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# Power Engineering | Smart Grid | Micro Grid

## Training systems on the generation, distribution and management of electrical energy:

- Power engineering training system, distribution training system
- Energy generation training system, renewable energy generation training system
- Transformer training system, high-voltage transmission lines training system, protective systems training system
- Energy management training system, smart grid training systems

## The Lucas-Nülle training systems have been designed in anticipation of the newest developments:

- Smart measuring instruments provided with various communication interfaces (e.g. LAN, RS485, USB) and control elements
- SCADA Power Engineering Lab software for the intelligent control and evaluation of "smart grids" using Soft PLC
- SCADA software designed for educational purposes
- Permits investigation of dynamically alternating loads and power generation inside the laboratory
- Intelligent energy management
- Modular integration of renewable energies into a smart grid using protective engineering
- Wind power plant with doubly-fed asynchronous generator (DFIG) and synchronisation to the grid
- Interactive multimedia training course

## Renewable Energies



## **Renewable Energies**

The move away from coal, oil and nuclear power to renewable forms of energy is gaining momentum. Today, technology has evolved to a point where solar energy, wind power, hydrogen fuel and biomass can be exploited as environmentally friendly energy sources.

Throughout the world well-qualified technicians and engineers are being sought after to help keep this trend moving forward. Today, technologies are undergoing rapid change. This trend is being compounded by rising expectations in training and education. Lucas-Nülle has developed the appropriate training systems needed to cope with the ever more complex world of training and education.

## **EWG 2 Small wind power plant trainer**



## **EWG 2 Small wind power plant trainer**

Small wind power plants up to approx. 5 kW power are being deployed today for decentralised power supplies. These plants generate DC voltage. The energy can be stored in accumulator batteries using charge controllers. Inverters are used to generate AC voltage for operating consumers requiring the standard electricity supply voltage. The effects of wind power and the mechanical design of wind power stations can be emulated down to the last detail using the servo machine test stand and the software WindSim. The corresponding Interactive Lab Assistant Multimedia course imparts knowledge, provides interactive experiment setup support and allows for PC-assisted evaluation of the measurement data.

### Training content:

- Understand the design and operation of modern small wind power stations
- Explore the physical fundamentals “from wind to wave“
- Become familiar with different wind power station concepts
- Design and initial operation of a small wind power generator
- Operation with fluctuation wind force in off-line operation
- Energy storage, optimisation of the system
- Design of an off-grid system for the generation of AC voltage
- Explore hybrid systems for off-grid power supply using wind power and photovoltaic systems (wind/solar trainer)

### Basic equipment set, consisting of:

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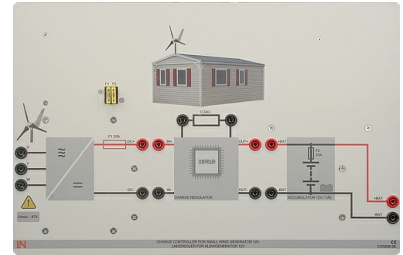
Pos.	Product name	Bestell-Nr.	Anz.
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1 **Charge controller for small wind generator 12 V**

CO3208-3E

1

The charge controller is specially designed for the operation of small-scale wind turbines. It ensures optimum charging of the associated battery. If the battery is unable to charge up any further, the excess energy is converted into heat by means of load resistors. This ensures that there is always a load on the wind generator and prevents it rotating at unacceptably high speeds. In addition to the charge controller itself, both the battery and load resistors are integrated into the package.



The charge controller has the following features:

- Battery voltage 12V
- Charging/discharging current: 20A
- Load resistor 0.34ohms/300W
- Battery capacity 7Ah
- Terminals: 4mm safety sockets
- Dimensions: 297 x 456 x 105mm (HxWxD)
- Weight: 6.3 kg

2 **Synchronous generator 12V for small wind power plant with permanent magnets**

SE2683-1M

1

The generator is a permanently excited synchronous generator of similar design to this used in small-scale wind turbines.

- Voltage with no load: 19 V
- Nominal current: 10 A
- Nominal speed: 1000 rpm
- Nominal power: 0.3 kW
- Provision of motor data by electronic nameplate EDD (Electronic Drive Data)
- Dimensions: 340 x 210 x 210 mm (WxHxD)
- Weight: 9 kg



### 3 Lamp board 12V

CO3208-1K

1

The lamp board allows for study and comparison of halogen and LED lights. The bulbs are of the same brightness and each can be activated individually. This allows for a variety of power-consumption scenarios to be investigated.

The lamp board has the following features:

- Halogen lamps 25W
- LEDs 2W
- Operating voltage: 12V
- Dimensions: 297 x 114 x 210 mm (HxWxD)
- Weight: 1.2 kg



### 4 Load unit 1kOhm, 500W

CO3208-1J

1

Load resistor for solar module and solar power units.

The resistor can be used with the following:

- Solar module/simulation for recording characteristics and load resistance
- Solar charge regulator as load resistance
- Inverter as load resistor

The solar load is equipped with the following features:

- Resistor: 0...1 kOhm / 500 W continuously adjustable, with stepped winding
- Current:
  - 0 – 50 Ohm max. 6A
  - 51 – 200 Ohm max 2A
  - 201- 1k Ohm max 0.6A
- Connection terminals: 4 mm safety sockets
- Dimensions: 297 x 228 x 160 mm (HxWxD)
- Weight: 4.3 kg



## 5 Off-grid inverter 230V, 275VA

CO3208-1F

1

To operate standard commercially available electrical devices used in standalone solar power systems, the generated DC voltage must be converted into AC voltage. The board consists of a commercially available off-grid inverter which generates an output voltage of 230 V AC from an input voltage of 12 V DC. The off-grid inverter is equipped with a deep depletion protection facility with which it can be connected directly to a lead accumulator.

The off-grid inverter is equipped with the following features:

- On/off switch
- LED display of operating status
- Acoustic alarm to signal warnings
- Output voltage: sinusoidal 230V +/- 5%
- Power: 275VA
- Efficiency: 93%
- Safety functions:
  - Cut out for excess battery voltage
  - Over temperature and overload protection
  - Short-circuit protection
  - Pole reversal protection
- Connection terminals: 4 mm safety sockets
- Dimensions: 297 x 228 x 145 mm (HxWxD)
- Weight: 3.1 kg



## 6 Lamp board 230V

CO3208-1L

1

The lamp board permits the investigation and the comparison of light bulb, energy saving lamp and LED bulb.

All illuminant have the same brightness and can be switched on individually.

Technical Data:

- Light bulb: 25W
- Energy saving lamp: 4W
- LED-bulb 4W
- Operating Voltage: 230V/ 50/60Hz
- 3 sockets E27
- Dimensions: 297 x 114 x 210 mm (HxBxT)
- Weight: 1,8 kg



Additionally required, dynamic servo machine test stand:

Pos.	Product name	Bestell-Nr.	Anz.
7	Dynamic servo machine test system for 0.3kW machines incl. software ActiveServo	CO3636-6X	1



The servo-machine test bench is a complete testing system for examining electrical machines and drives. It consists of a digital controller, a brake and the ActiveServo software. The system combines state-of-the-art technology with ease of operation. The system also allows manual and automated synchronization to be carried out.

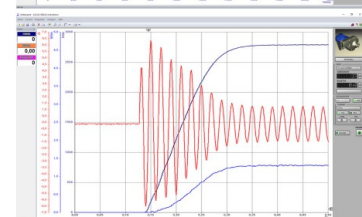
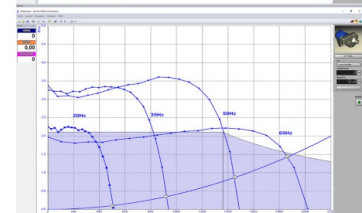
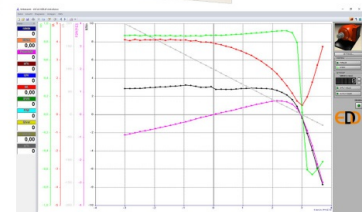
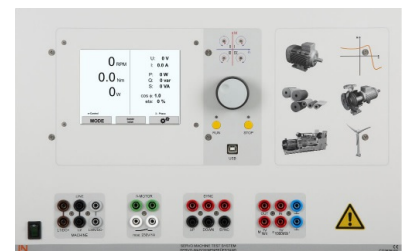
The controller has the following features:

- Dynamic and static four-quadrant operation
- 13 selectable operating modes/machine models (torque control, speed control, flywheel, lifting drive, roller/calander, fan, pump, compressor, winding gear, arbitrarily defined time-dependent load, manual and automated network synchronization)
- Testing for the presence of a shaft cover.
- Disconnection of the supply voltage of the motor under test in the absence of shaft cover
- Interface for reading electronic nameplates EDD of the machines under test
- Integrated galvanically isolated amplifier for voltage and current measurement
- 5.7" colour touch display
- Four-quadrant monitor
- Isolated USB interface
- Thermal monitoring of the machine under test
- Connection voltage: 400V, 45...65Hz
- Maximum power output: 4kVA
- Dimensions: 297 x 460 x 420mm (HxWxD)
- Weight: 16.5kg

The brake is self-cooled asynchronous servo-brake with resolver.

The motor and sensor leads are connected via polarity-safe plugs. The machine has thermal monitoring and, in conjunction with the controller, it constitutes a driving and braking system that is free of drift and requires no calibration.

- Maximum speed: 4000rpm
- Maximum torque 10Nm



- Temperature monitoring: continuous temperature sensor (PT1000)
- Resolver resolution: 65536 pulses/revolution
- Dimensions: 275 x 210 x 210mm (WxHxD)
- Weight: 6kg

ActiveServo is a program for recording characteristics of machines and for determining dynamic and static operating points. It emulates eight different loads (flywheel, pump, fan, calander, lifting drive, compressor, winding gear, arbitrarily configurable time-dependent load) for which the parameters can be individually configured.

Features:

- Measurement, calculation and display of mechanical and electrical variables
- (Speed, torque, mechanical power output, current, voltage, active, apparent and reactive power, efficiency, power factor)
- Simultaneous display of measured and calculated values (e.g. instant display of efficiency)
- Measurement of voltage and current (including RMS values even for non-sinusoidal waveforms)
- Configuration of settings via electronic nameplates EDD of the DUTs
- Speed or torque-controlled operation
- Recording of variables over time
- Programming of limiting values of speed or torque to prevent inappropriate loading of the machine under test.
- Operation in all four quadrants (display of generated torque)
- Arbitrarily defined ramp functions for PC-controlled load experiments
- Display of characteristics from several experiments to better illustrate the effect of parameter changes
- Export of graphics and measurements

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## 8 Rubber coupling sleeve, 0.3kW

SE2662-2A

1

Rubber coupling sleeve used for the coupling of two machines

- Permits rapid and safe assembly
- Designed with internal ring gear
- Material: rubber (neoprene)
- Dimensions: 40 x 45mm (length x diameter)
- Weight: 0.1kg



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9 **Coupling guard 0.3kW with LED lighting**

SE2662-7C

1

Connectable plastic guard as contact protection of the rotating coupling between two coupled machines

- Equipment: MacroLon clear with function plug
- Integrated lighting signals correct operation of safety functions
- Dimensions: 135 x 80 x 85 mm (H x W x D)
- Weight: 0.2 kg

Media:



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Pos.	Product name	Bestell-Nr.	Anz.
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10 **Interactive Lab Assistant: Small wind power plants**

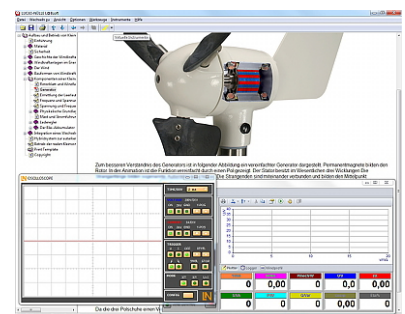
SO2800-3Q

1

The experiment instructions are provided by an interactive lab wizard course. This multimedia course guides students step by step through the topics of design and operation of small-scale wind turbines. Physical principles are explained by means of easily understood animations. The interactive lab wizard combined with virtual instruments creates a comfortable environment for experiments.

Features:

- Interactive experiment set-up
- Measurements and graphics can be saved in the experiment instruction pages themselves by means of drag and drop.
- Virtual instruments can be started directly from the experiment instruction pages
- Questions with feedback and evaluating logic to test knowledge
- Printed document for easy print-out of the experiment instructions complete with results
- CD-ROM with Labsoft browser, course software and virtual instruments



## Measuring instruments:

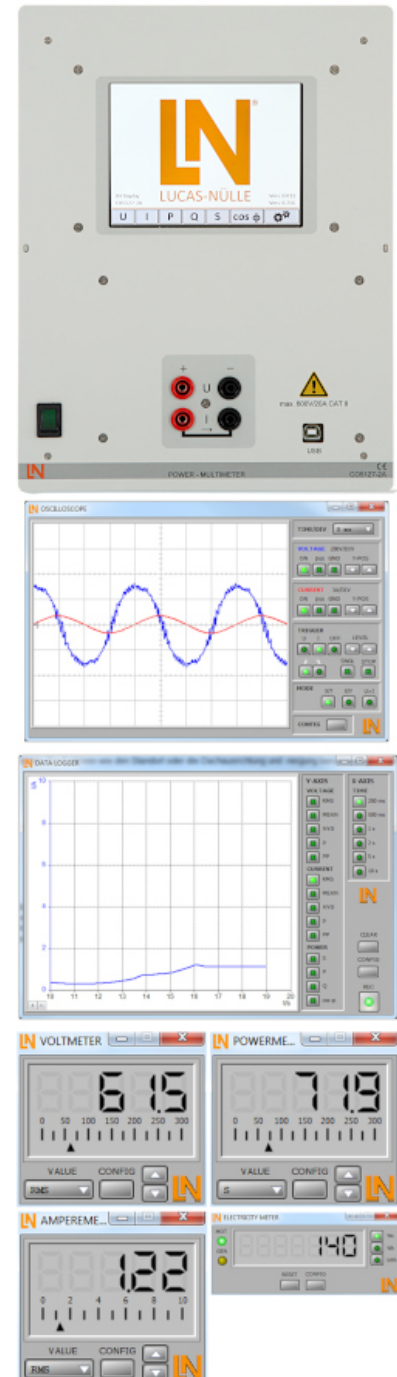
Pos.	Product name	Bestell-Nr.	Anz.
11	<b>Power-Multimeter</b>	CO5127-2A	1

The areas of electrical machines, power electronics and drive technology pose particular problems for measuring instruments. In addition to high-performance overload protection, the acquisition of measurement values must be performed accurately independently of the curve's shape. The universal measuring device has been designed particularly to satisfy these requirements. It can simultaneously replace as many as four different measuring instruments – constituting a current/voltmeter, power and phase-angle meter all in one. The graphic display allows for both student as well demonstration experiments. The VI Starter software included allows for visualisation of measurements on a PC.

- Simultaneous, measurement of voltage and current independent of the curve shape (max. 600 V, 20 A) (measurement of clocked voltages)
- Calculation of active, apparent and reactive power as well as the power factor
- Measurement of the total rms (RMS-AC+DC), AC rms (RMS-AC) and arithmetic mean (AV-AC+DC)
- Impervious to electrical damage up to 20 A/600 V
- Large-scale, touch colour graphic display (5.7")
- Large-scale display or display of up to 4 measurement values
- Digital or pseudo-analog display
- Isolated USB interface
- Internal resistance: current path 10 mΩ, voltage path 10 MΩ
- Voltage ranges: 30, 300, 600 V
- Current ranges: 1, 10, 20 A
- Measurement accuracy: 2%
- Automatic or manual measurement range selection
- Demonstration test instrument for measuring properties of the electricity supply
- Operating voltage: 230V, 50/60Hz
- Dimensions: 297 x 228 x 85 mm (HxBxT)
- Weight: 1.5 kg

The VI Starter software allows all the measurements to be displayed on the PC. Up to 17 different displays can be opened.

- Oscilloscope display of voltage, current and power
- Consumption meter to display power consumed and output
- Data logger for 14 different variables
- Data export for data logger
- Characteristic recorder
- LabVIEW driver and supplied examples



Accessories:

Pos.	Product name	Bestell-Nr.	Anz.
12	<b>Safety connecting plug 4mm with tap (2x), black, 1000V/32A CAT II</b>	SO5126-3R	25

Moulded insulation

- both sides with touch protection (safety plug + safety sockets), distance 19 mm
- transition resistance max. 6 mΩ
- rated data: 1000 V / 32 A CAT II
- colour black



13 **Set of safety measurement cables, 4mm (31 leads)**

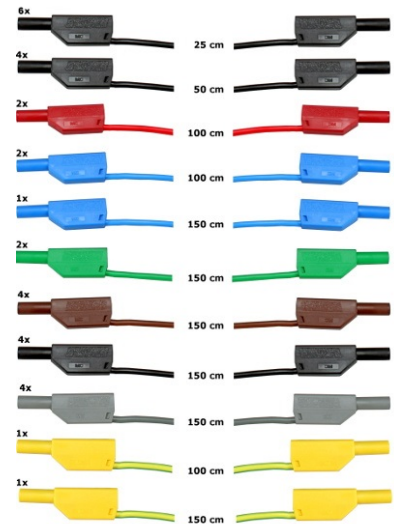
SO5148-1L

1

Safety measurement cables with 4mm safety plugs, coloured, PVC insulation, highly flexible

Each set includes the following:

- 6 x 25cm long, black
- 4 x 50cm long, black
- 2 x 100cm long, blue
- 2 x 100cm long, red
- 1 x 100cm long, green/yellow
- 1 x 150cm long, blue
- 1 x 150cm long, green/yellow
- 2 x 150cm long, green
- 4 x 150cm long, brown
- 4 x 150cm long, black
- 4 x 150cm long, grey
- Wire cross section 2.5 mm<sup>2</sup>
- Capacity/category: 600V CAT II, 32A



14 **Mobile aluminum experiment stand, 3 levels, power strip with 6 sockets, 49"x28"x79" WxDxH (1250x700x1995mm)**

ST7200-4C

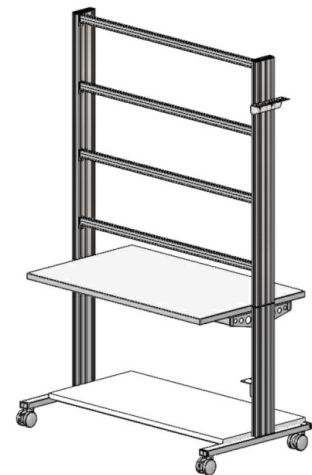
1

High-quality mobile experiment and demonstration trolley from the SybaPro range featuring aluminium table legs and low-level shelf. This trolley is suitable for mounting under-table cabinets and is compatible with all add-ons and extensions in the SybaPro range.

It is supplied with one shelf, an angle bracket for attaching a PC and a cable holder.

#### Table top + Shelf:

- 30-mm table top made of highly compressed, multi-layer fine chipboard conforming to DIN EN 438-1
- Colour grey, RAL 7035, with 0.8-mm slightly textured laminate coating (Resopal) on both sides, conforming to DIN 16926
- Resistant to many chemicals and reagents including dilute acids and alkalis
- Resistant to heat, e.g. molten solder or heating at specific points such as by soldering tips or cigarette ends
- Frame with solid impact-resistant protective edging made of 3mm thick RAL 7047 coloured plastic
- Coating and adhesive are PVC free
- Power strip with 6 outlet sockets mounted underneath the table top, lead and earthed plug



#### Frame:

- 2 extruded aluminium profiles with multiple grooves 1800 x 120 x 40 mm (WxHxD)
- 8 equally sized grooves in extruded aluminium profiles (3 on each side and 1 each on the front and back)
- Grooves accommodate standard industrial mountings
- 4 H-shaped aluminium profiles, 1150 mm, for 3-layer organisation of DIN A4 panels
- Space for extension of power supply duct
- Base made of rectangular tubing with 4 swiveling double casters, 2 of which have brakes
- Table frame made of tough combination of rectangular tubing around the full perimeter
- Acid-resistant epoxy-resin coating, 80 µm thick (approx.), colour RAL 7047

#### Cable holder:

- Width 200 mm with 12 cable slots to accommodate 48 x 4-mm safety measurement leads

#### PC attachment bracket:

- With 3 screw-on rubber stoppers, dimensions 65x65x114 mm approx. (top fixing for PC)

- > The height of the cable holder and PC attachment bracket can be adjusted along the aluminium profiles
- > For attachment to left or right, fastening materials included
- > Acid-resistant epoxy-resin powder coating of thickness 80 µm approx., colour RAL 7047

Dimensions:

- Height of table top 760 mm
- 1250 x 1970 x 700 mm (WxHxD)

The mobile experiment stand is supplied in kit form and needs to be assembled by customers themselves.

**15 Monitor holder for flat screen monitor of weight up to 15 kg / 33 lbs VESA 75/100**

ST8010-4T

1

Pivoting monitor holder for attachment to aluminium profiles of furniture in the SybaPro range. Allows a monitor to be placed in the optimum position so that work and experiments are less tiring.



- Pivoting arm with two-part joint
- Quick-lock for adjustment to any height on extruded aluminium profile
- VESA fastening 7.5 x 7.5cm
- Includes VESA 75 (7.5x7.5) - VESA 100 (10x10) adapter
- 2 Cable clips
- Adequate carrying capacity 15 kg / 33 lbs
- TFT monitor can be turned parallel to the table edge
- Separation can be adjusted to anywhere between 105 and 480 mm

Additionally included:

Cable management set for installing cables along the profiles of the aluminium lab system furniture in the SybaPro range, consisting of:

- 3 Cross cable binders for front and rear grooves of aluminium profile
- 3 Cross cable binders for side grooves of aluminium profile
- 12 Cable ties
- 4 Aluminium cover profiles for covering and enabling wires to be run along the grooves of an aluminium profile

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## 16 Keyboard adapter for flat screen monitor holders

ST8010-4G

1

Keyboard adapter for use in combination with flat screen monitor holders

- Mounted between monitor and mount for flat screen monitor holder
- Variable 3-level height adjustment via multiple pre-drilled mounting holes
- Two rows of mounting holes for use with equipment meeting VESA 75 and VESA 100 standards
- Keyboard shelf inclined by about 30° for comfortable and ergonomic usability
- Keyboard shelf with 11-mm folded edging to prevent falling, including handle
- Variable 2-level depth attachment for keyboard shelf (252/276 mm)
- Extra-wide keyboard shelf (640 mm) can accommodate a mouse as well
- Depth of keyboard shelf 172 mm
- Includes two cable clips for guiding and bundling cables
- Maximum load 10 kg
- Dimensions (HxWxD) 360 x 640 x 276 mm



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## 17 Protection cover for three-level experiment trolleys

ST8010-9Y

1

Dust cover for three-level experiment trolleys

- For protecting equipment from dust and damp
- For keeping equipment out of sight (the cover must not be transparent, so is therefore opaque)
- Colour: matt dark grey with printed LN logo in orange)
- Material: nylon fabric with polyurethane coating
- High resistant to tearing, impregnated to be washable and waterproof





## Additionally recommended

### Small wind power plants for outdoors and presentation

#### Training content:

- Understand the design and operation of modern, small wind power plants
- How to set up, put into operation and operate an authentic small wind power plant
- Explore the physical fundamentals “from wind to shaft“
- Set up and put into operation a small wind power generator
- Outdoor operation

Pos.	Product name	Bestell-Nr.	Anz.
18	<b>Small-scale wind turbine 370W, with demonstration mast</b>	CO3208-3F	1

This small-scale wind turbine is suitable both for laboratory demonstrations or use outdoors. Its built-in permanent-field synchronous generator produces direct current, which can then be stored by a rechargeable battery. The rotor blades can be adjusted in a manner similar to the pitch adjustment used in large-scale wind power plants.

The small-scale wind turbine possesses the following features:

- Power output: 370W
- Nominal wind speed 12.5m/s
- Rotor diameter 1.2m
- Control of rotor blades dependent on wind speed
- Permanent-field generator, 3-phase with rectifier
- Demonstration mast with base, made of V2A steel
- Height of generator axle: 1.5m
- Weight: 18.3kg



19 Mast set for small-scale wind turbine

CO3208-3G

1

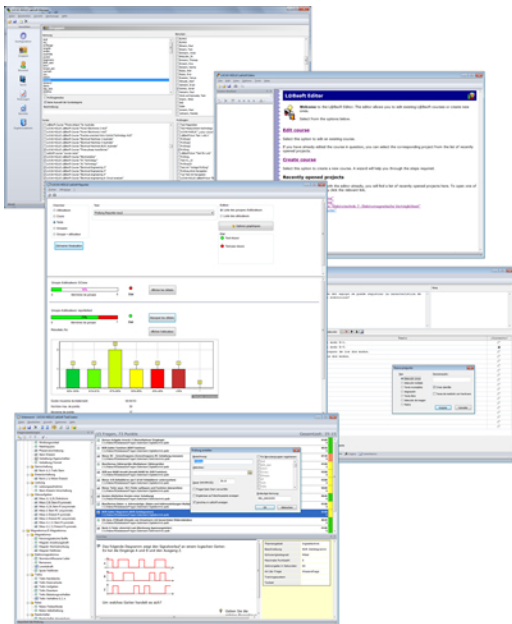
The mast set allows the small-scale wind turbine set to be used out of doors. It includes an extension to the supplied mast along with guy cables, bracing and anchoring for attaching to the ground. Use of this mast set raises the axle of the wind turbine to a height of 3m.

The mast set includes the following components:

- Mast extension, 1.5m with bracing eyelets, made of VA steel
- 3 Guying cables, diam. 3mm, made of steel
- 3 Cable tensioners
- 3 Ground anchors
- Weight: 8.3kg



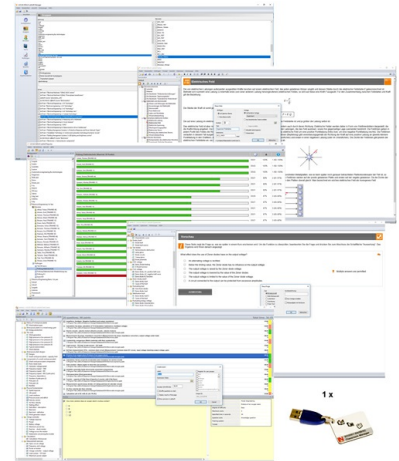
Recommended learning management software for all LN multimedia courses:



Pos.	Product name	Bestell-Nr.	Anz.
20	LabSoft Classroom Manager 5.0 software suite, single license	SO2001-5A	1

LabSoft Classroom Manager is a comprehensive set of administration software for the UniTrain system and all LabSoft courses. Classroom Manager comprises the following independent program components:

- LabSoft Manager: Administration of students and courses in LabSoft
- LabSoft Reporter: Student reports and statistics
- LabSoft Editor: Creation and editing of courses and tests
- LabSoft Questioner: Creation of questions, measuring exercises and sets of questions for courses and tests
- LabSoft TestCreator: Automatic generation of tests on the basis of sets of questions



Features:

- Ease of use of all programs thanks to graphical user interface in all component programs
- For use in local area networks or on stand-alone PC
- Ease of installation
- No additional database software required
- Access control via USB dongle
- Available languages: DE, EN, ES, FR, RU, PT, ZH, LO

LabSoft Manager:

- Administration of LabSoft network installation
- Administration of an unlimited number of students and courses in LabSoft
- Addition, deletion and editing of courses and tests in LabSoft
- Addition, deletion and editing of students and student data
- Addition, deletion and editing of student groups (classes)
- Assignment of students to classes
- Activation of team function in LabSoft
- Assignment of courses and tests to students or classes

LabSoft Reporter:

- Electronic monitoring of student progress
- Graphical presentation of progress in courses and tests
- Presentation of student or group results
- Reports on courses, tests, single users or classes
- Summary of results and time
- Export of data to clipboard or file
- Display and printing of tests which have been taken with the candidate's original answers

- Multiple search options for students, classes, courses or tests

#### LabSoft Editor:

- HTML editor for easy to use editing of LabSoft courses
- Editing of course pages
- Wizard for creation of new courses and course pages
- Automatic inclusion of new courses in an existing LabSoft installation
- Automatic creation of IMS-compatible navigation tree without the need for programming knowledge
- Moving course pages within the navigation tree at the click of a mouse
- Editing in WYSIWYG mode
- HTML view and page preview
- Insertion of graphics, animations and tables
- Insertion of test questions
- Page templates for a variety of page types

#### LabSoft Questioner:

- Program for creating and editing questions, practical measuring exercises and sets of questions (question files) for electronic evaluation
- Easy creation of exercises and questions for courses and tests
- 7 different types of question: single and multiple choice, missing text, assignment, matrices, arbitrary text, selection of images
- Ability to input meta data (points, time for questions, difficulty, required resources, etc.)
- Easy specification of tolerances for practical measuring exercises
- Changes to the assessment criteria for courses or tests (including after the test has been taken)

#### LabSoft TestCreator:

- Program for automatically creating electronic tests from sets of questions (question files)
- Automatic and manual selection of questions and measuring exercises
- Filter functions (e.g.: type of question, difficulty) for pre-selection of questions
- Automatic generation of tests according to a set time or number of questions
- Various test options: arbitrary order of questions in a test, immediate display of results after completion
- Automatic registration of tests in LabSoft
- Preview function showing the test as created

#### Includes:

- CD-ROM with LabSoft Classroom Manager
- 1 USB-dongle for operation of program

System requirements:

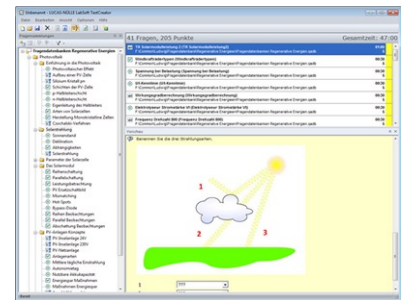
- Server or PC with Windows 7, 8, 8.1 or 10
- Microsoft Internet Explorer 9.0 or higher
- Minimum 200 MB free disk space
- 1 free USB-port for USB-dongle

## 21 Collection of assignments Power Engineering / Renewable Energies

SO2001-6D

1

Collection of electronic assignments questions and measuring exercises for the UniTrain courses on the topic of electrical power engineering and renewable energies. With the help of Labsoft TestCreator, these questions and measuring exercises can easily be assembled into electronic tests. The tests can then be carried out in LabSoft.



- A total of some 200 questions and measuring exercises for the UniTrain courses on the topics of Photovoltaics, Fuel cell technology, Transient processes in AC and DC networks and the multimedia course Small wind power plant
- About 25% are practical exercises to be carried using the training systems in order to test handling skills and practical abilities
- About 30% are newly assembled questions previously contained in the courses
- It is possible to extend the collection with your own questions and assignments
- Other collections can be imported
- All questions and assignments can be edited
- 6 different types of questions (single choice, multiple choice, missing text, matching, matrix matching and image choice)
- Extensive metadata for all questions and assignments to make it easier to create tests (degree of difficulty, points, topic area, time to complete, type of question, training systems needed for practical exercises)