DIVERSITY IS OUR STRENGTH

The solutions presented by our brands

- LEYBOLD
- ELWE TECHNIK
- FEEDBACK

allow us to provide you with a comprehensive range of didactic technical teaching systems:

**MULTIMEDIA**
- COM3LAB - the multimedia laboratory for electrical engineering and electronics

**AUTOMOTIVE TECHNOLOGY**
- Electromobility
- Driver assistance systems

**RENEWABLE ENERGY**
- LEYBOLD Plug-in system STE

**ELECTRICAL ENGINEERING**
- Plantsimulation
- Industry 4.0
- Automation
- Electrical Machines
Our systems are particularly suitable for the following areas of teaching and learning:

- Vocational schools
- Master craftsman / Technical schools
- Universities and advanced technical colleges as well as
- In-service training
- Schools with technical classes

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COM3LAB - 4-channel oscilloscope  p. 5
COM3LAB EasyConnect  p. 6
COM3LAB software  p. 6
COM3LAB courses communications technology  p. 7

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COM3LAB
THE MASTER UNIT

CHARACTERISTICS

- Interface for tablet, PC and laptop
- Simple and quick assembly and disassembly
- Intuitive studying
- Functional design through clear lettering and layout
- Active guidance
- Compatible with existing courses
- Digital analyser, function generator and frequency counter
- Integrated USB interface for external measuring devices
- USB charging socket for tablets
- Network interface, WiFi and USB
- Security lock for fixing the experiment boards
- Anti-theft protection (port for Kensington Lock)

LABORATORY WITH VIRTUAL MEASURING DEVICES

On all COM3LAB courses users have the full measurement laboratory provided by the Master Unit (two multimeters, 4-channel oscilloscope, function generator, spectrum analyser and digital analyser). This allows diverse complex electronic systems to be measured and analysed precisely using only the Master Unit and the COM3LAB software.
MULTIMEDIA

4-CHANNEL OSCILLOSCOPE

THE NEW 4-CHANNEL OSCILLOSCOPE

This new software module communicates bi-directionally with the 4-channel oscilloscope on the Master Unit and therefore enables the utilisation of this measuring device in the COM3LAB courses.

ADVANTAGES OF THE NEW 4-CHANNEL OSCILLOSCOPE

- Simultaneous measurement and analysis of voltage and current signals of all three phases for COM3LAB courses:
  - Power Electronics I (700 2101)
  - Power Electronics II (700 22)
  - Three Phase Technology (700 2401)
  - Electrical Machines (700 2501)

- Simultaneous measurement and analysis of voltage signals (Input / Output / Intermediate positions) of the control systems and simultaneous measurement of reference, manipulated and control variables for COM3LAB courses:
  - Control Technology I: (700 8201)
  - Control Technology II: (700 83)

CHARACTERISTICS

- 4 differential inputs
- Measurement rate: 1 M sample second per channel
- Resolution: 12 bit per channel
- Memory depth: 1 K sample per channel
The Master Unit can be transformed into a wireless access point in a few seconds and with only one press of a button (hold the on/off switch) so any standard notebook or Windows tablet can be connected.

The new EasyConnect function complements the previous connectivity possibilities between the Master Unit and the PC/notebook/tablet, such as e.g. USB interface, an interface between the Master Unit and an existing (W)LAN network.

**ADVANTAGES OF THE NEW EASYCONNECT FUNCTION**
- No additional cables (USB or LAN) required
- No existing network (LAN or WLAN) required
- Quick and easy connection set-up

**CHARACTERISTICS**
- 802.11 access point with an ESSID name

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All course contents can be tested as DEMO version without the hardware courses.

A free of charge full version can be downloaded on our website quickly and easy.

We provide „how to use“ instructions on our YouTube channel. Just type "LD COM3LAB Demo" in the YouTube search box.

“How to use: COM3LAB Demo - English”
User name: demo, password: demo

**ADVANTAGES**
- COM3LAB can be used in international classes as you can switch between languages as required
- Compatible with Windows 7, 8 and 10

**CHARACTERISTICS**
- Parallel installation of all languages is possible
- In addition, a voice output for selected courses can be installed

---

**COM3LAB SOFTWARE**

FREE OF CHARGE AT WWW.LD-DIDACTIC.COM
The communication technology courses are now also suitable for Windows 64-bit systems. The adaptation means that the courses are compatible with the Windows operating systems 7, 8 and 10.

**LEARNING OBJECTIVES**

- Learning basic physical principles
- Knowledge of different transmission methods
- Independent application and design of the transmission media

**AREAS OF LEARNING**

- Installation and maintenance of information and communication systems for aircraft
- Recording and representation of signal processing operations in information technology equipment

**TARGET GROUPS**

- Vocational schools (aircraft electronics technician, information electronics technician)
- Advanced technical colleges/universities (communications technology)

---

**CHARACTERISTICS**

- Signal generator
- Stereo (de)coder, RDS coder
- FM transmitter in hybrid module technology (SMD) and FM tuner with RDS function
- Transmission/reception frequency 433.75 MHz – licence-free ISM frequency
- Telescopic aerial
- Amplifier with loudspeaker

**TOPICS**

**COMMUNICATION / RF TECHNOLOGY**

- Modulation/demodulation
- Stereophony and RDS
- Transmitting aerial, FM tuner
- Signal transmission (alphanumeric data, telematics, telemetry, cryptography) – two Master Units and the two courses are required.
**ELECTROMOBILITY**

**HIGH VOLTAGE TRAINER**

---

**CHARACTERISTICS**

- **Power supply:** 3 x 400 V AC, 50 Hz
- **CEE socket connection**
  - 400 V / 16 A, 6 h, male
- **HV DC:** ~201 V DC
- **On-board voltage supply:** 12 V DC
- **Charging socket:** Type 2
- **Operating modes:** Off, Cut, Measure
- **Rated connected load**
  - E-motor: $P_n = 0.3$ kW
- **Maximum motor current:** $I_{\text{max}} = 3 \times 0.2$ A
  - (short-term 2 x 0.7 A @ t<30 sec.)
- **Connection voltage, E-motor:** 3 x 230 V AC
- **Weight:** approx. 40 kg

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**ADVANTAGES**

- Non-hazardous in use
- Integrated into the new curriculum

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**TOPICS**

- Standards and safety guidelines, safety rules
- Dual voltage on-board power supply systems
- Connection systems for HV cables
- Functionality of electrical drives
- Components in HV systems
- The asynchronous machine as a traction motor
- Accident prevention regulations
- Original safety disconnection plug and safety line
- Testing HV power supply
- Monitoring device
- Switchable crash signal with evaluation
- Monitoring of isolation resistance according to ISO 6469-3
- Testing isolation resistance
- Protection measures in motor vehicles
- Establishing “HV intrinsically safe vehicle”
- Disconnection procedure
- Protection against reconnection
- Hazards due to the influence of electric current
- Charging systems and operating modes
- Logical OR circuits (Wired-OR)
- Criteria for the utilisation of testing equipment
- HV-DC/DC converter
- HV air conditioning compressor
- Diagnostics for malfunctions on HV systems
- Working with circuit diagrams
- Service and repair

---

**ELECTROMOBILITY**

**HIGH VOLTAGE TRAINER**
The power grid of an electric vehicle is an on-board Class B voltage network, and is an isolated power supply system when in driving mode. Students can undertake practical exercises with the automotive high voltage trainer in handling the high-voltage components in hybrid/electric vehicles, regardless of the brand of the vehicle. The trainer is not only suitable for class demonstrations by a teacher but also for practical training by students.

The system is designed in a way that measurements can be performed safely and without special safety equipment. This means that the cutting and disconnection of HV components can be done safely, under load, as part of the teaching process and so effects such as arcing are visible.

After being cut, new high-voltage cables must be pre-assembled and installed.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Art. No.</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>739 947</td>
<td>Automotive high-voltage trainer</td>
</tr>
<tr>
<td>1</td>
<td>732 104</td>
<td>Squirrel cage motor 230/400 0.3</td>
</tr>
<tr>
<td>1</td>
<td>739 949</td>
<td>HV PC measuring adapter for electrical mobility</td>
</tr>
<tr>
<td>1</td>
<td>689 0817</td>
<td>HV tool kit</td>
</tr>
<tr>
<td>1</td>
<td>739 950</td>
<td>Charging cable, mode 2, 1 ~</td>
</tr>
<tr>
<td>1</td>
<td>731 07</td>
<td>Shaft end cover</td>
</tr>
<tr>
<td>1</td>
<td>689 0819</td>
<td>HV cable</td>
</tr>
<tr>
<td>1</td>
<td>689 0818</td>
<td>HV cable set, 3 units</td>
</tr>
</tbody>
</table>

LEARNING OBJECTIVES

- The students can inspect and repair hybrid and high-voltage systems, their components and system extensions
- Identifying components (high-voltage batteries, inverter, converter, electric motor)
- Planning the diagnosis and repair for high-voltage systems and their components
- Risk assessment from measurements under voltage (touch and arc protection)
- Performance of measurements (insulation, potential equalization, voltage drop measurement, battery cell voltage, temperature determination) under tension with diagnostic and measuring equipment (high-voltage measuring devices)
- Testing of functions (control signals of the electric motor when driving) on high-voltage systems
- Evaluation of measured values and signals for plausibility and creating test reports
- Repair of high-voltage components in accordance with the manufacturer’s specifications
- Switching of modules in components and manufacture of high-voltage lines in compliance with the electromagnetic compatibility with different connection technologies (adaptation of high-voltage lines)

<table>
<thead>
<tr>
<th>Quantity</th>
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<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>739 948</td>
<td>Private charging station</td>
</tr>
<tr>
<td>1</td>
<td>739 951</td>
<td>Charging cable, mode 3, 3 ~</td>
</tr>
</tbody>
</table>

MORE INFORMATION CAN BE FOUND IN OUR WEB SHOP AT WWW.LEYBOLD-SHOP.COM.
Energy-efficient systems are implemented to reduce the electrical power consumption in a modern passenger car. The electromechanical power steering system requires high steering assistance power from the on-board 12 V electrical system only when needed. To achieve this permanently excited DC shunt motors are used located directly on the steering column. The steering torque sensor detects the manual steering torque applied by the driver via the steering wheel as an input value. Torque assistance, appropriate for the respective drive situation, is then generated from this input value, taking into account other environmental values. Only new original vehicle parts are considered in this application.

**LEARNING OBJECTIVES**

- Analysis of the suspension systems in the vehicle
- Evaluation of the vehicle self-diagnosis
- Analogue, digital and computer-integrated sensor and actuator technology
- Manufacturer-specific network maps and topologies
- Data exchange and system interfaces
- Different types of networking for control devices
- Databus systems, voltage level, timing, cabling technology

**TOPICS**

- Comparison of electrical and hydraulic power steering
- Functionality of torque sensors
- Design and construction of torsion bars
- Function of worm gears
- Self-locking and non-self-locking gearboxes
- Gearbox efficiency
- Personalised parameter sets
- Directional stability corrector e.g. with side winds
- Automatic parking assistant
- Lane keeping assistant
- Active steering for ESP support

**TOUCH & FEEL:**

- Physiological experience of the steering assistance
The STE CAN databus node is a didactic CAN databus node designed as a plug-in element that is used for recording a sensor signal and generating an actuator signal. With up to 4 modules, a high-speed CAN network can be configured on a plug-in board. The intelligent ID assignment “AutoID” assists the user. Configuration by a PC is not required. The databus nodes recognise each other and are Plug & Play capable, i.e. they can be plugged in or unplugged during ongoing operation. Each module can evaluate a sensor signal. The following sensors are supported:
- Analogue sensors with output voltages of up to +12 V
- Digital sensors with an output voltage of +5 V or +12 V
- Sensors with PWM interface

Accordingly, every module can also generate an output signal. The following signals can be generated:
- Analogue signals
- PWM signals

Apart from the data messages, network messages (NWM) are also generated by which the participants can be arranged in the topology. Furthermore, the CAN databus is characterised by the following features:
- Active error management via CAN-Retry
- Configuration without computer via CAN-AutoDetect

All common ISO faults can easily be applied to the CAN databus. The device is of course short-circuit proof and protected against overload. The CAN signals can be examined with an oscilloscope, with Sensor-CASSY 2 (524 013SKFZ) or with the protocol analyser CAN Bus multi-adapter (773 961).

**LEARNING OBJECTIVES**
- Analogue, digital and computer-integrated sensor and actuator technology
- Manufacturer-specific network maps and topologies
- Data exchange and system interfaces
- Different types of networking for control devices
- DATABUS systems, voltage level, timing, cabling technology
- Manufacturer independent teaching of databus basics

### CHARACTERISTICS
- CAN databus: class C
- Transmission rate: 500 kbps
- Power supply: 12 – 15 V DC
- Permissible sensor voltage: ±12 V
- Output power: 6 W
- Short-circuit protection: yes

### TOPICS
- Design and structure of a CAN bus network
- CAN messaging structure: ID and data
- ISO compliant handling of bus errors
- Connection of sensors and actuators

### TABLE

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Art. No.</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>758 201</td>
<td>CAN-Databus node, STE 6/50/100</td>
</tr>
<tr>
<td>1</td>
<td>758 205</td>
<td>Stage switch for blower, STE 4/50</td>
</tr>
<tr>
<td>1</td>
<td>758 206</td>
<td>Blower, STE 4/50</td>
</tr>
</tbody>
</table>
RENEWABLE ENERGY
LEYBOLD PLUG-IN SYSTEM STE

TOPICS AND SCOPE OF EXPERIMENTS

- Fundamental principles for power generation using photovoltaics and wind energy as well as the fundamental principles for energy storage systems
- Analysis of the power fluctuations in grids drives, photovoltaic systems and wind energy plants
- Experiments on supplying a building using conventional power stations and in combination with photovoltaic systems, wind energy and energy storage
- Experiments on voltage behaviour in a radial distribution network with photovoltaic systems depending on consumption, and with the implementation of intelligent local network stations, energy storage and load management
- Scenario experiments for conductor cable monitoring and for more complex Smart Grid systems as well as their behaviour in the case of a fault

The proportion of renewable power stations has now reached a point such that security of supply based on tried and tested grid principles can no longer be guaranteed.

“Smart” concepts, which provide the integration of smart grid components can solve these problems. However, the resulting changes are extensive. Current consumption-oriented generation will have to convert to production-oriented consumption with associated changes to training requirements.

The LEYBOLD STE „Smart Grid“ has demonstrative experiments on these topics:

- Volatile production
- Operation of the conventional power grid
- Problems with the integration of renewable energies
- Operation of „smart“ energy solutions
The interpretation of the gained measurement values enables interesting lessons that, used alongside technical competence, develop particularly the communication and evaluation capabilities of students.

**LEARNING OBJECTIVES**

- Characteristics of various power generation technologies
- Coupling and controlling various energy generation systems
- Comparison of generation and load profiles

**ADVANTAGES**

- A cost-efficient alternative to large-scale equipment, offering comparable learning content
- Construction of different scenarios and topologies by learning groups
- Interfaces to computer simulations and controllers are prepared
- Optimised for CASSY measuring systems

**ADDON COMPONENTS**

**WIND GENERATOR WITH INTERCHANGEABLE BLADES**

The wind turbine consists of a base unit and the rotor essays. Up to 24 different wind rotors can be mounted on the wind turbine. Thus the efficiency of the different designs can be studied. By combining with the „Smart Power Source“ day balances of various construction forms can be compared.

*(Fig. shows moderate wind at the countryside measured by the Mobile-CASSY 2).*

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>580 0133</td>
<td>Wind generator 4/50</td>
</tr>
<tr>
<td>580 0135</td>
<td>Wind generator 4/50/100</td>
</tr>
<tr>
<td>580 0138</td>
<td>Set of wind rotors</td>
</tr>
</tbody>
</table>

**SOLAR MODULE**

The solar module is representative for a photovoltaic system and the lamp for the sun. By turning the module, the change of the angle of incidence to the PV system based on the position of the sun, is demonstrated. Experiments on the efficiency by heating or shading can be realized easily.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>580 0113</td>
<td>Solar module 5.2V, 380mA</td>
</tr>
<tr>
<td>580 0129</td>
<td>Stand solar module</td>
</tr>
<tr>
<td>580 0130NA</td>
<td>Table lamp without lamp</td>
</tr>
<tr>
<td>580 0131</td>
<td>Lamp 120W</td>
</tr>
</tbody>
</table>

**SMART POWER SOURCE – INTELLIGENT POWER PLANT SIMULATION**

This component is the core of the smart grid system. The smart power source is a voltage and power source that simulates the behavior of photovoltaic systems, wind generators or power plants over a day. 10 s in the experiment correspond to an hour (240 s per day). The current time is displayed by the LEDs. Many different modes can be set manually via the touch function (weather, type of power plant, faults). In addition, a control by the PC and thus a synchronisation of several generators in a „smart grid“ scenario can be performed via the existing USB interface. Experiments on the stability of the grid and planning of energy generation can also easily be performed.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>580 0402</td>
<td>Smart Power Source</td>
</tr>
</tbody>
</table>
RENEWABLE ENERGY
LEYBOLD PLUG-IN SYSTEM STE

STE BATTERY TECHNOLOGY

LEARNING OBJECTIVES
- Understanding different types and their characteristics
- Use of the right batteries for various applications
- Investigation of different loading and unloading procedures

TOPICS
AND SCOPE OF EXPERIMENTS
- Internal resistance of voltage sources
- Interconnection of voltage sources
- U-I characteristics of different battery types
- Loading and unloading at different battery types
- Operating an electric car with different battery types

STE WIND ENERGY & ELECTRICITY GENERATION

LEARNING OBJECTIVES
- Effects of the shape of rotor blades on energy yield
- Conjunction between wind speed, speed of rotation and yield
- Energy surplus and feeding into the grid

TOPICS
AND SCOPE OF EXPERIMENTS
- Energy balance and efficiency of a wind energy plant
- U-I characteristic curve and speed of rotation of a wind energy plant
- Speed of rotation and power depending on wind speed
- Comparing Savonius and three-blade rotors
- Advantages and disadvantages of various shapes of blades
LEARNING OBJECTIVES

- The student learns about the behaviour of solar modules in various operating and environmental conditions as well as the functions of photovoltaic systems
- Inverter and DC/AC converter

TOPICS AND SCOPE OF EXPERIMENTS

- Dependence of solar cell power on the intensity and type of illumination
- U-I characteristic curve of the solar cell under various operating conditions
- Functionality of shunt, serial and PWM controllers
- Functionality and characteristics of an MPP tracker
- Inverter and DC/AC converter

ADVANTAGES OF THE PLUG-IN SYSTEM STE RENEWABLE ENERGY

- Independent study and solidifying the knowledge by the uncomplicated handling of the diversified experiments in a plug-in system
- Clearly arranged in a solid case for transportation and storage
- Well-known plug-in system, can be combined
- Safe and flexible

RECOMMENDED

- CASSY
  Mobile-CASSY 2 (524 005) ideal for direct measurement
  Sensor-CASSY 2 (524 013)
  UIP-Sensor S (524 062 1) ideal for Winfact and Cassy Lab
  CASSY Lab 2 (524 220)

- WinFact
  COM3LAB / CASSY Edition, englisch (734 482)
  Simulate, measure and control the power consumption of a STE renewable energy systems.

ALL STE PLUG-IN BLOCKS ARE ALSO AVAILABLE SEPARATELY AT WWW.LEYBOLD-SHOP.COM.
ELECTRICAL ENGINEERING
AUTOMATION

TOPICS
- M1 Logic basic functions
- M2 Digital function modules
- M3 Motor ON/OFF
- M4 Reversing contactor
- M5 Star-delta switching
- M6 Star-delta reverse switching
- M7 Reciprocating table control
- M8 Dahlander circuit
- M9 DS motor with 2 coils
- M10 DS motor self-starter
- M11 Conveyor belt system
- M12 Reactive current compensation
- M13 Heating control
- M14 Running light
- M15 Filling machine
- M16 Tank system
- M17 Coal mill
- M18 Embossing machine
- M19 Ventilator control
- M20 Construction site light signalling system
- M21 Light signalling system
- M22 Collective transport conveyor
- M23 Conveyor belt feeding system
- M40 Silo control
- M41 Reactor
- M42 Load lift
- M43 Pump control
- M44 Waste water pump system
- M45 Monitoring of 3 pumps
- M46 Pump system (pressure)
- M47 Drinks machine
- M48 Mixing system
- M49 Process control

CHARACTERISTICS
- 12 digital inputs,
  12 digital outputs
- 2 analogue inputs,
  2 analogue outputs
- 4 relays with normally closed contact
- Control and display elements:
  - 6 buttons, 6 latching switches, 33 LEDs
  - 2 potentiometers with 0 ... 10 V DC
  - 1 bar display comprising 24 segments
  - 1 USB connection
  - 1 Ethernet connection

COMBINATION WITH FREE OF CHARGE COM3LAB TEACHING SOFTWARE
ASIMA II is the optimal plant simulator for LOGO! S7–1200 and S7–1500.

There are 33 various systems available. These can be set up via a code switch and are illustrated via the coloured masks. The spectrum ranges from “Testing PLC functions” to “complex systems with control logic”. The newly integrated USB/Ethernet interfaces make it possible to expand the ASIMA II to an Industry 4.0 system.

The device is designed for school and student experiments. Practical tasks challenge the student to solve this control or regulating problem with his or her own programme. A solution approach is supplied as a file.

The target groups are trainees of trade and industry and students specializing in automation technology. The course offers experiments at an intermediate level for the vocational schools and also for bachelor training.

**LEARNING OBJECTIVES**
- Programming of simple basic circuits
- Programming of compact systems
- Programming of complex systems and devices

**ADVANTAGES**
- Simple handling
- Low maintenance
- Large diversity with the various systems for every level
- ASIMA II can be combined with COM3LAB teaching software
- Multiple systems can be combined to economically-priced industry 4.0 system simulations

Equipment set E6.7.1.3 ASIMA II plant simulator
CHARACTERISTICS

Description of the PLC system panel

- 24 digital inputs including 16 inputs with push-button switch; 16 digital outputs are accessible directly via 4-mm safety sockets
- 32 digital inputs and 32 digital outputs directly accessible via 27-pin plug connector with assignment for MCS model
- 2 analogue input channels and 2 analogue output channels accessible via 4-mm safety sockets
- Up to 8 analogue input channels and 4 analogue output channels are accessible on two 30-pin connectors depending on the PLC
- ASIMA II is directly accessible via the 50-pin ASIMA plug connector
- PROFINET is available, the prerequisite for Industry 4.0 projects
- PROFIBUS can be connected either directly or via a communication module depending on the selected CPU
- The power supply unit will be connected via a standard mains plug with a switch
- The power supply unit is designed for 190 W at 120 V 60 Hz and 230 V 50 Hz. The mains voltage will be automatically identified and switched
- The control voltage is 24 V DC with a maximum of 8 A

The following CPUs are available:

- S7 1512C PN
- S7 1512C PN/DP
- S7 1516 PN/DP
With the new basic device for Siemens PLC, LD DIDACTIC provides the possibility to combine the new trainer packages with the tried and tested teaching systems by LEYBOLD and ELWE Technik.

Especially suitable for apprentices in electrical engineering in trade and industry. Basic knowledge of the fundamentals of contactor control, programming of PLC and instructions about the risks of electrical engineering is required.

**LEARNING OBJECTIVES**

Students should learn the essential functions for a programmable logic controller (PLC).

- Programms of PLCs
- Knowledge of logic and control functions
- Testing the programmes
- Setting up and configuring network connections for PROFINET and PROFIBUS/DP

**ADVANTAGES**

- Simple design
- Industry-related
- CPUs with Ethernet capability

The Siemens system comprises of a PLC with power supply unit, Ethernet cables and the software SIMATIC STEP 7 Professional.

The Siemens PLC devices are suitable for student experiments according to the tasks specified in the enclosed experimental description. The operation of the PLC, the creation of a PLC programme or the inspection of the functions are just a few examples of the tasks.

**SUPPLEMENTS**

This system can be supplemented with the following systems.

- Contactor controls, 24 V DC (module system, panel system)
- Controlling with end and proximity switching
- ASIMA II - supporting 40 training systems
- MCS system 3 stations control via PLC
- MCS system 5 stations control via PLC with PROFIBUS

<table>
<thead>
<tr>
<th>Equipment set</th>
<th>Trainer package</th>
</tr>
</thead>
<tbody>
<tr>
<td>E6.6.3.1_b</td>
<td>SPS S7-1512C-1 PN</td>
</tr>
<tr>
<td>E6.6.3.2_b</td>
<td>SPS S7-1512C-1 PN + DP</td>
</tr>
<tr>
<td>E6.6.3.3_b</td>
<td>SPS S7-1516 PN/DP</td>
</tr>
</tbody>
</table>

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WWW.ELWE-TECHNOLOGY.COM
The fault analysis is conducted in 4 steps:

- Description of the fault
- Presumed cause
- Fault evaluation via measuring
- Description of the test method

**TOPICS**
- Fault localisation in contactor circuits
- Compact device with integrated fault simulation
- On/Off switching
- Reversing contactor circuit
- Reversing contactor circuit with limiting switches
- Automatic star-delta switching
- Dahlander circuit
- Automatic Dahlander reversing circuit
- Automatic Dahlander reversing circuit with limiting switches

**ADVANTAGES**
- Compact and robust
- Simple and practical
- Removable protective hood

**CHARACTERISTICS**
The device for fault localisation in contactor circuits. Compact device with integrated fault simulation.

The ELWE Technik bestseller has been reworked by LD DIDACTIC so that the highest safety requirements are fulfilled.

The core of the device is the front, containing a large number of break-throughs, behind which the measurement and connection points for the contactor circuits are located.

By applying various masks, only those measuring and connection points remain available that are relevant to the circuit depicted on the mask. All points not required remain behind the mask.

The control panel is located in the lower part of the front and contains switches, pushbuttons, indicator lights and connection sockets for external limit switches.

On the left side of the practice device, a switch panel for the trainer is located behind a lockable door, which contains a programming field beside the main fuses and main key entry for the load circuit.

Three lamps for the control and load circuit and an EMERGENCY-OFF pushbutton are mounted on the top of the practice device so as to be clearly visible to the trainer.

The manual for the fault simulator contains many student experiments with tasks that can be easily performed. The measurements are made with a voltage tester and continuity tester.

Especially suitable for vocational trainees and apprentices in the field of electrical engineering in trades and industry. Preliminary knowledge concerning the contactor circuits to be analysed is required. This knowledge can be acquired from the equipment sets contactor circuits 24 V AC (module system), contactor circuits 230 V (module system), contactor circuits 24 V AC (panel system) or contactor circuits (panel system).

**LEARNING OBJECTIVES**

- Fault localisation in contactor circuits
- Function of contactor circuits

Equipment set E6.5.2.4  Contactor circuit fault simulator
MACHINE TESTING SYSTEM 4.0

- Torque measurement of ± 9 Nm
- Visibility of the measuring equipment for torques
- Offset adjustment ± 0.3 Nm
- Gain adjustment ± 1.96 Nm under 1 kg
- Use of the system in both directions ± 5,000 min⁻¹
- Machinery terminal block is mounted on the top for easy accessibility

ADVANTAGES

- Input for temperature sensors to protect the test machines against overheating.
- The machine testing system will shut down the test machine when it overheats. Damage to the test machinery will therefore be prevented.
- The test machinery is equipped with a didactic terminal board with a print-out of the winding diagram.
- All the winding ends are routed to 4-mm safety sockets in the terminal board.
- Computer-aided measurement recording delivers significant measurement results.
The Machine Testing System 4.0 has been developed for the latest demands of modern drive units.

The electrical machine is increasingly considered to be more than just a standalone unit but as a combination of systems in drive technology. Two factors drive the ongoing development of machinery:

**ENERGY EFFICIENCY**

An increase in efficiency can no longer be achieved by the machine on its own. The drive unit, i.e. the interaction of power electronic components with the machine, considerably increases the overall efficiency.

**AUTOMATION**

The area Industry 4.0 requires more and more drive systems with higher dynamics at high torque and a simultaneous reduction of volume. These demands can only be achieved by optimized drive units.

For that reason the need to investigate a complete drive system in schools and universities has increased considerably.

**SAFETY REQUIREMENTS FOR EXPERIMENTS**

Modern drive systems also have increased hazard potential. In order to avoid such hazards, many standards for drive units have been created or supplemented such as:

- Hazards from leakage currents in machinery and control systems
- Hazards from circuit feedback
- Hazards from interference signals from machinery and control systems

The experiments are executed with typical industrial machines. The test system and the machine under test form a study bench. All rotating shafts are protected against unintended touch by means of transparent covers.

A mechanical locking system takes up any mechanical / and also prevents, along with the electrical coupling control, the test bench being disassembled during operation.
Characteristic curves for the test machines are recorded by the machine testing system. The electrical power for the test machines is provided by a special laboratory power supply.

The system can also handle test machines which are controlled and regulated via modern power electronics.

Installation of EMC-compliant machinery connections and, for safety reasons, necessary potential equalisation are simple to implement with this system.

**LEARNING OBJECTIVES**

Students are able to implement connections for various machines types, analyse the behaviour in different load situations, compute the characteristic values and to record the machine-typical characteristic curves.

- Protective measures and electrical safety
- Design and commissioning of electrical machines
- Application of starter motor switching
- Evaluation of characteristic curves for electrical machines

**ADVANTAGES**

- Torque measurement
- Simple handling
- High safety requirements
- EMC-optimized design
- Possibility for potential equalisation
System safety is increased by fixing the machine on a bench. Mechanical impulses that can occur due to the cut-off of IPM and synchronised motors are absorbed on both sides by the bench and the mechanical locking. The new bench allows a flexible configuration of the machines and the machine testing system.

MACHINE BENCH AND LOCKING SYSTEM

Thanks to the new design of the drive unit, the actual measuring principle becomes visible for the students. The measuring system can now be harmonised for improving torque measurement. A mechanical zero-point setting is provided for this purpose, as well as the possibility to inspect and calibrate the measurements with weights.

MACHINE TESTING SYSTEM

The shaft is connected through a hood, which is positioned on its own bench, with the benches of the machine and pendulum machine. The drive shafts can only be touched after dismantling the drive unit system. In addition, the locking system for the bench is monitored electronically, so that the system will be switched off as soon as the benches are separated.

PROTECTION AGAINST CONTACT WITH ROTATING PARTS

The supplementary potential equalisation is necessary for protecting people and systems. A break in the protective earth would energise the machine or even the complete system as the leakage current can be conducted directly via the stator to the motor and to the plant.

A hazard can only be prevented by designing the complete system with a very low-resistance earth potential.

POTENTIAL EQUALISATION

All the motors are isolated against the bench so that unnecessary loop currents cannot increase the interference signals and unwanted leakage current cannot affect the measuring sensors. This is a prerequisite for Industry 4.0 capable frequency converters and servo drives as well as the associated speed, rotational angle and position sensors.

EMC

All machines are designed with one shaft end. The terminal block has been positioned on the top for flexible setting up of experiments.

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