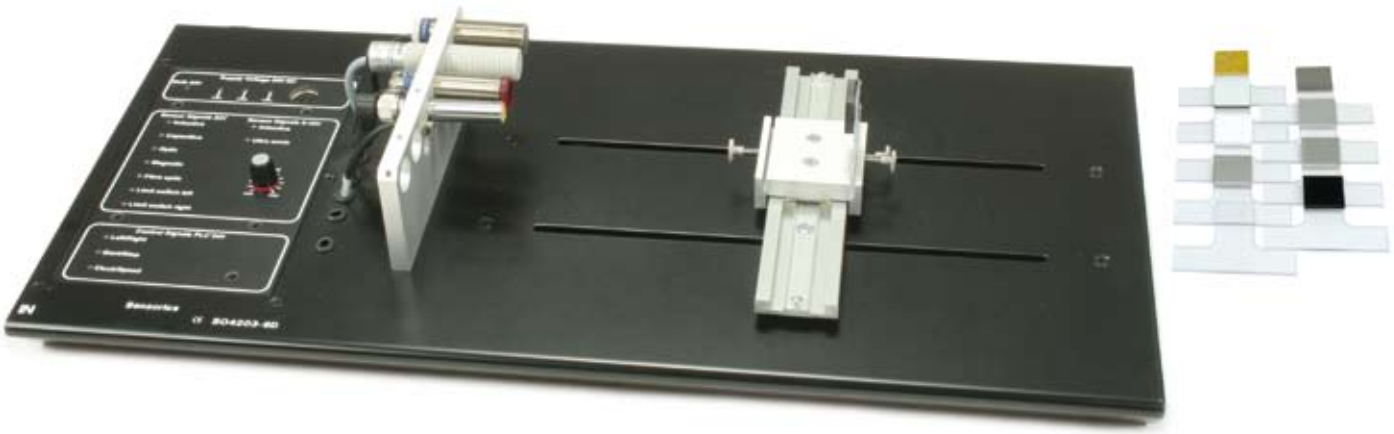
Article no.: SO4204-8U, consisting of

1 x CD with "Sensors for automation" course
1 x Experiment board "Sensors"
1 x Set of material samples

Optional:
Article no.: SO4002-4A
1 x Optional analogue sensor

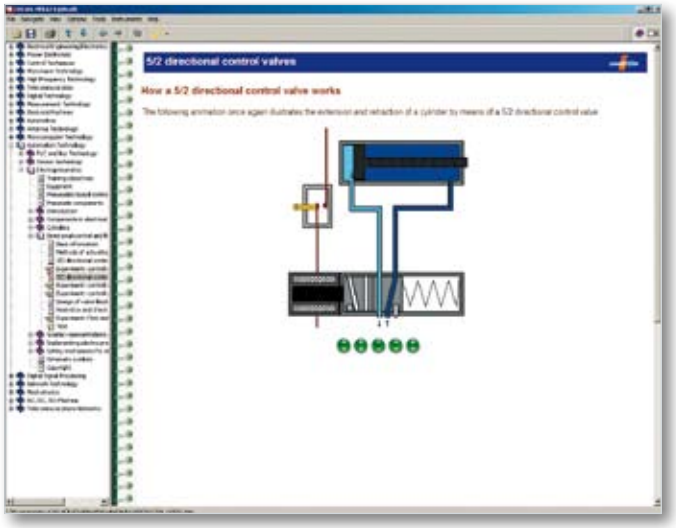
Article no.: SO4002-4B
1 x Optional ultrasonic sensor

Article no.: SO4203-2V
Aluminium carry case for experiment board



Pneumatics/Electropneumatics

Pneumatic Cylinders
Distribution Valves
Control Elements



In recent years, compressed air has become increasingly popular as a medium for the transfer of energy. Pneumatic systems are used frequently for conveyance, drilling, grinding, clamping, sorting, and control. This is attributable in part to the incomparable simplicity and economy of compressed-air machinery in certain areas of automation.

Training contents

- How single-action and double-action cylinders operate
- Introduction to different directional control valves
- Design and function of electropneumatic controls
- Hard-wired programmable controls
- Programmable logic controllers
- Recording displacement-time diagrams
- Time-dependent controls

Article no.: SO4204-8V, consisting of

1 x CD with "Pneumatics/Electropneumatics" course
1 x Experiment card "Electropneumatics"
3 x One-way restrictor valves
1 x Set of pneumatic tubes

Optional:
Article no.: SO4203-2V
Aluminium carry case for experiment board

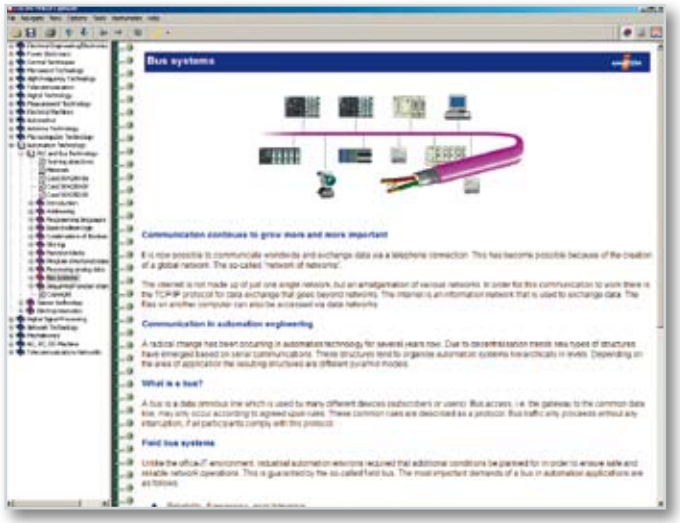
Compact Automation, PLC and Bus Technology

Programmable Logic Controllers

Today's highly automated industrial landscape is characterised by machines that operate virtually autonomously. As a rule such systems are operated by programmable logic controls. Further advances such as decentralised control systems used in conjunction with field-bus systems are continuing to gain importance.

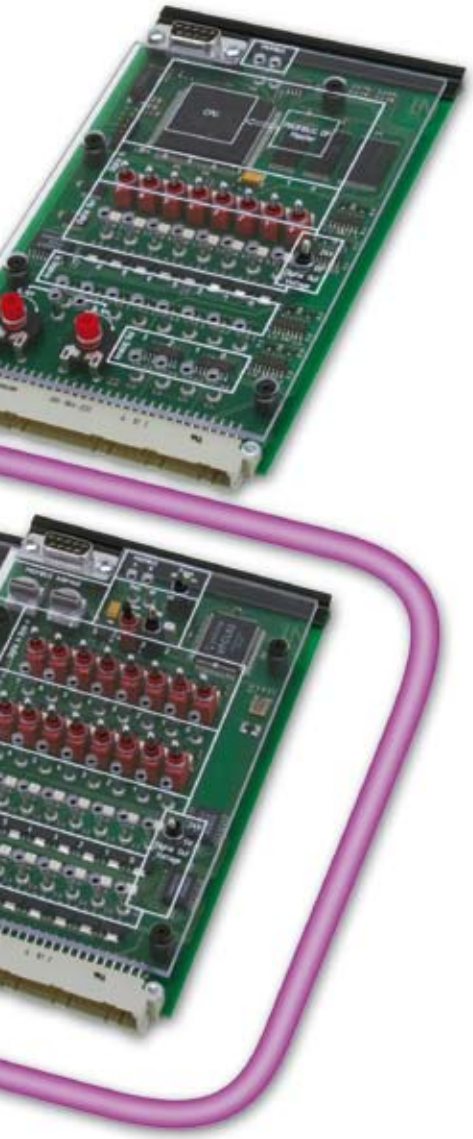
Training contents

- Introduction to the fundamentals and basic concepts of programmable logic control and the operation of such systems
- Introduction to the programming of a PLC unit
- Creating logical operations using storage elements up to and including more complex networks
- Programming of timers, counters and other functions
- Designing a traffic light circuit
- Conversion of non-electrical measurements into electrical signals



Article no.: SO4204-8N, consisting of

1 x CD with "PLC and bus technology" course
1 x Experiment card with "CPU with PROFIBUS DP master"
2 x Experiment cards with "PROFIBUS DP slave"
1 x Experiment card with "PLC application models"

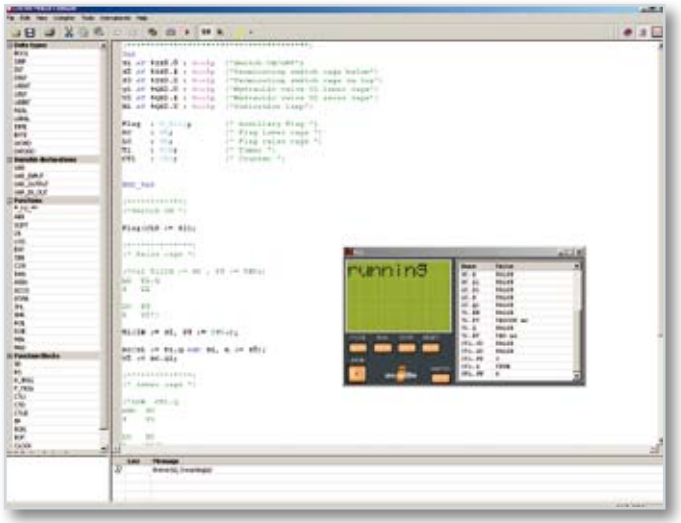


Field-bus Systems
Process Field-bus (PROFIBUS)

PLC units alone are no longer seen as the central hub of an automated system. Automation solutions are now regarded as integrating sensor systems, drive technology and other actuators as well as the components used to operate and observe the process. Total integration of all the various systems is now possible using standardised field-bus systems, for example.

Training contents

- Operation of a decentralised peripheral system using a network comprising PROFIBUS DP master and slaves
- Programming and commissioning of a field-bus system using special software tools, such as PROFIBUS Monitor and PROFIBUS Tester
- Introduction to data transfer structures and protocols
- Data transfer and fault analysis



Mechatronics

Conveyor Belts
Sorting
Assembly
Processing
Testing
Handling
Storage
Routing
Buffering
Production Line

UniTrain-I system

- Complete, portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB

- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msample/s
- 9 measurement ranges, 100 mV - 50 V
- 22 time ranges, 1 µs-10 s
- 16 digital inputs and outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

Experiment card: CPU with PROFIBUS-DP master

- 8 digital inputs
- 8 digital outputs
- 8 analogue inputs
- 4 analogue outputs
- PROFIBUS interface

Work and programming environment

- PLC
- Digital IO display
- PROFIBUS Monitor
- PROFIBUS Tester

LabSoft training and experiment software

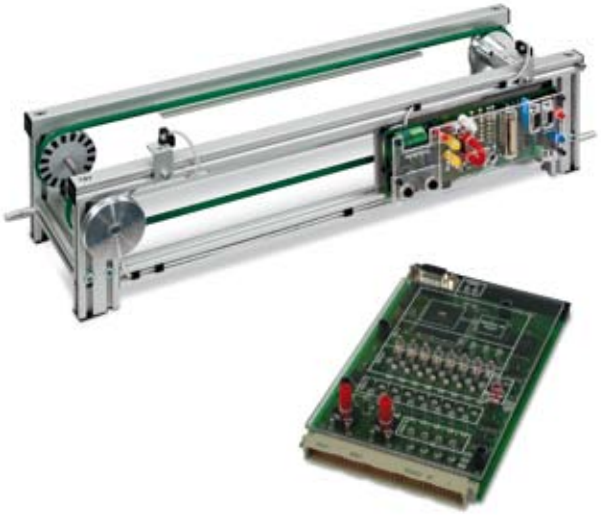
- Huge selection of courses
- Comprehensive theory
- Animation
- Interactive experiments with instruction guide
- Flexible navigation
- Documentation of experiment results
- Tests

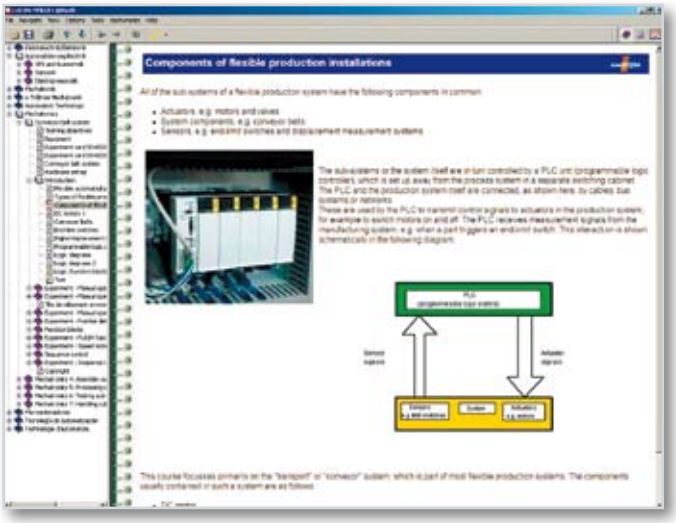
IMS® Transfer Systems

Transfer System with DC Drive

Training contents

- Generating controlled movements on one axis
- Incremental positioning of a workpiece carrier
- Interlocking of forward and reverse mode
- Programming a monitor for slippage or halting of the belt
- Handling different safety circuits and interlocks
- Understanding the function and operation of sensors
- Connecting the PROFIBUS DP field-bus system and putting it into operation





Article no.: SO4204-8K, consisting of

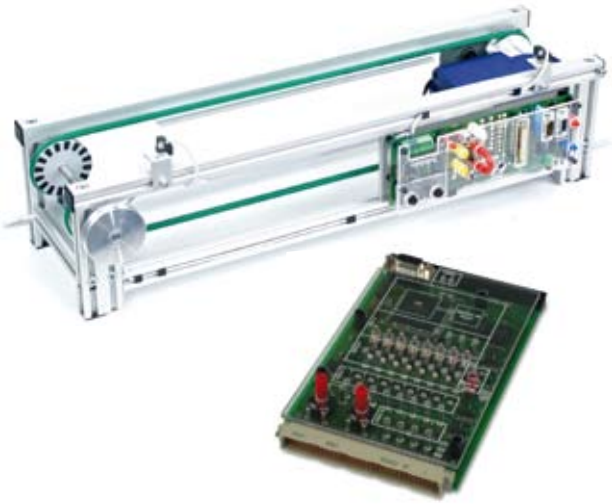
1 x CD with "Transfer system with DC drive" course
1 x Experiment card "CPU with PROFIBUS DP master"
1 x PROFIBUS cable for connection to conveyor belt

To complete the course, conveyor belt section IMS® 1.2 is required.

Transfer System with Three-phase Drive

Training contents

- Assembly, adjustment and testing of mechanical components
- Controlling the speed and direction of a frequency converter's drive
- Movement in inching mode
- Automatic transport of a workpiece carrier with holding time
- Programming movements with limit switches and slip monitoring



Article no.: SO4204-8L, consisting of

1 x CD with "Transfer system with three-phase drive" course
1 x Experiment card "CPU with PROFIBUS-DP master"
1 x PROFIBUS cable for connecting the conveyor belt

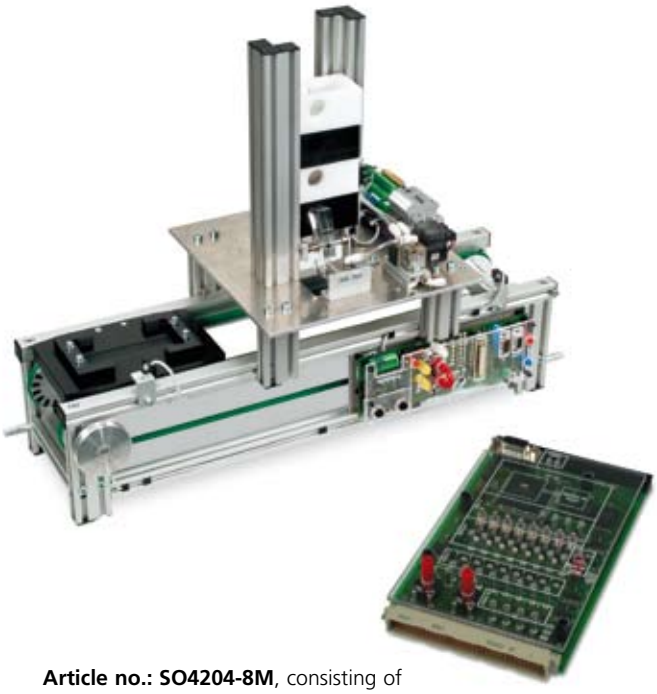
To complete the course, conveyor belt section IMS® 1.3 is required.

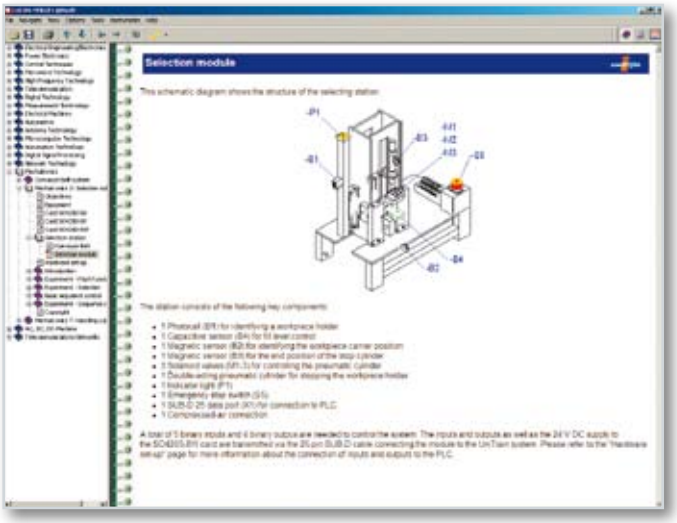
IMS® Sub-systems

Sorting

Training contents

- Assembly, set-up and testing of pneumatic cylinders and valves
- Familiarisation with sub-systems for top/bottom workpiece sections
- Defining sorting process sequences
- Programming production processes in manual and automatic mode





Article no.: SO4204-8M, consisting of
1 x CD with "Sorting sub-system" course
1 x Experiment card "CPU with PROFIBUS DP master"
1 x Profibus cable for connection of conveyor belt and station

To complete the course, conveyor belt sections IMS® 1.2 and IMS® 3 "sorting" are required.

Assembly

Training contents

- Assembly, set-up and testing of pneumatic cylinders and valves
- Familiarisation with sub-systems for top/bottom workpiece sections
- Defining assembly process sequences
- Programming production processes in manual and automatic mode

Article no.: SO4204-8O, consisting of

1 x CD with "Assembly sub-system" course
1 x Experiment card "CPU with PROFIBUS DP master"
1 x PROFIBUS cable for connection of conveyor belt and station

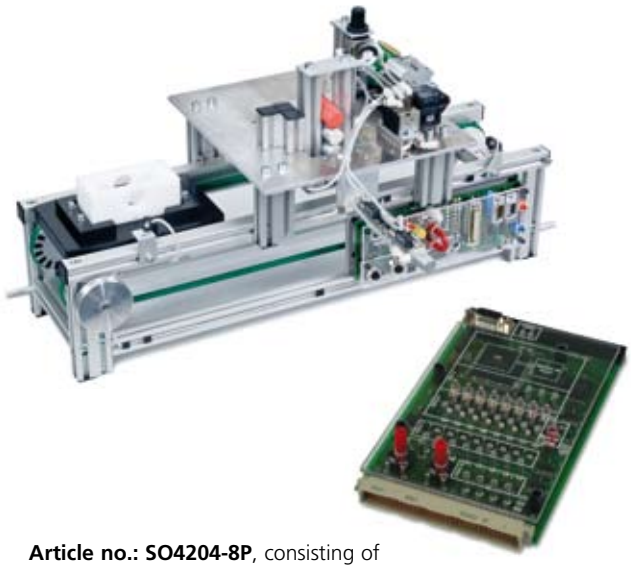
To complete the course, conveyor belt sections IMS® 1.2 and IMS® 4 "Assembly" are required.

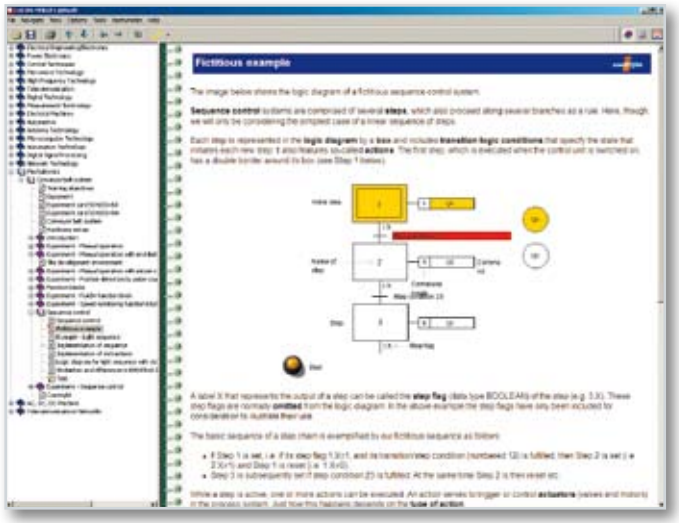
IMS® Sub-systems

Processing

Training contents

- Assembly, adjustment and testing of pneumatic cylinders and valves
- Workpiece identification
- Work step monitoring
- Defining process sequence for simple workpiece processing
- Programming the production process in manual and automatic operating modes





Article no.: SO4204-8P, consisting of

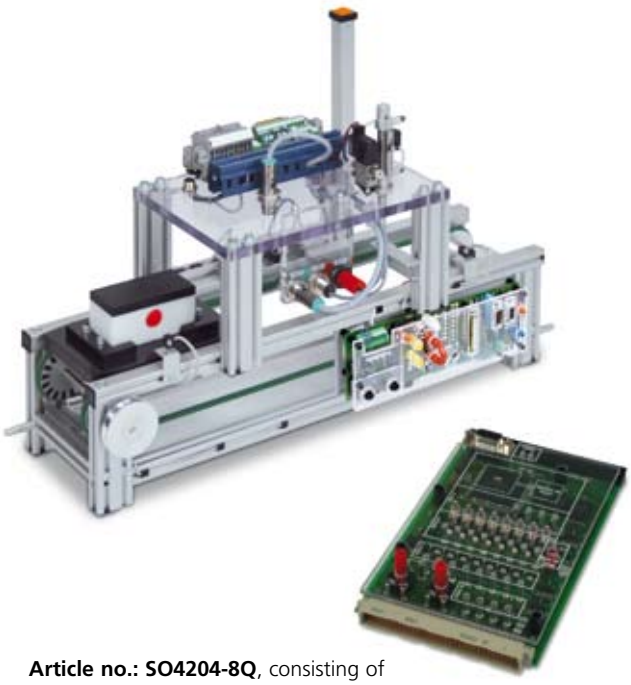
1 x CD with "Processing sub-system" course
1 x Experiment card "CPU with PROFIBUS DP master"
1 x PROFIBUS cable for connection of conveyor belt and station

To complete the course, conveyor belt sections IMS® 1.2 and IMS® 5 "Processing" are required.

Testing

Training contents

- Assembly, adjustment and testing of pneumatic cylinders and valves
- Optical, inductive, capacitive and magnetic test sensors
- Defining the process sequence for simple workpiece testing
- Programming a test sequence in manual and automatic operating modes



Article no.: SO4204-8Q, consisting of

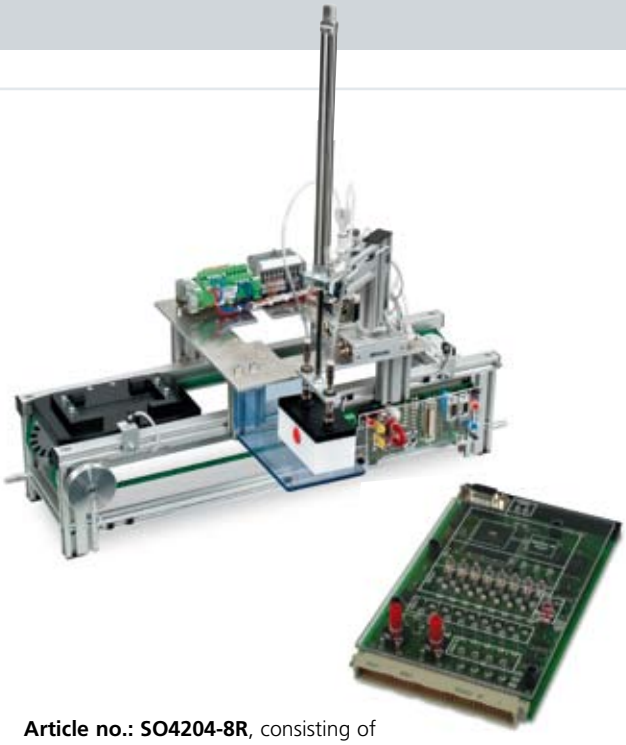
1 x CD with "Testing sub-system" course
1 x Experiment card "CPU with PROFIBUS DP master"
1 x PROFIBUS cable for connection of conveyor belt and station

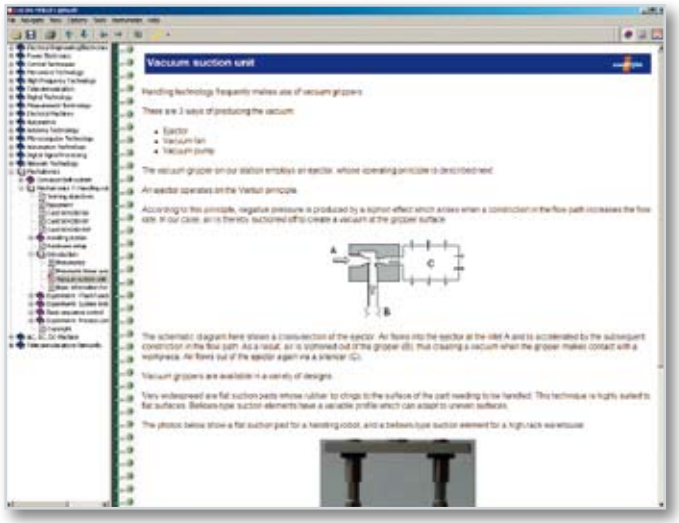
To complete the course, the conveyor belt sections IMS® 1.2 and IMS® 5 "Testing" are required.

Handling

Training contents

- Assembly, adjustment and testing of pneumatic cylinders and valves
- Vacuum generator, vacuum suction unit with sensor technology
- Define a process sequence for simple workpiece sorting
- Set-up and control of a pneumatic linear unit
- Programming the sorting process in manual and automatic operating modes





Article no.: SO4204-8R, consisting of

1 x CD with "Handling sub-system" course
1 x Experiment card "CPU with PROFIBUS DP master"
1 x PROFIBUS cable for connection of conveyor belt and station

To complete the course, conveyor belt sections IMS® 1.2 and IMS® 7 "Handling" are required.

Storage

Training equipment

- Assembly, adjustment and testing of pneumatic cylinders and valves
- Defining a process sequence for a stacking system
- Positioning the storage level using incremental position resolvers
- Programming a step chain
- Programming the complete storage process in manual and automatic operating mode

Article no.: SO4204-8S, consisting of

1 x CD with "Storage sub-system" course
1 x Experiment card "CPU with PROFIBUS DP master"
1 x PROFIBUS cable for connection of conveyor and station

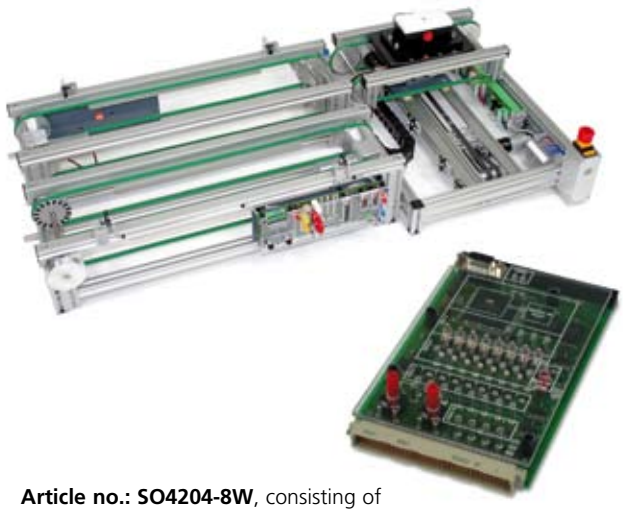
To complete the course, conveyor belt sections IMS® 1.2 and IMS® 8 "Storage" are required.

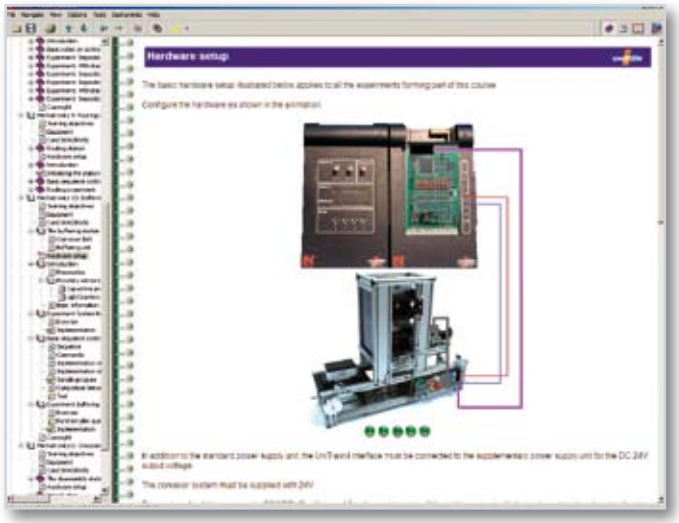
IMS® Sub-systems

Routing

Training contents

- Assembly, adjustment and testing of pneumatic cylinders, valves and sensors
- Learning about a routing unit
- Starting and controlling a linear unit
- Defining process flow
- Programming routing operations in manual and automatic mode





Article no.: SO4204-8W, consisting of

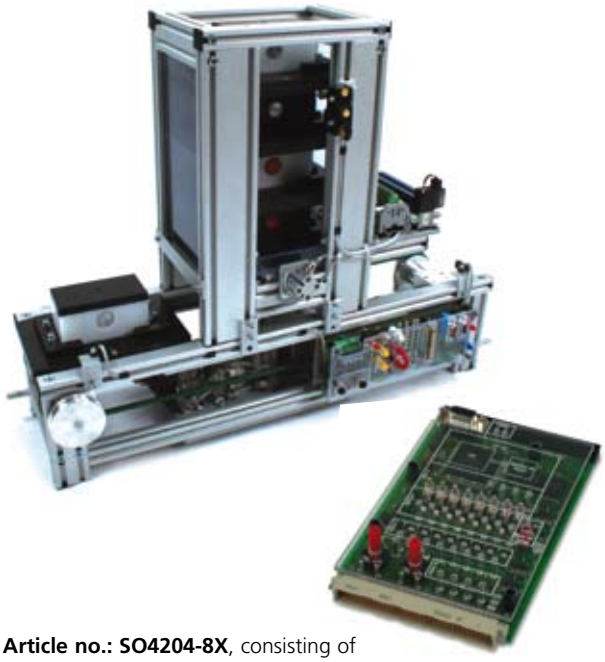
1 x CD with "Routing sub-system" course
1 x Experiment card "CPU with PROFIBUS-DP master"
1 x PROFIBUS cable for connecting the conveyor belt and station

To complete the course, conveyor belt sections IMS® 1.2 and IMS® 9 "Routing" are required.

Buffering

Training contents

- Assembly, adjustment and testing of pneumatic cylinders, valves and sensors
- Learning about a buffer unit
- Defining process flow
- Programming production processes in manual and automatic mode



Article no.: SO4204-8X, consisting of

1 x CD with "Buffering sub-system" course
1 x Experiment card "CPU with PROFIBUS-DP master"
1 x PROFIBUS cable for connecting the conveyor belt and station

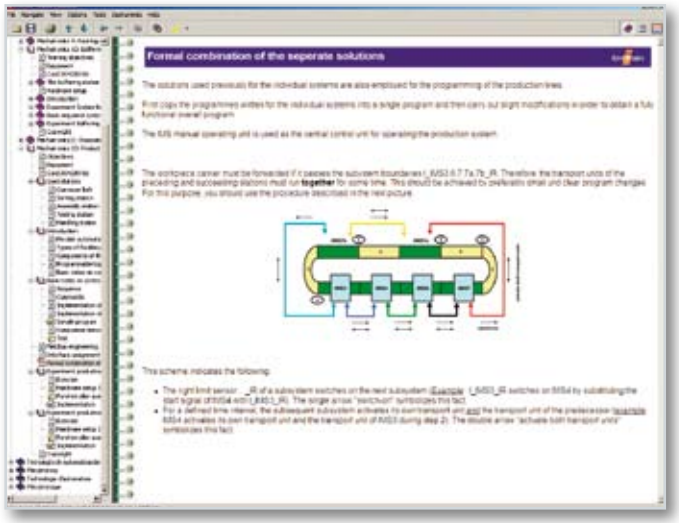
To complete the course, conveyor belt sections IMS® 1.2 and IMS® 10 "Buffering" are required.

IMS® Production Line

Production Line

Training contents

- Assembly, adjustment and testing of pneumatic cylinders, valves and sensors
- Defining process flow
- PROFIBUS planning and operation
- Integrated connection of individual systems to form a network
- Programming production processes



Article no.: SO4204-8Z, consisting of

1 x CD with "Production line" course
1 x Experiment card "CPU with PROFIBUS-DP master"
1 x PROFIBUS cable for connecting the production facility

To complete this course, IMS® 23 "Production line with 3 sub-systems" or IMS® 24 "Production line with 4 sub-systems" is required.

Automotive Technology

Electronics/Digital Technology
Sensors and Actuators
Power Generation
Diagnostics
Comfort Systems
Bus Systems
Fibre Optics
Steering
Chassis
Brakes
Transmission

UniTrain-I system

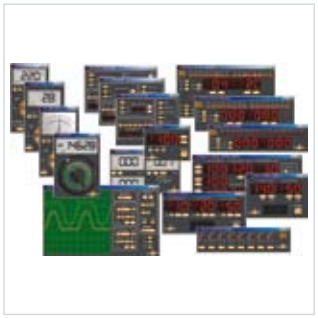
- Comprehensive portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Theory and practice in conjunction

UniTrain-I interface with USB interface

- Oscilloscope with 2 analogue differential inputs
- Sampling rate 40 Msamples/s
- 9 measuring ranges 100 mV - 50 V
- 22 time ranges 1 µs - 10 s
- 16 digital inputs/outputs
- Function generator for frequencies up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Accommodates experiment cards
- Experiment voltage supply ± 15 V, 400 mA
- Experiment voltage supply 5 V, 1 A
- Variable DC or three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards



Integrated measuring equipment and power supplies

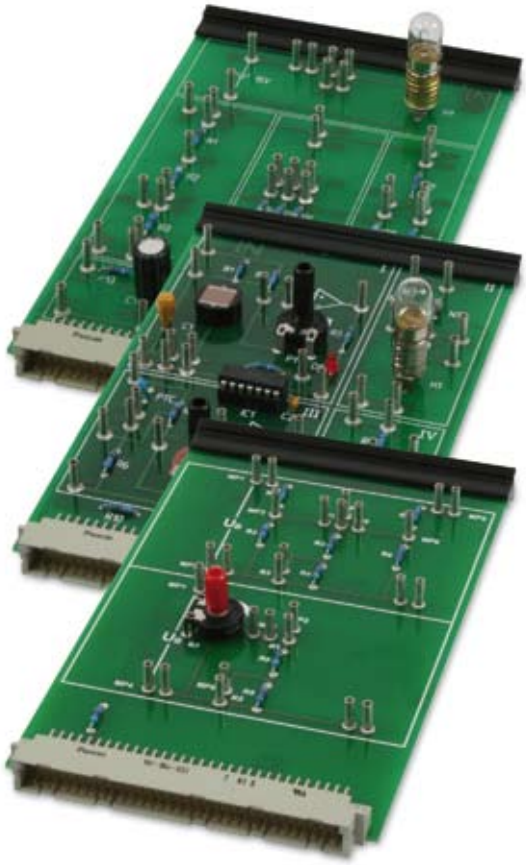
- Multimeters, ammeters, voltmeters
- Dual-channel storage oscilloscope
- Function generator and waveform generator
- Three-way AC/DC power supply
- Three-phase power supply
- ... and many other instruments

LabSoft training and experiment software

- Huge selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation of experiment results
- Tests

Electrical Engineering

DC Technology
AC Technology
Components



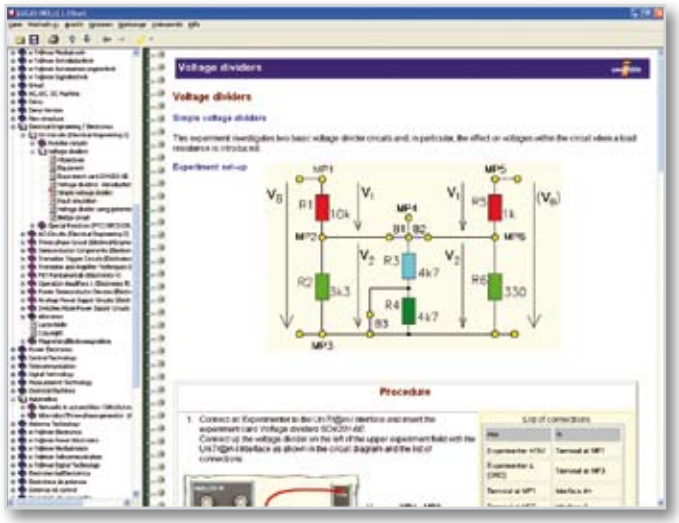
The increasingly significant role of electrical and electronic components in motor vehicles necessitates a practical study of the principles of electrical engineering.

Training contents

- Basic terminology: current, voltage, resistance
- Handling voltage sources and measuring instruments
- Experimental verification of Ohm's and Kirchhoff's laws
- Measurements on series/parallel circuits and voltage dividers
- Recording characteristics of variable resistors (LDR, NTC, PTC, VDR)
- Fault simulation

Article no.: SO4204-7A, consisting of

1 x CD with "Fundamentals of automotive engineering" course
1 x Experiment card "Resistor circuits"
1 x Experiment card "Voltage dividers"
1 x Experiment card "Variable resistors"



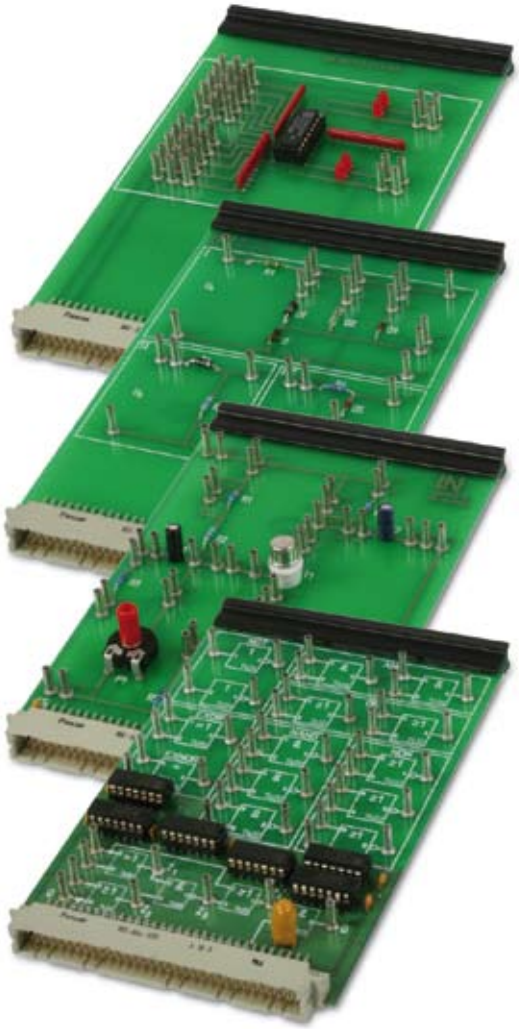
Electronics and Circuit Engineering

Semiconductor Components
Transistors and Amplifier Circuits
Digital Technology

A knowledge of the properties and functions of electronic components forms the basis for understanding and analysing the role of these components and related circuitry in motor vehicles.

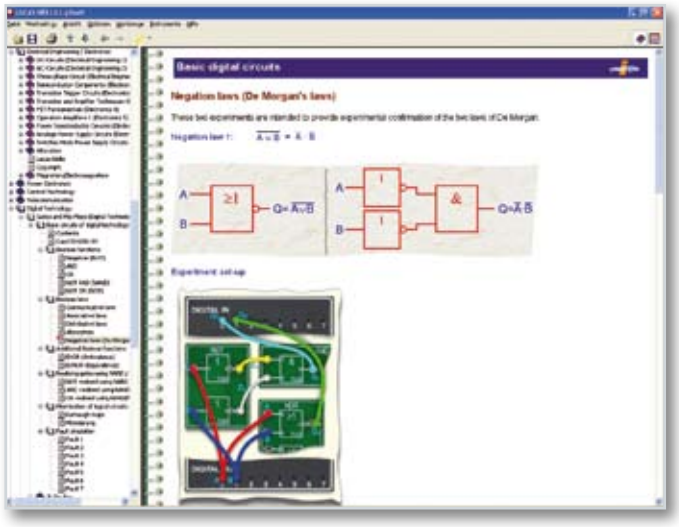
Training contents

- Determining the valve and rectification capabilities of a diode
- Recording diode characteristics
- Basic transistor circuits
- Setting the operating point in a transistor circuit
- Gain of emitter-follower and collector-follower circuits
- Design of basic logic circuits
- Boolean functions and laws
- Static and dynamic switching response of JK flip-flops
- Design of a counter circuit



Article no.: SO4204-7B, consisting of

1 x CD with "Fundamentals of automotive engineering" course
1 x Experiment card "Diodes"
1 x Experiment card "Basic transistor circuits"
1 x Experiment card "Basic digital circuits"
1 x Experiment card "JK flip-flops"



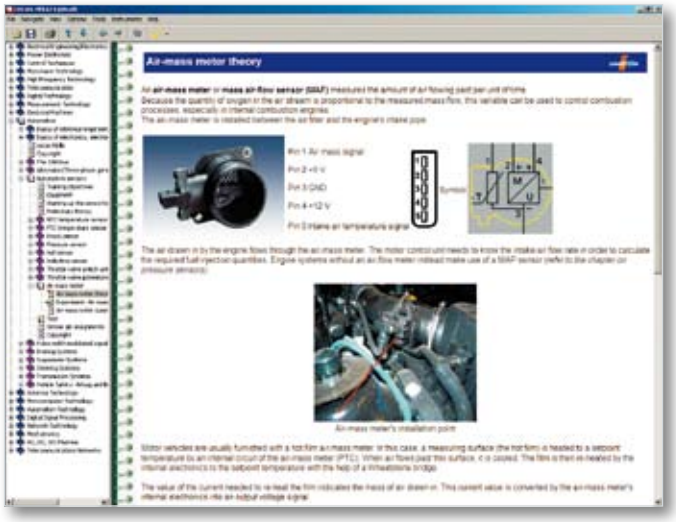
Sensors in Motor Vehicles

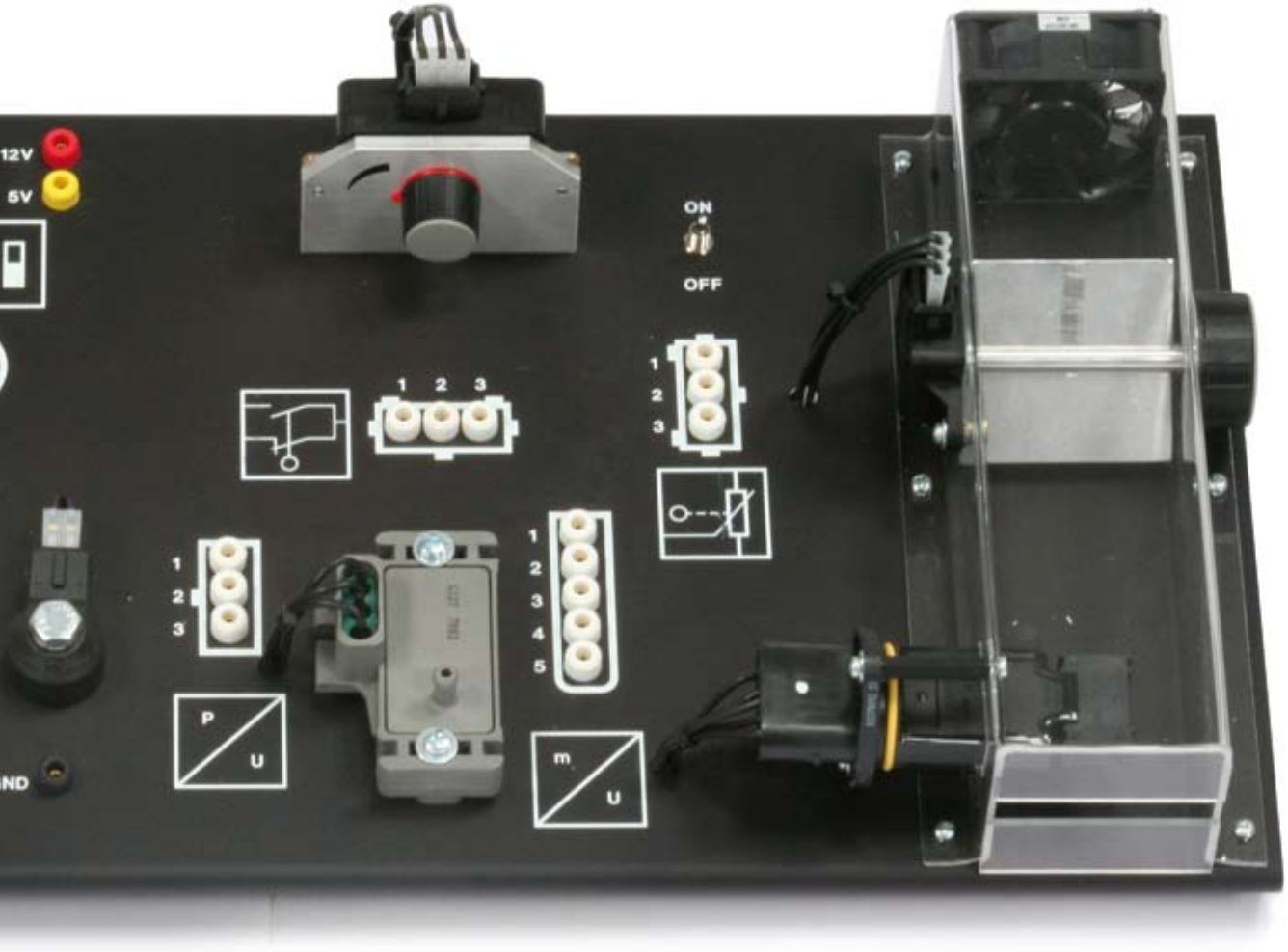
Original Automotive Sensors
Temperature and Speed Measurement
Knock Sensor
Air-flow Meter

In modern vehicles more and more components are being provided with electronic monitoring and control. Sensors are used to detect physical quantities and output a corresponding electrical signal that can be processed by the control units.

Training contents

- Physical principles used in sensors: induction, Hall effect, piezo effect
- The role of sensors in engine management
- Inductive and Hall-effect speed sensors
- Measurement of throttle settings: throttle valve switches and potentiometers
- Air-flow measurement via heater filament and hot-film sensors
- Pressure measurement in the intake manifold
- Ignition point detection via a knock sensor
- Temperature measurement using NTC and PTC temperature sensors





Article no.: SO4204-7F, consisting of

1 x CD with "Sensors in motor vehicles" course
1 x Experiment card "Sensors in motor vehicles"

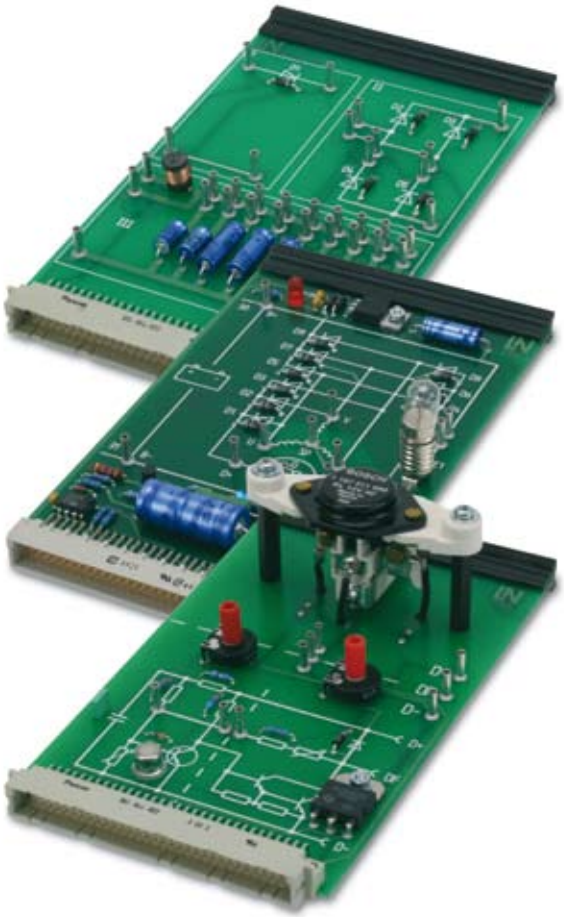
Optional:
Article no.: SO4203-2V

Aluminium carry case for experiment board

Three-phase Generator

Electric Fields
Induction
Rectification
Voltage Generation
Control

Nearly all modern motor vehicles are equipped with an alternator for generating the required electrical energy.

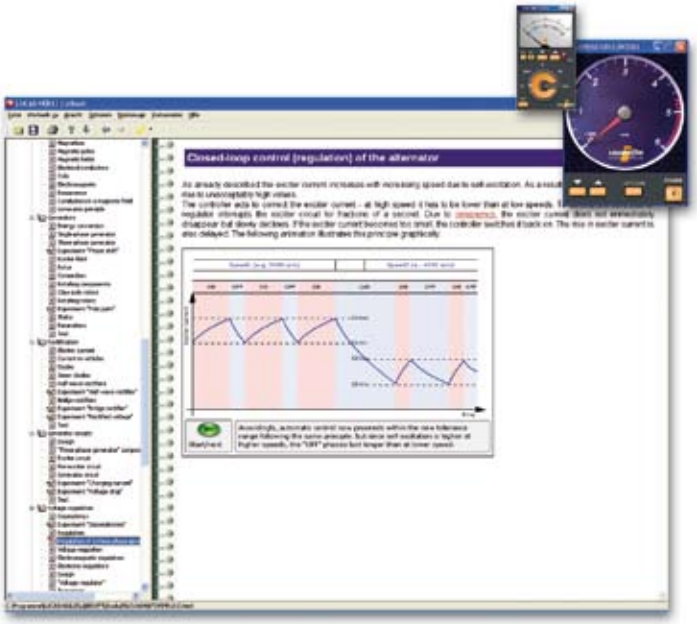


Training contents

- Principle of a generator
- 3-phase power
- Diodes and rectification
- How an unregulated 3-phase generator works
- Discrete voltage regulator
- Integrated voltage regulator
- How a regulated 3-phase generator works
- Fault diagnosis

Article no.: SO4204-7D, consisting of

1 x CD with "Three-phase generator" course
1 x Experiment card "Rectifiers for motor vehicles"
1 x Experiment card "Three-phase generator for motor vehicles"
1 x Experiment card "Voltage regulator for motor vehicles"



Pulse-width Modulated Signal in Automotive Engineering

Principles of PWM
Power Saving
Diagnostics

Many actuators in vehicles need to perform in a variety of ways. Some actuators need to respond to a range of inputs rather than a simple on or off. Such devices are controlled using pulse-width modulated signals.

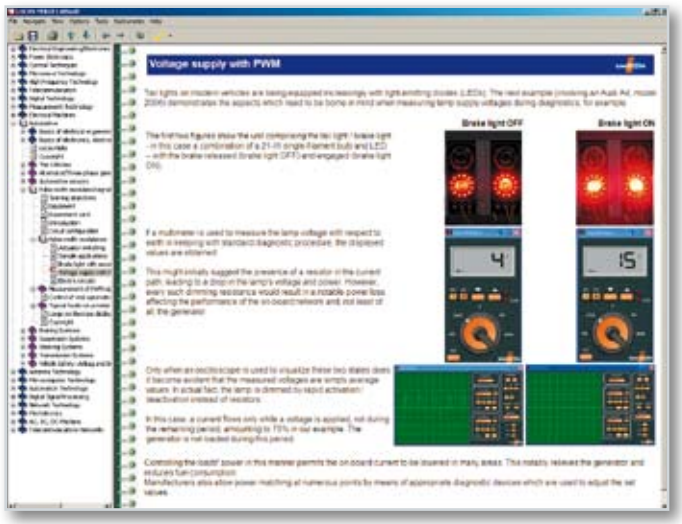
Training contents

- The principle of PWM
- Uses of PWM in vehicles
- Controlling the power consumption of electrical loads using PWM
- Measurement of characteristic parameters for a PWM signals: frequency, amplitude, mark-space ratio
- Pulse widths, edges and signal forms
- Control and operating circuits
- Measurement of PWM signals
- Diagnostics for PWM-controlled components

Article no.: SO4204-7J, consisting of

1 x CD with "PWM signals in automotive engineering" course
1 x Experiment card "FET amplifier output stage"

When taking this course, it is recommended that an external 12-15 V power supply (e.g. LN CO3216-1C) be used.



Communication via CAN Bus

Bus Levels
CAN Protocol
Programming
Diagnostics

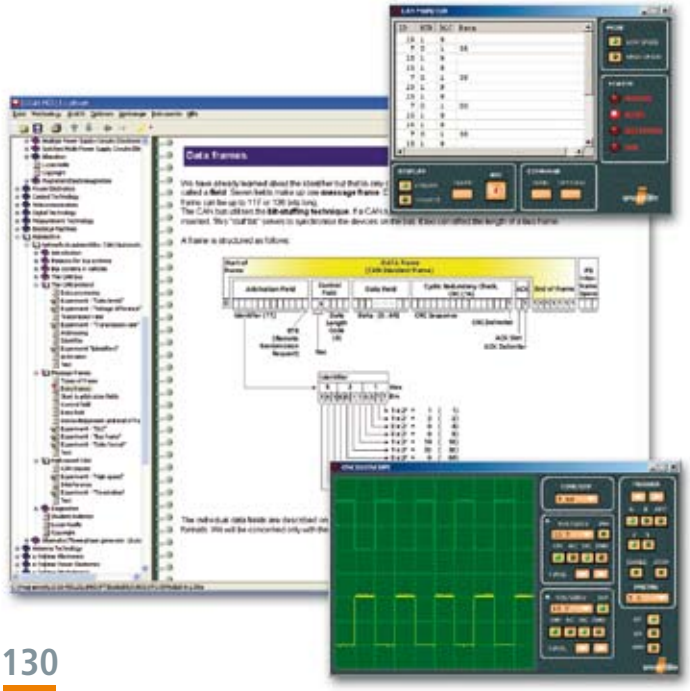
A modern motor vehicle possesses a large number of electronic control units communicating with each other constantly via digital bus systems.

Training contents

- Reasons for using bus systems in motor vehicles
- Topology and components of the CAN system used in vehicles
- Differences between low-speed and high-speed CAN
- Electrical properties of a CAN bus
- Data rate, identifiers, addressing and arbitration (low-speed and high-speed CAN)
- Structure of a packet frame in a CAN message
- Analysis of CAN messages using CAN Monitor or oscilloscope
- Editing and sending CAN messages using a PC
- Fault finding

Article no.: SO4204-7K, consisting of

1 x CD with "CAN bus" course
1 x Experiment card "Car front"
1 x Experiment card "Car rear"



CAN Bus Training Projects

CAN Vehicle Lighting
Programming
Diagnostics

The training project for lighting supplements the original CAN bus with an interface permitting control of any standard lighting system. The switches and buttons on the cards of the UniTrain-I CAN bus course can be used to operate the lights.

Supplement to SO4204-7K
Article no.: CO3216-2Z, consisting of

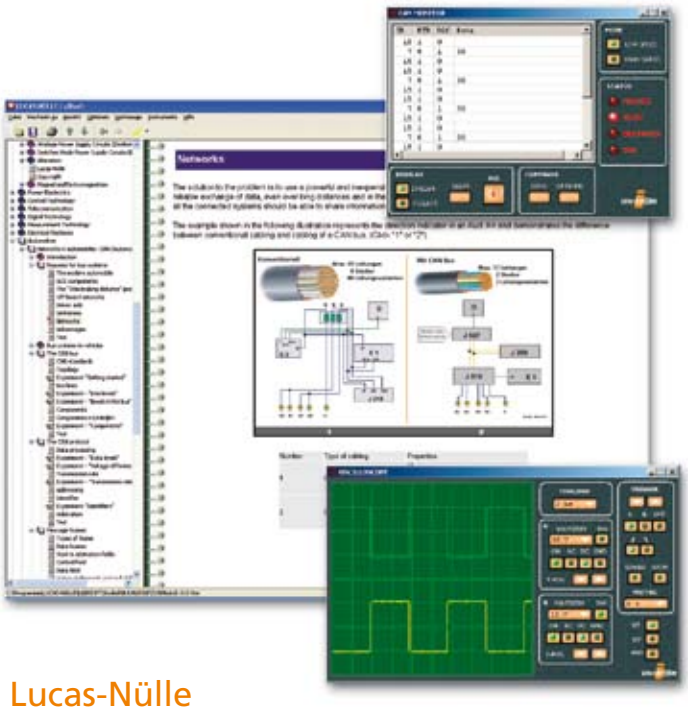
1 x Interface for vehicle lighting
(ALC1 Lighting not included)

CAN Comfort Features
Programming
Diagnostics

The training project for passenger doors integrates an original vehicle door model into the experiment system. This permits control of basic door functions such as electric window winders and electrically adjustable door mirrors using CAN messages as employed in real Volkswagen vehicles. The data traffic occurring on the CAN bus can be analysed with the help of the LabSoft program.

Supplement to SO4204-7K
Article no.: SO3216-2Y, consisting of

1 x VW Golf V passenger door



LIN Bus

LIN Protocol
Message Structure
Bus Components

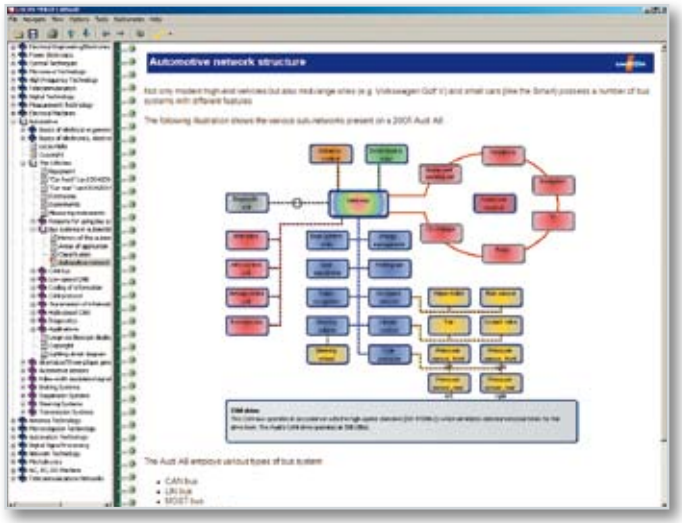
In addition to a CAN bus, the slightly simpler LIN bus is also used in some vehicles. It is mainly used for safety-related comfort functions.

Training contents

- Development of bus systems in vehicles
- Topology and components of a LIN bus system
- Electrical properties of a LIN bus
- Addressing on a LIN bus
- Master and slave principle
- Investigation of data packets by measurement
- Structure of message frames
- Analysis of LIN messages
- Editing and sending LIN messages
- Fault finding

Article no.: SO4204-7E, consisting of

1 x CD with "LIN bus" course
1 x Experiment card "Controls for door windows and mirrors"
1 x Experiment card "Window winding motor"
1 x Car door mirror



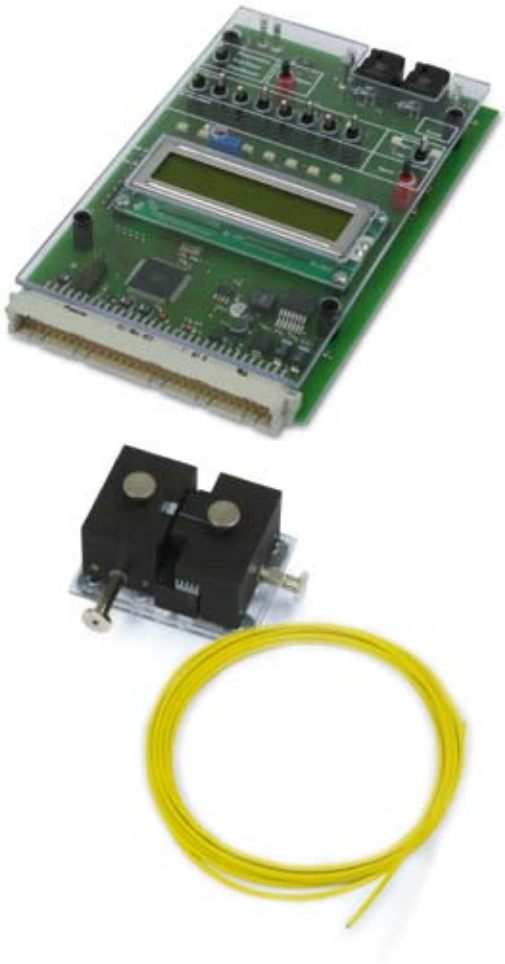
Optical Data Buses for Automotive Applications

Optical Transmission of Signals
Optical Fibres
Bus Systems

Currently optical bus systems are only being used for the so-called "Infotainment systems" in luxury vehicles. However, due to the increasing quantities of data being processed in vehicles, it is likely that optical systems will find more wide-ranging use in future.

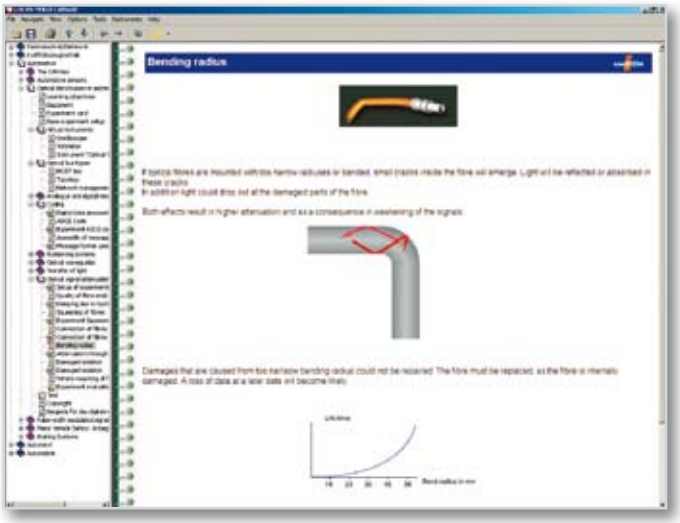
Training contents

- Data networks in a vehicle
- Reasons for using optical systems in a vehicle
- Fundamentals of a MOST bus
- MOST protocol and controllers
- Diagnosis of a broken ring
- Design of optical fibre systems in motor vehicles
- Optical bus systems in vehicles
- Fundamentals of ray optics (diffraction, reflection)
- Attenuation in an optical fibre
- Electric and optical measurements on optical fibres



Article no.: SO4204-7H, consisting of

1 x CD with "Optical data buses for automotive applications" course
1 x Experiment card "Optical fibre system for a vehicle"
1 x Optical gauge
2 x Optical fibres



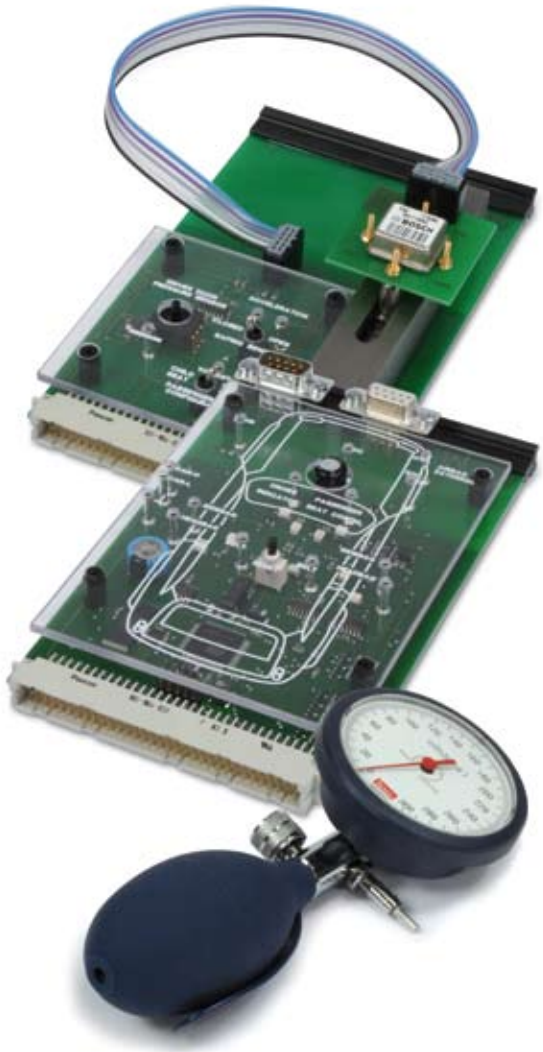
Airbag, belt tensioners and crash response

Airbags
Belt Tensioners
Crash Response

Active safety systems like airbags or belt tensioners have for many years been standard fittings for all sorts of vehicles. In order to ensure that they function correctly, they need to be checked on a regular basis.

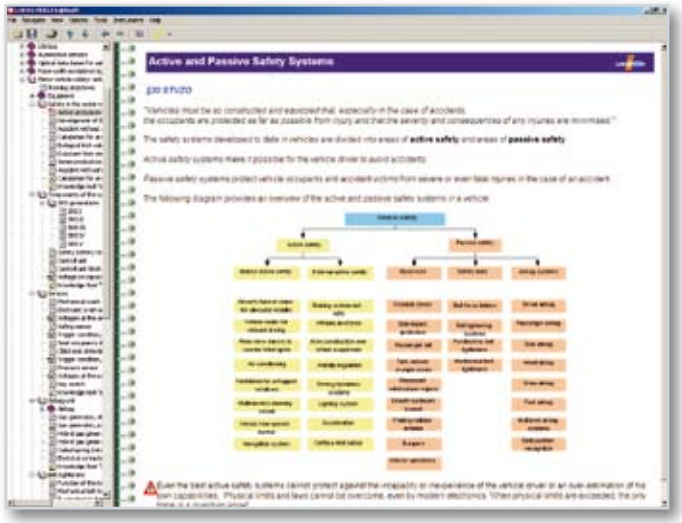
Training contents

- Active and passive safety systems in a vehicle
- Function of an airbag and belt tensioners
- Safety switches and detonators
- Function of pressure and acceleration sensors
- Measuring acceleration
- Typical crash situations
- Trigger times and sequences of consequences
- Error management for airbag systems
- Fault finding



Article no.: SO4204-6Z, consisting of

1 x CD with "Airbag, belt tensioners and crash response" course
1 x Experiment card "Model vehicle with airbag and belt tensioners"
1 x Experiment card "Airbag related sensors"



Hybrid Drives in Automobiles

Drive Configurations
Operating Modes
Electric Drives

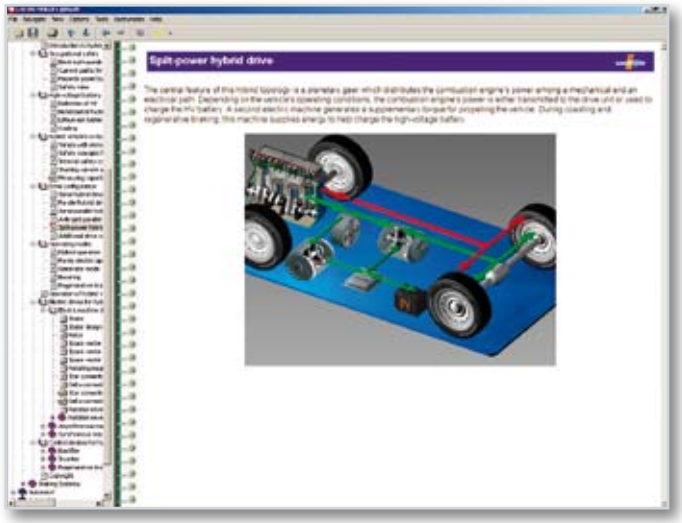
Development and production of hybrid vehicles are logical and necessary measures in view of concerns regarding our earth's future. Low emission and fuel consumption levels set standards for coming generations of modern automobiles.

Training contents

- Safety rules to be observed when working on hybrid vehicles
- Differences between various drive configurations (serial / parallel hybrid systems, mixed hybrids)
- Various operating modes of hybrid drives
- Design and function of electric drives for hybrid vehicles
- Functions of an inverter and intermediate circuit
- Design and function of three-phase machines
- Experimental investigation of a three-phase machine's operating characteristics
- Components forming part of a hybrid vehicle's on-board network
- Measurements of a frequency converter's voltages
- Investigations of energy and power flows

Article no.: SO4204-6V, consisting of

1 x CD with "Hybrid drives in automobiles" course
1 x Experiment card "Three-phase machine"
1 x Experiment card "Self-commutated converter"
1 x Experiment card "Frequency converter"
1 x Flywheel
1 x Set of 3 rotors



Pulse Generation and Ignition Systems

Coil Ignition
Transistor Ignition
Engine Management

Petrol-driven internal combustion engines require an ignition system to ignite the mixture of petrol and air. Whereas older vehicles had coil or transistor-triggered spark plugs, the job is mainly accomplished nowadays using engine management systems.

Training contents

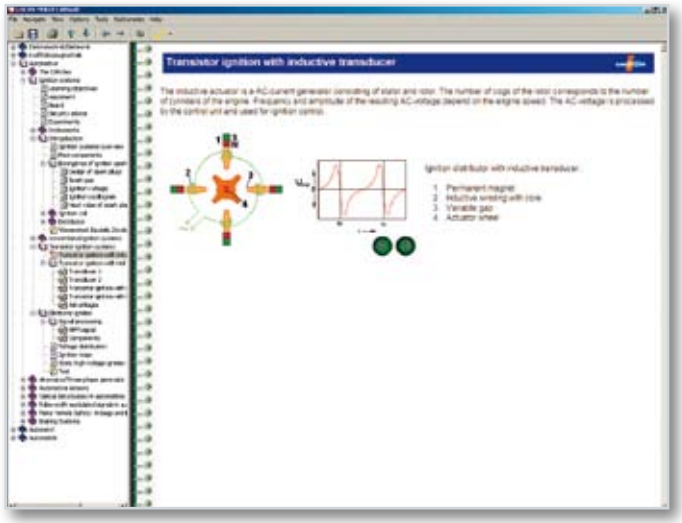
- Voltage and current
- Contact-triggered ignition systems (SZ)
- Transistor ignition and induction sensors (TZ-I)
- Transistor ignition and Hall sensors (TZ-H)
- Distributorless ignition systems (DIS)
- Physical measurements
- Induction
- Hall effect
- Anti-knock control
- Firing angles

Article no.: SO4204-7C, consisting of:

1 x CD with "Pulse generation and ignition systems" course
1 x Experiment board with mechanical model of a crankshaft and cylinder

Optional:
Article no.: SO4203-2V

Aluminium carry case for experiment board



Common Rail Diesel Injection System

Sensors and Actuators
High-pressure Pumps
Piezo-injectors

The advent of high-pressure injection has allowed diesel engines' emission levels to be lowered progressively. Diesel engines have now attained a market share of almost fifty percent in Europe. The latest common rail systems make it possible to realize unprecedented performance and emission levels.

Training contents

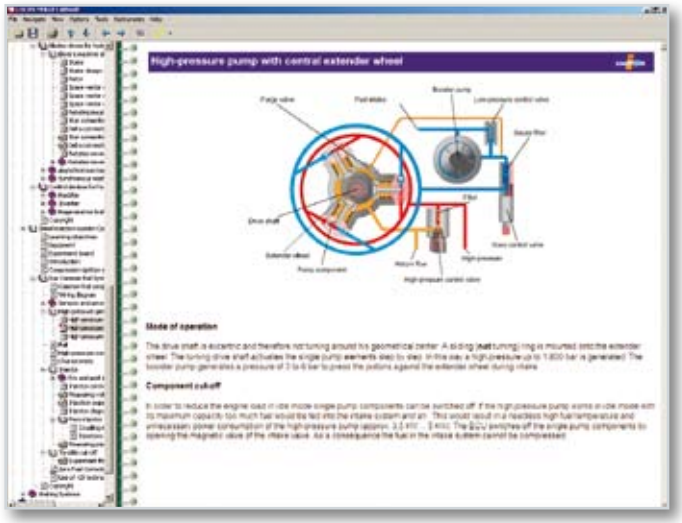
- Requirements for diesel injection systems
- Introduction to various designs
- Design and function of a common rail system
- Fault localization on a common rail system
- Comparison between the injection characteristics of common rail and conventional systems
- Learning about mixture formation and combustion processes
- Investigation of the fuel system
- Fuel injection
- Low- and high-pressure conveyance
- Electrical tests of injectors
- Investigating the hydraulics of a common rail system

Article no.: SO4204-6X, consisting of

1 x CD with "Common rail diesel injection system" course
1 x Experiment board with a mechanical model of a crankshaft and cylinder, as well as an electronic speed gauge

Optional:
Article no.: SO4203-2V

Aluminium carry case for the experiment board



Solar Technology for Motor Vehicles

Function of Solar Cells
Energy Conversion
Automotive Applications

In the case of motor vehicles too, solar energy can help reduce the consumption of fossil energy and, consequently, CO2 emissions. Due to the limited installation areas available, however, only small electrical consumers can presently be supplied by on-board solar cells.

Training contents

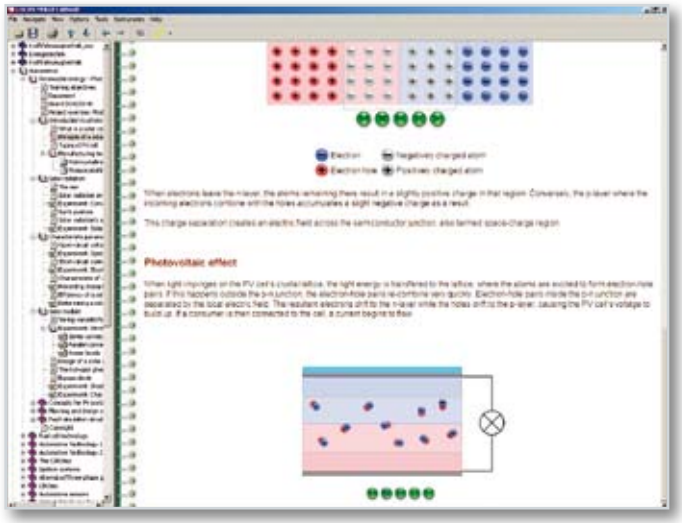
- Introduction to the design and function of solar cells
- Basic concepts related to solar radiation
- Measurement of no-load voltage and short-circuit current
- Determining a solar cell's efficiency
- Possible applications of solar energy in motor vehicles
- Possible installation points for solar cells in motor vehicles
- Limitations on use of solar energy in motor vehicles
- Investigating a solar facility's operation in direct and storage mode

Article no.: SO4204-6N, consisting of

1 x CD with "Solar energy for motor vehicles" course
1 x Experiment board "Photovoltaics"

Optional:
Article no.: SO4203-2V

Aluminium carry case for the experiment board



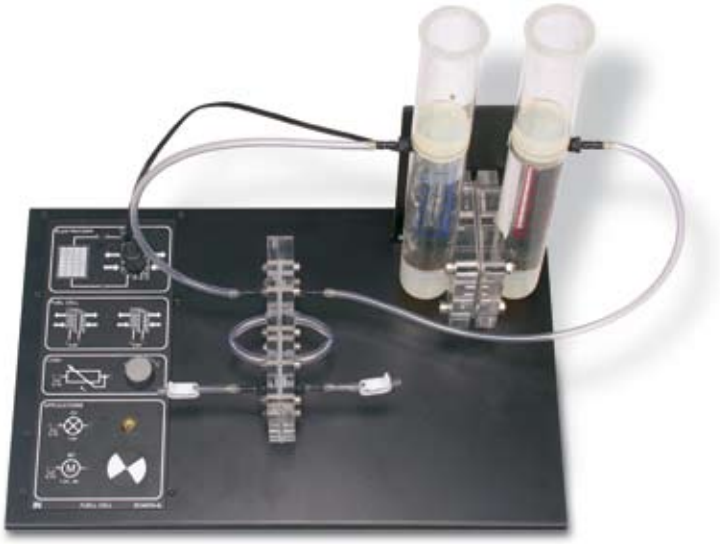
Fuel Cells

Electricity Generation
Components
Drive Concepts

Though fuel cells as power sources for electric drives in motor vehicles are still in the trial stage, they offer distinct advantages compared to accumulators: Longer range, less space and energy production directly according to demand. However, one problem that still has to be solved is the need for a broad-based network of hydrogen supply stations.

Training contents

- Introduction to the design and function of fuel cells
- Components of an automotive fuel-cell drive
- Recording of characteristics
- Advantages and disadvantages of automotive fuel cells
- Description of the chemical processes occurring during electrolysis
- Determining a fuel cell's efficiency
- Investigating series and parallel connections of fuel cells
- Recording an electrolyser's V-I characteristic

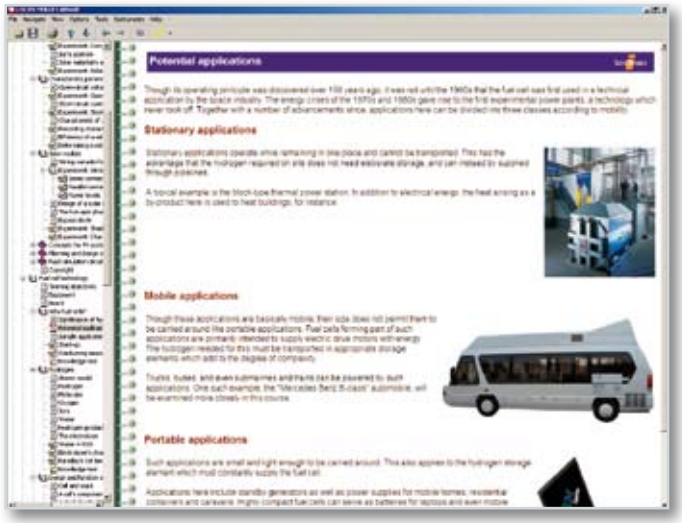


Article no.: SO4204-6M, consisting of

1 x CD with "Fuel cells" course
1 x Experiment board with a fuel cell, electrolyser and electrical consumers

Optional:
Article no.: SO4203-2V

Aluminium carry case for the experiment board



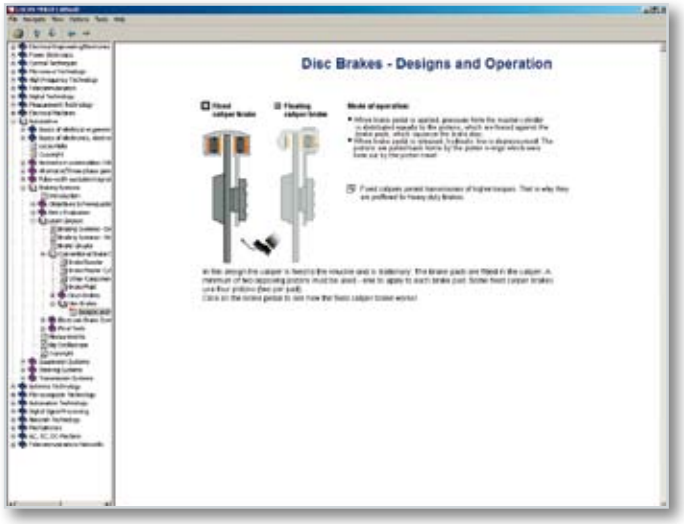
Brake Systems

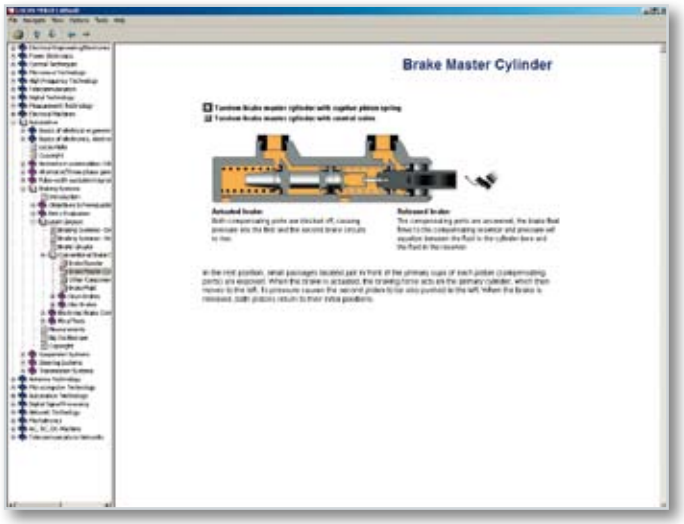
Brake Modules
ABS, ESC, TCS
Brake Assist

Braking systems are becoming ever more complex in modern vehicles. Use of electronic aids such as ABS, traction control and electronic stability control has become standard practice. Electro-mechanical braking (brake-by-wire) has also reached testing phase and will be appearing in new cars soon.

Training contents

- Design of braking systems
- Main brake cylinder
- Brake boosters
- Drum brakes
- Disc brakes
- Anti-lock braking system (ABS)
- Traction control (TCS)
- Electronic stability control (ESC)
- Brake assist
- Electro-hydraulic braking
- Electro-mechanical braking





Article no.: SO4204-6R, consisting of

1 x CD with "Brake systems" course

Chassis Technology

Suspension

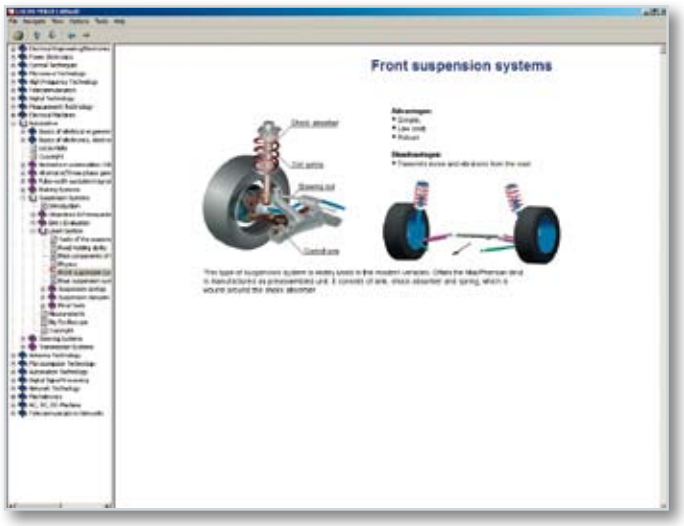
Springs

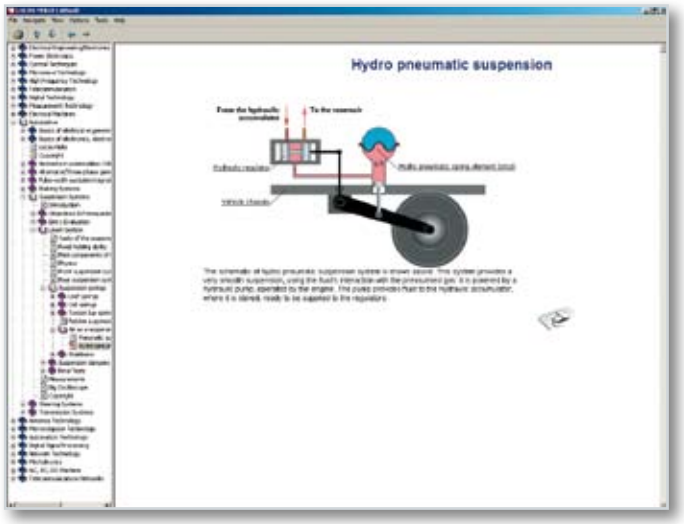
Shock Absorbers

Chassis and suspension systems have to perform a multitude of tasks.For a safe and comfortable journey they have to guarantee good traction while at the same time being able to absorb the impact created by uneven road surfaces.

Training contents

- What a chassis has to do
- Design and components for a chassis suspension
- Front-wheel suspension
- Rear-wheel suspension
- Leaf springs
- Coil springs
- Torsion springs
- Air suspension
- Stabilisers
- Hydraulic shock absorbers
- Telescopic shock absorbers





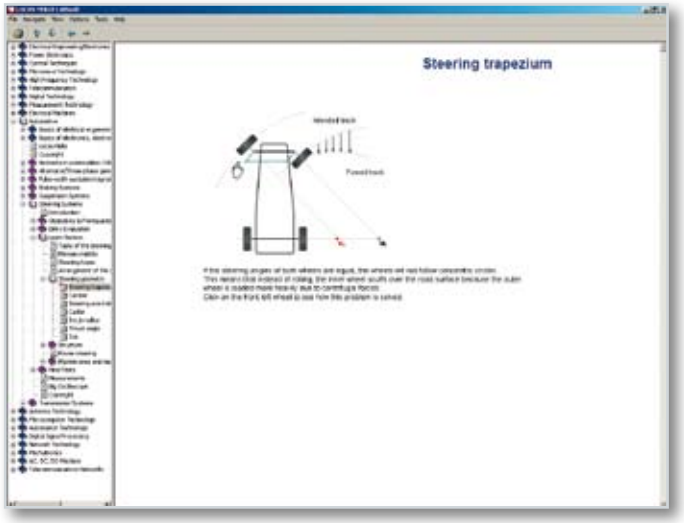
Article no.: SO4204-6S, consisting of

1 x CD with "Chassis technology" course

Steering and Transmission

Training contents

- Design and components of a steering system
- Steering geometry: tracking, camber, castor offset
- Steering axis inclination
- Steering gear and linkage
- Measurement and calibration of steering gear
- Diagnostics

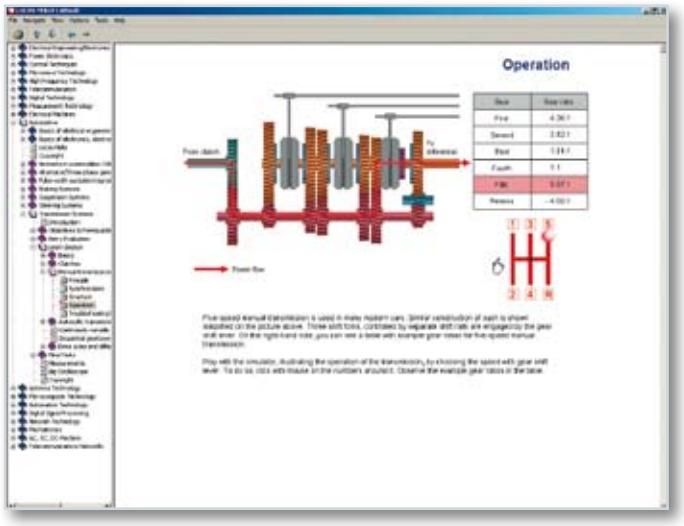


Article no.: SO4204-6T, consisting of

1 x CD with course "Steering systems"

Training contents

- Design and components of a drive train
- Clutch
- Manual and automatic transmission
- Planetary gears and torque converters
- Continuously variable transmission
- Sequential transmission
- Differential transmission
- Drive shafts
- Front-wheel drive, rear-wheel drive, four-wheel drive



Article no.: SO4204-6U, consisting of

1 x CD with "Gearbox and drive train" course

The Whole is Greater than the Sum of its Parts

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