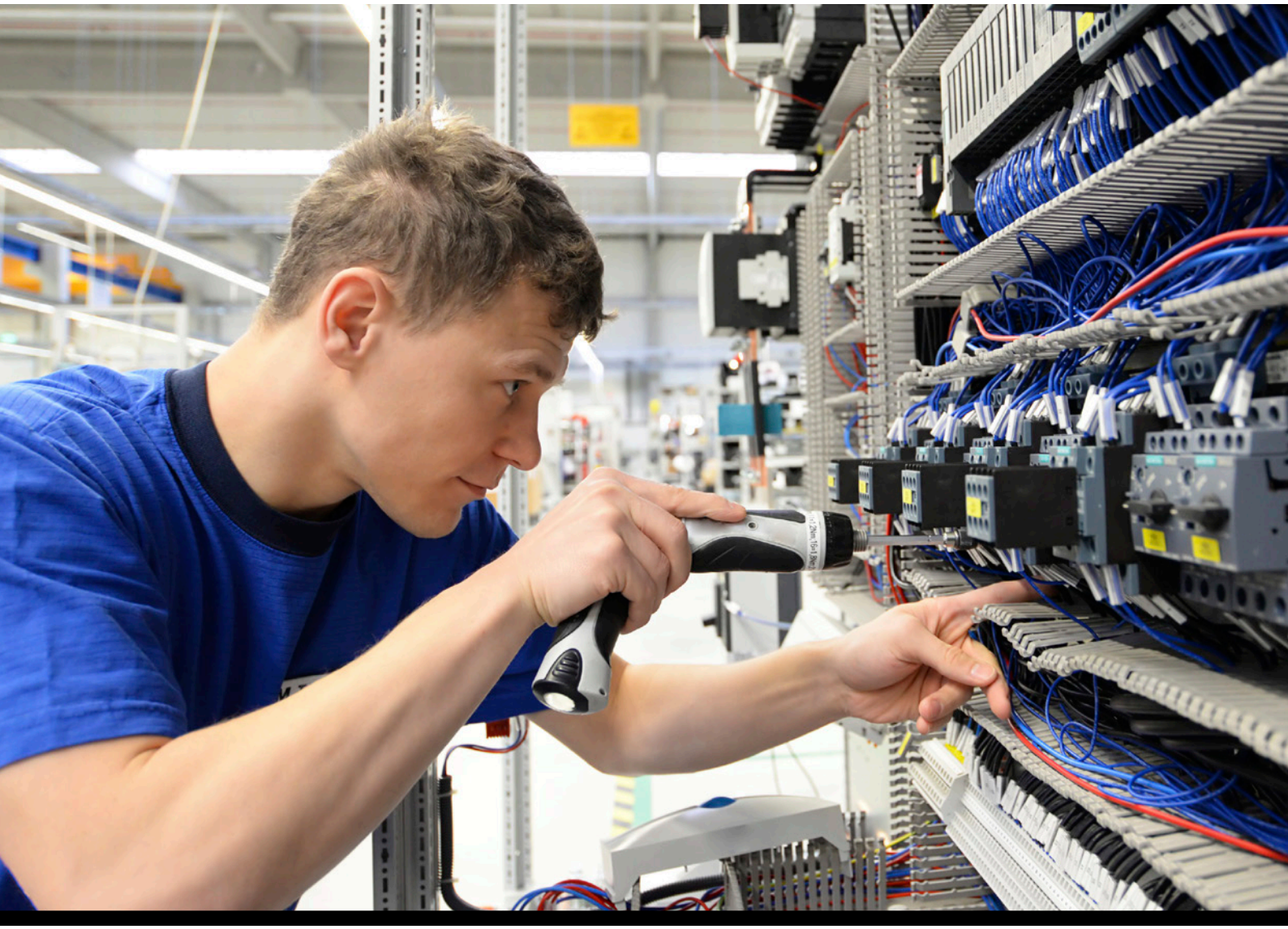
LEYBOLD®

ELECTRICAL ENGINEERING



- FUNDAMENTALS
- ELECTRICAL DRIVES
- POWER ENGINEERING
- BUILDING TECHNOLOGY
- COMMUNICATIONS TECHNOLOGY
- CONTROL ENGINEERING & AUTOMATION

LD DIDACTIC

INTRODUCTION

Headquarter Huerth, Germany

LEYBOLD®

Feedback

ELWE® TECHNIK

THE SECRET OF SUCCESS IS THE MIX OF THEORY & PRACTICE

The planning, carrying out and recording of experiments is an important element of a well-founded education in science and engineering. In order to reinforce newly acquired knowledge, experiments must be well matched to the theory.

Our holistic approach is inspired by the German dual education system: Germany's dual system of vocational education and training has been a major factor in our country's economic success over the past six decades. It involves both in-company training and education at vocational schools to ensure a successful mix of theory and practice.

A COMPETITIVE ADVANTAGE IN A HIGHLY COMPETITIVE WORLD

We believe in the importance of education as a fundamental driver of personal, national and global development. In a highly specialised world, knowledge has become a decisive factor: Specialised personnel are in greater demand than ever. Investing in the practical training of your students, you equip them with important skills that the labour market requires.

THE PASSION FOR TEACHING EQUIPMENT IS IN OUR DNA

From the very beginning in 1850 we at LEYBOLD concentrate on how to make academic content understandable and tangible for students at different levels of scientific and technical education. Therefore we are proud that for generations our training and educational systems have made a significant contribution to knowledge transfer in natural sciences and engineering.

Nevertheless, in more than 160 years of experience we have found that you can achieve a lot when keeping pace with customer needs: we continuously challenge ourselves to preserve our high quality standards and develop our products and services in line with changing curricula and new technologies.

PREMIUM QUALITY MADE BY LEYBOLD, FEEDBACK & ELWE

The LD DIDACTIC Group is a leading global manufacturer of high quality science and engineering teaching and training systems for:

- Schools (secondary schools)
- Vocational colleges
- Technical colleges
- On-the-job training
- Universities

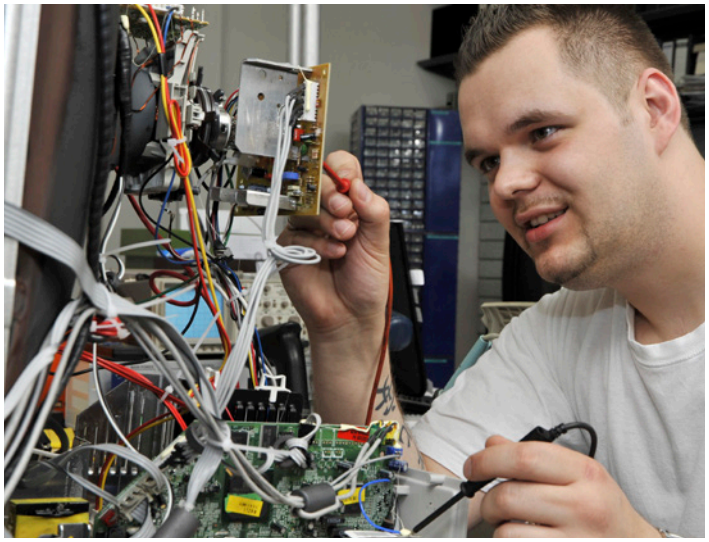
We can supply all from a single source: Teaching systems, experiment literature and training documentation for the engineering application as well as for the science fundamentals.

SUMMARY

E1 Fundamentals of electr(on)ics

To understand everyday electrical and electronic devices training is required. Such technical training can only be effective when suitable teaching aids, training equipment and systems are used.

The first chapter of the LD DIDACTIC fundamentals is a general introduction about the physical principles of electricity. The fundamentals are provided by the STE plug-in systems. They are available for AC, DC and three-phase technology as well as various experiments in electronics. A very special system is the teaching models for investigation of the various functions and operations of electrical machines. Finally and importantly at the end of this chapter there are pre-mounted trainers as an alternative or expansion for the STE system.



E1.1 FUNDAMENTALS
- E1.1.1 ELECTROSTATICS
- E1.1.2 ELECTRICAL FIELDS
- E1.1.3 ELECTRICAL CHEMISTRY
- E1.1.4 ELECTRICAL BASIC CIRCUITS
- E1.1.5 ELECTRICAL MAGNETISM & INDUCTION
- E1.1.6 BASICS OF GENERATORS & MOTORS

E1.2 BASICS OF ELECTRICITY
- E1.2.1 DC TECHNOLOGY
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E1.3 BASICS OF ELECTRONICS
- E1.3.1 DISCRETE ELECTRONIC COMPONENTS
- E1.3.2 BASICS OF LOGIC CIRCUITS
- E1.3.3 MULTIVIBRATOR CIRCUITS
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- E1.3.6 HIGH FREQUENCY TECHNOLOGY
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- E1.3.10 ELECTRONIC MEASURING CIRCUITS
- E1.3.11 POWER SUPPLY CIRCUITS WITH IC
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E1.4 PRE-MOUNTED TRAINERS
- E1.4.1 OPERATIONAL AMPLIFIER TUTOR
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E1.5 COM3LAB MULTIMEDIA: FUNDAMENTALS OF ELECTRICAL ENGINEERING
- E1.5.1 COM3LAB MULTIMEDIA: DC TECHNOLOGY
- E1.5.2 COM3LAB MULTIMEDIA: AC TECHNOLOGY
- E1.5.3 COM3LAB MULTIMEDIA: ELECTRICAL COMPONENTS
- E1.5.4 COM3LAB MULTIMEDIA: DIGITAL TECHNOLOGY
- E1.5.5 COM3LAB MULTIMEDIA: THREE-PHASE TECHNOLOGY

E1.2.1
DC TECHNOLOGY

The equipment in the STE suitcase lends itself for storage and as a student's workstation. It serves as a case for various STE equipment sets in its cover and can be used to conduct experiments in the classroom. The cover can be separated from the base.

STE can also be delivered in a simple bench top version or mounted on a panel.

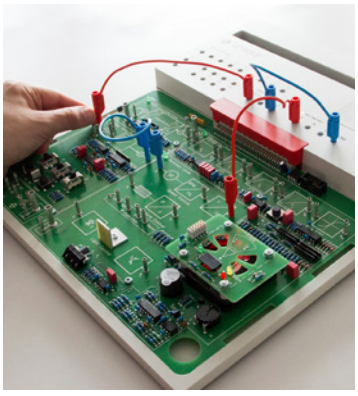
E1.5
FUNDAMENTALS WITH COM3LAB

COM3LAB is used at schools level and higher education in electrical engineering and electronics. Electrical engineering can be taught and learned both theoretically and practically with COM3LAB. COM3LAB is the interface between theory and practice. Subject matters are not only presented theoretically but also simultaneously deepened with practical experiments.

COM3LAB consists of a Master Unit and several courses (experimental board + CD-ROM). The master unit is the basic device through which the software and experimental boards communicate with each other.

The courses provide descriptive theory and many experiments in the widest range of subjects within electrical engineering and electronics. All experiments must be conducted personally, while the measurements provide real values.

Ideal for direct transformation from theory into practice.



E2 Electrical Drives

Based on the fundamentals acquired in E1, this area covers all aspects of the electrical machine as it is used in drive technology dealt with the second part of E2. The systems are easy to operate, modularly designed with short assembly times. All of the machines are built in 0.3 kW or 1.0 kW models and are designed with current standard syllabus taken into account. Each system allows manual or computer-assisted experimentation.

The LD DIDACTIC training panel system is also used for power electronics and drive technology and makes it possible to convey the technical knowledge of this field. The training panels and functional units with block circuit diagrams and signal diagrams permit clear and understandable assembly of the experiment circuits.

E2.1 EDUCATIONALLY DESIGNED MACHINES

- E2.1.1 MACHINE LABS USING THE STE
  - E2.1.1.1 ELECTROMAGNETISM & INDUCTION
  - E2.1.1.2 3-PHASE TRANSFORMERS
  - E2.1.1.3 3-PHASE RECTIFICATION
  - E2.1.1.4 GENERATORS & MOTORS
- E2.1.2 COM3LAB MULTIMEDIA: MOTORS & GENERATORS
  - E2.1.2.1 COM3LAB MULTIMEDIA: BASICS OF ELECTRICAL MACHINES
- E2.1.3 MACHINE ASSEMBLY KITS
  - E2.1.3.1 ELM BASIC MACHINES FOR EXTRA-LOW VOLTAGE
  - E2.1.3.2 ELM EFFICIENCY MACHINES FOR EXTRA-LOW VOLTAGE
  - E2.1.3.3 ELECTRICAL MACHINE TEACHING MODELS FOR EXTRA-LOW VOLTAGE
  - E2.1.3.4 MACHINES WITH ROTOR KITS
  - E2.1.3.5 ELECTRICAL MACHINES TRAINING SYSTEM

E2.2 INDUSTRIAL MACHINES 300 W

- E2.2.1 TRANSFORMERS, 300 W (0.3 KW)
  - E2.2.1.0 TRANSFORMERS
  - E2.2.1.1 3-PHASE TRANSFORMER
  - E2.2.1.2 SCOTT TRANSFORMER
  - E2.2.1.3 AC TRANSFORMER
  - E2.2.1.4 AC TOROIDAL CORE TRANSFORMER
  - E2.2.1.5 AC AUTOTRANSFORMER

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- E2.2.2 DC MACHINES, 300 W (0.3 KW)
  - E2.2.2.0 DC MACHINES
  - E2.2.2.1 DC COMPOUND MACHINE
  - E2.2.2.2 UNIVERSAL MOTOR
- E2.2.3 AC MACHINES, 300 W (0.3 KW)
  - E2.2.3.0 AC MACHINES
  - E2.2.3.1 UNIVERSAL MOTOR
  - E2.2.3.2 CAPACITOR MOTOR R
  - E2.2.3.3 CAPACITOR MOTOR CS BASIC
- E2.2.4 3-PHASE INDUCTION MACHINES (0.3 KW)
  - E2.2.4.0 INDUCTION MACHINES
  - E2.2.4.1 SQUIRREL CAGE MOTOR, 400/600
  - E2.2.4.2 SQUIRREL CAGE MOTOR, 230/400
  - E2.2.4.3 SLIP RING MOTOR
  - E2.2.4.4 SQUIRREL CAGE MOTOR D
  - E2.2.1.5 SQUIRREL CAGE MOTOR SW
  - E2.2.4.6 SQUIRREL CAGE MOTOR, 400/690
  - E2.2.4.7 SQUIRREL CAGE MOTOR, 230/400
  - E2.2.4.8 SQUIRREL CAGE MOTOR 230/400 BRAKE BASIC
- E2.2.5 3-PHASE SYNCHRONOUS MACHINES, 300 W (0.3 KW)
  - E2.2.5.0 SYNCHRONOUS MACHINES
  - E2.2.5.1 SALIENT POLE ROTOR
  - E2.2.5.2 SMOOTH POLE ROTOR, 230/400
- E2.2.6 SYNCHRONMACHINE PERMANENT EXCITATION
  - E2.2.6.1 SYNCHRONIOUS MACHINE WITH PERMANENT EXCITATION IPM & FREQUENCY CONVERTER
- E2.2.7 FEEDBACK ELECTRICAL MACHINES
  - E2.2.7.0 ELECTRICAL MACHINES CORE SYSTEM
  - E2.2.7.1 MULTI-CHANNEL POWER SENSOR
  - E2.2.7.2 DISSECTIBLE MACHINES SYSTEM
  - E2.2.7.3 THYRISTOR CONTROL PRINCIPLES
  - E2.2.7.4 THYRISTOR & D.C. MOTOR CONTROL TRAINER
  - E2.2.7.5 D.C. MOTOR CONTROL TRAINER

E2.3 INDUSTRIAL MACHINES 1 KW

- E2.3.1 TRANSFORMERS, 1 KW
  - E2.3.1.0 TRANSFORMERS
  - E2.3.1.1 3-PHASE TRANSFORMER
  - E2.3.1.2 SCOTT TRANSFORMER
  - E2.3.1.3 AC TRANSFORMER
  - E2.3.1.4 AC TOROIDAL CORE TRANSFORMER
  - E2.3.1.5 AC AUTOTRANSFORMER

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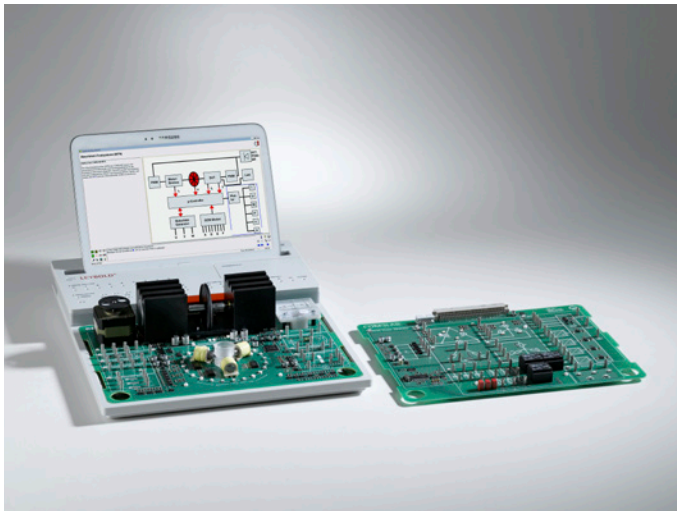
E2 Electrical Drives



E2.1.2.1
BASICS OF ELECTRICAL MACHINES

The target group comprises commercial apprentices and students of electrical machine technology. The course offers introductory experiments at a simple level and more advanced topics for undergraduate education.

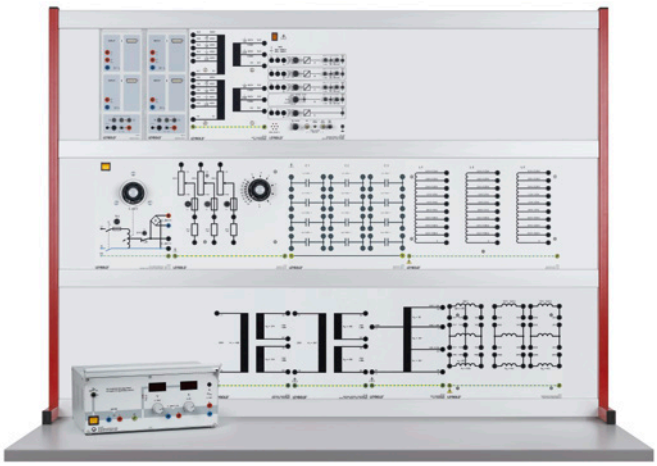
In the COM3LAB course Electrical Machines the features of commutator machines, rotary field machines and stepper motors are developed in demanding experiments.

E2.2.1.3
AC-TRANSFORMATOR 0,3

This individual equipment set is used to investigate AC transformers. The AC transformer (single-phase transformer) is a standard module which can be used for many applications across the whole of electrical engineering. The experiments are carried out using transformers on training panels in panel frames.

Objectives

- Protective measures & electrical safety
- Set-up of power generation systems according to circuit diagrams
- Use of commercial measuring instruments, hand-held multimeters, oscilloscopes, measuring interfaces



E2.2.4.0
INDUCTION MACHINES, 0.3 KW

The complete equipment set is equally suitable for student experiments in laboratories with low voltage supplies (400 V three-phase) and for setting up on a mobile trolley for demonstration by teachers in a classroom.

Objectives

- Protective measures & electrical safety
- Use of starting circuits
- Assessment of electrical machine characteristics

E2 Electrical Drives

E2.3.2 DC MACHINES, 1 KW
- E2.3.2.0 DC MACHINES
- E2.3.2.1 DC MULTIFUNCTION MACHINE
- E2.3.2.2 UNIVERSAL MOTOR

E2.3.3 AC MACHINES, 1 KW
- E2.3.3.0 AC MACHINES
- E2.3.3.1 UNIVERSAL MOTOR
- E2.3.3.2 CAPACITOR MOTOR R

E2.3.4 3-PHASE INDUCTION MACHINES, 1 KW
- E2.3.4.0 INDUCTION MACHINES
- E2.3.4.1 SQUIRREL CAGE MOTOR, 400/600
- E2.3.4.2 SQUIRREL CAGE MOTOR, 230/400
- E2.3.4.3 SLIP RING MOTOR
- E2.3.4.4 SQUIRREL CAGE MOTOR D
- E2.3.1.5 SQUIRREL CAGE MOTOR SW

E2.3.5 3-PHASE SYNCHRONOUS MACHINES, 1 KW
- E2.3.5.0 SYNCHRONOUS MACHINES
- E2.3.5.1 SALIENT POLE ROTOR
- E2.3.5.2 SMOOTH CORE ROTOR

E2.4 POWER ELECTRONICS

E2.4.1 COMPACT SYSTEMS FOR POWER ELECTRONICS
- E2.4.1.1 POWER ELECTRONICS WITH THE STE
- E2.4.1.2 COM3LAB MULTIMEDIA: POWER ELECTRONICS
- E2.4.1.3 POWER ELECTRONICS, COMPLETE EQUIPMENT (MODULE SYSTEM)

E2.4.2 LINE-COMMUTATED CONVERTERS
- E2.4.2.1 STATIC CONVERTER VALVES
- E2.4.2.2 FAULT SIMULATOR, PHASE CONTROL

E2.4.3 SELF-COMMUTATED CONVERTERS
- E2.4.3.1 SWITCHABLE VALVES & DC-TO-DC CONVERTERS
- E2.4.3.2 SWITCHED-MODE POWER SUPPLIES
- E2.4.3.3 INVERTERS
- E2.4.3.4 TG10.40 DC CHOPPER CONTROLLER
- E2.4.3.5 TG10.30 SWITCHING POWER SUPPLIES

E2.5 DRIVE TECHNOLOGY

E2.5.1 COMPACT SYSTEMS FOR DRIVE TECHNOLOGY
- E2.5.1.1 COM3LAB MULTIMEDIA: MACHINES & DRIVES
- E2.5.1.2 DRIVE CONTROL WITH TRAINING PANELS

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E2.5.2 INDUSTRIAL DC DRIVES
- E2.5.2.1 STATIC CONVERTER DRIVE WITH DC MACHINES
- E2.5.2.2 DC-CHOPPER DRIVE WITH DC MACHINES

E2.5.3 INDUSTRIAL 3-PHASE DRIVES
- E2.5.3.1 STATIC CONVERTER DRIVES & INDUCTION MACHINES
- E2.5.3.2 BASICS OF FREQUENCY CONVERTERS
- E2.5.3.3 DRIVES WITH EDUCATIONAL FREQUENCY CONVERTER
- E2.5.3.4 DRIVES WITH INDUSTRY FREQUENCY CONVERTER, 0.3 KW
- E2.5.3.5 DRIVES WITH INDUSTRY FREQUENCY CONVERTER, 1.0 KW

E2.6 SERVO TECHNOLOGY

E2.6.1 EDUCATIONALLY DESIGNED SERVOS
- E2.6.1.2 DC SERVO
- E2.6.1.3 AC SERVO
- E2.6.1.4 STEPPER MOTOR

E2.7 ELWE INDUSTRIAL MACHINES 300 W

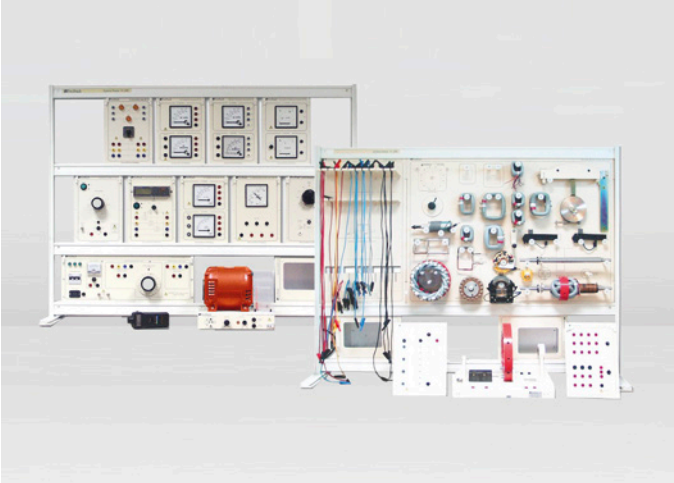
E2.7.1 TRANSFORMERS, 300 W (0.3 KW)
- E2.7.1.0 TRANSFORMERS
- E2.7.1.1 3-PHASE TRANSFORMER
- E2.7.1.2 SCOTT TRANSFORMER
- E2.7.1.3 AC TRANSFORMER
- E2.7.1.4 AC TOROIDAL CORE TRANSFORMER
- E2.7.1.5 AC AUTOTRANSFORMER

E2.7.2 DC MACHINES, 300 W (0.3 KW)
- E2.7.2.0 DC MACHINES
- E2.7.2.1 DC COMPOUND MACHINE
- E2.7.2.2 UNIVERSAL MOTOR

E2.7.3 AC MACHINES, 300 W (0.3 KW)
- E2.7.3.0 AC MACHINES
- E2.7.3.1 UNIVERSAL MOTOR
- E2.7.3.2 CAPACITOR MOTOR R

E2.7.4 3-PHASE INDUCTION MACHINES, 300 W (0.3 KW)
- E2.7.4.0 INDUCTION MACHINES
- E2.7.4.1 SQUIRREL CAGE MOTOR, 400/600
- E2.7.4.2 SQUIRREL CAGE MOTOR, 230/400
- E2.7.4.3 SLIP RING MOTOR
- E2.7.4.4 SQUIRREL CAGE MOTOR D
- E2.7.1.5 SQUIRREL CAGE MOTOR SW

E2.7.5 3-PHASE SYNCHRONOUS MACHINES, 300 W (0.3 KW)
- E2.3.5.0 SYNCHRONOUS MACHINES
- E2.3.5.1 SALIENT POLE ROTOR
- E2.3.5.2 SMOOTH POLE ROTOR



E2.2.7.2
DISSECTIBLE MACHINES SYSTEM

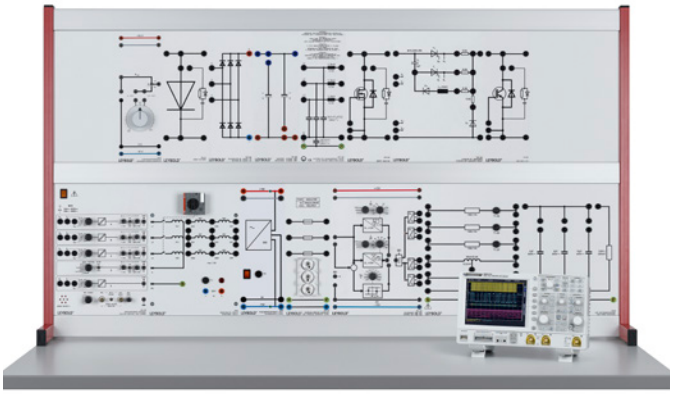
This trainer provides all the components to perform the full range of student assignments using the Dissectible Machine which enables construction and investigation of different machine assemblies. The system is used to study a wide range of topics, from the principles of magnetic circuits and electrical machine theory through to three phase synchronous machines. The system provides a hands-on approach to the understanding of electrical machines principles.

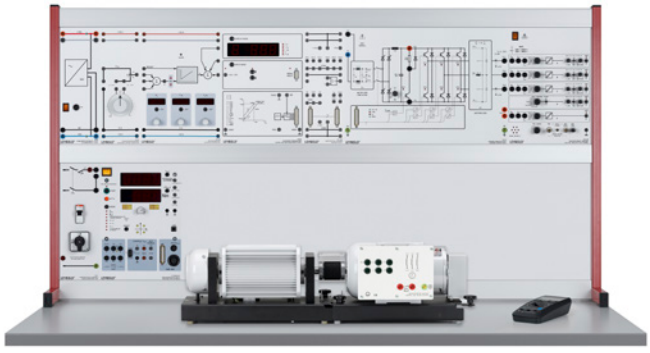
E2.4.3.1
SWITCHABLE VALVES AND DC-TO-DC CONVERTERS

Static converter valves with gate turn-off can be used to assemble a variety of DC choppers (DC/DC converters). Three different control methods are used for this:

Topics

- Thyristor with quenching circuit
- Power MOSFETs
- Insulated gate bipolar transistors (IGBTs)
- On-state characteristics





E2.5.3.3
DRIVES WITH EDUCATIONAL FREQUENCY CONVERTER

The power electronics part of this lab practical uses training panels. The electrical machine employed is an industrial machine on a base, whereby the characteristics of the machine can be determined using the Machine test system 0.3 KW. Power is supplied to the machine under test via an educationally designed frequency converter, which obtains it's power from the normal mains (mains voltage, 230 V).

Power electronics has developed from the technology of static converters to become one of the most important and all-encompassing areas of electrical engineering. The job of power electronics is to switch, control and convert electrical energy using power semiconductors with the best possible efficiency. One key application is drive technology.

E3 Electrical Power Engineering

Power engineering deals with the generation, transmission, distribution and utilization of electric power. By scaling of 1:1000 for electrical quantities (i.e. instead of 380 kV only 380 V is used) the systems operating responses are not only realistic, but can also be graphically demonstrated. In order to keep in close touch with actual practice, commercially available industrial equipment is used in this system. This is of particular importance in the area of protective measures.

Renewable power stations become more important in our life, which cause new problems in the traditional power network. „Smart" concepts, which provide the integration of smart grid components can solve these problems. LD Didactic provides a compact STE trainer for this topic.

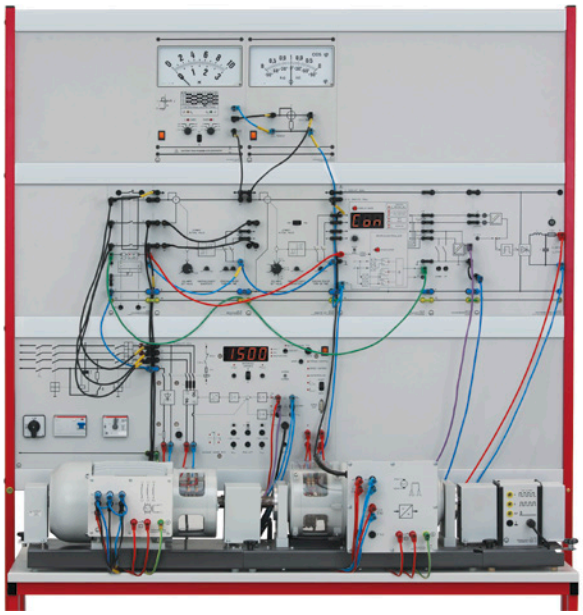
E3.1 POWER GENERATION
- E3.1.1 SYNCHRONOUS GENERATOR
- E3.1.2 SYNCHRONISATION CIRCUIT
- E3.1.3 AUTOMATIC SYNCHRONISATION CIRCUIT
- E3.1.4 GENERATOR POWER FACTOR CONTROL
- E3.1.5 GENERATOR ACTIVE POWER CONTROL

E3.2 POWER TRANSMISSION / POWER DISTRIBUTION
- E3.2.1 THREE-PHASE TRANSFORMERS
- E3.2.2 TRANSMISSION LINE MODEL 380 KV
- E3.2.3 GENERATOR FED TRANSMISSION SYSTEM WITH RLC LOADS
- E3.2.4 PARALLEL & SERIES CIRCUITS OF TRANSMISISON LINES
- E3.2.5 THREE-PHASE DOUBLE BUS BAR SYSTEM
- E3.2.6 TG 17.140 DOUBLE BUSBAR SYSTEM
- E3.2.7 CURRENT & VOLTAGE TRANSFORMERS
- E3.2.8 PROTECTIVE RELAYS
- E3.2.9 PROTECTION OF A SINGLE POWER TRANSMISSION LINE
- E3.2.10 PROTECTION OF TWO PARALLEL POWER TRANSMISSION LINES
- E3.2.11 PROTECTION OF TWO SERIES POWER TRANSMISSION LINES

E3.3 ENERGY UTILIZATION
- E3.3.1 REACTIVE POWER COMPENSATION OF AN INDUCTIVE LOAD
- E3.3.2 POWER CONSUMPTION MEASUREMENT & PEAK LOAD MONITORING

E3.4 SMART GRID
- E3.4.1 TRAINING SYSTEM „SUPPLY OF A BIG CITY"

E3.5 POWER GRID & RENEWABLE ENERGY
- E3.5.1 COM3LAB MULTIMEDIA: PHOTOVOLTAICS
  - E3.5.1.1 PHOTOVOLTAIC WITH COM3LAB
  - E3.5.1.2 SOLAR ENERGY STE
  - E3.5.1.3 WIND ENERGY STE
  - E3.5.1.4 BATTERY TECHNOLOGY STE
- E3.5.2 SOLAR ENERGY STE
  - E3.5.2.1 SMART GRID STE
- E3.5.3 WIND ENERGY STE
  - E3.5.3.1 VISULATION OF THE POWER GRID (SCADA)
- E3.5.4 BATTERY TECHNOLOGY STE
- E3.5.5 SMART GRID STE

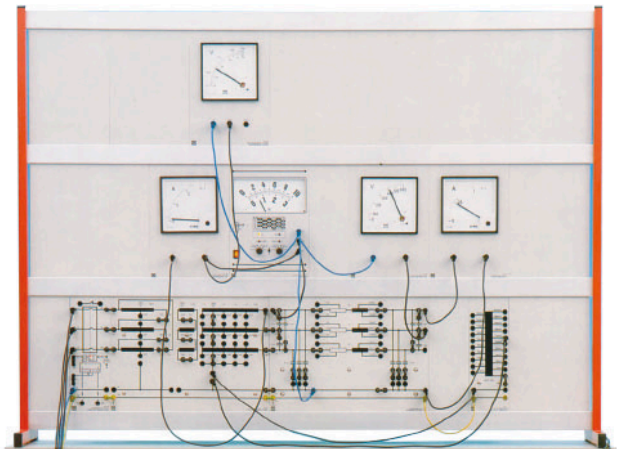


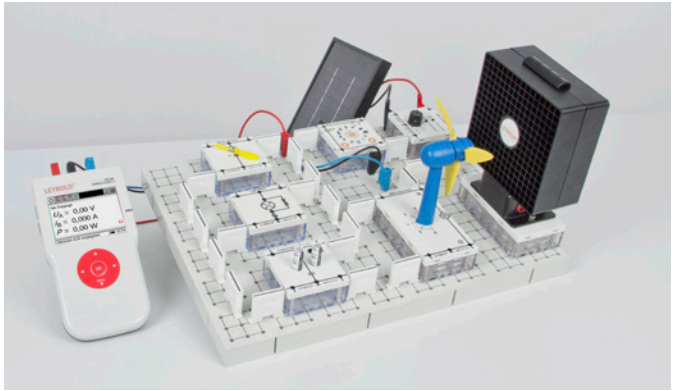
E3.1.4
GENERATOR POWER FACTOR CONTROL

The equipment sets can be used separately or can be combined to form one large power station trainer. Using a 1 kW synchronous generator with smooth core rotor, knowledge is conveyed on the conversion of mechanical energy into electrical energy (E3.1.1). The mechanical energy required is supplied by a DC pendulum machine, with which the torque is measured. Synchronization to the mains is carried out manually (E3.1.2) or automatically (E3.1.3) using a synchronizing device. The cos φ (E3.1.4, shown) and active power (E3.1.5) of the generator synchronized to the mains can be controlled using the corresponding training panels. The equipment sets can be used separately or can be combined to one big power station trainer (E3.1).

E3.2.2
TRANSMISSION LINE MODEL 380 KV

Using this equipment set it is possible to assemble a complete power transmission system. From a transformer with tapping switch to the power circuit breakers and 380 kV power transmission line model up to and including line termination with surge impedance. Various investigations are carried out on this power transmission system: no-load, operation with natural load, symmetrical and unsymmetrical short-circuit, parallel and series compensation of the transmission lines as well as neutral-point connection. Because of the possibility of connecting the 380 KV transmission line models in parallel and series, more complex transmission systems can be dealt with (E3.2.10 and E3.2.11).





E3.5.5
SMART GRID STE

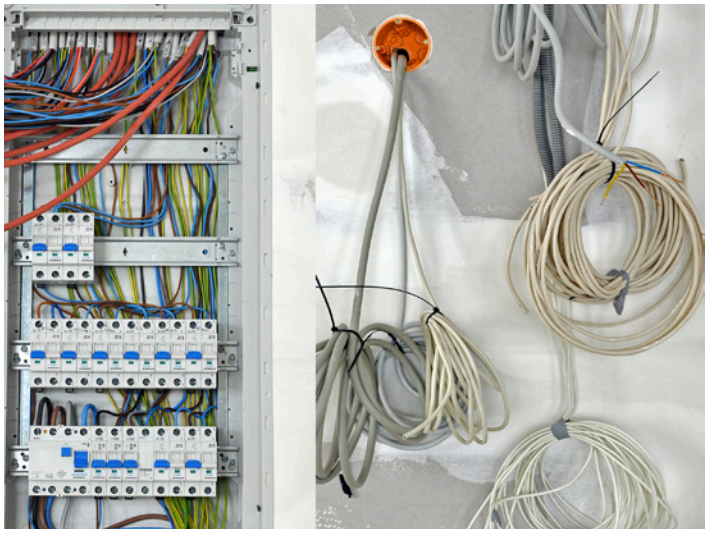
The increasing proportion of renewable energy sources in power generation such as photovoltaic and wind turbines in combination with conventional power plants requires a completely new (intelligent or „smart") network management.

LEYBOLD STE „Smart Grid" provides vivid experiments on the subject: volatile production operation of the conventional power grid, problems with the integration of renewable energy and operations.

E4 Building technology

Since more residential housing are making use of photovoltaic systems, it leads to the requirement for related training equipment. Since more and more houses are combined with photovoltaic system, there is of course there is also some related training equipment.

The equipment sets, compact equipment sets and standard EIB/KNX with related software are usually available in two version: the training panel system TPS from LEYBOLD and the module system from ELWE. The content about protection circuits is according to German standards VDE and combines compact equipment set with real life measurement equipment. Finally, the smart building technology starts with one basic unit, which can be expanded step by step with various technologies. Here, we use the industrial standard EIB/KNX with a related standard software.



E4.1 HOUSE INSTALLATION TECHNOLOGY

- E4.1.1 INSTALLATION CIRCUITS (PANEL SYSTEM)
  - E4.1.1.1 LAMPS & APPLIANCE CIRCUITS
  - E4.1.1.2 TG 4.100 INSTALLATION CIRCUITS WITH SWITCHES
  - E4.1.1.3 TG 4.110 INSTALLATION CIRCUITS WITH PUSHBUTTONS
  - E4.1.1.4 TG 4.115 BELL SYSTEM & DOOR OPENER, SUPPLEMENTARY SET
  - E4.1.1.5 TG 4.120 SWITCHING & DIMMING FILAMENT & HALOGEN LAMPS, SUPPLEMENTARY SET
  - E4.1.1.6 TG 4.130 INSTALLATION CIRCUITS WITH FLUORESCENT LAMPS
  - E4.1.1.7 TG 4.140 LIGHTING
- E4.1.2 INSTALLATION CIRCUITS (MODULE SYSTEM)
  - E4.1.2.1 U 4.100 INSTALLATION CIRCUITS WITH SWITCHES
  - E4.1.2.2 U 4.110 INSTALLATION CIRCUITS WITH PUSH BUTTONS
  - E4.1.2.3 U 4.115 BELL SYSTEM & DOOR OPENER, SUPPLEMENTARY EQUIPMENT
  - E4.1.2.4 U 4.120 SWITCHING & DIMMING FILAMENT & HALOGEN LAMPS, SUPPLEMENTARY EQUIPMENT
  - E4.1.2.5 U 4.130 INSTALLATION CIRCUITS WITH FLUORESCENT LAMPS
  - E4.1.2.6 U 4.140 LIGHT TECHNOLOGY
  - E4.1.2.7 WALL FOR CONCEALED INSTALLATION WITH ACCESSORIES & TOOLS

E4.2 PHOTOVOLTAIC SYSTEMS

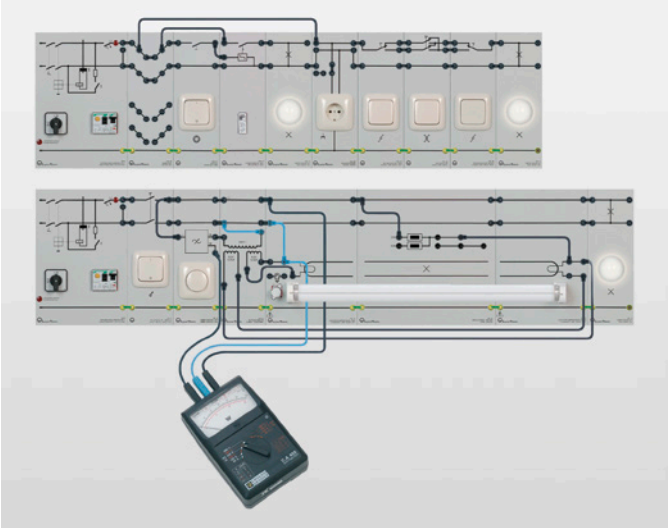
- E4.2.1 PHOTOVOLTAIC SYSTEM (PANEL SYSTEM)
- E4.2.2 U 4.500 PHOTOVOLTAIC ENGINEERING (MODULE SYSTEM)

E4.3 PROTECTION CIRCUITS

- E4.3.1 TEST & FAULT SIMULATOR VDE
- E4.3.2 TG 0100 PROTECTION CIRCUITS VDE 0100 (PANEL SYSTEM COMPLETE)
- E4.3.3 U 0100 PROTECTION CIRCUITS VDE 0100 (MODULE SYSTEM COMPLETE)
- E4.3.4 FAULT SIMULATOR „PROTECTION FOR SAFETY"
- E4.3.5 EXPERIMENTAL CASE ON ELECTRICAL PROTECTIVE MEASURES
- E4.3.6 FAULT SIMULATOR FOR INSTALLATION CIRCUITS
- E4.3.7 FAULT SIMULATOR VDE 0701

E4.4 SMART BUILDING

- E4.4.1 EUROPEAN INSTALLATION BUS EIB/KNX
  - E4.4.1.1 EIB/KNX COMPACT TRAINER WITH ETS SOFTWARE
  - E4.4.1.2 FUNDAMENTALS OF EIB/KNX WITH ETS SOFTWARE
  - E4.4.1.3 LIGHTING MANAGEMENT BY EIB/KNX WITH ETS SOFTWARE
  - E4.4.1.4 EIB/KNX LINE COUPLING WITH ETS SOFTWARE



E4.1.1.1
LAMPS & APPLIANCE CIRCUITS

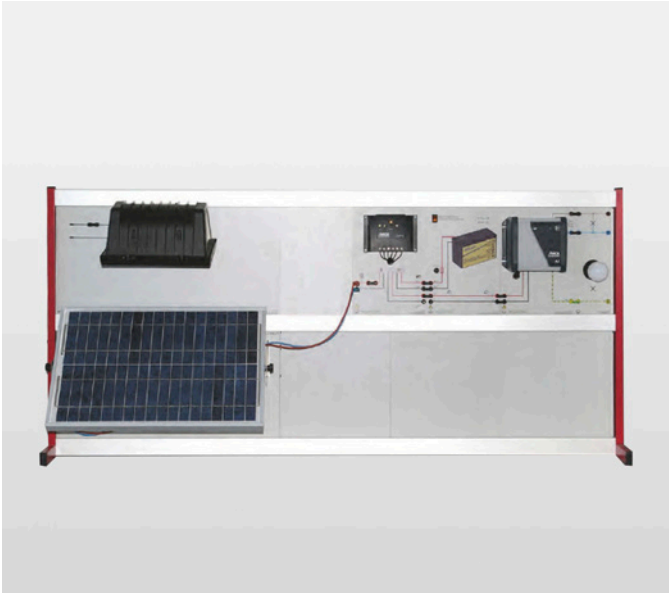
LD DIDACTIC Electrical Installation: an alternative to workshop classes! This set deals with standard installation circuits for all general service lamps and fluorescent lamps in conjunction with our training panel system. This requires no tools so the student can concentrate entirely on putting the accrued knowledge into practice. Particular emphasis is placed on adherence to the applicable regulations governing electrical installations. Safety sockets and cables guarantee optimal low-voltage range protection against personal injury during the experiments.

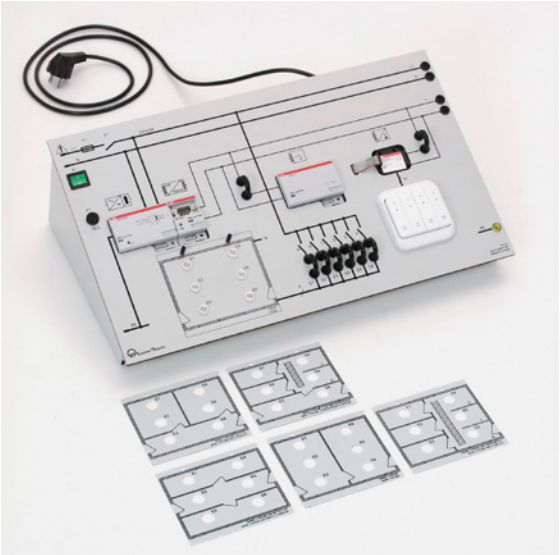
Protection is provied against personal injury during the experiments.

E4.2.1
PHOTOVOLTAIC SYSTEMS

The importance of environmentally-friendly technology is increasing in the coming years. This trend is also reflected in the portfolio of LD DIDACTIC. Therefore, the TPS photovoltaic device training system comprises a further component within our Greentec facilities. The new facilities use customary solar components in an educational format and gives realistic results, thus creating the optimal connection between theory and practice.

The topics include the generation of power in the solar modules, the storage of the power generated and the handling of AC consumers using an inverter. Using Sensor-CASSY 2 and the CASSY Lab Software the experiments produce graphical results that are easy to interpret.





E4.4.1
EUROPEAN INSTALLATION BUS EIB/KNX

The EIB Basic System (729 740) for the European Installation Bus is the intelligent solution for independent laboratory or student practice station. This completely functional system illustrates the essential characteristics and advantages of the EIB, because it contains all of the components necessary for experimentation. The training panel can be used when mounted in a frame or as a tabletop unit with slanted experimenting surface.

The configuration of devices within this system permits all classic lamp circuits, such as on/off, change-over, staircase, and many others, to be implemented with bus technology. The binary outputs can be connected to the six built-in lamps or to external AC loads by connecting with 4 mm safety connecting leads. The five masks are aids to quickly and comprehensively change the room concept or problem situation.

E5 Communications technology

When hearing telecommunications, most people immediately think about voice telephony, however, in reality, the subject is wider than that. It encompasses communication at a distance not only of voice but also data and images and has become one of the world's most lucrative industries.

Therefore, training in communication technology needs to quality students in a wide range of topics such as: modulation, coding, lines, services, protocols, antennas, RF technology, radar etc. In this wide field, the communication technology from LD DIDATIC is tailored to the needs of state of the art training for many aspects of telecommunication. Experiments are carried out either by means of training panels or with multimedia courses and are available for a basic as well as a more sophisticated level.

E5.1 COMMUNICATION NETWORKS

- E5.1.1 E5.1.1.1 FUNDAMENTALS OF LOCAL & TRUNK EXCHANGE SYSTEMS
- E5.1.1.2 DECT TELEPHONE SETS
- E5.1.2 WIRELESS COMMUNICATIONS
- E5.1.2.1 MOBILE PHONE TRAINER
- E5.1.2.2 ZIGBEE TRAINER
- E5.1.2.3 WIRELESS DIGITAL COMMUNICATIONS TRAINING SYSTEM
- E5.1.3 COMPONENTS FOR DIGTIAL DATA TRANSFER
- E5.1.3.1 BLUETOOTH TRAINER
- E5.1.3.2 USB TRAINER
- E5.1.3.3 RFID TRAINER
- E5.1.3.4 EMBEDDED INTERNET TRAINER
- E5.1.3.5 FPGA-TRAINER

E5.2 TRANSMISSION TECHNOLOGY

- E5.2.1 ANALOGUE TRANSMISSION TECHNOLOGY
- E5.2.1.1 FOURIER ANALYSIS & SYNTHESIS
- E5.2.1.2 AMPLITUDE MODULATION
- E5.2.1.3 QUADRATURE AMPLITUDE MODULATION
- E5.2.1.4 FREQUENCY & PHASE MODULATION

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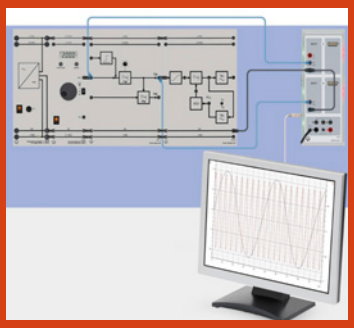
- E5.2.2 DIGITAL TRANSMISSION TECHNOLOGY
- E5.2.2.1 PULSE CODE MODULATION
- E5.2.2.2 PULSE TIME MODULATION
- E5.2.2.3 DELTA MODULATION
- E5.2.2.4 SHIFT KEYING & MODEM TECHNOLOGY
- E5.2.3 COM3LAB MULTIMEDIA: TELECOMMUNICATIONS
- E5.2.3.1 TRANSMISSION TECHNOLOGY
- E5.2.4 NOISE & MODULATION
- E5.2.4.1 NOISE ON ANALOG TRANSMISSION LINES
- E5.2.4.2 NOISE ON DIGITAL TRANSMISSION LINES
- E5.2.5 COM3LAB MULTIMEDIA: TRANSMISSION CHANNELS
- E5.2.5.1 TELECOMMUNICATION LINES
- E5.2.5.2 COMMUNICATION TECHNOLOGY
- E5.2.5.3 COMMUNICATION NETWORK
- E5.2.6 TELECOMMUNICATIONS WITH FIBRE OPTICS
- E5.2.6.1 FIBRE OPTICS TRAINER
- E5.2.6.2 DATA TRANSMISSION WITH FIBER OPTIC LINES
- E5.2.7 PHOTONICS FOR ENGINEERS
- E5.2.7.1 FIBRE OPTICAL SENSORS
- E5.2.7.2 EMISSION & ABSORPTION
- E5.2.7.3 FIBRE OPTICAL SPECTRUM ANALYSER
- E5.2.7.4 OPTICAL TRANSMITTER & RECEIVER
- E5.2.7.5 FIBRE OPTICS WORKSHOP
- E5.2.7.6 PHOTONICS CHANNEL POF

E5.2.1.4 FREQUENCY & PHASE MODULATION



Frequency and phase modulation are forms of angle modulation. Frequency modulation happens to play a major role in commercial telecommunications (VHF radio). With this training system the students learn about modulators as important non-linear systems. FM is widely used for broadcasting radio programs. The spectrum of FM is non-linear. It contains of an infinite number of sidelines.

E5.4.5.1 ANTENNALAB 300

The AntennaLab is an integrated package of hardware and software for teaching and demonstrating common antenna configurations at all levels of study. It can also be used as a design tool by those engaged in research and development of antenna systems.

AntennaLab is operated in conjunction with a PC and the whole system can easily be accommodated on a standard laboratory bench. The equipment comprises two towers, approximately 1 metre high, one of which contains a low-power generator controlled by a frequency synthesizer, and a motor/shaft encoder assembly to rotate the antenna under test. The antenna being investigated is mounted on a small platform on top of this tower. The „receiver" tower contains a receiver controlled by a frequency synthesizer and produces a d.c. output representing the received signal intensity. A broadband array of log periodic antennas is mounted on this tower and is not changed in normal use. The receiver and generator synthesizers are synchronised, the two tower assemblies being linked by a five-metre multiway cable carrying both power and data. The „generator" tower is linked to the microcomputer. A selection of components is supplied with the system to enable most of the common antenna types to be constructed.

E6 Control Engineering & Automation

Advanced automation is increasingly requiringthe monitoring and control of technical processes and production techniques to autonomous control systems. Mechanical controls are thus relieving humans from performing monotonous control and operating tasks. However, technical systems often require a level of accuracy, speed and reliability that humans would not be able to fulfill.

The training system for control engineering employs training panel systems TPS as well as the multimedia training system COM3LAB for basic and advanced courses. For automation technology, LD DIDACTIC has didactically engineered SIMATIC components for practice-oriented training and education and 4 mm connectors. With ASIMA II there is a equipment set from basic PLC to Industry 4.0 available.

E6.1 MEASUREMENT TECHNOLOGY & SENSORICS
- E6.1.1 MEASURING ELECTRICAL QUANTITIES
  - E6.1.1.1 DC TECHNOLOGY
  - E6.1.1.2 AC TECHNOLOGY
  - E6.1.1.3 ELECTRONIC MEASUREMENT CIRCUITS
- E6.1.2 MEASURING NON-ELECTRICAL QUANTITIES
  - E6.1.2.1 SENSORS & TRANSDUCERS
- E6.1.3 COM3LAB MULTIMEDIA: MEASUREMENT TECHNOLOGY
  - E6.1.3.1 BASICS OF ELECTRICAL ENGINEERING
  - E6.1.3.2 OPERATIONAL AMPLIFIER
  - E6.1.3.3 INSTRUMENTATION & SENSOR TECHNOLOGY

E6.2 DIDACTIC CONTROL TECHNOLOGY
- E6.2.1 CONTROL TECHNOLOGY WITH STE
  - E6.2.1.1 CLOSED LOOP BRIGHTNESS CONTROL
  - E6.2.1.2 CLOSED LOOP VOLTAGE CONTROL
- E6.2.2 COM3LAB MULTIMEDIA: CONTROL TECHNOLOGY
  - E6.2.1.1 BASICS OF CLOSED LOOP CONTROL ENGINEERING
  - E6.2.1.2 ADVANCED OF CLOSED LOOP CONTROL ENGINEERING
  - E6.2.1.3 CONTROL & INSTRUMENTATION PRINCIPLES
  - E6.2.1.4 CONTROL OF DIDACTICAL SYSTEMS

E6.3 APPLIED CONTROL TECHNOLOGY
- E6.3.1 TECHNICAL CONTROLLED SYSTEMS
  - E6.3.1.1 TEMPERATURE CONTROL
  - E6.3.1.2 FLOW & LEVEL CONTROL
  - E6.3.1.3 CONTROL OF AIRFLOW
  - E6.3.1.4 BRIGHTNESS CONTROL
  - E6.3.1.5 SPEED & VOLTAGE CONTROL
  - E6.3.1.6 HEELING CONTROL
- E6.3.2 SERVO CONTROL
  - E6.3.2.1 DC SERVO
  - E6.3.2.2 AC SERVO
  - E6.3.2.3 STEPPER MOTOR
- E6.3.3 PROCESS ENGINEERING
  - E6.3.3.1 COMPACT TRAINER: PROCESS CLOSED LOOP CONTROL
  - E6.3.3.2 CHEMICAL ENGINEERING: BLUE-BOTTLE PROCESS
- E6.3.4 SYSTEMS & COMPONENTS OF CONTROL ENGINEERING
  - E6.3.4.1 ELECTRONIC CONTROLLED SYSTEMS
  - E6.3.4.2 DIGITAL CLOSED LOOP CONTROL
  - E6.3.4.3 FUZZY CONTROL
  - E6.3.4.4 FREQUENCY RESPONSE & CONTROLLER DESIGN
  - E6.3.4.5 STABILITY & OPTIMISATION
- E6.3.5 TECHNICAL PROCESSES WITH LARGE SCALE MODELS
  - E6.3.5.9 BALL & PLATE CONTROL SYSTEM
  - E6.3.5.11 INVERTED PENDULUM
  - E6.3.5.12 TWIN ROTOR MIMO SYSTEM
  - E6.3.5.13 MODULAR SERVO SYSTEMS
  - E6.3.5.14 MAGNETIC LEVITATION SYSTEM
  - E6.3.5.15 PRECISION MODULAR CONTROL WORKSHOP

E6.4 INDUSTRIAL CONTROLLERS & CONTROLLED SYSTEMS
- E6.4.1 INDUSTRIAL CONTROL SYSTEMS
  - E6.4.1.1 AUTOMATIC CONTROL WITH COMPACT CONTROLLERS
  - E6.4.1.2 CONTROL OF AN INDUSTRIAL MACHINE 0.3 KW
- E6.4.2 HAND'S ON TRAINING SYSTEMS
  - E6.4.2.1 PROCESS INSTRUMENTATION
  - E6.4.2.2 TEMPERATURE IN AIRSTREAM
  - E6.4.2.3 LEVEL & FLOW
  - E6.4.2.4 FOUR-TANK SYSTEM
  - E6.4.2.5 TEMPERATURE IN WATER

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E6 Control Engineering & Automation

E6.2.2.4
COM3LAB MULTIMEDIA: CONTROL OF DIDACTICAL SYSTEMS

The equipment includes the COM3LAB Control Technology courses and the didactic controlled systems set of machines 10W, digital temperature and Liquid control system.

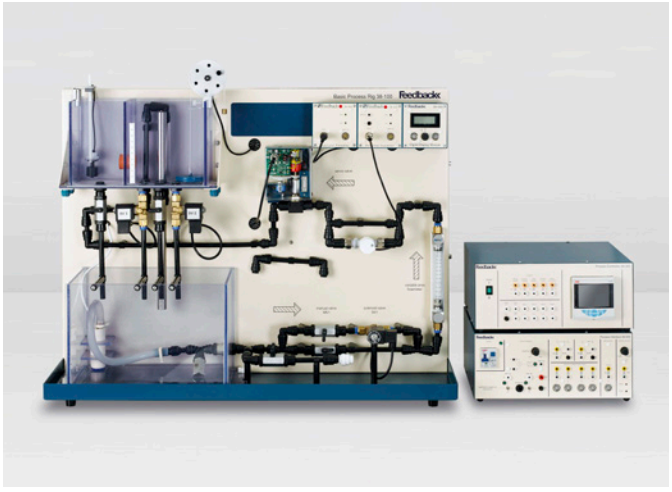
The courses COM3LAB control technology offer extensive analysis tools and setting options and enable an optimum parameterization of the controller.

- Liquid control system
- Temperature controlled system
- Set of machines

E6.3.1
TECHNICAL CONTROLLED SYSTEMS

Extended industrial processes are often divided for clarity into sub-processes. This allows the gradual start-up of the production and efficient troubleshooting in case of failure. Each of the following equipment sets contain as a key component a technical controlled system, which is part of such a sub-process:

- E6.3.1.1 Temperature Control
- E6.3.1.2 Flow and Level Control (Picture)
- E6.3.1.3 Control of Airflow
- E6.3.1.4 Brightness Control
- E6.3.1.5 Speed and Voltage Control
- E6.3.1.6 Heeling Control



E6.4.2.3
PROCESS CONTROL: LEVEL & FLOW

The Level & Flow Process Control trainer is a single loop system allowing the study of the principles of process control, using liquid level and flow rates as the measured process variables.

- Flow and Level control
- On-Off and proportional control
- P, PI and full PID control
- Advanced process control

E6 Control Engineering & Automation

E6.5.2.4
FAULT SIMULATOR TRAINER: CONTACTOR CIRCUITS

The core of the device is at the front containing a large number of lead-throughs behind which the measuring and connecting points for the contactor circuits are located. By applying various masks, only the 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 face and contains switches, push-buttons, indicator lights and connection sockets for external limit switches.

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

Two 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.

E6.7.1.3
ASIMA II PLANT SIMULATOR PLC S7 ADVANCED

The ASIMA II Plant Simulator is the optimal plant simulator for S7-1516. There are 33 different types of plant available. They are set by the use of a code switch and coloured masks. These range from „Testing of PLC functions" to „Complex plant with control system". Therefore it is possible to use the ASIMA in a large number of learning stages.

- Programming of simple basic circuits
- Programming machine circuits
- Programming of small plants
- Programming of complex systems & devices

More details about our products and equipment can be found at:

WWW.LEYBOLD-SHOP.COM

PHYSICS
CHEMISTRY
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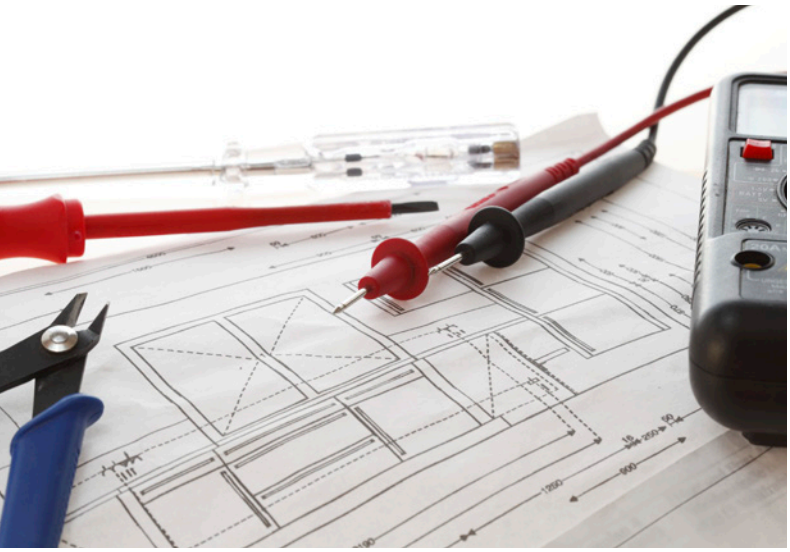
CONTACT

GERMANY:

LD DIDACTIC GmbH
Leyboldstr. 1
50354 Huerth, Germany
Tel.: +49 2233 604 0
Fax: +49 2233 604 222
E-Mail: info@ld-didactic.de
www.ld-didactic.com



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