LEYBOLD®

CONTROL ENGINEERING
& AUTOMATION

CONTROL TECHNOLOGY – AUTOMATION –
INDUSTRY 4.0

LD DIDACTIC

BENEFITS OF THE LEYBOLD SOLUTIONS

TPS-SYSTEMS
Easy to move and set up. Small enough to transport; large enough for impressive experiments.

DIGITISED PROCESSES
Modern control and automation systems are digitised processes, based on microcontrollers and software.

MODULAR
Easily combinable processes, delivering unsurpassed adaptability for individual problems. TPS devices can be combined into extensive and complex overall configurations.

EXPANDABLE
The combination of technical and electronic sub-processes (controlled systems and system simulations) mean higher demands of trainees and students for model processes and sequencers. Systems can be expanded to Industry 4.0.

COMPUTER SUPPORT
Professional software, such as „TIA Portal", „WinFACT", „LabVIEW™", „espial" or „MATLAB™" , allow for programming and optimisation of control problems. The systems of the CASSY family (Sensor-CASSY 2, Profi-CASSY and CASSY Lab 2) are available for evaluation and optimisation of control systems.

PLUG & PLAY
Electronic manuals with prepared measurement data files or proposed solutions are all part of the equipment. No laborious calibrations and preliminary adjustments required.

WHAT IS THIS ALL ABOUT?

The catalogue describes equipment, experiments and devices for control engineering and automation. Before the advent of information processing systems, control engineering was often described in terms of instrumentation and control.

Early controllers, in the form of hard-wired relay and contactor circuits, increased productivity on the assembly lines of American slaughterhouses and in the emerging automotive industry as early as in the late 19th century.

To distinguish relay and contactor controls from modern programmable logic controllers (PLCs), they are sometimes called hard-wired programmed logic controls. Their theoretical background is simple. Due to the hard-wiring, all solutions are adapted individually to a specific application. Only the development of programmable logic controllers in the last third of the 20th century, brought along the breakthrough, leading to widespread use of controllers in virtually the entire industrial production. Unlike control technology, control engineering is heavy on theory.

Automatically sequenced and fixed command control for disturbance compensation can be found in many areas of daily living today. Apart from the usual system evaluations – such as by step responses – they require specific measures and optimisations. This catalogue's great size reflects its practical significance.

In order to make it easier to orient yourself, the catalogue is organized into the following subchapters:
- Measurement technology & sensors
- Didactic control engineering
- Applied control engineering
- Industrial control engineering
- Control technology
- Automation technology
- Process automation
- Hydraulics
- Pneumatics
- Industry 4.0

The setups contain very different learning systems from connector systems through to multimedia courses, experiment plates, and system simulations. In addition to the specially designed, didactic devices, it offers specially prepared training and teaching packages on the basis of industrial components, particularly in the area of programmable logic controllers (PLCs).

LEYBOLD®

LEYBOLD®

INDUSTRY 4.0 –
FOR VOCATIONAL TRAINING & CONTINUING EDUCATION

The transformation of the industrial world and its continuing digitisation place increasing demands on skilled workers and engineers.

The foundations must be laid during training. Therefore we – as a developer and producer of educational systems with years of experience – are called upon to prepare these topics for training and classes in a didactically and methodically clear manner.

With strong partners such as:

- Siemens
- Bosch Rexroth

we have managed to prepare original components of industry manufacturers using our TPS system. This makes these products understandable and user friendly for the real world of training.

The LEYBOLD concept is modular, allowing the training and the didactic concept to be transferred from the complex system to the fundamentals, as well as vice versa.

Teaching Industry 4.0 with LEYBOLD systems:

- FEEDBACK sensor technology fundamentals
- LEYBOLD COM3LAB as multimedia support
- LEYBOLD control engineering – because it is not just about controlling
- Siemens PLC as industrial controller
- LEYBOLD ASIMA, compact, flexible universal system simulation
- Complete System Industry 4.0

CONTENTS

HIGHLIGHT PRODUCTS

## ASIMA II
773 050

The System Simulator ASIMA II is the perfect addition for the SPC S7-1516. A total of 33 different systems are available. The experiment spectrum ranges from testing of SPC functions through to complex systems with controllers and facilitates universal use of ASIMA in education. The COM3LAB course, ASIMA, is included.
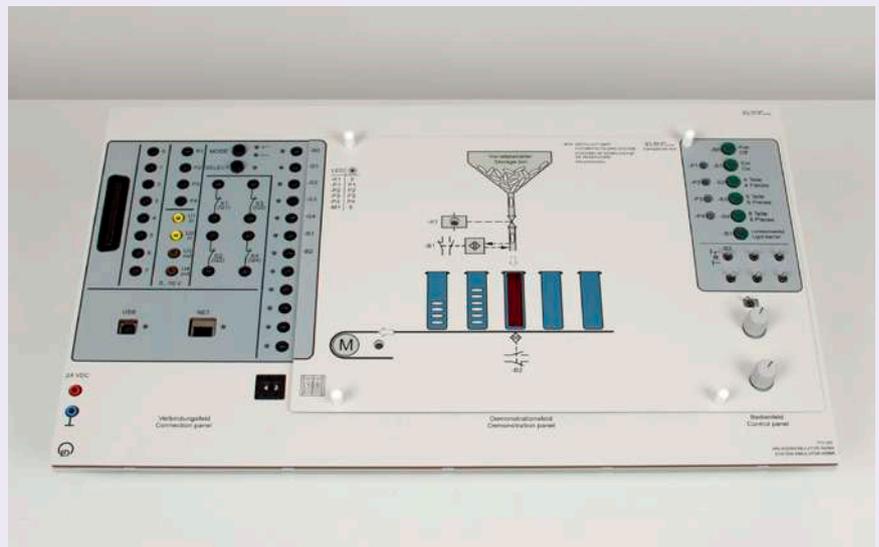
MECHATRONIC & INDUSTRY 4.0
E6.7.2 & E6.9

It allows creating a continuous learning approach, from the fundamentals up to an industrial production system. Mechatronic models help the student create a transition to real industrial systems. It forms the prerequisite for the operation, maintenance and repair of complex production systems.
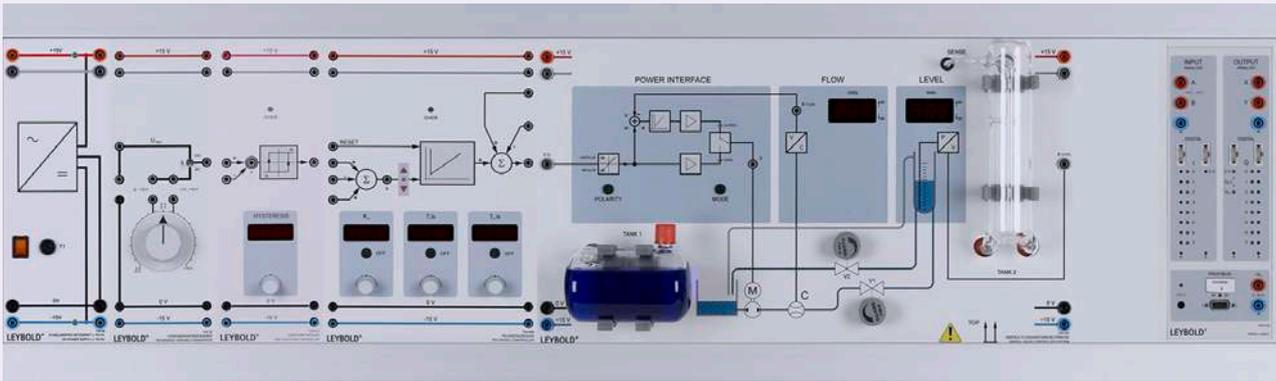
FLOW & LEVEL CONTROL

E6.3.1.2

The liquid control system is comprised mainly of a pump as well as holding and measuring tanks. Two valves are used to control inflow and outflow of the fluid. The device contains an impeller wheel flowmeter with subordinate flow controller.

A dip tube with pressure sensor detects the liquid level in the measuring tank and converts it into an electric signal. The measurement values of the flow and fill level are displayed on 7-segment displays. The digital liquid control system is characterised by a very compact build. It is delivered complete with all sensors and operation equipment and needs very few accessories.

TWIN ROTOR MIMO SYSTEM

E6.3.5

The dual rotor system illustrates the principles of a non-linear MIMO (Multiple Input, Multiple Output) system with significant cross-coupling. The system acts like a helicopter with fixed angles of attack of the rotor blades, in which the aerodynamic forces are controlled by varying the rotational speeds of the two motors. Significant cross-coupling between the two axes occurs, as each rotor affects both angular positions. Using the Advantech PCI card, an impressive development environment for digital control can be created. The user is guided through the design process and learns to identify the system by means of phenomenological process models, dynamic analysis, discrete models, controller design, controller tests on the model, controller implementation in real-time applications, implementation of various control strategies and data visualisation.

PID DIGITAL CONTROLLER NET

734 064N
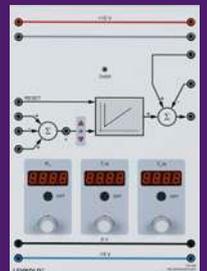
Networked 32-bit digital controllers for integration into the LeyLab network. The digital controller is configured, for example, as a P, PI, PD, or PID controller as a control for continuous processes. Including input summing junction for two reference variables and one control variable, measuring point for control difference, trend display of the control difference with three LEDs. The P, I and D component can be switched off individually.
Including output summing junction for adding or subtracting two external and internal disturbances. The internal disturbance can be switched through the network. Choice of controller parameters via buttons and rotary encoders.
The integrator works with an anti-wind-up limit. The differentiator uses an adaptive smoothing algorithm to reduce the quantisation noise and is equipped with an internal slew limiter.

COM3LAB MULTIMEDIA
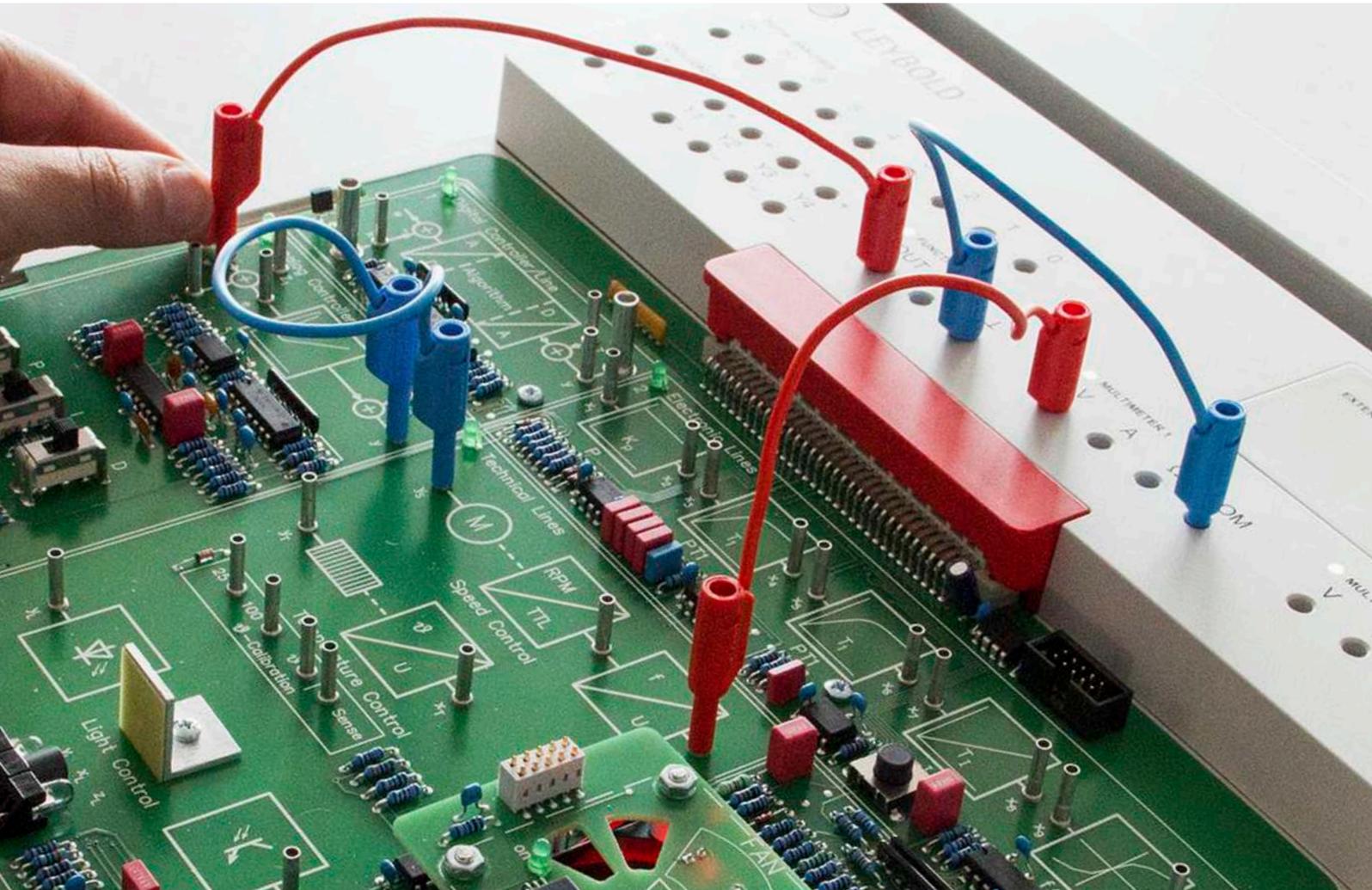
MASTER UNIT

The master unit is compatible with all courses and includes two digital multimeters, a function generator, a digital storage oscilloscope, and a digital analyser. A completely new subject area can be accessed by simply changing the course PCB in the master unit.

OPTIMUM COMBINATION OF THEORY AND PRACTICE

COM3LAB Multimedia combines interactive learning software with real hardware and is used in schools, universities and industrial companies for training in various fields of electrical engineering and electronics.

Likewise, the COM3LAB courses on instrumentation and control faithfully implement the modern methods of blended learning. They offer flexible application in the classroom since they are suitable for demonstration, hands-on self-study, or for project work in teams.

COM3LAB COURSE: AUTOMATION & BUS TECHNOLOGY

This course provides the basic knowledge of programmable logic controllers (PLCs) and demonstrates their networking, including sensors and actuators, based on the PROFIBUS.

With many examples, explanations, exercises and practical tasks, fundamentals and operation of PLCs and PROFIBUS are presented in an intuitively accessible manner.

The compact and complex hardware of this course enables practical transfer of knowledge. The ability to connect additional external PROFIBUS components provides extensive options for presenting the processes in bus and automation technology realistically and without much effort.
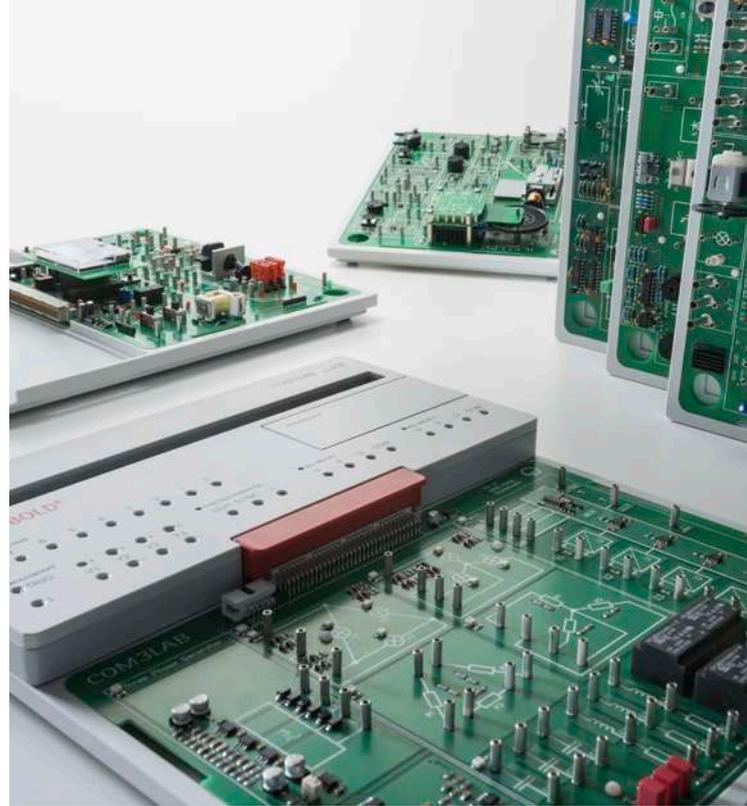
COM3LAB COURSE: CONTROL TECHNOLOGY I & II

These courses teach control engineering practically with many examples. Important learning objectives, such as fuzzy control, stability analysis in accordance with Nyquist, or controller optimisation, can be achieved with additional cost for controlled systems, instrumentation and control equipment.

The course, Control Technology I, focuses on getting to know the different controllers. Analysis and calculations of controlled systems are developed step by step.

The course, Control Technology II, covers complex control systems and their behaviour.

COM3LAB COURSE: OPERATIONAL AMPLIFIER

This course provides insight into the world of the operational amplifier. From a standard circuit through to realisation of a function generator, it covers all important topic areas. This course gives students the foundation for other courses in control engineering.

COM3LAB COURSE: SENSOR TECHNOLOGY

It teaches the basic knowledge of measuring non-electrical variables. Using many examples, explanations, exercises and practical tasks, it presents the principles and functions of the sensors and the associated measuring circuits in an intuitively accessible manner.

TPS – TRAINING PANEL SYSTEM
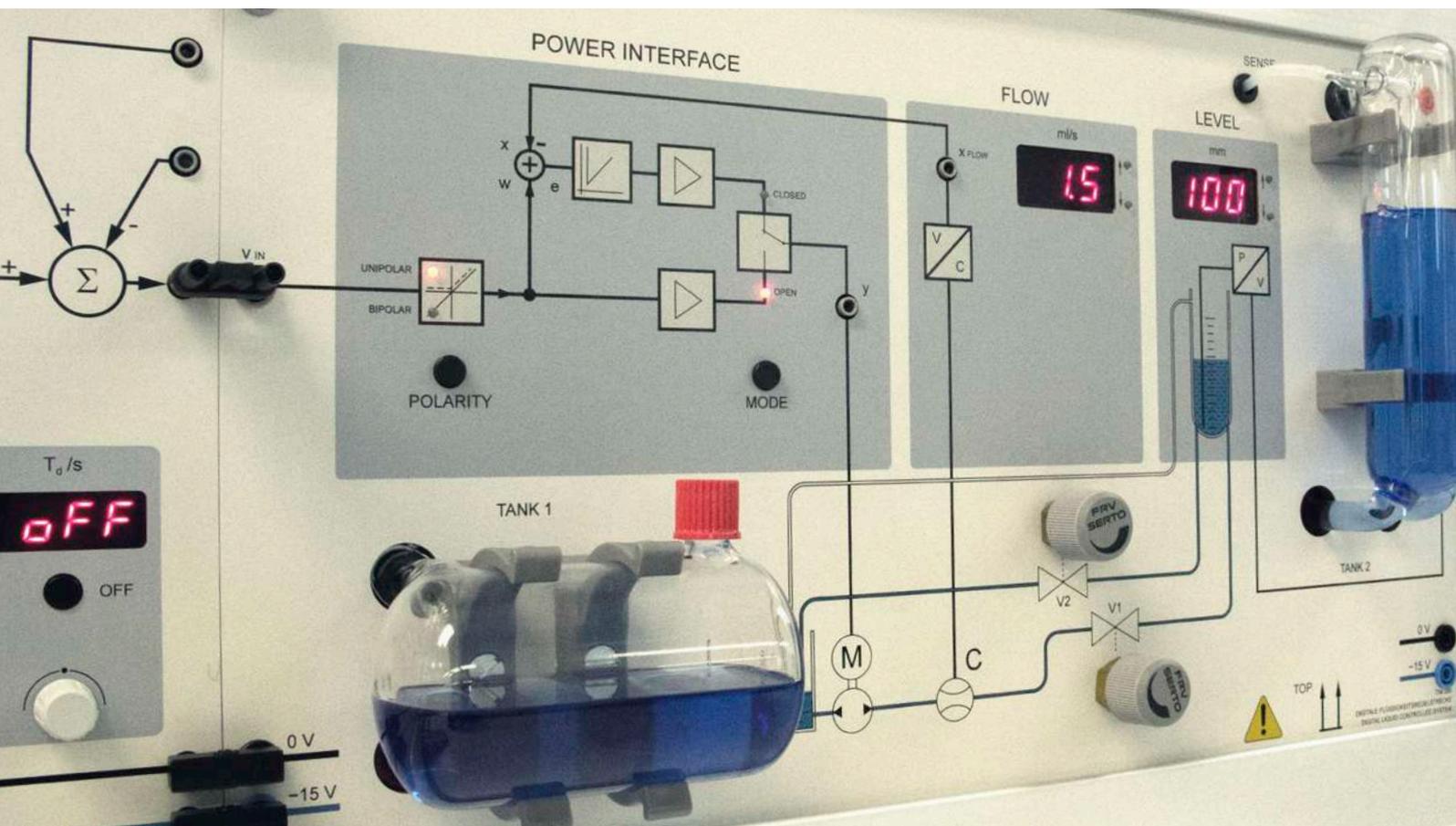
The LEYBOLD training panels are the centerpiece of the successful training systems. The equipment set configurations feature an outstanding modular design. All of the required training fields can be covered in their respective training topic areas using the TPS training panel equipment sets.

THE MODULAR TRAINING PANEL SYSTEM FOR STUDENT EXPERIMENTS & CLASSROOM DEMONSTRATIONS

- Use of original components

- Experiment literature for classroom preparation and experiment procedur

- Featuring clearly laid out frontal panels

- High scratch and wear resistance
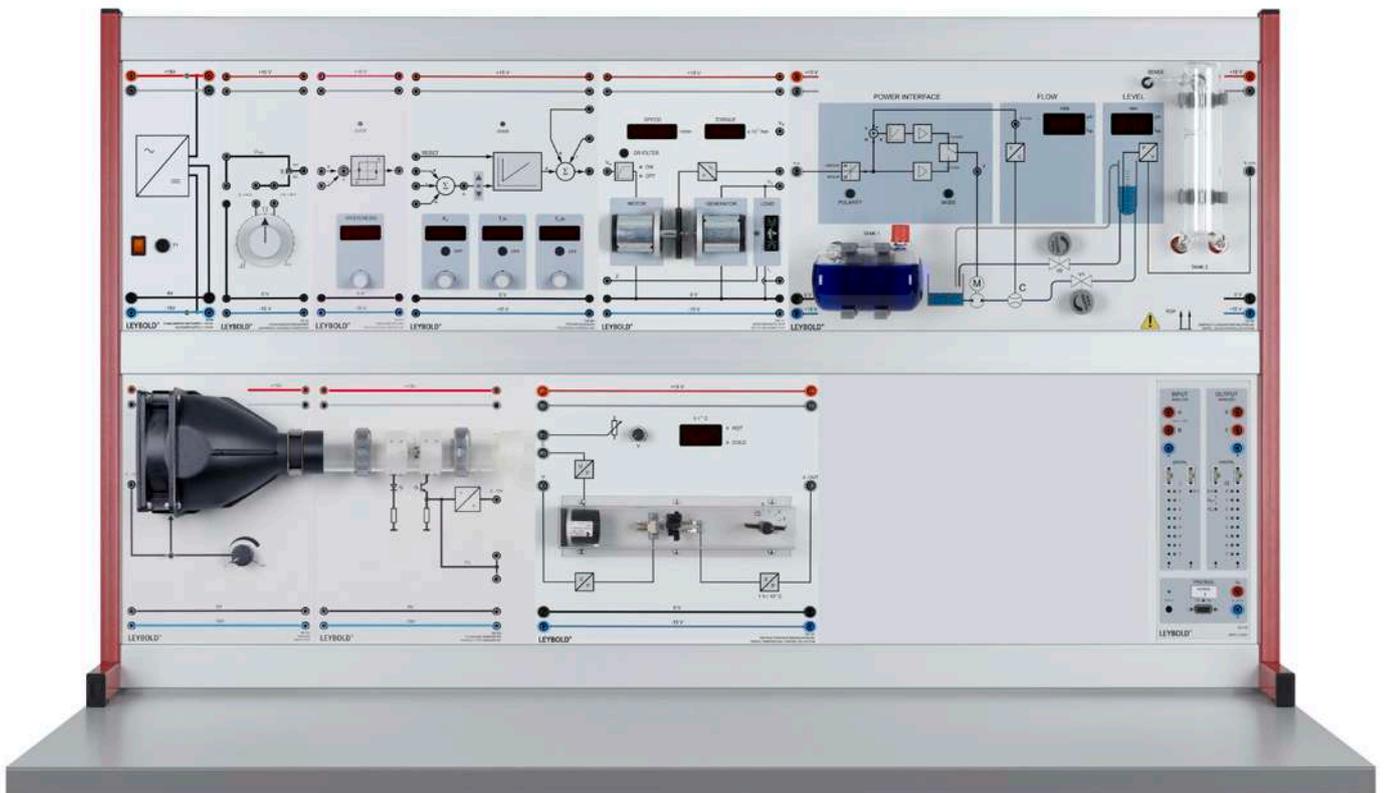
The systematic use of 4-mm safety sockets, cables and bridging plugs (jumpers), ensure that the experiment procedures are carried out safely. With the support of extensive experiment instructions and literature the students and trainees have lots of opportunities to acquire knowledge and new skills while at the same time deepening what they have already learned previously.

The proven TPS training panel system is also perfectly suited for instructors who have to demonstrate complex experiments. The additional TPS.NET and CASSY technologies offer the option of conducting all experiments with computer assistance. This builds a bridge between traditional learning and new technologies.
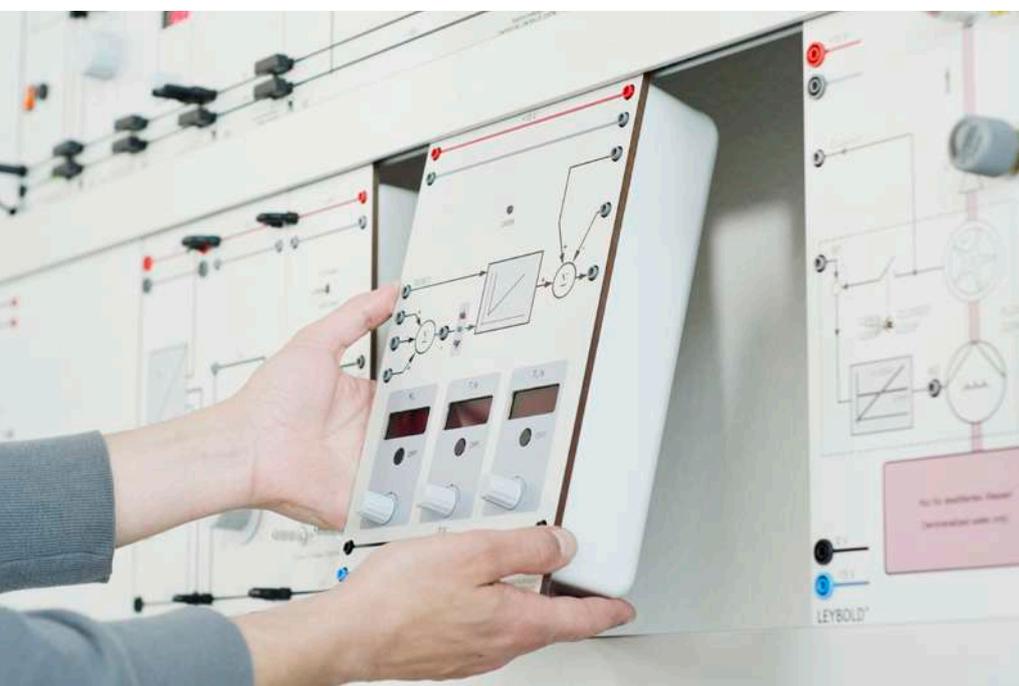
Thanks to the modular design, technology labs can quickly and easily be outfitted or extended using the TPS system.

STE PLUG-IN SYSTEM

The LEYBOLD plug-in system is a tried and tested experimentation program for electrical engineering and electronics. The extensive experimentation program covers beside the basics also advanced topics, for example, communications, IT, open take out and closed-loop control technology as well as areas from automotive electronics.

Instruction sheets for students and accompanying teacher information are available to assist with the performance of experiments. The printed symbols on the plug-in housing elements, connectors and training panels provide the experiment set-ups with a circuit-like appearance. This facilitates the knowledge transfer between the circuit diagrams in the text books and the circuitry being assembled and makes the documenting of the experiment set-ups easier to do. At the end it ultimately promotes circuit-based thinking, learning and experimenting.

The STE case is the storage solution which also serves as a student workstation. The cover can be used to accommodate various STE equipment sets and also assist in performing experiments in the classroom. The clearly configured storage design permits quick setup and a quick start to experimenting.
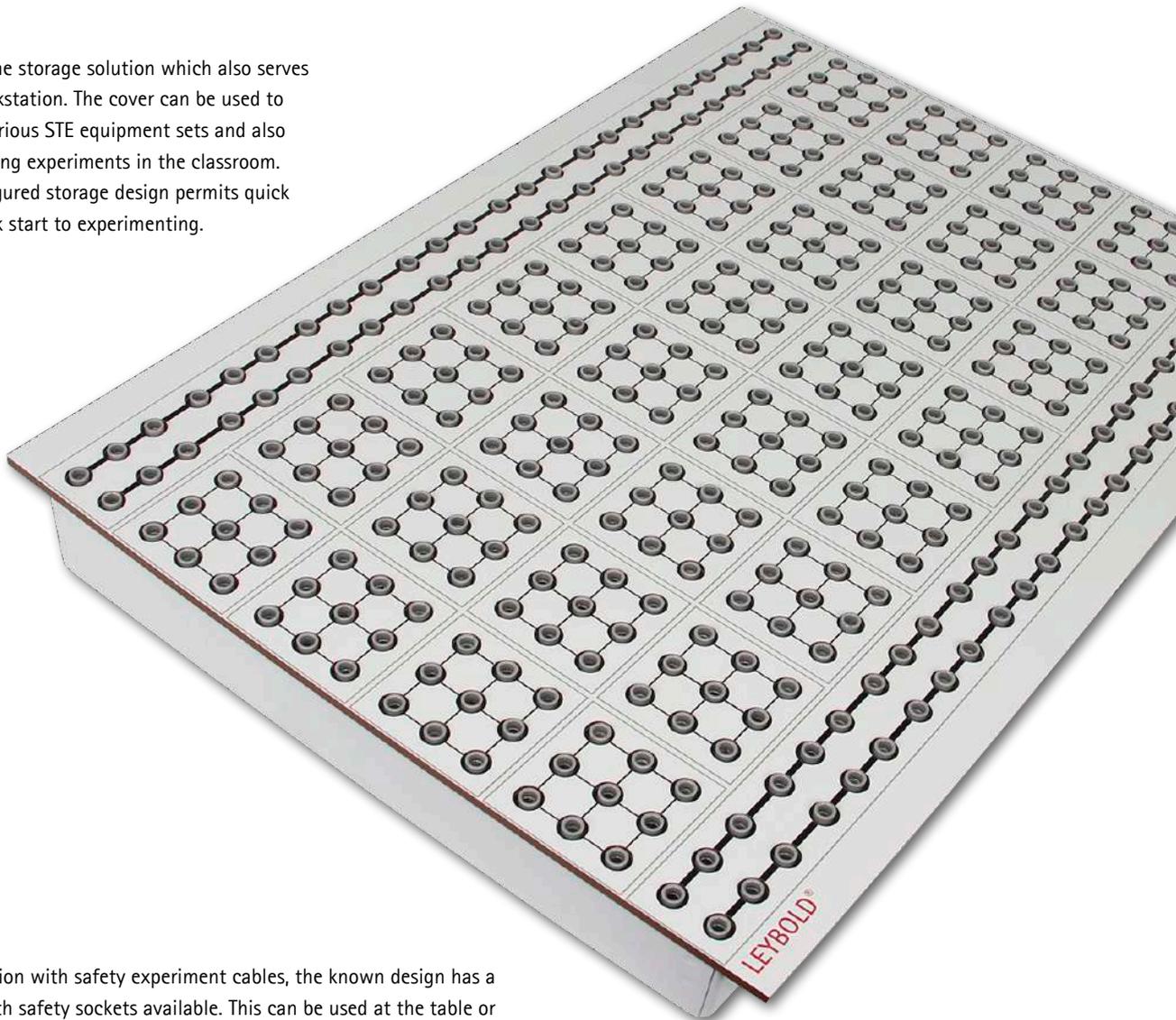
For experimentation with safety experiment cables, the known design has a Plug-in board with safety sockets available. This can be used at the table or for demonstration in the panel frame.

The STE elements come ready for operation and assembly with their electrical and electronic components encased in transparent housings to protect against external mechanical damage. Thanks to the transparent bottom part the original component is visible.

CASSY – COMPUTER-ASSISTED MEASUREMENT & EVALUATION
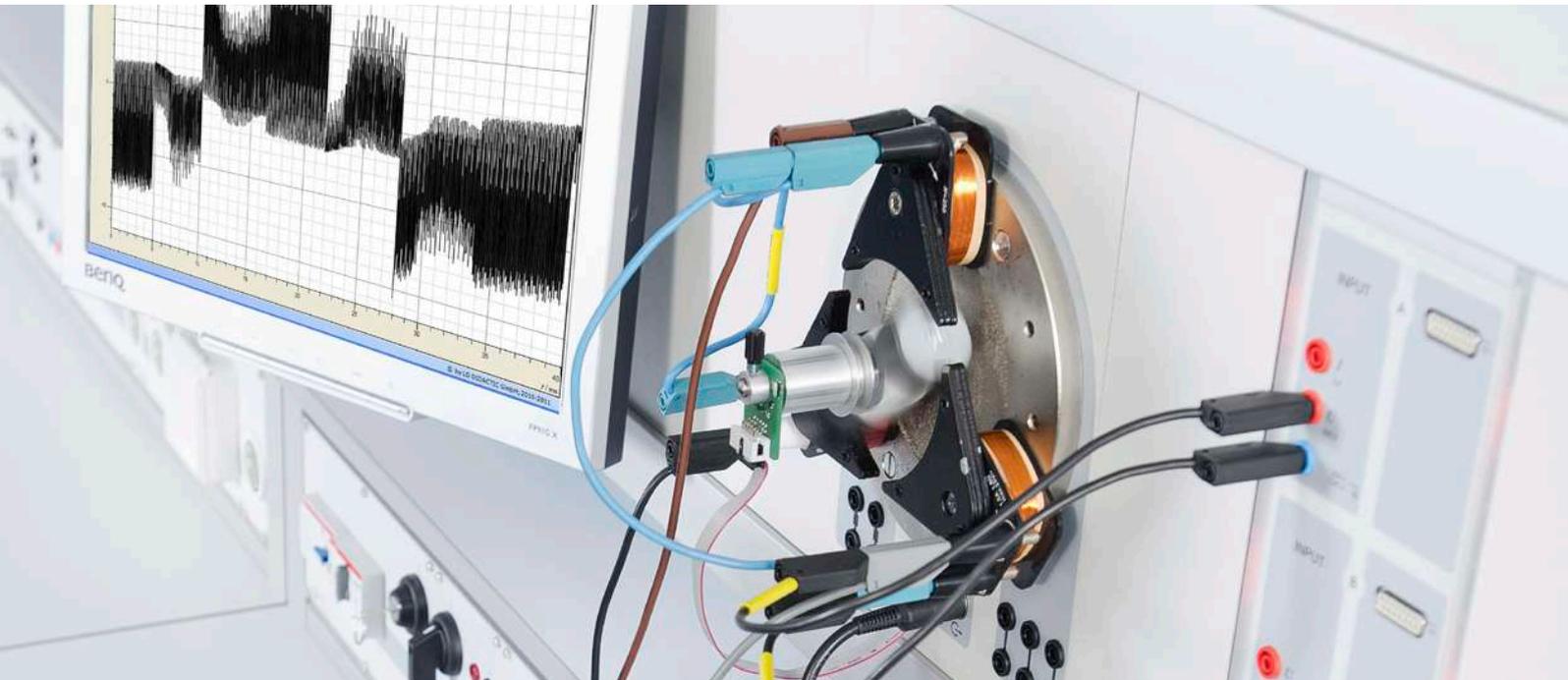
The modular CASSY system makes computer-assisted measurement and evaluation possible for all training and educational levels up to university level.

THE CASSY SYSTEM COVERS:

1. Interfaces for recording measurement data

2. Comprehensive offering of sensors for the detection of electrical and non-electrical variables

3. CASSY Lab 2: The intuitive and easy-to-use software for measurement and evaluation designed to fit all of the equipment and sensors

SOFTWARE (SELECTION)

- CASSY Lab 2
- WinFACT
- MATLAB
- LabVIEW
- LEYLAB
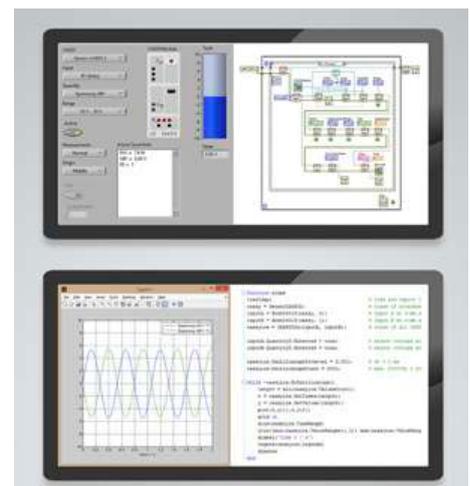
SENSOR-CASSY 2

INTERFACE FOR RECORDING MEASUREMENT DATA

- For connection to the USB port of a computer, to an additional CASSY module or to the CASSY display (WiFi optional)

- Simultaneous measurement of voltage, current and two additional variables possible

- Automatic sensor box recognition

- Can be setup as table-top, console or demonstration unit (also in CPS/TPS experiment frames)

PLUG & PLAY

Automatic detection and setting of Sensor-CASSY and sensor boxes

COMPATIBLE

with all CASSY sensor boxes and sensors

Sensor-CASSY 2 (524 013) provides two electrically separated voltage inputs, an alternative current input and two sensor box inputs parallel to this. All inputs have variable measurement ranges.
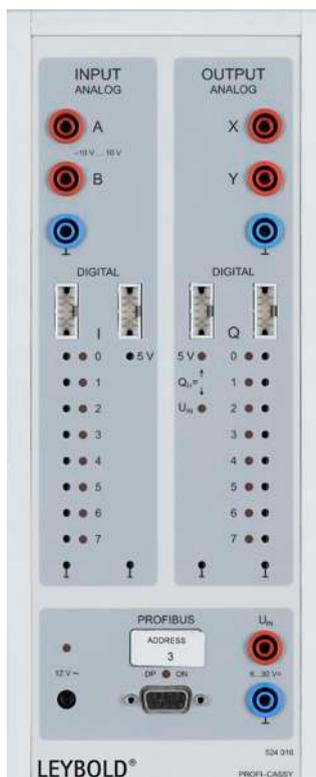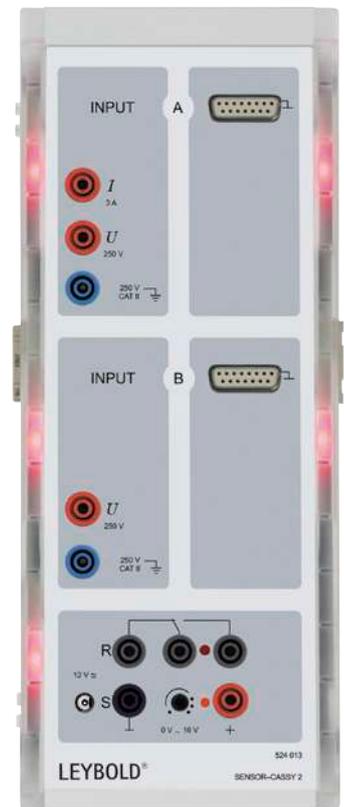
PROFI-CASSY

INTERFACE FOR ALL AREAS OF ELECTRICAL ENGINEERING

- For connection to the USB port of a computer,

- Microcontroller-controlled with the CASSY-operating system (upgrades and expansions can be easily updated anytime via software)

- Variable set-up as table-top, console or demonstration device (also in CPS/TPS experiment frames)

More details about our products and equipment can be found at:
WWW.LEYBOLD-SHOP.COM

DOCUMENT CENTER
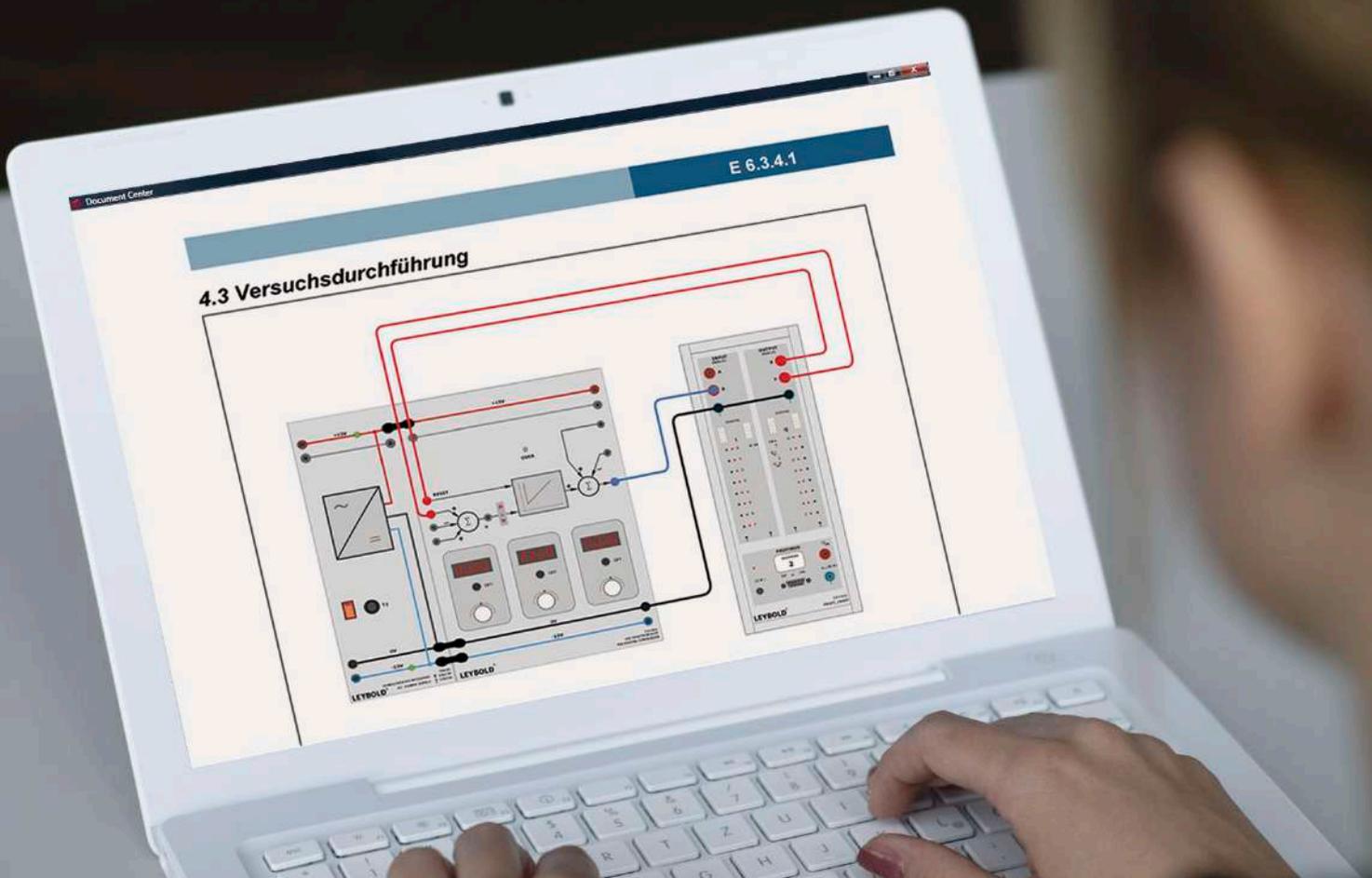
LEYBOLD'S ELECTRONIC LIBRARY

■ Display and manage student experiment literature, demonstration experiment instructions or operating instructions in one program

■ Automatically update all documents thanks to free online updates

■ Benefit from convenient, fault-tolerant keyword and catalogue number search features

THE DAYS OF ENDLESS SEARCHING ARE OVER

The time consuming search for experiment instructions in folders is finally over. The free-of-charge Document Center saves you valuable class preparation time. With the Document Center you have digital access to all the technical documentation which we have placed at your disposal (partially with costs) in the form of extensive literature packets.

Once installed, you can set the documents to automatically update to the latest versions. The literature packets are clearly displayed in the form of a table of contents that also guides you intuitively to the desired document. The more literature packets you have installed, the more entries you will have in your table of contents.

Using the fault-tolerant search function you can quickly and easily find the correct document. Here again, the more literature packets installed, the more powerful the search function becomes.

CONDUCT EXPERIMENTS INTERACTIVELY & LOG THE RESULTS DIGITALLY

Literature packets not only contain documents but also application data. Thus, for example, it is possible to take settings and examples from one of the experiment descriptions included in the literature packet and load this data into CASSY Lab 2 with a simple click of the mouse.

If student and teacher versions from a packet are installed, switching back and forth between versions is also as easy as a mouse click. Student documents can be filled out in the Document Center and logged findings saved or printed out as a hardcopy.
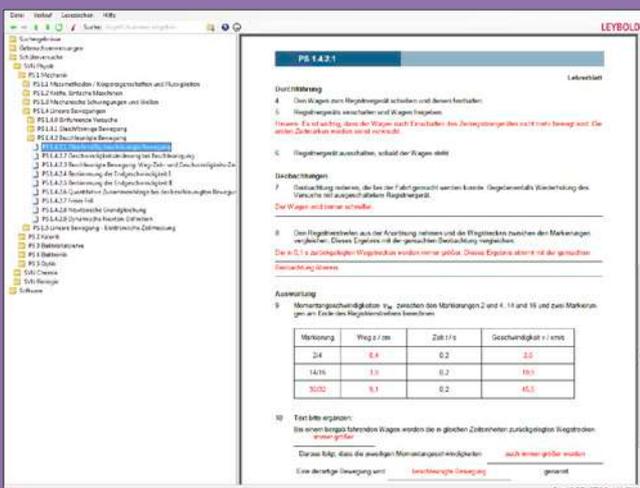
Teacher version
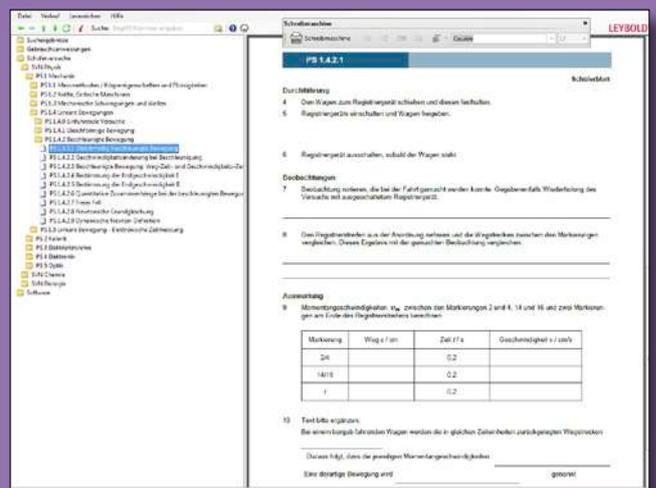
Student version

LEYBOLD BENEFITS

- established content

- practical experiments

- educational materials for presentation

- documentation with solutions

- flexible use in teaching

- time saving by complete set-up

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
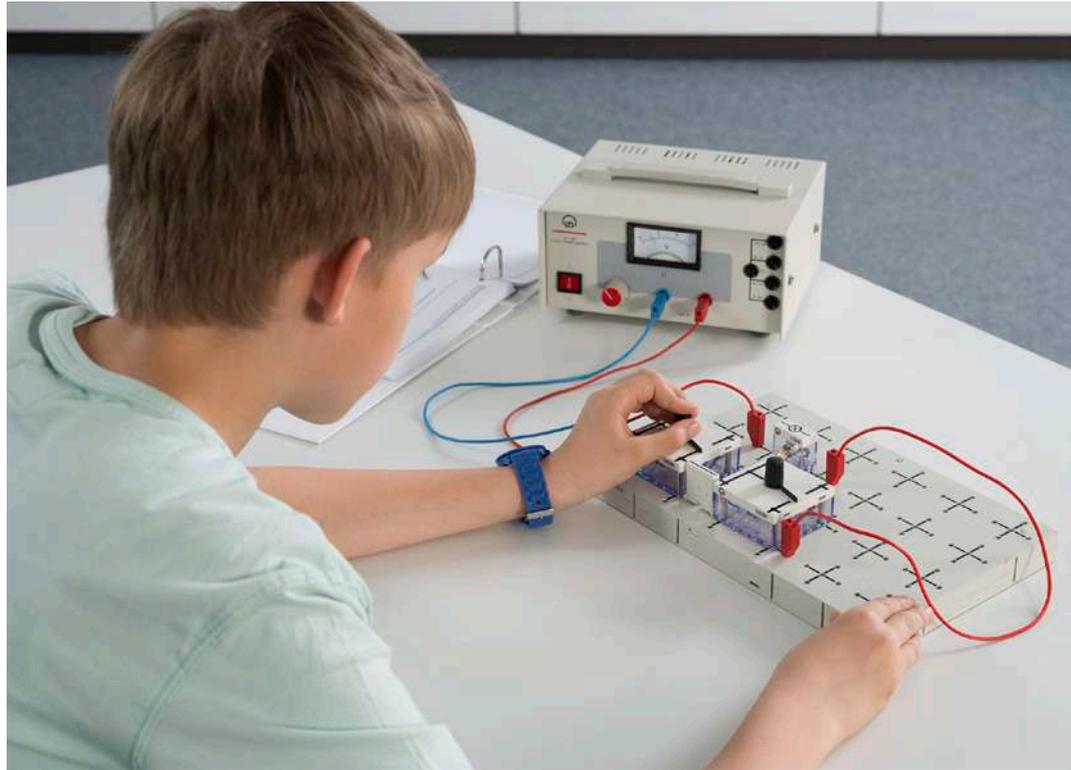
DC Technology (E6.1.1.1)

Cat. No.	Description	E6.1.1.1	E6.1.1.2	E6.1.1.3
727 512	Basic Set T 2.2, STE	1		
576 74	Plug-in board, DIN A4, STE	1	1	1
521 485	AC/DC power supply, 0...12 V/3 A	1	1	1
685 44ET4	Batteries, 1.5 V (AA), set of 4	1	1	
531 120	Multimeter LDanalog 20	2	2	
LDS 00001	Stopwatch, digital	1		
501 48	Bridging plugs, STE 2/19, set of 10	1	1	1
500 421	Connecting lead 19 A, 50 cm, red	3	3	
500 424	Connecting lead 19 A, 50 cm, black	3	3	
565 622	LIT: DC Circuits T 2.2 (English)	1*		
727 513	Basic Set T 2.3		1	
726 962	Function generator 200 kHz		1	1*
562 791	Plug-in power supply, 12 V AC		1	1*
575 214	Oscilloscope 30 MHz, two-channel, analogous		1	1
575 24	Screened cable, BNC/4 mm		1	1
726 19	Panel frame SL85, single-level		1	
727 531N	Basic set STE 6.1.1			1
727 649N	Supplementary Set T 6.1.11			1
531 2741	Digital multimeter 3315			1
501 532	Connecting leads, 19 A, set of 30			1
726 88	AC/DC stabilizer			1*
531 282	Multimeter Metrahit Pro			1*
531 57	Multimeter METRAport 3A			1*
727 510N	Complete equipment set DC/AC/EL			1*

Cat. No.	Description	E6.1.1.1	E6.1.1.2	E6.1.1.3
565 712	LIT: Discrete components and basic circuits in electronics T 6.1.1			1*
565 852	LIT: Electronic Measuring Device Circuits T 6.1.11			1*

* additionally recommended

DC Technology

The topics covered range from the construction of simple circuits through to Kirchhoff's Circuit Laws and Ohm's Law as well as the measurement of characteristic curves of non-linear resistances. Also included are experiments for DC technology and the load characteristics of voltage sources.

AC Technology

The topics covered range from the production and graphing of AC current parameters through to measurement technology and how to use an oscilloscope. Measurements are taken from AC circuits with ohmic, capacitive, and inductive elements.

Electronic Measurement Circuits

Basic equipment for the design and measurement of electronic voltage measuring devices. Topics are the frequency-compensated input circuit with protective circuit, the high-impedance input amplifier, measuring amplifier for direct and alternating voltage as well as precision rectifiers.

E6.1.2

MEASURING NON-ELECTRICAL QUANTITIES

E6.1.2.1
Sensors & Transducers
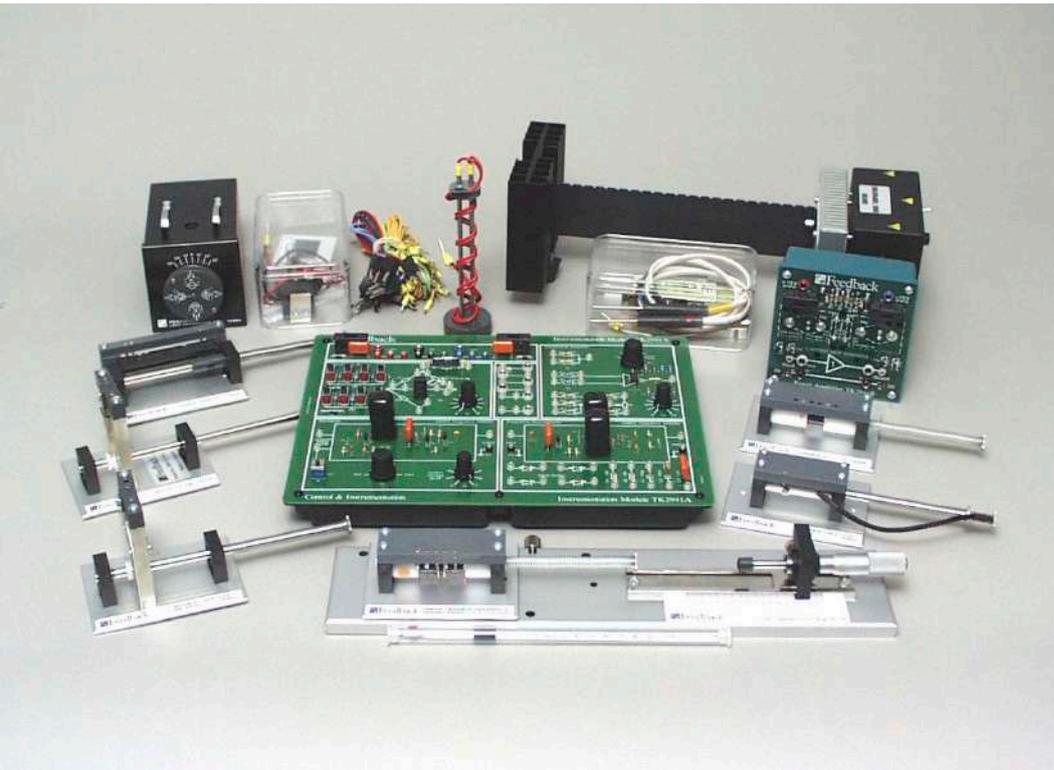
Sensors & Transducers (E6.1.2.1)

Cat. No.	Description	E6.1.2.1
TK2 942-1	Complete Transducers Kit	1

Sensors & Transducers

Force and temperature are known examples of non-electrical quantities that need to be converted for further processing in automatic control systems. The components of this training system are based on real industrial sensors. The internal structure and the principle of operation of the sensors remain hidden from the user. The sensors are optimized for the specific application.

System

Many engineering applications and systems depend on accurate measurements and monitoring. Transducers are fundamental to the measurement process, consequently the study of different types of transducers, how they operate and how their output signals can be processed, is essential knowledge for engineers.

Features

The TK2942-001 Tranducers Kit introduces students to the concepts and understanding of common transducer devices and standard signal conditioning methods via 28 excellent practical assignments. It comprises the Measurements Package TK2941M, the Electro-mechanical Transducers Kit TK2941E, the Heat Transducers Kit TK2941H, the Light Transducers Kit TK2941L, the Power Supply 01-100 and includes all leads and accessories.

Topics

- Electro-mechanical transducers utilising variation in resistance
- Wheatstone bridge
- Amplifiers
- Liquid depth & resistivity
- Displacement
- Strain
- Electro-mechanical transducers
- Utilising variation in capacitance
- Variable area & distance
- Use of an oscillator & discriminator in FM systems
- Electro-mechanical transducers utilising variation in inductance
- Electromagnetic inductance
- Variable inductance transducer
- Mutual inductance transistor
- Linear variable differential transformer
- Transducer circuits
- Light transducers
- The nature of light
- Photoconductive cell
- Semiconductor photodiode
- Phototransistor
- Spectral response
- Heat transducers

E6.1.3

COM3LAB MULTIMEDIA: MEASUREMENT TECHNOLOGY

E6.1.3.1
Basics of Electircal Engineering

E6.1.3.2
Operational amplifier

E6.1.3.3
Instrumentation &
Sensor Technology

Basics of Electircal Engineering (E6.1.3.1)

Cat. No.	Description	E6.1.3.1	E6.1.3.2	E6.1.3.3
700 1101	COM3LAB Course: DC Technology I	1		
700 1201	COM3LAB Course: DC Technology II	1		
700 1301	COM3LAB Course: AC Technology I	1		
700 1401	COM3LAB Course: AC Technology II	1		
700 1501	COM3LAB Course: Electronic Components I	1		
700 1601	COM3LAB Course: Electronic Components II	1		
700 9101	COM3LAB Course: Protoboard II	1		
700 9102	COM3LAB: Protoboard II Accessories	1		
700 020	COM3LAB: Master Unit	1	1	1
700 022	Set of Safety Cables (2 mm, 16 Qty., 6 x 30 cm & 10 x 15 cm)	1	1	1
688 129	Mains cable with hock-proof plug and cold connector	1	1	1
700 00CBT	DVD: COM3LAB Software	1	1	1
700 027	COM3LAB: Suitcase	1*	1*	1*
700 8101	COM3LAB Course: Operational Amplifier		1	
700 8401	COM3LAB Course: Sensor Technology			1
700 8402	COM3LAB: Sensor Technology Accessories			1
	additionally required: 1 PC with Windows 7/8/10			

* additionally recommended

Basics of Electrical Engineering

The COM3LAB courses introduce the fundamentals of electrical engineering. They familiarise students with the measurement of current and voltage in direct and alternating current circuits. It also trains students in how to use function generators, multimeters and oscilloscopes.

Operational amplifier

This course gives you insight into the world of the operational amplifier. From the standard circuit to the implementation of a function generator, all important topic areas are dealt with. This course forms the basis for the courses of control technology.

Instrumentation & Sensor Technology

The operational amplifier COM3LAB course gives participants an understanding of important basic electronic circuits such as amplifiers, filters, evaluation circuits, etc.

The sensor technology COM3LAB course builds upon this with emphasis on the measurement of non-electric variables. Graphics, animations and quizzes liven up the theory section. Real experiments and especially hands-on experience with real sensors and evaluation circuits are central to this multimedia set. The sensor technology course is very compact and despite the wealth of experiments is still very compact.

Experiments are operated and evaluated with COM3LAB CBT.

E6.2 DIDACTIC CONTROL TECHNOLOGY

E6.2.1

CONTROL TECHNOLOGY WITH CASSY

E6.2.1.1
Closed Loop Brightness Control

E6.2.1.2
Closed Loop Voltage Control
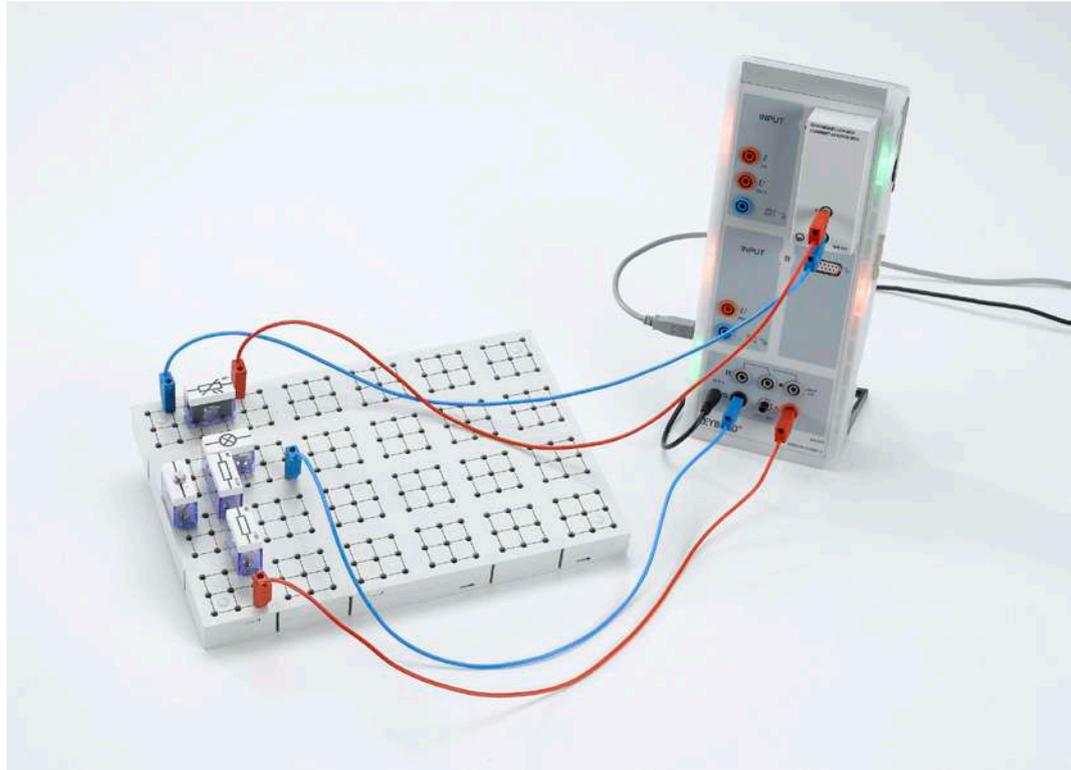
Closed Loop Brightness Control (E6.2.1.1)

Cat. No.	Description	E6.2.1.1	E6.2.1.2
576 74	Plug-in board, DIN A4, STE	1	1
579 05	Lamp holder, E10, lateral, STE 2/19	1	
505 10	Bulbs, 3.8 V/0.27 W, E10, set of 10	1	1
579 13	Toggle switch, STE 2/19	1	1
578 02	Photoresistor LDR 05, STE 2/19	1	
577 20	Resistor, 10 W, STE 2/19	1	
577 23	Resistor, 20 W, STE 2/19	1	
577 28	Resistor, 47 W, STE 2/19	1	
577 32	Resistor, 100 W, STE 2/19	1	
524 013	Sensor-CASSY 2	1	1
524 220	CASSY Lab 2	1	1
524 031	Current source box	1	
501 46	Connecting leads, 19 A, 100 cm, red/blue, pair	2	2
579 43	Motor and tachogenerator, STE 4/19/50		2
307 641ET5	PVC tubing, 6 mm diam., 5 m		1
579 06	Lamp holder, E10, top, STE 2/19		3
501 48	Bridging plugs, STE 2/19, set of 10		1
524 011USB	Power-CASSY USB		1
	additionally required: 1 PC with Windows 7/8/10		

Closed Loop Brightness Control

The aim of the experiments is the computer-aided realisation of closed control loops. With PID- and 2-Point controllers the power of an incandescent lamp is controlled, whose brightness is measured using a photo resistor.

Closed Loop Voltage Control

The aim of the experiments is the computer-aided realisation of closed control loops. PID- and 2-point controllers supervise a generator which supplies a constant voltage independently of the load.

Experiments are operated and evaluated with CASSY Lab 2.

Basics of Closed Loop Control Engineering (E6.2.2.1)

E6.2.2

COM3LAB MUTLIMEDIA: CONTROL TECHNOLOGY

E6.2.2.1
Basics of Closed Loop Control Engineering

E6.2.2.2
Advanced Closed Loop Control Engineering

Cat. No.	Description	E6.2.2.1	E6.2.2.2
700 8101	COM3LAB Course: Operational Amplifier	1	1
700 8201	COM3LAB Course: Control Technology I	1	1
700 8401	COM3LAB Course: Sensor Technology	1	1
700 8402	COM3LAB: Sensor Technology Accessories	1	1
700 020	COM3LAB: Master Unit	1	1
700 022	Set of Safety Cables (2 mm, 16 Qty., 6 x 30 cm & 10 x 15 cm)	1	1
688 129	Mains cable with hock-proof plug and cold connector	1	1
700 00CBT	DVD: COM3LAB Software	1	1
700 027	COM3LAB: Suitcase	1*	1*
700 83	COM3LAB Course: Control Technology II		1
700 3101	COM3LAB Course: Automation and Bus Technology		1
	additionally required: 1 PC with Windows 7/8/10		

* additionally recommended

Basics of Closed Loop Control Engineering

The Fundamentals of the Control Engineering multimedia training package has at its core the courses for sensor technology and Control Engineering I. This ensures that all aspects of classic Control Engineering are covered. The additional Operational Amplifier course explains the function of important basic electronic circuits. It gives learners an understanding of the control engineering of sensors, controllers, transformers, etc.

Objectives
• Behaviour of control circuit and open-path control
• Use of sequence and fixed value control
• Characteristics of analogue and digital controllers
• etc.

Advanced Closed Loop Control Engineering

The multimedia training package Advanced Control Engineering contains the package Fundamentals of Control Engineering as well as the courses Automation and Bus Technology and Control Engineering II.

Objectives
• Evaluation of the stability of control circuits
• Discussion of controller-related questions in the frequency range
• Integration of external control circuits
• etc.

Experiments are operated and evaluated with COM3LAB CBT.

E6.2.2

MUTLIMEDIA:
CONTROL TECHNOLOGY

E6.2.2.3
Control & Instrumentation
Principles

Control & Instrumentation Principles (E6.2.2.3)

Cat. No.	Description	E6.2.2.3
33- 033	Control & Instrumentation Principles	1
93- 420	ESPIAL Software Package	1
93- 400	ESPIAL Tools	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

System

This trainer allows the investigation of control system principles by using a servo mechanism comprising a d.c. motor, a variety of sensors and both analogue and digital controllers. Students are also introduced to the fundamentals of transducers and signal processing. The curriculum is divided into twenty four assignments ranging from basic control concepts to more advanced topics such as transfer function analysis.

Features

The product uses Espial software (supplied separately) in which each assignment comprises clear objectives, background, theory and experimentation. All required test instrumentation is provided within the software and includes a four-channel real-time data logger and bar-graph display, voltmeter, frequency counter and transfer function analyzer with Bode and Nyquist displays. The system comprises three items, the mechanical unit, electronic unit and a power supply. The mechanical unit is an open-board format containing a servo mechanism and support electronics. It contains a power amplifier driving a d.c. motor connected to a set of transducers and an adjustable eddy current brake. the digital encoders are of pen construction to allow visual inspection of their functionality. A dual-function LCD meter measures either voltages or rotation speed. The electronic unit comprises an open printed circuit board with front panel mimic. It contains analogue signal processing blocks, an embedded controller with USB interface, analogue to digital converters, PWM drive and the instrumentation data converters. A complete block diagram is on the front panel with access via 2 mm sockets to allow each practical to be configured rapidly and the instrumentation blocks connected. LEDs show the output signals from the digital encoders. A function generator block is provided with sine, square and triangle output signals.

Control of didactical systems (E6.2.2.4)

E6.2.2

COM3LAB MUTLIMEDIA: CONTROL TECHNOLOGY

E6.2.2.4
Control of didactical systems

Cat. No.	Description	E6.2.2.4
700 8201	COM3LAB Course: Control Technology I	1
700 83	COM3LAB Course: Control Technology II	1
700 020	COM3LAB: Master Unit	1
700 022	Set of Safety Cables (2 mm, 16 Qty., 6 x 30cm & 10 x 15 cm)	1
688 129	Mains cable with hock-proof plug and cold connector	1
700 00CBT	DVD: COM3LAB Software	1
500 851	Safety connecting leads, 32 A, set of 32	1
501 511	Set of 10 bridging plugs, black	1
568 222	LIT: Fundamentals of Automatic Control Technology II, Vol. 2	1
726 09	Panel frame T130, two-level	1
726 86	DC-Power Supply ± 15 V/3 A	1
734 111	Set of machines 10 W	1
734 121	Digital Temperature Controlled System	1
734 265	Digital Liquid Controlled System	1
	additionally required: 1 PC with Windows 7/8/10	

Liquid control system

In this project the liquid level measurement is used in order to maintain a preslecetable filling level height with a control loop. In the process, the filling level is controlled by the digital controller of the COM3LAB control technology. The system is very clear and shows the interplay of reference and actual value on closed control loops in didactic form. Filling level and flow can both be examined on one unit.

Temperature controlled system

The task is to control the precisely defined temperature profiles for the casting metal in its housing, in order to keep it constant. These temperature profiles are set by using the thermally quick temperature control system. The good control dynamics shorten the measuring time. The temperature control system can be actively cooled via the COM3LAB control technology and the control behavior can be analyzed using switchable disturbance variables.

Set of machines

With the course COM3LAB control technology, the output voltage of the generator is kept constant even when changing the load. The set of machines used here enables a multitude of experiments to be carried out. With the virtual laboratory of COM3LAB, the step response of the system can be recorded, the optimum control parameters identified or timeline diagrams of the controlled system recorded.

Experiments are operated and evaluated with COM3LAB CBT.

E6.3 APPLIED CONTROL TECHNOLOGY

E6.3.1

TECHNICALLY CONTROLLED SYSTEMS

E6.3.1.1
Temperature Control

Temperature Control (E6.3.1.1)

Cat. No.	Description	E6.3.1.1
734 064N	PID digital controller Net	1
734 02	Reference variable generator	1
734 121	Digital Temperature Controlled System	1
734 011	Two position controller	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1
726 86	DC-Power Supply ± 15 V/3 A	1
500 59	Safety bridging plugs, black, set of 10	1
500 592	Safety bridging plugs with tap, black, set of 10	1
500 641	Safety connecting lead, 100 cm, red	3
500 642	Safety connecting lead, 100 cm, blue	3
500 644	Safety connecting lead, 100 cm, black	3
726 10	Panel frame T150, two-level	1*
734 482	WinFACT COM3LAB / CASSY Edition	1*
775 680EN	LIT: E6.3.1.1 Temperature Control	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Temperature Control

Controlling the temperature of residential buildings, vehicles, or workpieces is a classic example of systems with large time constants. The temperature controlled system works with two-point controllers as well as with PID and software controllers. It has a 7-segment display for the current temperature. A halogen lamp serves as the heat source and also ensures visibility of the heating process. The temperature is measured with an NTC thermistor. A ventilator and closable cap are available in the heater duct for investigation of the disturbance behaviour. Two integrated power amplifiers (for heating and cooling) facilitate direct activation with the controller, control elements are not necessary. The temperature controlled system can also be operated with fuzzy controlling.

Topics

- Characteristic curve for the temperature controlling system
- Recording the jump response
- Optimal amount, replacement controlled system
- Technical controller
- Controller in the limit range
- Empirical tuning of controllers
- etc.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

Flow & Level Control (E6.3.1.2)

E6.3.1

TECHNICALLY CONTROLLED SYSTEMS

E6.3.1.2
Flow & Level Control

Cat. No.	Description	E6.3.1.2
734 011	Two position controller	1
734 02	Reference variable generator	1
734 064N	PID digital controller Net	1
734 265	Digital Liquid Controlled System	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1
726 86	DC-Power Supply ± 15 V/3 A	1
500 59	Safety bridging plugs, black, set of 10	2
500 592	Safety bridging plugs with tap, black, set of 10	1
500 641	Safety connecting lead, 100 cm, red	3
500 642	Safety connecting lead, 100 cm, blue	3
500 644	Safety connecting lead, 100 cm, black	3
726 10	Panel frame T150, two-level	1*
734 482	WinFACT COM3LAB / CASSY Edition	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Flow & Level Control

The liquid control system is comprised mainly of a pump as well as holding and measuring tanks. The inflow and outflow of liquids can be manipulated using two valves. The device contains an impeller wheel flowmeter with subordinate flow controller. An immersion pipe with pressure sensor records the fill level in the measuring tank and converts it into an electric signal for the fill level. The measured variables for flow rate and fill level are displayed on 7-segment displays. The digital liquid control system is characterized by a very compact build. It is delivered complete with all sensors and operation equipment and needs very few accessories.

Topics

- Control design through pole-zero compensation
- Determination of the controller gain Kp from a batch run
- Control unit design through numerical optimization
- Rule of thumb method
- Digital liquid controlled system
- Flow measurement
- etc.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.3.1

TECHNICALLY CONTROLLED SYSTEMS

E6.3.1.3
Control of Airflow
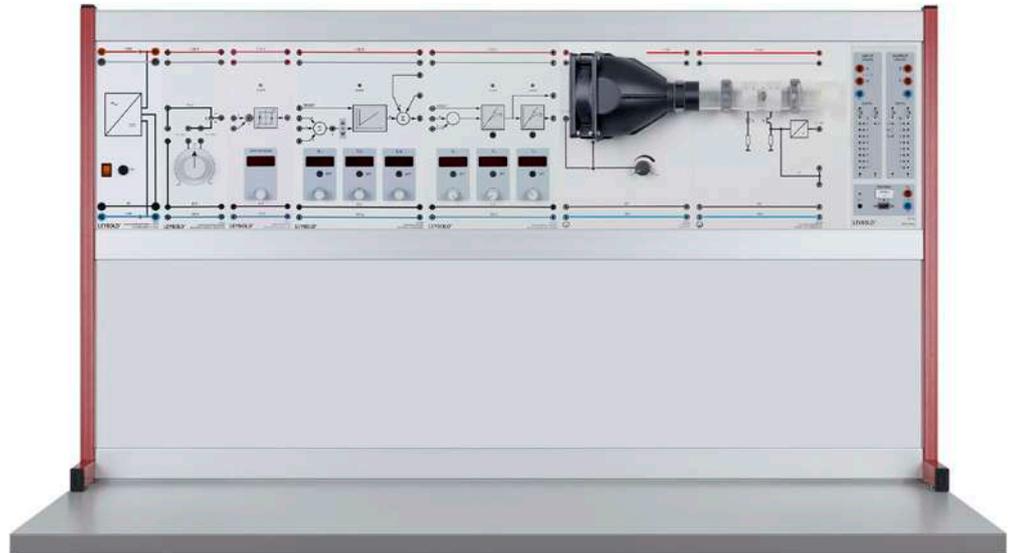
Control of Airflow (E6.3.1.3)

Cat. No.	Description	E6.3.1.3
734 02	Reference variable generator	1
734 011	Two position controller	1
734 064N	PID digital controller Net	1
734 091	Digital Controlled System	1
666 630	Blower	1
666 632	Windmill type anemometer	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1
726 86	DC-Power Supply ± 15 V/3 A	1
500 59	Safety bridging plugs, black, set of 10	1
500 592	Safety bridging plugs with tap, black, set of 10	1
500 641	Safety connecting lead, 100 cm, red	3
500 642	Safety connecting lead, 100 cm, blue	3
500 644	Safety connecting lead, 100 cm, black	2
726 10	Panel frame T150, two-level	1*
734 482	WinFACT COM3LAB / CASSY Edition	1*
734 492	WinFACT LD Licence	1*
775 682EN	LIT: E6.3.1.3 Control of airflow	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Control of Airflow

The airflow system is comprised of a sensor for measuring the flow and a controllable wind generator. The wind generator is directly activated, with a PID controller for example. An external power amplifier is not necessary for this. The airflow in the measuring tube is measured with a vane wheel anemometer. The cap on the air tube acts upon the controlled system as an external disturbance variable.

Topics

- Measuring airflow
- Step responses of the controlled system
- Evaluation of the step response with adjusting function
- Determination of the system parameters of a PT2 component
- Computer-based system identification
- Empirical optimisation for the airflow system
- etc.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.3.1

TECHNICALLY CONTROLLED SYSTEMS

E6.3.1.4
Brightness Control
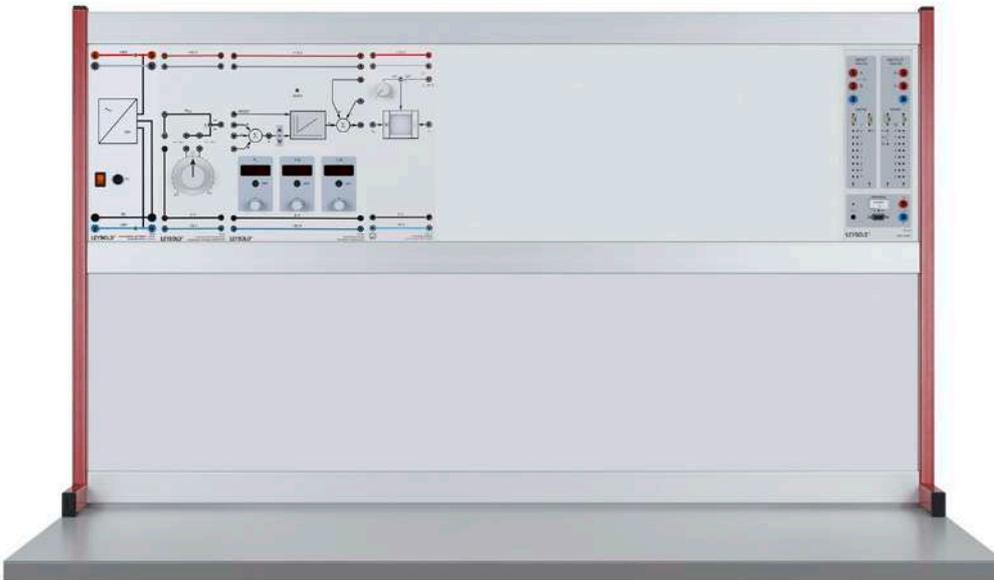
Brightness Control (E6.3.1.4)

Cat. No.	Description	E6.3.1.4
734 02	Reference variable generator	1
734 064N	PID digital controller Net	1
734 311	Light controlled system	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1
726 86	DC-Power Supply ± 15 V/3 A	1
500 59	Safety bridging plugs, black, set of 10	1
500 592	Safety bridging plugs with tap, black, set of 10	1
500 641	Safety connecting lead, 100 cm, red	3
500 642	Safety connecting lead, 100 cm, blue	1
500 644	Safety connecting lead, 100 cm, black	1
726 10	Panel frame T150, two-level	1*
734 482	WinFACT COM3LAB / CASSY Edition	1*
775 683EN	LIT: E6.3.1.4 Brightness Control	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Brightness Control

Light control systems contain light sources for usable and disturbance light as well as a photo sensor. The LED light sources are activated directly with the controller. An external control element (power amplifier) is not necessary. The diffusing screen spatially influences the controlled system as an external disturbance variable. Influenced by the relatively high limit frequencies of the opto semiconductors, the light control system has a time response similar to a fast PT1 system. The resulting system order is n = 1; there is only one main energy store. Light control is required for rooms where light is critical to safety, such as in sports arenas or hospitals. One biological example would be the ability of the eye to adapt to different levels of brightness (pupils).

Topics

- Characteristic curve for the temperature controlling system
- Recording the jump response
- Optimal amount, replacement controlled system
- Technical controller
- Controller in the limit range
- Empirical tuning of controllers
- etc.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.3.1

TECHNICALLY CONTROLLED SYSTEMS

E6.3.1.5
Speed & Voltage Control

Speed & Voltage Control (E6.3.1.5)

Cat. No.	Description	E6.3.1.5
734 02	Reference variable generator	1
734 064N	PID digital controller Net	1
734 111	Set of machines 10 W	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1
726 86	DC-Power Supply ± 15 V/3 A	1
500 59	Safety bridging plugs, black, set of 10	1
500 592	Safety bridging plugs with tap, black, set of 10	1
500 641	Safety connecting lead, 100 cm, red	3
500 642	Safety connecting lead, 100 cm, blue	3
500 644	Safety connecting lead, 100 cm, black	2
726 10	Panel frame T150, two-level	1*
734 482	WinFACT COM3LAB / CASSY Edition	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Speed & Voltage Control

The 10 W machine set has two direct current machines with permanent excitation and an electronically controllable load. The machines are mechanically connected to each other by way of their shafts and come together to form a motor-generator unit. Load characteristic lines are recorded and disturbance interferences in speed and voltage control are investigated with the electronically controllable load. The drive engine and load are driven directly by the upstream controller. An external control element is not necessary for this. A switchable prefiltergives the 10 W machine set the dynamic behaviour of a larger machine set.

Topics

- Characteristic curve for the temperature controlling system
- Recording the jump response
- Optimal amount, replacement controlled system
- Technical controller
- Controller in the limit range
- Empirical tuning of controllers
- etc.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

Heeling Control (E6.3.1.6)

E6.3.1

TECHNICALLY CONTROLLED SYSTEMS

E6.3.1.6
Heeling Control

Cat. No.	Description	E6.3.1.6
510 48	Magnets, 35 mm Ø, pair	1
734 02	Reference variable generator	1
734 064N	PID digital controller Net	1
734 091	Digital Controlled System	1
734 300	Heel Controlled System	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1*
726 86	DC-Power Supply ± 15 V/3 A	1*
500 59	Safety bridging plugs, black, set of 10	1*
500 592	Safety bridging plugs with tap, black, set of 10	1*
500 641	Safety connecting lead, 100 cm, red	3*
500 642	Safety connecting lead, 100 cm, blue	3*
500 644	Safety connecting lead, 100 cm, black	3*
309 42	Colouring, red, 10 g	1
726 10	Panel frame T150, two-level	1*
775 690EN	LIT: E6.3.1.6 Heeling control	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Heeling Control

Heeling is the rolling movement of a ship on a swell or during loading. Heeling is especially noticeable when freight trains are driven onto ferries. For rail vehicles, the railway leading onto the ferry should be free of breaks in the rails where the ferry and pier meet. Controlling problems of this nature – involving position stabilisation – can be investigated with the heeling control model. The system can be equally well operated with the PID digital controller (734 064) or a software controller on a WinFACt basis. Position controlling using ballast tanks is also important for aircraft.

Topics
• Characteristic curve for the temperature controlling system
• Recording the jump response
• Optimal amount, replacement controlled system
• Technical controller
• Controller in the limit range
• Empirical tuning of controllers
• etc.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.3.2

SERVO CONTROL

E6.3.2.1
DC Servo

E6.3.2.2
AC Servo

E6.3.2.3
Stepper Motor
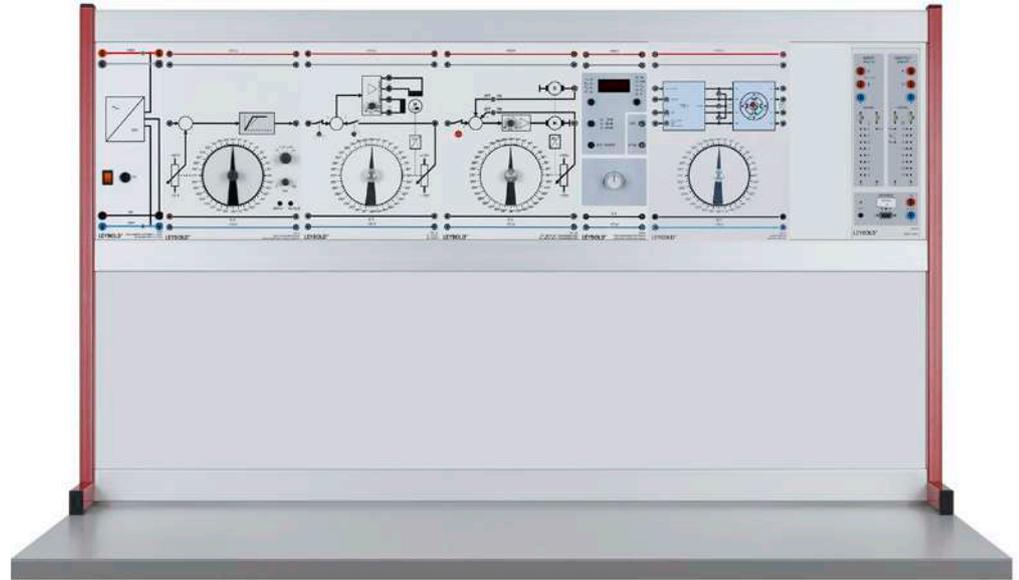
DC Servo (E6.3.2.1)

Cat. No.	Description	E6.3.2.1	E6.3.2.2	E6.3.2.3
734 10	Servo setpoint generator	1	1	
734 44	DC servo with tachogenerator	1		
734 36	Mass Disc with Hook	1		
524 016S2	Profi-CASSY Starter 2	1		1*
726 09	Panel frame T130, two-level	1	1	1
726 86	DC-Power Supply ± 15 V/3 A	1	1	1
500 59	Safety bridging plugs, black, set of 10	1	1	1
500 641	Safety connecting lead, 100 cm, red	1		1
500 642	Safety connecting lead, 100 cm, blue	1		
500 644	Safety connecting lead, 100 cm, black	2		1
775 325EN	LIT: E2.6.1.2 DC Servo	1*		
734 482	WinFACT COM3LAB / CASSY Edition	1*	1*	
726 10	Panel frame T150, two-level	1*	1*	
734 02	Reference variable generator		1	
734 45	AC servo		1	
524 013S	Sensor-CASSY 2 Starter		1	
500 851	Safety connecting leads, 32 A, set of 32		1	
775 330EN	LIT: E2.6.1.3 AC Servo		1*	
728 55	Stepper motor			1
726 962	Function generator 200 kHz			1
531 57	Multimeter METRAport 3A			1
	additionally required: 1 PC with Windows 7/8/10			

* additionally recommended

DC Servo

The equipment set incorporates student experiments which can be carried out in a laboratory safely using safety extra-low voltage. Experiment instructions are contained in a manual in either printed or digital form.

AC Servo

The equipment set incorporates student experiments which can be carried out in a laboratory safely using safety extra-low voltage. Experiment instructions are contained in a manual in either printed or digital form.

Stepper Motor

Stepper motors are a special variety of synchronous motor with a large number of pole pairs. The rotor follows the stator field in steps, the size of which is determined by the number of poles. With normal loading, the angular position of the rotor can be determined precisely. If overloaded, however, step losses arise and information about the current position of the rotor is lost. Stepper motors can be wired to operate in both half-step and full-step modes. Due to their discontinuous operation, stepper motors are the ideal drive systems for digital servo systems.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.3.3

PROCESS ENGINEERING

E6.3.3.1
Compact Trainer:
Process Closed Loop Control
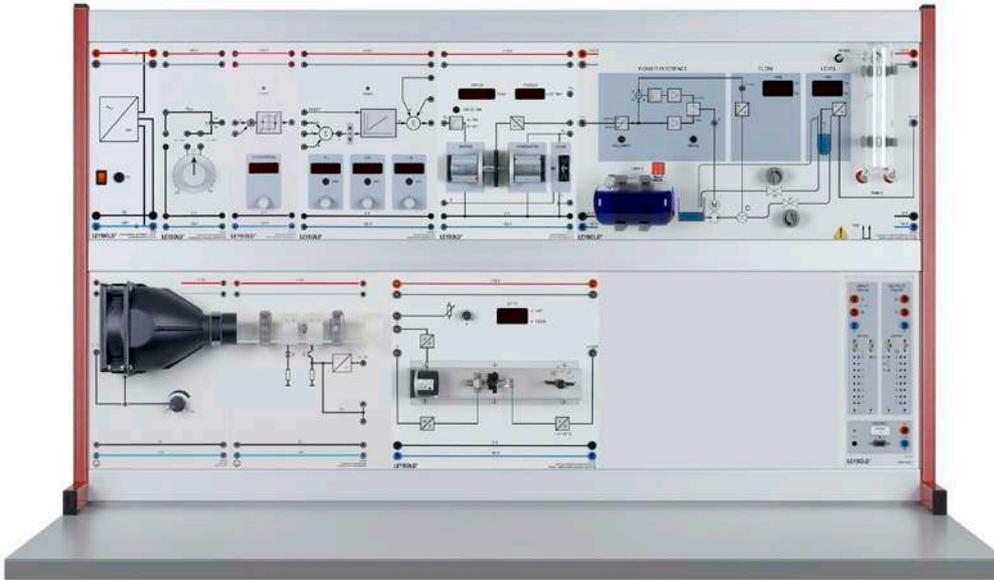
Compact Trainer: Process Closed Loop Control (E6.3.3.1)

Cat. No.	Description	E6.3.3.1
734 064N	PID digital controller Net	1
734 02	Reference variable generator	1
734 121	Digital Temperature Controlled System	1
734 265	Digital Liquid Controlled System	1
734 111	Set of machines 10 W	1
666 630	Blower	1
666 632	Windmill type anemometer	1
734 011	Two position controller	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1
726 86	DC-Power Supply $\pm$ 15 V/3 A	1
500 59	Safety bridging plugs, black, set of 10	3
500 592	Safety bridging plugs with tap, black, set of 10	1
500 641	Safety connecting lead, 100 cm, red	3
500 642	Safety connecting lead, 100 cm, blue	3
500 644	Safety connecting lead, 100 cm, black	3
726 10	Panel frame T150, two-level	1*
734 482	WinFACT COM3LAB / CASSY Edition	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Process Closed Loop Control

Large, intricate processes are often broken down into sub-processes in the interest of clarity. This facilitates the step-by-step commissioning of production facilities and efficient error resolution when a breakdown occurs. The setup is comprised of various different sub-processes.

Each controlled system on its own is perfect for the execution of numerous experiments. At the same time the module experiment design featuring experiment plates allows for easy combination of sub-processes. If you integrate additional electronic transfer components (from E 6.3.4), then additional dead time and time constants arise that influence the entire process.

Following equipments could be connected:
• Temperature regulations
• Fill level control
• Flow controlling
• Current control
• Speed control

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.3.3

PROCESS ENGINEERING

E6.3.3.2
Blue-Bottle Control

Blue-Bottle Control (E6.3.3.2)

Cat. No.	Description	E6.3.3.2
524 013	Sensor-CASSY 2	1
524 220	CASSY Lab 2	1
524 069	Immersion photometer S	1
666 425	Panel frame C50, two-level, for CPS	1
666 438	Woulff's bottle with manometer, CPS	1
667 3095	Screw cap, GL 45, with hole	1
667 3107	Silicone seal GL 45/26, 10 pcs	1
666 482	Aeration pump, controllable, CPS	1
501 44	Connecting leads, 19 A, 25 cm, red/blue, pair	1
667 7977	Electronic Balance 440-3N, 200 g : 0.01 g	1
664 157	Watch glass dish, 125 mm diam.	2
666 966	Spoon-ended spatula, PP, 180 mm	2
666 003	Pipetting ball (Peleus ball)	1
665 996	Graduated pipette, 5 ml	1
665 756	Measuring cylinder, 500 ml, with plastic base	1
604 501	PVC tubing, 7 mm diam., 1 m	1
604 460	Hose clamp, 8...12 mm	1
602 347	Laboratory bottle, 500 ml, GL 45 thread	1
673 2920	Methylene blue solution, 100 ml	1
673 6800	Sodium hydroxide, pellets, 100 g	1
672 1100	D(+)-Glucose, 100 g	1
675 3400	Water, pure, 1 l	1
	additionally required: 1 PC with Windows 7/8/10	

Blue-Bottle Control

The blue bottle experiment is a model experiment for a organic redox system. The redox indicator methylene blue is reduced by glucose to its colourless form which is then oxidised by air to form again the coloured version. The air is led into solution by a pump. Additional glucose in solution will then reduce it to its colourless form. The process is reversible. In this experiment a automated version with a two-point control system is used.

Topics

- To learn about organic redox reactions and redox indicator methylene blue
- To perform the blue bottle experiment in a new, automated version
- To set up and use a two-point control system
- To perform photometry using an immersion photometer
- To use carbohydrates such as glucose as a reducing age

Experiments are operated and evaluated with CASSY Lab 2.

E6.3.4

SYSTEMS & COMPONENTS OF CONTROL ENGINEERING

E6.3.4.1
Electronic Controlled Systems

E6.3.4.2
Digital Closed Loop Control
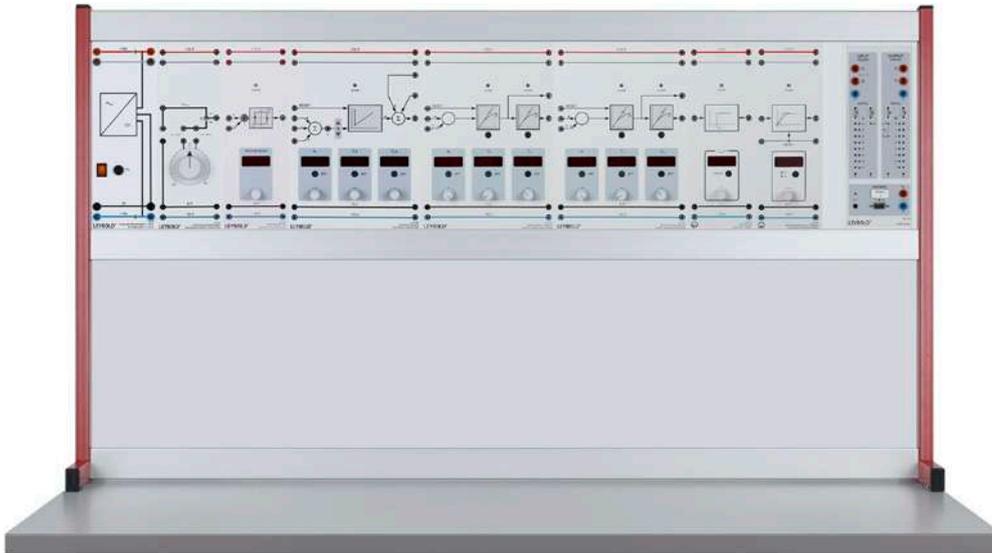
Electronic Controlled Systems (E6.3.4.1)

Cat. No.	Description	E6.3.4.1	E6.3.4.2
734 02	Reference variable generator	1	1
734 011	Two position controller	1	
734 064N	PID digital controller Net	1	1
734 091	Digital Controlled System	2	2
734 0891	Dead time element	1	
734 0951	2nd Order transfer element	1	
524 016S2	Profi-CASSY Starter 2	1	1
726 09	Panel frame T130, two-level	1	1
726 86	DC-Power Supply ± 15 V/3 A	1	1
500 59	Safety bridging plugs, black, set of 10	1	3
500 592	Safety bridging plugs with tap, black, set of 10	1	1
500 641	Safety connecting lead, 100 cm, red	3	3
500 642	Safety connecting lead, 100 cm, blue	3	3
500 644	Safety connecting lead, 100 cm, black	3	3
564 19EN	LIT: E6.3.4.1 Control of Electronic Lines	1*	
734 482	WinFACT COM3LAB / CASSY Edition	1*	1*
734 41	Sample and Hold Element		1
726 10	Panel frame T150, two-level		1*
734 492	WinFACT LD Licence		1*
775 700EN	LIT: E6.3.4.2 Digital Control		1*
	additionally required: 1 PC with Windows 7/8/10		

* additionally recommended

Electronic Controlled Systems

The setup facilitates experiments on a wide variety of levels: ranging from the basics to university-level learning. It investigates the transfer components in the time range and the behaviour of the controlled systems formed by them. Digital adjusters for controller parameters and system time constants facilitate simple, intuitive operation of devices with higher precision. This allows for fast, reproducible, and targeted experimentation. Continuous and discontinuous controller designs are available to choose from. The Profi-CASSY interface is ideally equipped to support the use of graphic analysis methods (e.g. using the tangent method) and facilitates experiments with modern interface controllers and computer-aided control technology. For more in-depth experimentation and for simulations, it is recommended that you also use the WinFACT software.

Topics
- Setpoint and disturbance behaviour
- Recording and analysing step responses
- Output parameters of an open-path control
- Time response of transfer components
- Second order transfer component
- Behaviour of the dead-time component
- etc.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.3.4

SYSTEMS & COMPONENTS OF CONTROL ENGINEERING

E6.3.4.3
Fuzzy Control

E6.3.4.4
Frequency Response &
Controller Design

E6.3.4.5
Stability & Optimisation

Fuzzy Control (E6.3.4.3)

Cat. No.	Description	E6.3.4.3	E6.3.4.4	E6.3.4.5
734 091	Digital Controlled System	1	2	2
734 121	Digital Temperature Controlled System	1		
734 111	Set of machines 10 W	1		
734 300	Heel Controlled System	1		
524 016S2	Profi-CASSY Starter 2	1	1	1
726 09	Panel frame T130, two-level	1	1	1
726 86	DC-Power Supply ± 15 V/3 A	1	1	1
500 59	Safety bridging plugs, black, set of 10	1	1	1
500 592	Safety bridging plugs with tap, black, set of 10	1	1	1
500 641	Safety connecting lead, 100 cm, red	2	2	2
500 642	Safety connecting lead, 100 cm, blue	2	2	2
500 644	Safety connecting lead, 100 cm, black	2	2	2
510 48	Magnets, 35 mm Ø, pair	1		
726 10	Panel frame T150, two-level	1*	1*	1*
775 692EN	LIT: E6.3.4.3 Fuzzy-Control	1*		
734 492	WinFACT LD Licence	1*	1*	1*
734 265	Digital Liquid Controlled System	1*		
666 630	Blower	1*		
666 632	Windmill type anemometer	1*		
734 064N	PID digital controller Net		1	1
734 0891	Dead time element		1	1
734 0951	2nd Order transfer telement		1	1
500 612	Safety connecting lead, 25 cm, blue		1	
775 720EN	LIT: E6.3.4.4 Frequency Response of Linear Systems & Controller Design in the Frequency Domain		1*	
775 730EN	LIT: E6.3.4.5 Stability & Optimisation			1*

Cat. No.	Description	E6.3.4.3	E6.3.4.4	E6.3.4.5
	additionally required: 1 PC with Windows 7/8/10			

* additionally recommended

Fuzzy Control

Fuzzy logic is a technology for controlling and regulating technical systems without mathematical modelling. With fuzzy logic, control strategies are simply defined with colloquial elements. To formulate the control-related problems in the form of linguistic (= language) rules, physical input variables (e.g. Temperature) are fuzzified, meaning converted from a crisp to a fuzzy value using a membership function.

Frequency Response & Controller Design

The frequency response of a system is usually illustrated graphically, for which there are two different graphing methods called the Bode plot and the Nyquist plot. With this setup, frequency responses of real transfer components are measured and recorded. For a PT3 controlled system, a PI controller is designed in accordance with the compensation method. In the Bode diagram, the stability of the closed control circuit is determined from the phase margin of the open circuit.

Stability & Optimisation

Investigating stability and optimising controlled systems are two of the most important tasks related to control engineering. The result decides the usability of the controller for the intended purpose.

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

Ball & Plate (E6.3.5.9)

E6.3.5

TECHNICAL PROCESSES WITH LARGE SCALE MODELS

E6.3.5.9
Ball & Plate

Cat. No.	Description	E6.3.5.9
33-052	Ball & Plate Control System	1
	additionally required: 1 PC with Windows 7/8/10	

Ball & Plate

The Ball and Plate Control System is controlled by (National Instruments NI) LabVIEW using a NI interface card and demonstrates a classic control problem of balancing a sphere on a flat surface and maintaining its position. It can then be programmed to make the ball describe a circular or any other shaped path around the plate. The unique electromagnetic table actuation enables the study of this unstable system in real-time using sophisticated controllers in NI LabVIEW. The progressive nature of the student exercises enables the study of the problem from first principles to more advanced control concepts. The product provides a useful insight into control engineering at all levels of undergraduate study and enables advanced users to model and control the Ball and Plate using their own strategy.

Topics

- Non-linear model simplification
- Non-linear model testing
- Model linearization
- Plant control
- PID controllers
- Plate orientationcontrol
- etc.

A LabVIEW™ license is required for this experiment and is not included in the scope of delivery.
The equipment can require additional software modules.

E6.3.5

TECHNICAL PROCESSES WITH LARGE SCALE MODELS

E6.3.5.11
Inverted Pendulum
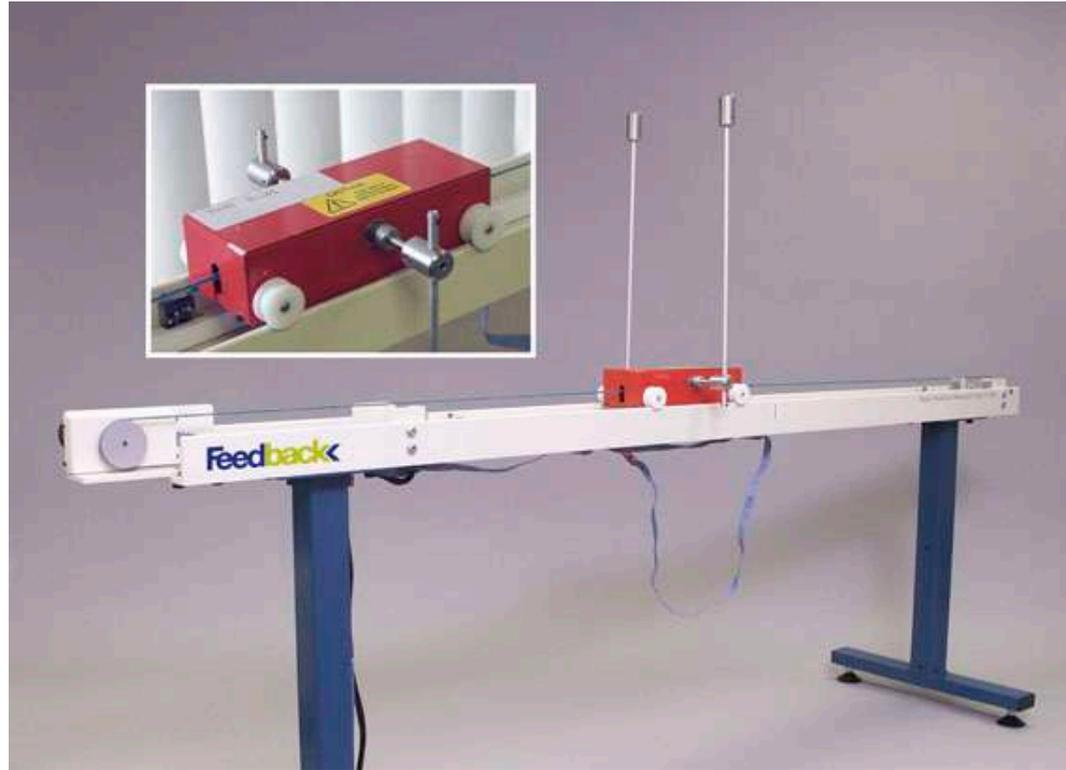
Inverted Pendulum (E6.3.5.11)

Cat. No.	Description	E6.3.5.11
33-005-PCI	Set Digital Pendulum System	1
	additionally required: 1 PC with Windows 7/8/10	

Inverted Pendulum

The Digital Pendulum is a modern version of a classical control problem; that of erecting and balancing a free swinging pendulum in its inverted position or moving a hanging pendulum in a controlled manner. The cart on the track is digitally controlled to swing up (self erecting) and to balance the pendulum into an upright sustained position or to move the cart with pendulum in an unperturbed down position. The cart track is of limited length, imposing constraints on the control algorithm. In pendulum mode the system is used to control the twin arm pendulum from an initial position, hanging at rest with the cart in the centre of its travel along the track, to a final position with the pendulum upright and the cart restored to its central position. In crane mode the control problem is to move the position of the cart without undue movement of the pendulum. This problem is typical of that experienced when controlling a gantry crane. Using MATLAB™ together with the detailed training manuals supplied by Feedback and an Advantech PCI card (which creates an impressive digital control system development environment) the user is guided through the design process using phenomenological process models, dynamics analysis, discrete models identification, controller design, controller tests on the model, controller implementation in real-time applications, implementation of various control strategies and visualisation.

Topics

- Pendulum Model
  - Equations of motion
  - Non-linear model
  - Linear models
  - etc.

- Pendulum set-up control
  - Plant control
  - PID controller
  - PID control of cart model position
  - etc.

A MATLAB™ license is required for this trial and is not included in the scope of delivery.

The equipment can require additional software modules.

E6.3.5

TECHNICAL PROCESSES WITH LARGE SCALE MODELS

E6.3.5.12
Twin Rotor MIMO System

Twin Rotor MIMO System (E6.3.5.12)

Cat. No.	Description	E6.3.5.12
33-007-PCI	Set Twin Rotor MIMO System	1
	additionally required: 1 PC with Windows 7/8/10	

Twin Rotor MIMO System

The twin-rotor system demonstrates the principles of a non-linear MIMO (multiple input, multiple output) system, with significant cross-coupling. It's behaviour resembles a helicopter, but the angle of attack of the rotors is fixed and the aerodynamic forces are controlled by varying the speeds of the motors. Significant cross-coupling is observed between the actions of the rotors, with each rotor influencing both angle positions. Using MATLAB™ (not supplied) together with the detailed training manuals supplied by Feedback and an Advantech PCI card which creates an impressive digital control system development environment, the user is guided through the design process using phenomenological process models, dynamics analysis, discrete models identification, controller design, controller tests on the model, controller implementationin real-time applications, implementation of various control strategies and data visualisation.

Topics

- 1-degree of freedom (DOF), PID stabilising & tracking horizontal controller
- 1-DOF, PID stabilising & tracking vertical controller with gravity compensation
- 2-DOF, PID stabilising & tracking controller
- Parameter tuning
- Coupled dynamics analysis
- etc.

A MATLAB™ license is required for this trial and is not included in the scope of delivery.

E6.3.5

TECHNICAL PROCESSES WITH LARGE SCALE MODELS

E6.3.5.13
Modular Servo Systems
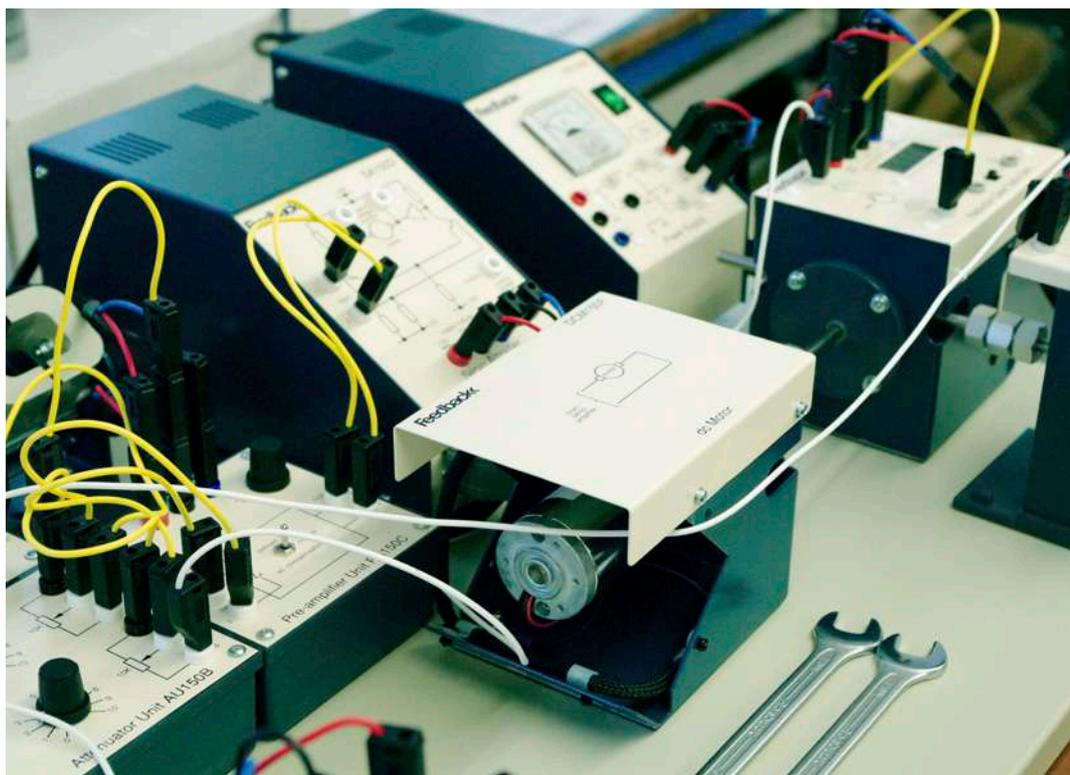
Modular Servo Systems (E6.3.5.13)

Cat. No.	Description	E6.3.5.13
MS1 50	Modular Servo System (DC, AC, DC/AC, complete system)	1
	additionally required: 1 PC with Windows 7/8/10	

Modular Servo Systems

The modular servo system enables students to study the theory and practice of automatic control systems. It illustrates modern circuitand constructional techniques. The system is modular and therefore, versatile. Each unitis fitted with a magnetic base which holds the unit to the plastic coated steel base plate, irrespective of the angle at which the base plate is positioned. Individual units may be so arranged to create operating block schematic systems and interconnections between the units are made by jumper leads terminated in 4 mm stackable plugs. The modular concept of the MS150 system permits the study of individual units and also, by combination, the investigation and performance testing of complete systems.

Topics

- Operational amplifiers
- Motor speed characteristics
- DC error channel
- Simple position control
- Closed-loop position control
- Simple speed control
- etc.

E6.3.5

TECHNICAL PROCESSES WITH LARGE SCALE MODELS

E6.3.5.14
Magnetic Levitation System

Magnetic Levitation System (E6.3.5.14)

Cat. No.	Description	E6.3.5.14
33-006-PCI	Magnetic Levitation System (MATLAB Vers.)	1
	additionally required: 1 PC with Windows 7/8/10	

Magnetic Levitation System

This classic magnetic levitation control problem is now presented in a new and innovative form. A 25 mm diameter, hollow steel sphere is suspended in space with visually appealing results and convenient time constants. Both analogue and digital control solutions are implemented.

Convenient sockets on the enclosure panel allow for quick changes of analogue controller gain and compensation components.

Topics

- Analogue Operation
  - Non-linear models
  - Unstable systems
  - Linearisation about an operating point
  - etc.

- Digital Operation
  - Non-linear models
  - Unstable systems
  - Linearisation about an operating point
  - etc.

A MATLAB™ license is required for this trial and is not included in the scope of delivery.
The equipment can require additional software modules.

E6.3.5

### TECHNICAL PROCESSES WITH LARGE SCALE MODELS

E6.3.5.15
Precision modular control workshop
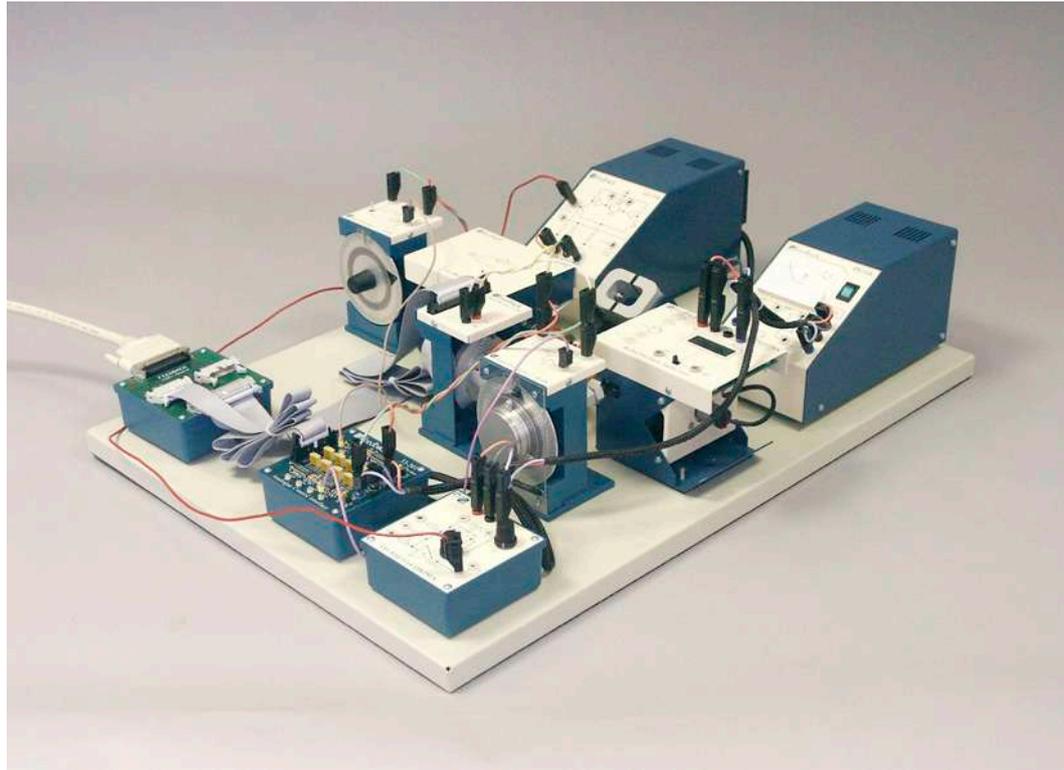
Precision modular control workshop (E6.3.5.15)

Cat. No.	Description	E6.3.5.15
33-008-PCI	Precision Modular Control Workshop	1
	additionally required: 1 PC with Windows 7/8/10	

Precision Modular Control Workshop

The Precision Modular Servo Workshop provides a rapid and direct path from control system design to hardware implementation. The resolution and accuracy of the system and the consistency of it's performance, makes the Precision Modular Servo Workshop ideal for serious study of digital linear servo control systems. As well as allowing study of digital control the Precision Modular Servo Workshop also provides a complete introduction to servos, from fundamental studies of analogue servos through to full, real-time digital control. It is fully supported with laboratory assignments which have been designed to give students a full understanding of the control paths within the equipment.

Topics

- Precision modular servo (PMS)
- Testing the d.c. motor
- PMS model identification - static friction compensation, model 1 & 2 identification
- PMS position control - PID control of motor position, real-time PID control of motor position, position tracking
- PMS control, under variable control conditions - simple gain scheduling algorithm, gain scheduling
- etc.

A LabVIEW™ license is required for this experiment and is not included in the scope of delivery.

The equipment can require additional software modules.

E6.4 INDUSTRIAL CONTROLLERS
& CONTROLLED SYSTEMS

E6.4.1

INDUSTRIAL CONTROLLERS & CONTROLLED SYSTEMS

E6.4.1.1
Automatic Control with Compact Controllers
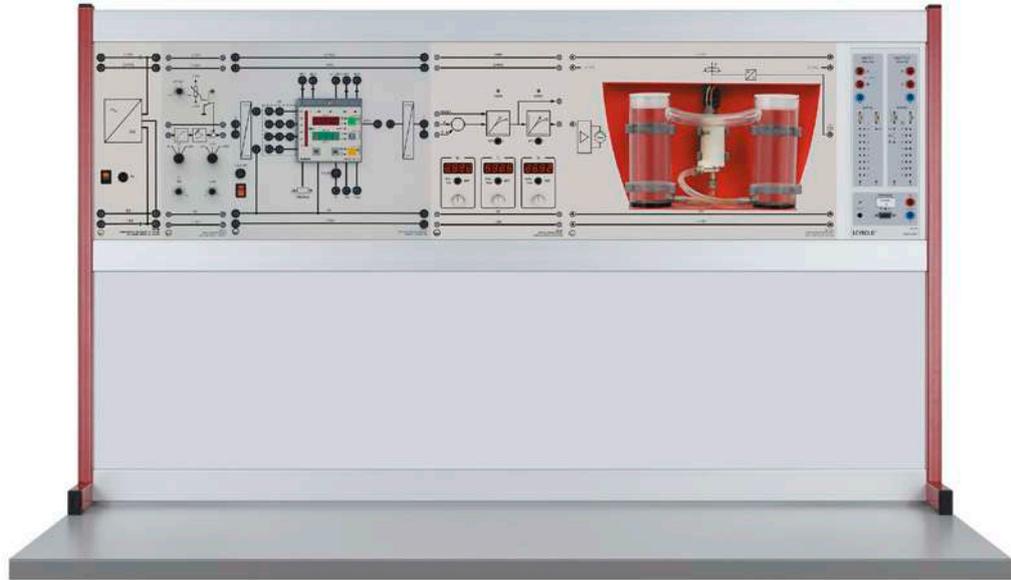
Automatic Control with Compact Controllers (E6.4.1.1)

Cat. No.	Description	E6.4.1.1
734 431	Compact controller	1
734 300	Heel Controlled System	1
734 091	Digital Controlled System	1
734 19	Gain and offset adjust	1
726 86	DC-Power Supply ± 15 V/3 A	1
524 016S2	Profi-CASSY Starter 2	1
726 09	Panel frame T130, two-level	1
500 59	Safety bridging plugs, black, set of 10	2
500 592	Safety bridging plugs with tap, black, set of 10	1
500 641	Safety connecting lead, 100 cm, red	2
500 642	Safety connecting lead, 100 cm, blue	1
500 644	Safety connecting lead, 100 cm, black	2
775 750EN	LIT: E6.4.1.1 Control with Industrial Compact Controllers	1*
726 10	Panel frame T150, two-level	1*

* additionally recommended

Automatic Control with Compact Controllers

This chapter describes experiments with the widely used compact controller Siemens SIPART DR 19 in the industry. The tests use only the analogue input X and analogue output Y of the SIPART DR 19. For the use of external sensors or the digital inputs and outputs, please refer to the manuals.

Topics
- Digital industrial controllers
- SIPART DR19
- Unipolar controller operation
- Bipolar controller operation
- Compact controller on the electronic control loop
- Fault control at the heel regulation range

Experiments are operated and evaluated with CASSY Lab 2.

E6.4.1

INDUSTRIAL CONTROLLERS & CONTROLLED SYSTEMS

E6.4.1.2
Control of an
Industrial Machine 0.3
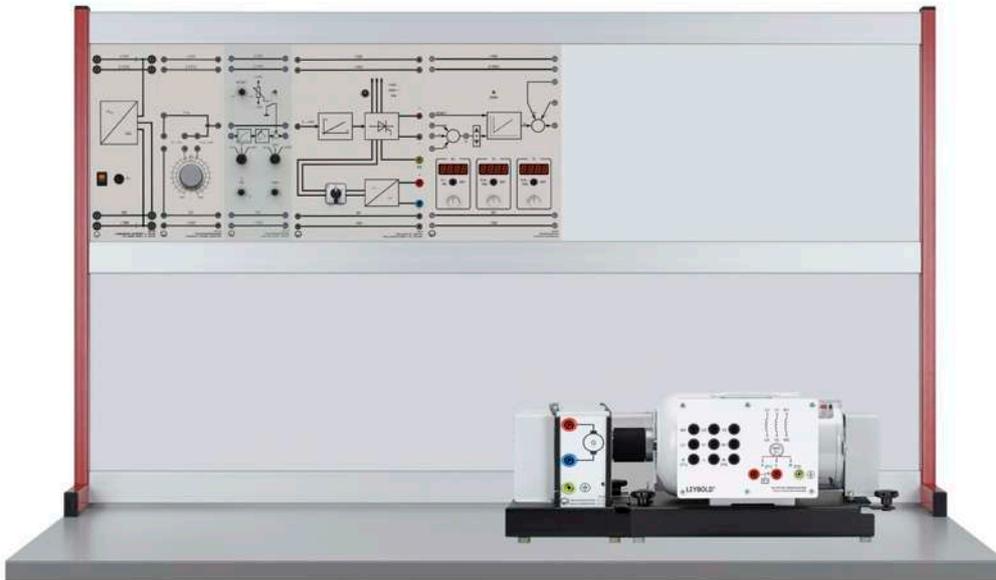
Control of an Industrial Machine 0.3 (E6.4.1.2)

Cat. No.	Description	E6.4.1.2
731 86	DC compound machine 0.3	1
734 02	Reference variable generator	1
734 19	Gain and offset adjust	1
734 22	Actuator 115...230 V/1 kW	1
734 064N	PID digital controller Net	1
775 755EN	LIT: E6.4.1.2 Control of IMA 300W	1*
726 09	Panel frame T130, two-level	1*
726 86	DC-Power Supply ± 15 V/3 A	1*
731 06	Coupling 0.3	1*
731 08	Coupling guard 0.3	1*
731 07	Shaft end guard 0.3	2*
731 09	Tacho generator 0.3	1*
524 016S2	Profi-CASSY Starter 2	1*
500 59	Safety bridging plugs, black, set of 10	2*
500 592	Safety bridging plugs with tap, black, set of 10	1*
500 644	Safety connecting lead, 100 cm, black	3*
500 604	Safety connecting lead, 10 cm, black	2*
500 640	Safety connecting lead, 100 cm, yellow/green	2*
500 641	Safety connecting lead, 100 cm, red	4*
500 642	Safety connecting lead, 100 cm, blue	5*
531 583	Multimeter METRAport 40 S	1*
	additionally required: PC with operating system Windows 7/8/10	

* additionally recommended

Control of an Industrial Machine 0.3 kW

An idling direct current motor loaded only by its own ventilator and bearing and brush friction is functioning as a technical controlled system. This establishes speed control in the first quadrant (active acceleration). Braking occurs passively via the ventilator and friction losses. In addition to the measurements, the process is simulated on the PC as well. A numerical optimisation of the controller is carried out in accordance with the ITAE criteria using the WinFACT LD Edition (734 491) software.

Topics

- Technical Controlled Systems
- Characteristic line for the drive engine
- Step response for an industrial machine
- Technical controller
- Controller tuning
- Determination of the controller parameters with PID Design Centre

Experiments are operated and evaluated with CASSY Lab 2 and WinFACT.

E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.1
Process Instrumentation

Process Instrumentation (E6.4.2.1)

Cat. No.	Description	E6.4.2.1
38-023	Process Instrumentation Trainer (PIT)	1
38-023-SW	PROCESS INST.TRNR UTY SW	1

Process Instrumentation

Modern control devices and sensors are becoming increasingly complex and functionally very powerful. This trainer enables students to be exposed to the selection and utilisation of such devices, the sensors, actuators and programmable devices being industrial units. It provides hands-on experience of their setting-up, calibration and use. The equipment is based on a mobile trolley incorporating all electrical, water (including a water heater) and air controls, a self-contained unit. The punched front panel provides a construction area that allows devices to be firmly fixed to it.

Topics
- Current loop resistor
- Current / pressure converter
- Control valve
- Pressure transmitters
- Flowmeter
- Frequency transmitter
- etc.

Temperature in Airstream (E6.4.2.2)
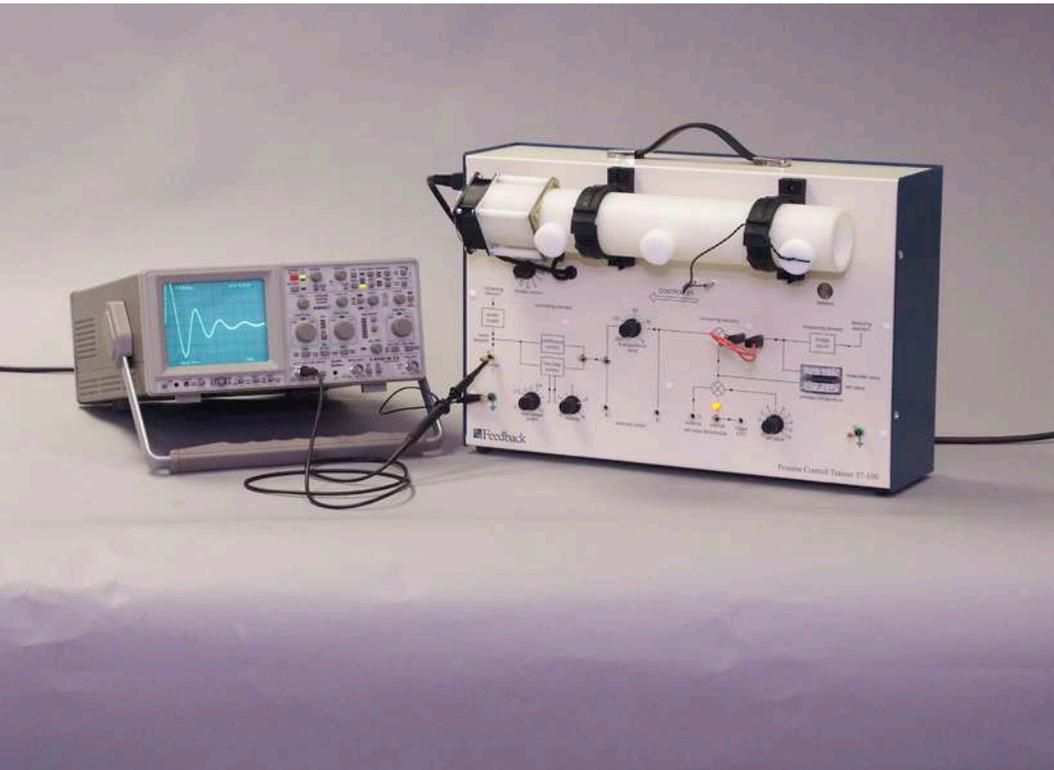
E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.2
Temperature in Airstream

Cat. No.	Description	E6.4.2.2
37-100	Process Control Trainer	1
531 831	Joule and wattmeter	1*
522 561	Function generator P	1*
PID 150Y	PID (proportional–integral–derivative) Controller	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Temperature in Airstream

The 37-100 Process Control Trainer teaches the basic characte-ristics of a large plant, but is compact and portable. It enables distance/velocity lag, transfer lag, system response, proportional and two step control to be demonstrated.

Topics

• A practical process in miniature
• Closed and open-loop continuous control
• Two-step control
• Fast response times enable dynamic behaviour to be seen on an oscilloscope
• Exhibits thermal time constants & time transport lag
• etc.

E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.3
Level & Flow
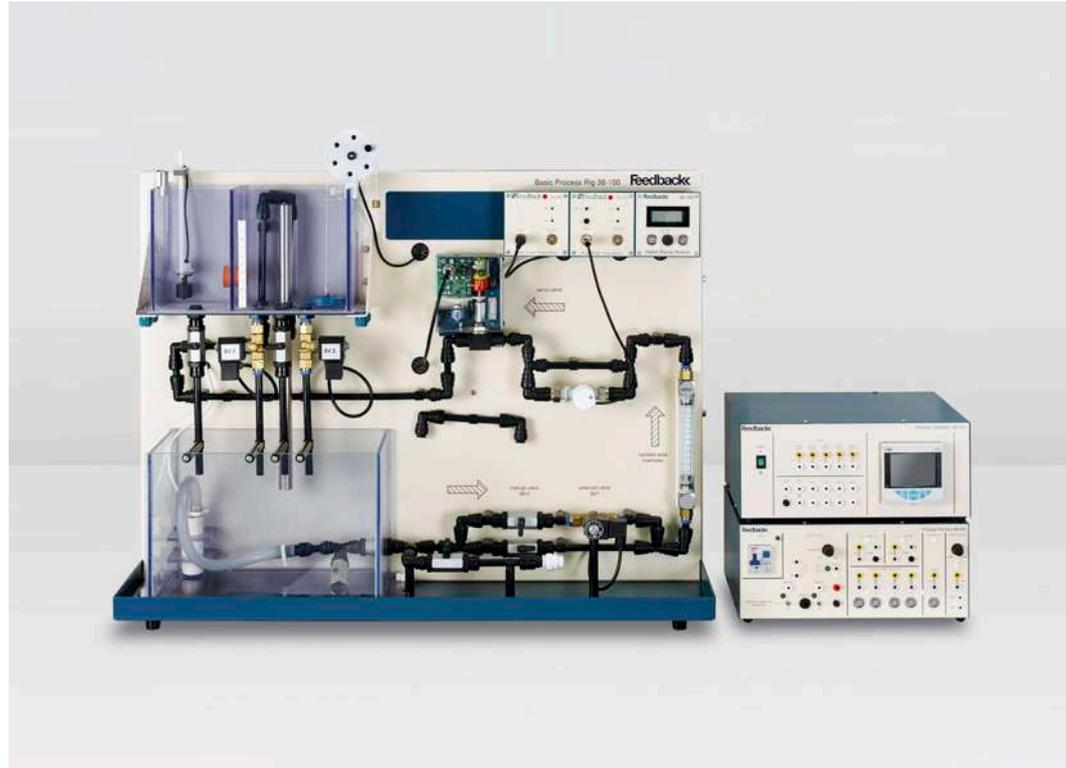
Level & Flow (E6.4.2.3)

Cat. No.	Description	E6.4.2.3
38-001	Level & Flow Process Control	1
93-420	ESPIAL Software Package	1*
38-002	Temperature Process Control	1*
38-610	Forced Air Cooler	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

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. The system is a completely self-contained, low pressure flowing water circuit supported on a benchtop-mounted panel, making it suitable for individual student work or for group demonstrations. It comprises a dual compartment process tank, linked to a sump tank by manual and solenoid operated valves. Water is pumped through the system, via a variable area flow meter and motorised control valve. Level is measured in the process tank. Flow is measured through an optical pulse flowmeter.

Topics

- Flow & level familiarisation & calibration
- Interface familiarisation & calibration
- Controller familiarisation & calibration
- Float Level Transmitter
- Pulse Flow Transmitter
- On-Off Control
- etc.

Experiments are operated and evaluated with ESPIAL.

The equipment can require additional software modules.

Four-Tank System (E6.4.2.4)
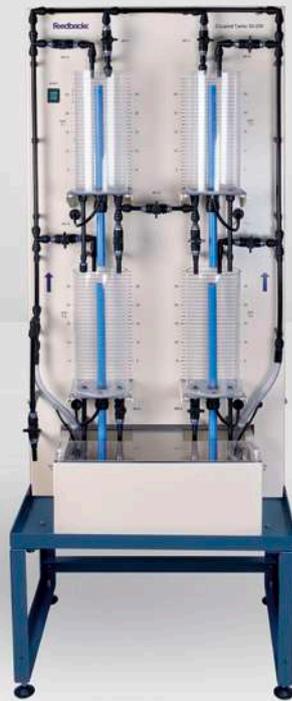
E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.4
Four-Tank System

Cat. No.	Description	E6.4.2.4
33-041	Coupled Tanks System (Prepared for MATLAB™)	1
	additionally required: 1 PC with Windows 7/8/10	

Four-Tank System

The Coupled Tanks set-up is a model of a chemical plant fragment. Very often tanks are coupled through pipes and the reactant level and flow has to be controlled. The Coupled Tanks experiment is designed so that the system can be configured. The Coupled Tanks system has 4 translucent tanks each with a pressure sensor to measure the water level. The couplings between the tanks can be modified by the use of seven manual valves to change the dynamics of the system imposing the use of different controllers. Water is delivered to the tanks by two independently controlled, submersed pumps. Step disturbances generation is provided by four manual valves. Drain flow rates can be modified using easy-to-change orifice caps. The system can be operated with MATLAB™, SIMULINK® or NI LabVIEW™.

Topics

- Non-linear model
- Linearisation
- Linear model simulation
- 1 tank & 2 tank identification
- PID control of water levels in top tanks
- PID control of water levels in bottom tanks
- etc.

A LabVIEW™ or MATLAB™ license is required for this experiment and is not included in the scope of delivery.

The equipment can require additional software modules.

E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.5
Temperature in Water

Temperature in Water (E6.4.2.5)

Cat. No.	Description	E6.4.2.5
38-002	Temperature Process Control	1
38-610	Forced Air Cooler	1*
93-420	ESPIAL Software Package	1*
38-001	Level & Flow Process Control	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Temperature in Water

The Temperature Training System is a two loop system, using water as the process fluid which allows the study of the principles of process control using primary and secondary circuit temperatures as the process variables to be controlled. Both circuits pass through the heat exchanger and the secondary circuit contains a fan-assisted cooling radiator. Thermistor temperature sensors are located in the inlet and outlet streams of both primary and secondary sides of the heat exchanger and the outlet of the radiator. The primary flow is also monitored. The Trainer can be used with a cold mains water supply through the Auxiliary Temperature Control Pack 38-480, which is supplied as part of the system. This comprises a motorised control valve, a flow meter and a signal conditioning unit. Alternatively the Temperature Trainer can be connected to the Level & Flow Process Trainer, which then supplies the cold water circuit. This combination allows more complex control systems to be investigated.

Topics

- Temperature familiarisation & calibration
- Interface familiarisation & calibration
- Controller familiarisation & calibration
- Pulse Flow Transmitter
- On-Off Control
- Study of P, PI and PID control of temperature & flow
- etc.

Experiments are operated and evaluated with ESPIAL.

The equipment can require additional software modules.

E6.4.2

TECHNICAL PROCESSES WITH
INDUSTRIAL COMPONENTS

E6.4.2.6
Cascaded Loop with
Remote Control

Cascaded Loop with Remote Control (E6.4.2.6)

Cat. No.	Description	E6.4.2.6
38-003	Level, Flow & Temperature Process Control	1
93-420	ESPIAL Software Package	1
38-610	Forced Air Cooler	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Cascaded Loop with Remote Control

The combined PROCON Level, Flow & Temperature Process Control System is self-contained and has all of the features of the individual Level & Flow and Temperature systems plus remote set-point control. Remote set-point control can be affected with the PROCON Level, Flow & Temperature Process Control System by using two process controllers. The 4-20mA analogue remote set-point input allows various forms of cascade control to be implemented between linked or interactive control loops. The process set-point can be local and remote or dual, selected from the front panel, or in response to a logic input. When dual set-point is selected the function can be ratio or bias action. A Programmable Logic Controller (PLC) 38-350 is also available separately. It can be used with the Process Interface 38-200 to provide an alternative control method with on/off elements to the standard Process Controller 38-300 (included).

Topics
- Flow & level familiarisation & calibration
- Temperature familiarisation & calibration
- Interface familiarisation & calibration
- Controller familiarisation & calibration
- Float level transmitter
- Pulse flow transmitter
- etc.

Experiments are operated and evaluated with ESPIAL.
The equipment can require additional software modules.

E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.7
Air Pressure
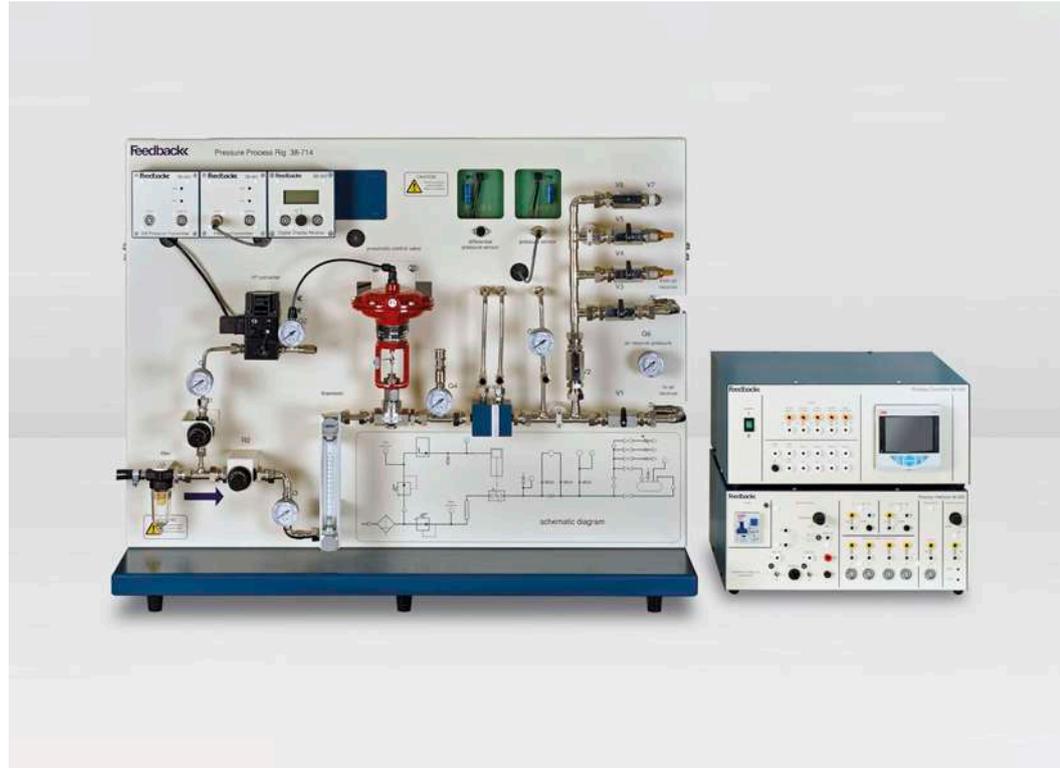
Air Pressure (E6.4.2.7)

Cat. No.	Description	E6.4.2.7
38-004	Pressure Process Control Trainer	1
93-420	ESPIAL Software Package	1
38-820-230	Air Compressor	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Air Pressure

The Pressure Process Control Training System is a single loop pneumatic control system. It enables the study of the principles of both pressure regulation of a process and the control of flow in a pressurised system. The system comprises a low pressure air circuit supported on a bench-mounted panel, making it suitable for individual student work or for group demonstration. The trainer requires a compressed air supply at a recommended input pressure of 40 psi (not supplied) An input filter/drier is used to clean the supplied air. Separately regulated branches provide air for the process and for valve control. The process branch comprises a regulator, a variable area flow meter, a pneumatically operated control valve, an orifice block with changeable orifice plates and both differential and point of measure pressure sensors.

Topics
- Pressure safety, familiarisation & calibration
- I/P converter & pneumatic control valve operation
- Controller familiarisation & calibration
- Automatic control systems
- Serial communication
- Pressure sensor
- etc.

Experiments are operated and evaluated with ESPIAL.

The equipment can require additional software modules.

E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.8
Distributed Control
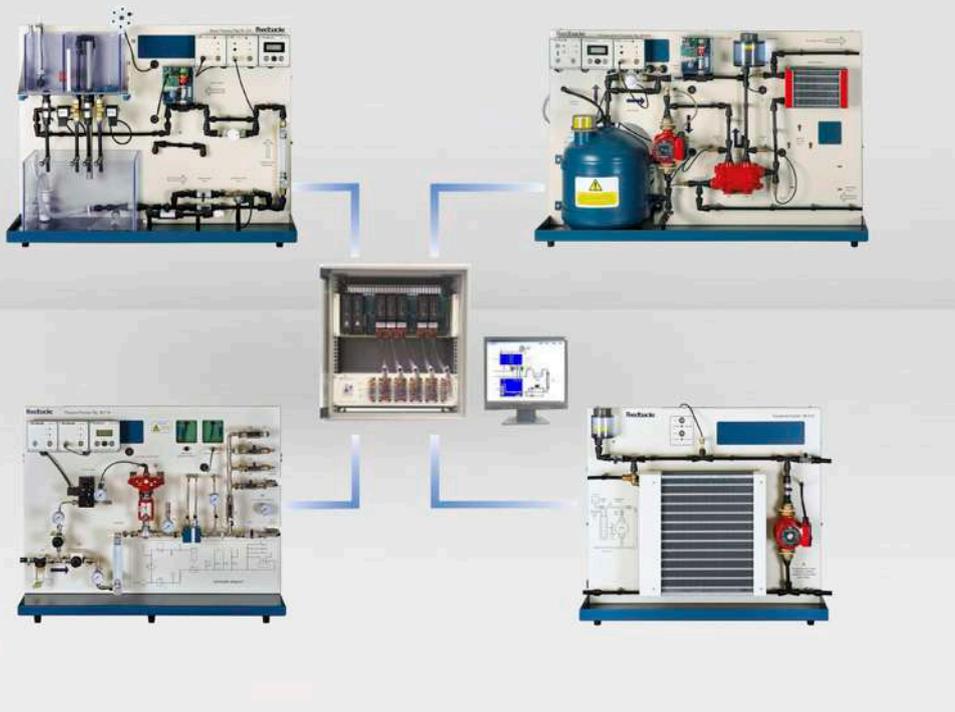
Distributed Control (E6.4.2.8)

Cat. No.	Description	E6.4.2.8
38-009	Distributed Control System (DCS)	1
38-820-230	Air Compressor	1
93-420	ESPIAL Software Package	1
38-820-120	PROCON COMPRESSOR 115V	1*

* additionally recommended

Distributed Control

The Feedback Distributed Control System (DCS) trainer is a complete training solution that combines the operations of a leading commercial DCS process management controller package, namely the Emerson Delta V, with an assortment of our proprietary training rigs.

The training rigs offer a range of processes:
- Level & Flow
- Temperature
- Pressure
- Forced Air Cooling

These may be operated separately or combined to produce a multi-process, multi-loop system. The trainer is supplied complete with the PC, software, controller and I/O modules that are needed to monitor and control the process rigs. A control cabinet houses the components that provide the interface between the PC and the rigs.

Topics
- Distributed control system background theory
- Delta V Explorer
- Trainer configuration
- Basic on-off control
- Advanced on-off control
- etc.

Experiments are operated and evaluated with ESPIAL.
The equipment can require additional software modules.

E6.4.2

TECHNICAL PROCESSES WITH INDUSTRIAL COMPONENTS

E6.4.2.9
Fault Diagnostics

Fault Diagnostics (E6.4.2.9)

Cat. No.	Description	E6.4.2.9
34–250	Industrial (fault–finding) Process Trainer	1
34–252–1	PLC Interface for 34–250	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Fault Diagnostics

This trainer teaches fault diagnosis and rectification in industrial processes. Faults are introduced by the instructor via switches concealed behind a locked compartment, to which the student does not have access. These switches provide both short circuits and open circuits and can also switch in or out circuit elements to simulate a variety of fault conditions.

Topics

- Introduction to the system
- Fault finding methodologies
- Fault analysis flow charts
- Fault finding from circuit diagrams
- Fault identification to line replaceable unit level
- etc.

E6.5 OPEN LOOP CONTROL ENGINEERING

E6.5.1

BASICS OF
OPEN LOOP CONTROL

E6.5.1.1
Compact Course:
Digital Technology
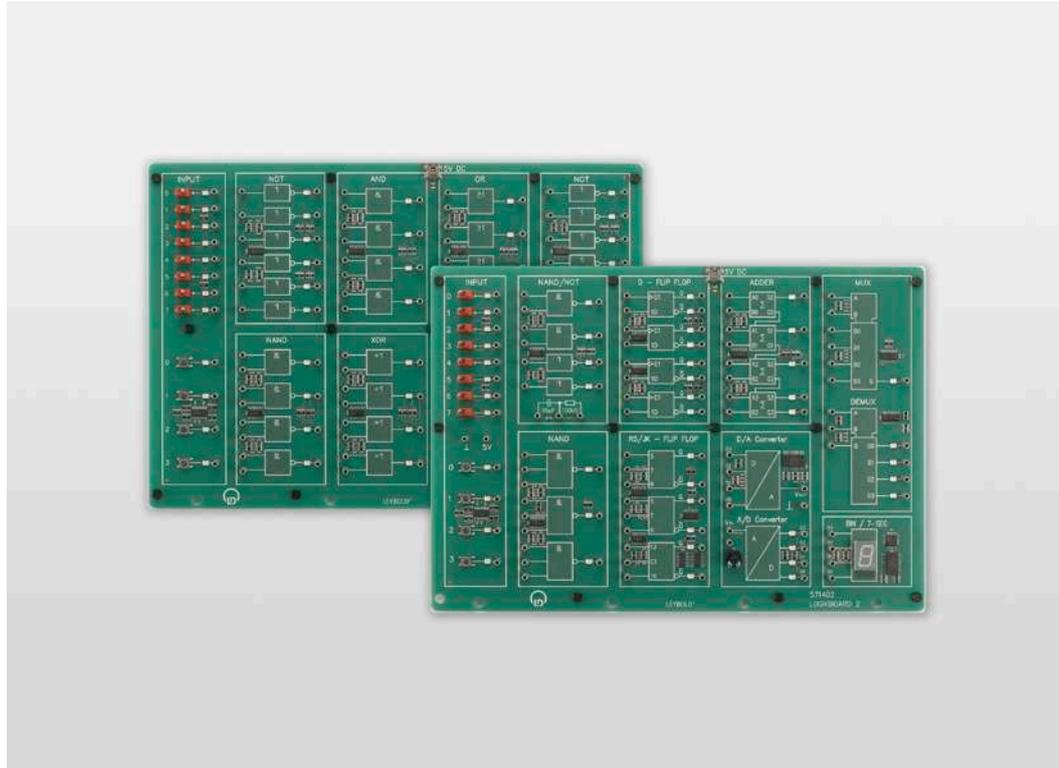
Compact Course: Digital Technology (E6.5.1.1)

Cat. No.	Description	E6.5.1.1
571 401	Logic board 1	1
571 402	Logic board 2	1

Compact Course Digital Technology

Theory and praxis of open loop control technology are basically carried out with two equipment sets for self-study.

Basic logic gates (AND, OR, NOT, NAND, XOR) of digital electronics are introduced. These are used to investigate the laws of logical operations (de Morgan's law, associative law and distributive law) and non-feedback logic circuits (switch networks). Then, simple flip-flop circuits with feedback are assembled to study storage of information. An adder is explored as a practical example of a switching network (logic circuits without feedback). Various flip-flop circuits enhance the knowledge of switching logic circuits with feedback. Applications of digital technology will be investigated, e.g. multiplexing, demultiplexing, control of a 7-segment display, and DAC respectively ADC conversion are covered. Switching states are displayed by means of an LED at each of the outputs.

Topics
- Logic gates: AND, OR, NOT and XOR
- flip-flop
- Adder
- AD converter / DA converter
- Multiplexer
- RS-flip-flops
- etc.
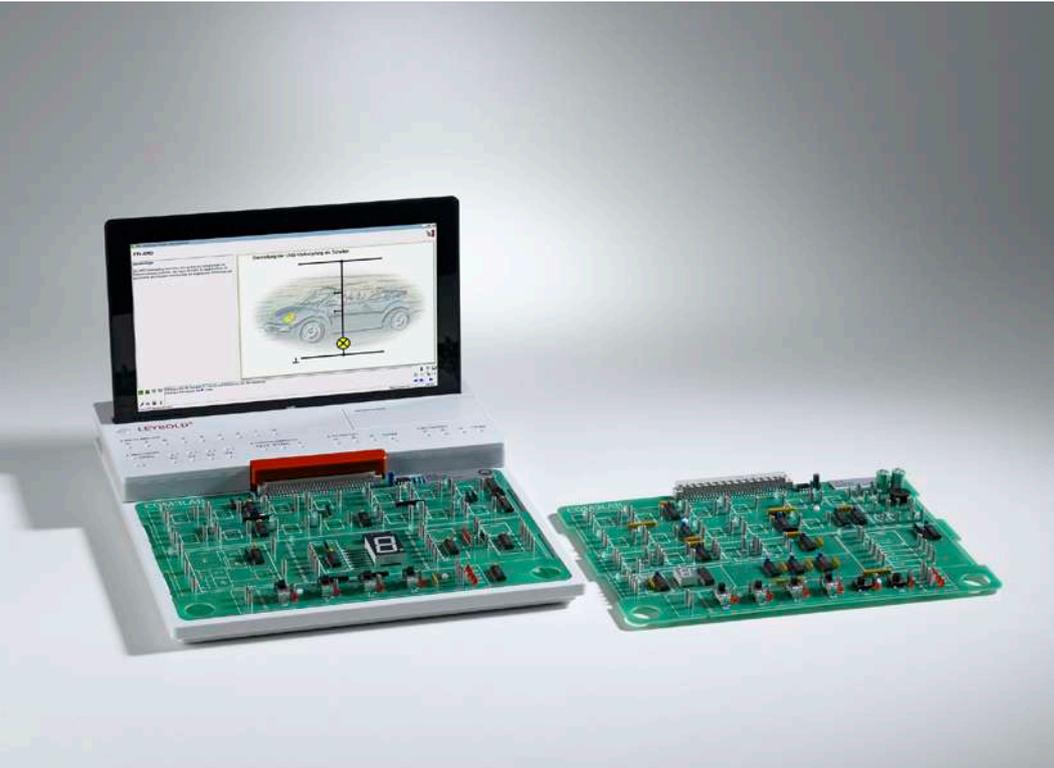
E6.5.1

BASICS OF
OPEN LOOP CONTROL

E6.5.1.2
Digital Technology

Digital Technology (E6.5.1.2)

Cat. No.	Description	E6.5.1.2
700 1701	COM3LAB Course: Digital Technology I	1
700 1801	COM3LAB Course: Digital Technology II	1
700 020	COM3LAB: Master Unit	1
700 022	Set of Safety Cables (2 mm, 16 Qty., 6 x 30 cm & 10 x 15 cm)	2
688 129	Mains cable with hock-proof plug and cold connector	1
700 00CBT	DVD: COM3LAB Software	1
700 027	COM3LAB: Suitcase	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Digital Technology I

In the course Digital Technology I the bases and laws of switch algebra are dealt with using logic links.

Topics
- TTL components (AND, OR, XOR)
- Link of binary inputs
- Basic laws
- etc.

Digital Technology II

In the course Digital Technology II various flip-flop applications, e.g. shift registers, parallel-serial converters or the serial data transmission are dealt with. Both courses deal extensively with troubleshooting.

Topics
- Flip-flop (RS, JK, D)
- Binary mat
- Forward and reverse counter
- etc.

Experiments are operated and evaluated with COM3LAB CBT.

E6.5.1

BASICS OF
OPEN LOOP CONTROL

E6.5.1.3
Embeded Systems
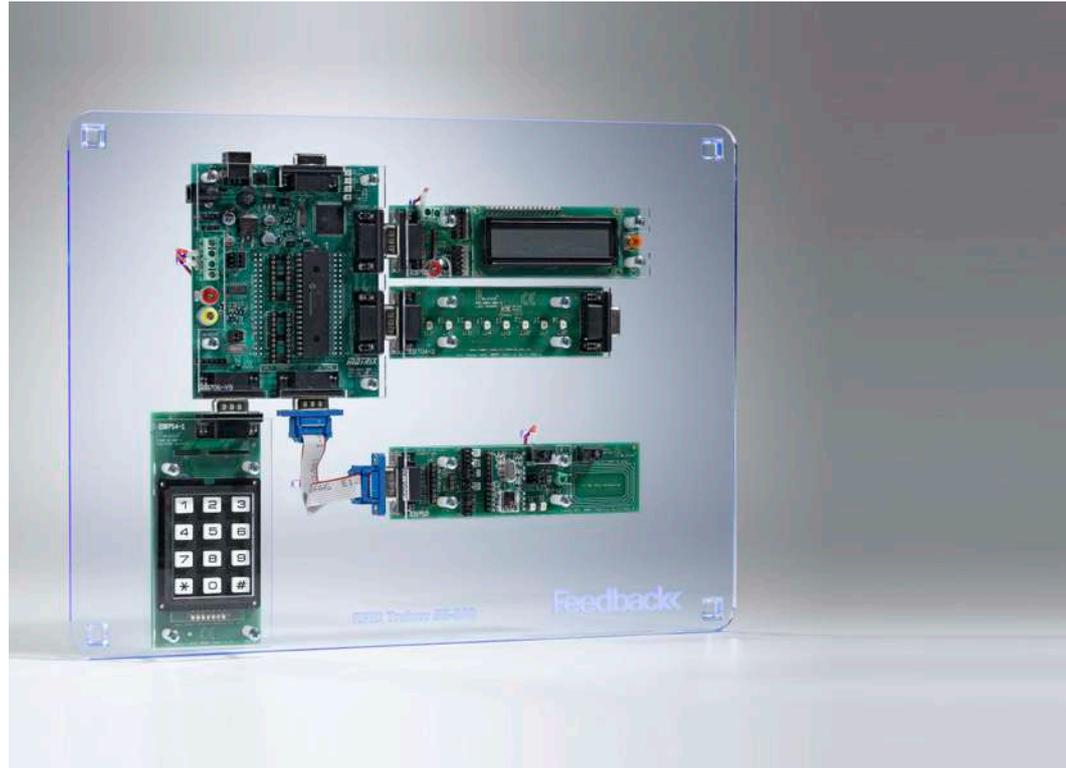
Embeded Systems (E6.5.1.3)

Cat. No.	Description	E6.5.1.3
55-500	RFID Trainer	1
55-600	Embedded Internet Trainer	1
55-800	FPGA Trainer	1
	additionally required: 1 PC with Windows 7/8/10	

Embeded Systems

The equipment consists of 3 trainers, which are widely used embedded systems in the control and in automation technology. With these systems, the student learns basic technologies for industry 4.0 systems and „Internet of Thinks (IoT). This is the basis for the development of fast-reacting sensors and communication systems, as these are necessary in microcontrollers or portable systems.

RFID Trainer

The RFID Trainer provides a complete course in developing RFID systems. It gives students who are familiar with microcontrollers an understanding of the programming involved in developing RFID systems. An RFID board and four RFID tags embedded into credit cards are included. This hardware enables students to learn about reading and writing transponder data in both I-code and Mirfare mode.

Embedded Internet Trainer

The Embedded Internet Trainer provides students with a full understanding for modern digital communications protocols and the development of embedded internet-based products.

FPGA Trainer

The Field-programmable Gate Array Trainer provides a platform for learning FPGA programming in either VHDL or Verilog. The trainer includes a FPGA development board, LED boards, switch boards, a dual 7-segment display board, a prototype board, serial D/A board and a power output board.

Topics

RFID Trainer
- RFID systems & applications
- Configuring RFID readers

Embedded Internet Trainer
- Ethernet, DLC, MAC, ARP, TCP, IP, UDP, ICMP, HTTP & POP3 protocols
- MAC packet structure & message creation using microcontrollers

FPGA Trainer
- PLD technology
- Getting to know QUARTUS II
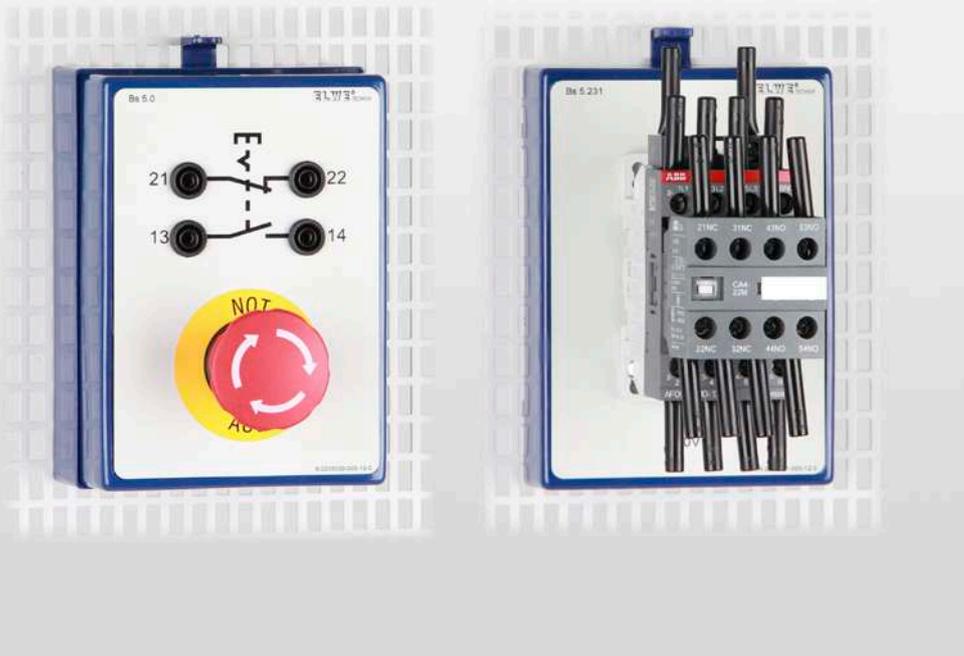
E6.5.2

INDUSTRIAL CONTROLS

E6.5.2.11
Contactor Controls
with Modules 24 V

E6.5.2.12
Contactor Controls
with Modules 230 V

Contactor Controls with Modules 24 V (E6.5.2.11)

Cat. No.	Description	E6.5.2.11	E6.5.2.12
8-2 405110-000-12-0	BS 5.110 Three-phase motor simulator	1	1
8-2 205000-000-12-0	BS 5.0 Emergency Shut-Down Pushbutton	1	1
8-2 205027-000-12-1	BS 5.27 Multifunction Relay	2	2
8-2 205028-000-12-0	BS 5.28 Auxilliary Contactor 24 V, 4 NCC's, 4 NOC's	3	
8-2 205031	BS 5.31 Contactor 24 V AC / DC	5	
8-2 205034-000-12-1	BS 5.34 Limit switch	2	2
8-2 215320-000-12-0	BS 5.320 Motor protection relay 0.63...1.0 A	1	1
8-2 205350-000-12-0	BS 5.350 Pilot lamp 24 V, triple	1	
8-2 205381-000-12-0	BS 5.381 Pushbutton switch 0-1-2	3	3
8-2 215900-000-12-0	BS 5.900 Circuit breaker, quadruple	1	1
8-2 230056-000-12-0	BS 30.56 Relay 24 V DC, 2 NOC / 2 NCC	1	1
531 192	Digital multimeter MX 24B	1	1
726 75	Three-phase supply unit with ELCB	1	1
562 793NA	Power Adapter 6...24 V	1	
500 851	Safety connecting leads, 32 A, set of 32	2	1
500 852	Safety connecting leads, 32 A, yellow/green, set of 10	1	2
726 30	Assembly Grid L130	1	1
732 203	Squirrel cage motor basic 400/690/0.3	1*	1*
731 07	Shaft end guard 0.3	1*	1*
8-2 205228-000-12-0	BS 5.228 Auxiliary contactor 230 V, 4 N/C, 4 N/O		3
8-2 205231-000-12-0	BS 5.231 Contactor 230 V		1
8-2 205351-000-12-0	BS 5.351 Pilot lamp 230 V, triple		1

Cat. No.	Description	E6.5.2.11	E6.5.2.12
726 890	DC-High Current Power Supp. 32/20		1

* additionally recommended

Contactor Controls with Modules

Even today, simple control circuits are still being realized economically, using contactor type circuits. But even complex PLC controls cannot be designed without external protective devices like pushbutton switch latching and contactor multiple latching. The topic Industrial Controls contains various switches, contactors, signal indicators, limit and proximity switches and can also be logically extended by the electrical machines program (E2). The assembly of control and load circuits is set up in a simple and straight forward fashion. All connections are made by 4 mm safety connecting leads. The extensive literature accompanying the equipment sets, explains the function and operation of the individual components and even includes the realization of complex machine and expert control circuits. The equipment set E6.5.2 Industrial Controls forms the foundations for more advanced training in PLC technology.

E6.5.2

INDUSTRIAL CONTROLS

E6.5.2.21
Contactor Controls
with Training Panels 24 V

E6.5.2.22
Contactor Controls
with Training Panels 230 V AC
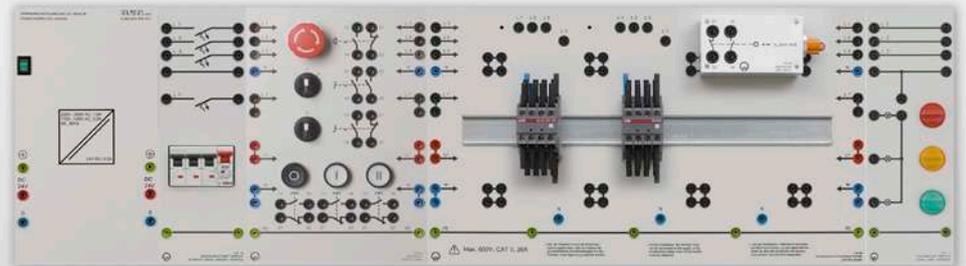
Contactor Controls with Training Panels 24 V (E6.5.2.21)

Cat. No.	Description	E6.5.2.21	E6.5.2.22
730 002	Operating panel	1	1
730 004	Base unit control circuits	1	1
730 321	AUX. CONTACTOR 24V 4NO 4NC	3	
730 331	Power Contactor 24 V 3 Main, 3 NO, 2NC	3	
732 151	Motor Protection Relay 0.6-1	2	2
730 072	Multi-function relay	1	1
730 37	Signal Lamp 24V, Threefold	1	
730 93	Limit Switch 1NO 1NC	1	1
726 10	Panel frame T150, two-level	1	1
726 75	Three-phase supply unit with ELCB	1	1
562 793NA	Power Adapter 6...24 V	1	1
500 59	Safety bridging plugs, black, set of 10	4	4
726 890	DC-High Current Power Supp. 32/20	1	
500 591	Safety bridging plugs, yellow/green, set of 10	1	1
500 851	Safety connecting leads, 32 A, set of 32	3	3
500 852	Safety connecting leads, 32 A, yellow/green, set of 10	1	1
648 07	Storage tray S24-FN	1	1
732 203	Squirrel cage motor basic 400/690/0.3	1*	1*
731 07	Shaft end guard 0.3	1*	1*
730 121	Auxiliary Contactor 4NO 4NC		3
730 131	PWR Contactor 3-pole 3NC 2NO		3
730 17	Signal Lamp, Threefold		1

* additionally recommended

Contactor Controls with Training Panels

- Basic control elements with contactor
- Basic control circuits with contactor
- Basic control circuits for machines

The experiment plate system is comprised of handy, robust experiment plates that are arranged on a frame in accordance with the specifications in the literature.

The industry standard equipment is affixed to the front. The operation and notification elements are installed on separate plates.

The electric components are wired directly to the corresponding safety connector using a 4 mm safety connection line for low voltage.

Topics

- Functionality of the circuits
- And-or circuits with contactors
- Motor switched on with a power contactor
- Catch of a contactor
- Locking of contactors
- Locking of buttons
- Reverse control
- etc.

E6.5.2

INDUSTRIAL CONTROLS

E6.5.2.5
Control with Limit &
Proximity Switches
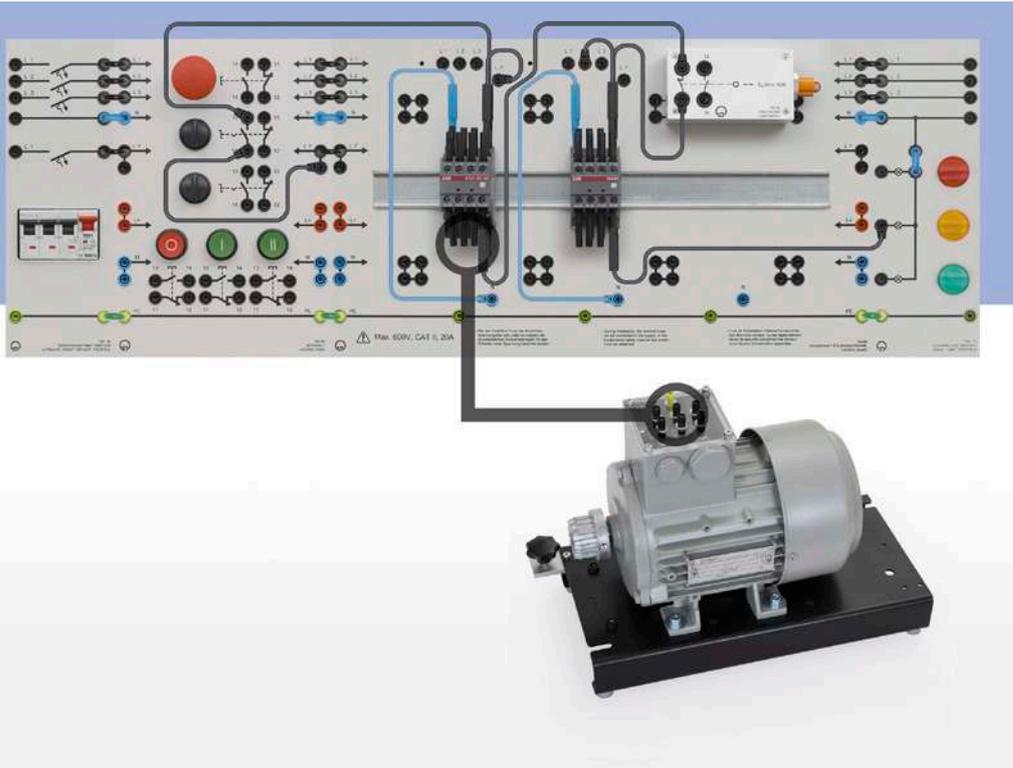
Control with Limit & Proximity Switches (E6.5.2.5)

Cat. No.	Description	E6.5.2.5
730 90	Gear w.2 Switch Arms 0.1/0.3	1
731 06	Coupling 0.3	1
731 08	Coupling guard 0.3	1
732 203	Squirrel cage motor basic 400/690/0.3	1
730 93	Limit Switch 1NO 1NC	2
730 94	Ind. Proximity Switch 2-AC/DC	1
730 95	Ind. Proximity Switch 3-DC	1
730 97	Cap. Proximity Switch 3-DC	1
730 99	Opt. Proximity Switch 3-DC	1
730 381	Relais 24V 1NO 1NC	1*
562 793NA	Power Adapter 6...24 V	1
566 242	LIT: Limit and Proximity Switches T 9.2	1*

* additionally recommended

Control with Limit & Proximity Switches
- Function and end position switches
- Sensor principles: mechanic, inductive and capacitive final position switch
- Controlling systems with end position switches.
- Use of contactor technology, small controllers, or SPC

End position switches register the maximum positions in systems. Depending on the application, final position switches can be built with mechanical, inductive, or capacitive sensors. Material, touchless operation, switching operation voltages and environmental conditions are criteria that go into selection. The learning system helps students to differentiate between the individual end position switches and use them in typical experiments.

Topics
- Final position stop
- Automatic reverse switching
- Dahlander reverse switching

E6.5.2

INDUSTRIAL CONTROLS

E6.5.2.3
Control with LOGO! 8 230 V

Control with LOGO! 8 230 V (E6.5.2.3)

Cat. No.	Description	E6.5.2.3
8-2 412890	Universal Logic Module LOGO! 8 230 RCE	1
773 090	Logo! Software	1
689 3000	RJ45 crossover Cable 2m	1
	additionally required: 1 PC with Windows 7/8/10	

Control with LOGO! 8 230 V
- Create programs
- Learn logistics and control functions
- Test the programs
- Configuring network connections

Programming a small controller on LOGO! 8 from Siemens. The student should learn the main functions of small controllers.

Experiment plate system with all necessary digital inputs and outputs and the necessary interfaces. The inputs can be reached via 4 mm safety connectors for 230 V and via installed circuits with notching and push function. The outputs are configured as potential-free relay contacts and are accessible via safety connectors on the front. There is the option to permanently position the connectors with bridging plugs at 230 V. The controller has an ethernet interface that is constructed as RJ 45. The control voltage amounts to 230 V AC.

Topics
- Star-delta circuit with time relay
- Reversing star/delta circuit
- Motor reverse control with cam-operated limit switch
- Slip ring rotor with stepped starter motor
- Pole-changing motor with divided coils
- Dahlander circuits
- etc.
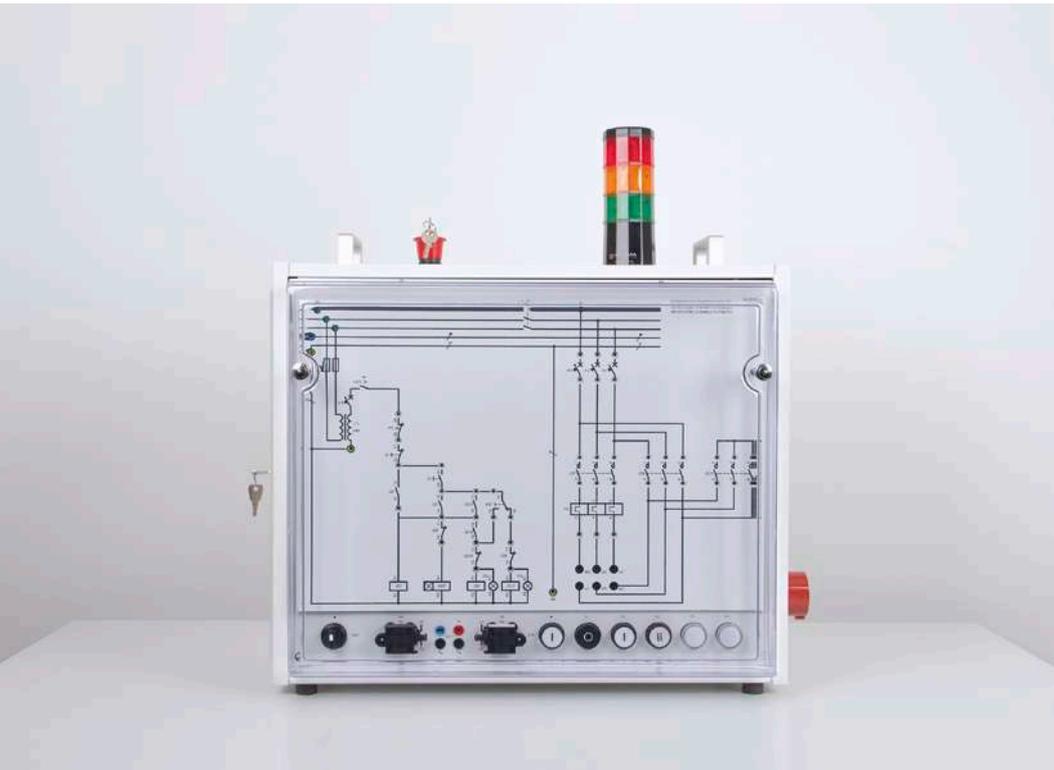
E6.5.2

INDUSTRIAL CONTROLS

E6.5.2.4
Fault Simulator:
Contactor Circuits

Fault Simulator: Contactor Circuits (E6.5.2.4)

Cat. No.	Description	E6.5.2.4
773 030	Fault simulator for Contactor circuits	1
8-5 305062-000-10-0	LIT: Fault simulator	1
727 292	Voltage detector	1
732 203	Squirrel cage motor basic 400/690/0.3	1*
732 24	Squirrel cage motor D 0.3	1*
731 07	Shaft end guard 0.3	1*
730 90	Gear w.2 Switch Arms 0.1/0.3	1*
731 06	Coupling 0.3	1*
731 081	Coupling guard 0.3 transparent	1*
730 93	Limit Switch 1NO 1NC	2*
500 851	Safety connecting leads, 32 A, set of 32	1*
500 640	Safety connecting lead, 100 cm, yellow/green	2*

* additionally recommended

Fault Simulator: Contactor Circuits

Fault localisation in contactor circuits. Compact device with integrated fault simulation.

Educational objectives
- Function of contactor circuits
- Fault localisation in contactor circuits

Compact device for systematic error detection in conventional contactor circuits. By masking different masks, only the measurement and connection points which are important for the circuit depicted on the mask are released.

On the left side of the device is behind a lockable door the control panel for the instructor, which contains next to the protection devices, the mask selector switch also error switch.

Students should learn a systematic error search with the help of voltage- and continuity testers.

The error analysis is carried out in 4 steps
- Description of the error
- Suppose cause
- Error detection by measurement
- Description Test method
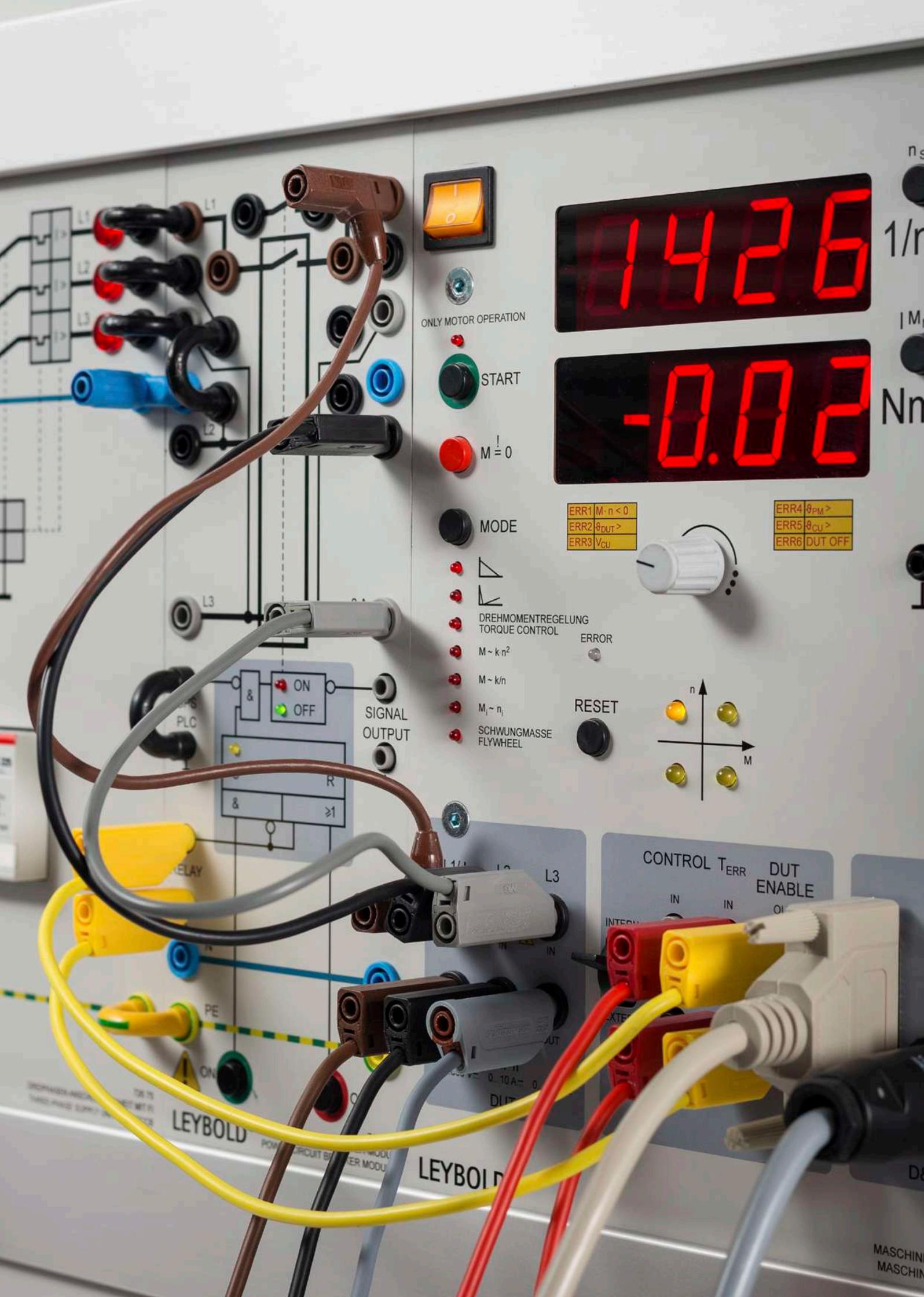
L1
L2
L3

L1
L2
L3

ONLY MOTOR OPERATION

START

M $\overset{!}{=}$ 0

MODE

DREHMOMENTREGELUNG
TORQUE CONTROL

M ~ k·n²

M ~ k/n

M$_i$ ~ n$_i$

SCHWUNGMASSE
FLYWHEEL

SIGNAL
OUTPUT

ON
OFF

PS
PLC

RELAY

R

PE

1426

1/m

-0.02

Nm

ERR1	M·n < 0
ERR2	ϑ_{DUT} >
ERR3	V$_{CU}$

ERR4	ϑ_{PM} >
ERR5	ϑ_{CU} >
ERR6	DUT OFF

ERROR

RESET

n

M
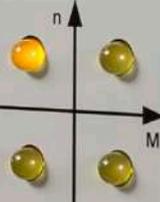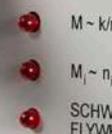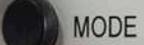
CONTROL T$_{ERR}$ DUT
ENABLE

IN   IN

INTERN

EXTERN

LEYBOLD

LEYBOLD

10 A

DUT

MASCHIN
MASCHIN

E6.6 AUTOMATION TECHNOLOGY

E6.6.1

COM3LAB MULTIMEDIA: AUTOMATION

E6.6.1.1
Basics of
Automation Technology

E6.6.1.2
Pneumatics Board

Basics of Automation Technology (E6.6.1.1)

Cat. No.	Description	E6.6.1.1	E6.6.1.2
700 3101	COM3LAB Course: Automation and Bus Technology	1	1
700 020	COM3LAB: Master Unit	1	1
700 022	Set of Safety Cables (2 mm, 16 Qty., 6 x 30 cm & 10 x 15 cm)	1	1
688 129	Mains cable with hock-proof plug and cold connector	1	1
700 00CBT	DVD: COM3LAB Software	1	1
728 871	Software: 5 Modells CBS 9 (single user)	1	
728 872	Software: 5 Models CBS 9 (licence for 25 places)	1	
730 4313	Bus connecting plug RS 485	1	
524 016S2	Profi-CASSY Starter 2	1	
700 027	COM3LAB: Suitcase	1*	1*
700 3501	COM3LAB Course: Electro Pneumatics		1
700 351	COM3LAB: Pneumatics Board		1
744 600	Low-noise Compressor		1*
744 902	Compressor Connection Hosing		1*
	additionally required: 1 PC with Windows 7/8/10		

* additionally recommended

Automation and Bus Technology

The COM3LAB course Bus and Automation technology teaches the basics of programmable logic controllers (PLC) and shows their interconnection including sensors and actuators using the PROFIBUS.

With many examples, explanations, exercises and practical tasks, the basic principles and functions of the PLC and the PROFIBUS are clearly illustrated.

The combination with external PROFIBUS components or an external system simulator enables the processes in the bus and automation technology to be illustrated and tracked as accurately as possible and without any great amount of effort.

Topics
- Motor control
- Traffic light control
- etc.

Pneumatics

The COM3LAB course Electropneumatics teaches the basics of electropneumatics using the BIBB standard tasks.

The COM3LAB course Automation technology explains the function and application of a PLC. Several examples make it easy to learn the PLC computer language.

Both courses can be combined so that complete process cycles can be executed and documented. This kind of project work supports independent and creative handling.

Topics
- Function and use of electronic and pneumatic components
- Electronic and pneumatic schematics
- etc.

Experiments are operated and evaluated with COM3LAB CBT.

E6.6.2

LOGIC CONTROLLERS & PROCESS VISUALISATION

E6.6.2.1
Basic Package LOGO! 8

E6.6.2.11
Trainer Package 6x LOGO! 8
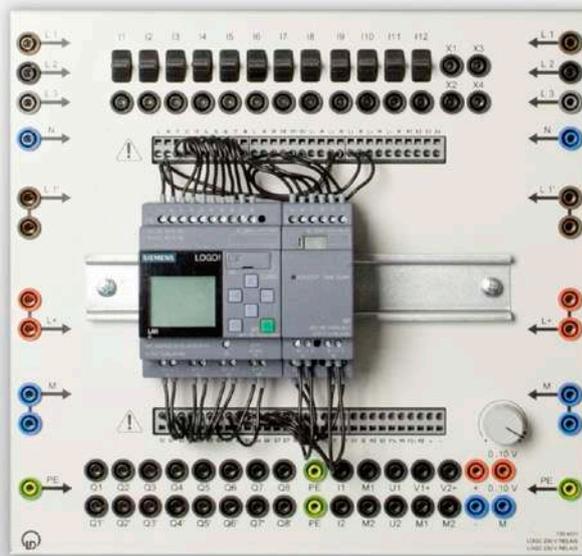
Basic Package LOGO! 8 (E6.6.2.1)

Cat. No.	Description	E6.6.2.1	E6.6.2.11
773 041	LOGO! 8 12/24	1	
8-2 412470-100-10-1	Power supply 24 V DC, 6.5 A, for 230 V AC	1	6
689 3000	RJ45 crossover Cable 2m	1	6
773 055	HMI Touch Panel Basic	1*	6*
773 090	Logo! Software	1	
726 10	Panel frame T150, two-level	1*	6*
500 59	Safety bridging plugs, black, set of 10	1*	6
500 591	Safety bridging plugs, yellow/green, set of 10	1*	6*
773 050	ASIMA Plant Simulator II	1*	6*
700 00CBT	DVD: COM3LAB Software	1*	1*
500 614	Safety connecting lead, 25 cm, black	24*	144*
500 611	Safety connecting lead, 25 cm, red	1*	6*
500 612	Safety connecting lead, 25 cm, blue	1*	6*
773 045	LOGO! 8 12/24 TP 6 x		1
	A selection of 12 masks can be found in E6.7.1.1.	1	1

* additionally recommended

Logic Controllers & Process Visualisation

When it comes to smaller control tasks, small control systems – also called control relays or logic modules – are the perfect introduction to the world of stored program controls. It is operated with an integrated key pad and LCD display. Alternatively, control programs can also be created on the PC.

Basic functions:
AND, OR, NOT, NANO, NOR, XOR

Special functions:
Power-on delay, Power-off delay, Impulse generator, Counter (forward and backward), Time switch

The experiments are carried out with the small controller LOGO! 8 from Siemens. The logic module is set on a base plate and hung in a profile frame. The students are expected to program the LOGO! 8 and learn the main functions of small controllers in the process.

Topics
- Programming a small controller
- Logic connections
- Timer and clock timer functions
- RS components
- Measure counting and frequencies
- Analogue value processing
- etc.

Experiments require the Siemens software LOGO! to create programs. The equipment can require additional software modules.

E6.6.3

PLC & PROCESS VISUALISATION

E6.6.3.1
Basic Package
S7-1512C-1 PN

E6.6.3.11
Trainer Package
S7-1512C-1 PN
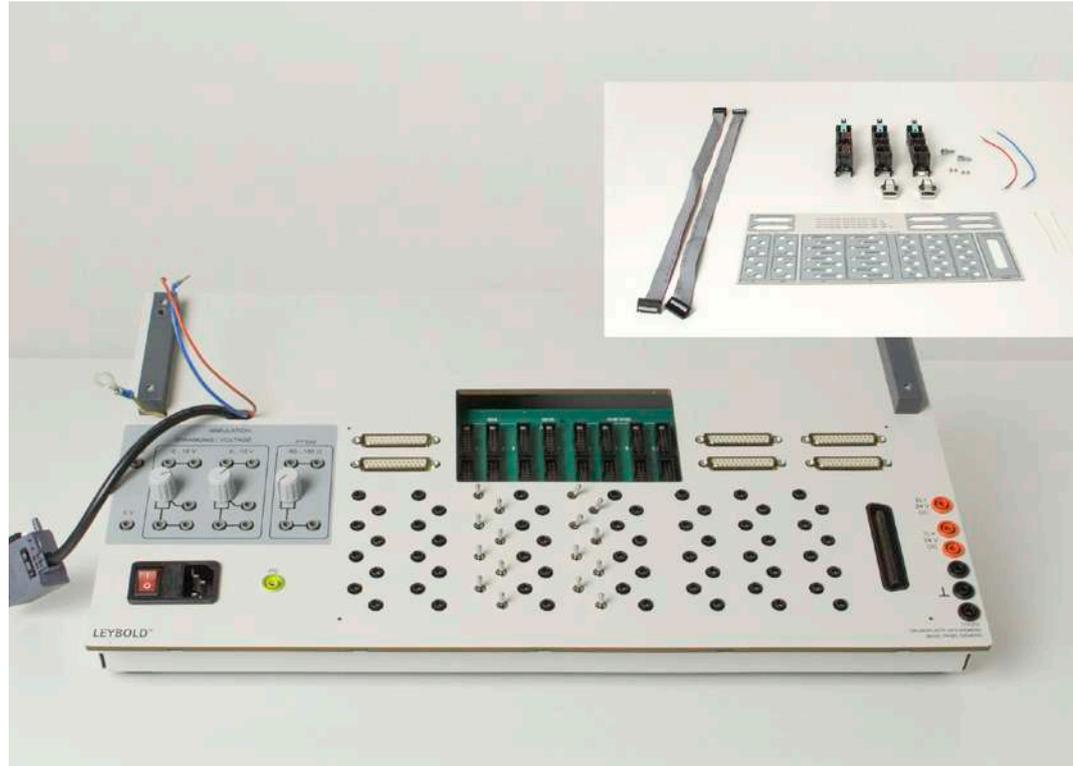
Basis Paket S7-1512C-1 PN (E6.6.3.1)

Cat. No.	Description	E6.6.3.1	E6.6.3.11
773 070	Basic Panel Siemens	1	
773 073	Assembly set PLC S7-1512	1	
8-1 012027-000-10-0	Siemens HMI TP700	1*	1*
726 10	Panel frame T150, two-level	1*	1*
500 59	Safety bridging plugs, black, set of 10	1*	1*
773 050	ASIMA Plant Simulator II	1*	1*
700 00CBT	DVD: COM3LAB Software	1*	1*
773 072	Simatic PLC S7-1512C-1 PN TP		1
	A selection of 33 masks can be found in E6.7.1.3.	1	1

* additionally recommended

PLC & Process Visualisation

Equipment set E6.6.3.1

This course familiarises students with the most important functions of a stored program control (SPC). The basic package for the Siemens SPC S7-1512C-1 PN contains only the assembly components and accessories. The SPC is not included in the kit.

Equipment set E6.6.3.11

This course familiarises students with the most important functions of a stored program control (SPC). The trainer package for Siemens SPC S7-1512C-1 PN contains assembly parts and accessories including the necessary SPC.

Educational objectives
- Creating programs
- Learn logistics and control functions
- Testing the programs
- Set up the network connections for Profi-Net

Topics
- Programming of an SPC
- Programming method KOP, FUP, AWL, S7-GRAPH
- Expanded program structure
- Logic connections
- Timer and clock timer functions
- etc.

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.

E6.6.3

PLC & PROCESS VISUALISATION

E6.6.3.2
Basic Package
S7-1512C-1 PN +DP

E6.6.3.21
Trainer Package
PLC S7-1512C-1 PN +DP

Trainer Paket S7-1512C-1 PN +DP (E6.6.3.21)

Cat. No.	Description	E6.6.3.2	E6.6.3.21
773 070	Basic Panel Siemens	1	
773 073	Assembly set PLC S7-1512	1	
8-1 012027-000-10-0	Siemens HMI TP700	1*	1*
773 091	Simatic Step 7 Prof. Training 1x	1*	
726 10	Panel frame T150, two-level	1*	1*
500 59	Safety bridging plugs, black, set of 10	1*	1*
689 3000	RJ45 crossover Cable 2m	1*	
773 050	ASIMA Plant Simulator II	1*	1*
700 00CBT	DVD: COM3LAB Software	1*	1*
773 075	Simatic PLC S7-1512C-1 PN +DP TP		1
	A selection of 33 masks can be found in E6.7.1.3.	1	1

PLC & Process Visualisation

Equipment set E6.6.3.2

This course familiarises students with the most important functions of a stored program control (SPC). The basic package for the Siemens SPC S7-1512C-1 PN+DP contains only the assembly components and accessories. The SPC is not included in the kit.

Equipment set E6.6.3.21

This course familiarises students with the most important functions of a stored program control (SPC). The trainer package for Siemens SPC S7-1512C-1 PN+DP contains assembly parts and accessories including the necessary SPC.

Educational objectives
• Operating the SPC
• Creating programs
• Learn logistics and control functions
• Testing the programs

Topics
• Programming of an SPC
• Programming method KOP, FUP, AWL, S7-GRAPH
• Expanded program structure
• Logic connections
• Timer and clock timer functions
• etc.

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.

E6.6.3

PLC & PROCESS VISUALISATION

E6.6.3.3
Basic Package
S7-1516 PN/DP

E6.6.3.31
Trainer Package
PLC S7-1516 PN/DP

Basic Package S7-1516 PN/DP (E6.6.3.3)

Cat. No.	Description	E6.6.3.3	E6.6.3.31
773 070	Basic Panel Siemens	1	
773 078	Assembly set PLC S7-1516	1	
8-1 012027-000-10-0	Siemens HMI TP700	1*	1*
773 091	Simatic Step 7 Prof. Training 1x	1*	
726 10	Panel frame T150, two-level	1*	1*
500 59	Safety bridging plugs, black, set of 10	1*	1*
689 3000	RJ45 crossover Cable 2m	1*	
773 050	ASIMA Plant Simulator II	1*	1*
700 00CBT	DVD: COM3LAB Software	1*	1*
773 077	Simatic S7-1516 PN/DP TP		1
	A selection of 33 masks can be found in E6.7.1.3.	1	1

* additionally recommended

PLC & Process Visualisation

Equipment set E6.6.3.3

This course familiarises students with the most important functions of a stored program control (SPC). The basic package for the Siemens SPC S7-1516-3 PN/DP contains only the assembly components and accessories. The SPC is not included in the kit.

Equipment set E6.6.3.31

This course familiarises students with the most important functions of a stored program control (SPC). The trainer package for Siemens SPC S7-1516-3 PN/DP contains assembly parts and accessories including the necessary SPC.

Educational objectives
- Operate the SPC
- Create programs
- Learn logistics and control functions
- Test the programs
- Set up the network connections for Profi-Net and Profi-Bus / DP

Topics
- Programming of an SPC
- Programming method LAD, SFC, STL, S7-GRAPH
- Expanded program structure
- Logic connections
- Timer and time switch functions, fast counter
- etc.

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.

E6.6.4

INDUSTRIAL BUS SYSTEMS

E6.6.4.1
AS-Interface
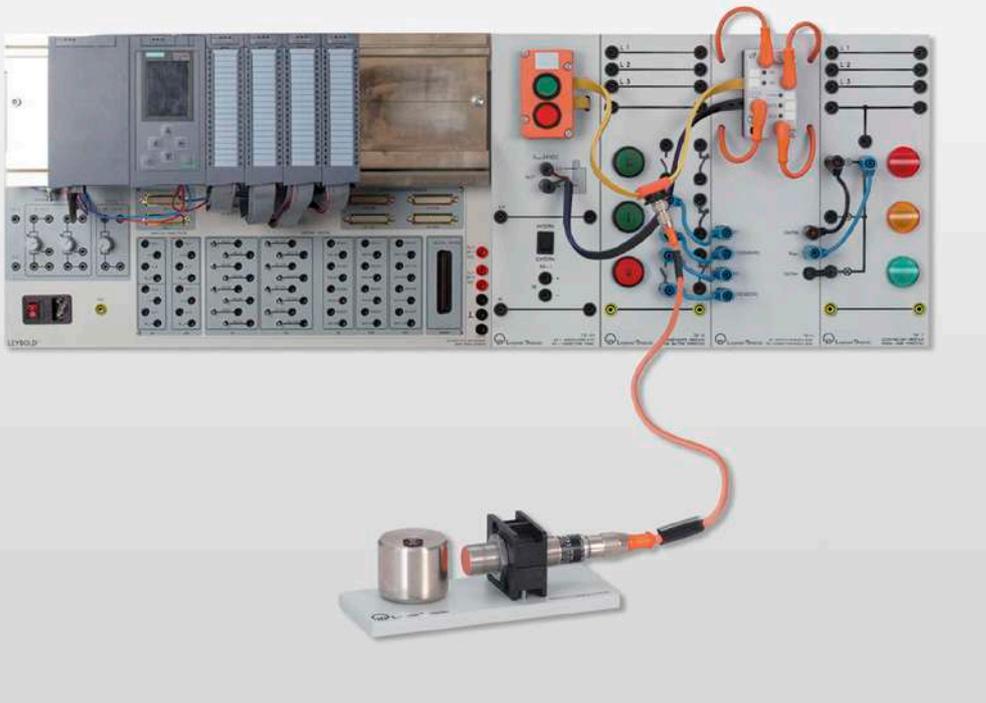
AS-Interface (E6.6.4.1)

Cat. No.	Description	E6.6.4.1
730 04	Pushbutton, Threefold	1
730 37	Signal Lamp 24V, Threefold	1
730 412	AS-I Connection Module 2E/2A	1
730 413	AS-I Set	1
730 414	AS-i Bus Testing Instrument	1
730 4312	Profibus cable	1
730 4101	DP / AS-I Communications Module	1
726 75	Three-phase supply unit with ELCB	1*
726 10	Panel frame T150, two-level	1*
500 59	Safety bridging plugs, black, set of 10	1*
500 614	Safety connecting lead, 25 cm, black	12*
500 611	Safety connecting lead, 25 cm, red	3*
500 612	Safety connecting lead, 25 cm, blue	3*
773 075	Simatic PLC S7-1512C-1 PN +DP TP	1*
773 077	Simatic S7-1516 PN/DP TP	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

AS-Interface

The student investigates the connection of sensors and actuators with the AS-i interface in the SPC. With the actuator sensor interface (AS-i), all you need is an unshielded two-wire cable to connect all sensors and actuators with the controller. The system is clearly organised and easy to install thanks to the cut-clamp technique.

Educational objectives
- Operate the SPC
- Connect the devices with the TIA portal
- Creating programs
- Connection of AS interface devices
- Testing the programs

Topics
- Programming of an SPC
- Connection of AS-i components
- Programming methods LAD, SFC, STL, S7-GRAPH

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.

E6.6.4

INDUSTRIAL BUS SYSTEMS

E6.6.4.2
PROFI-BUS
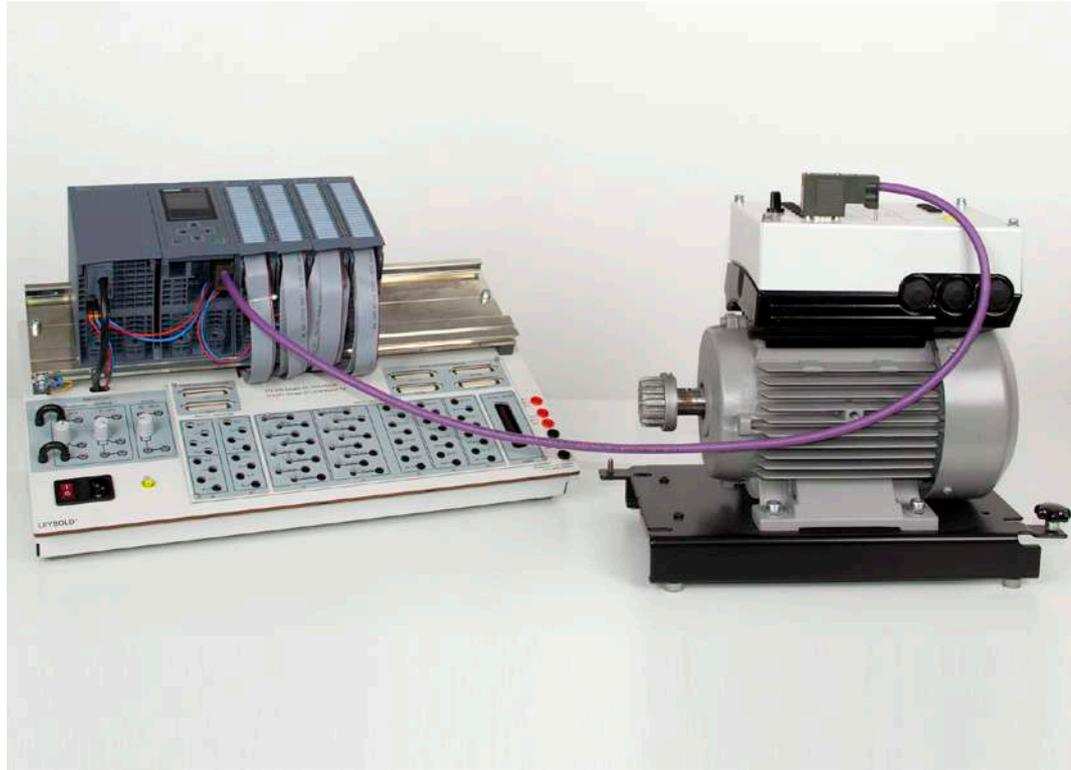
PROFI-BUS (E6.6.4.2)

Cat. No.	Description	E6.6.4.2
730 90	Gear w.2 Switch Arms 0.1/0.3	1
730 93	Limit Switch 1NO 1NC	2
730 95	Ind. Proximity Switch 3-DC	1*
730 97	Cap. Proximity Switch 3-DC	1*
732 46	Motor with FCC 0.3	1
735 314	LCP2 local control panel	1
730 431	Profibus Connection Cable	1
726 75	Three-phase supply unit with ELCB	1*
726 10	Panel frame T150, two-level	1*
500 591	Safety bridging plugs, yellow/green, set of 10	1*
500 644	Safety connecting lead, 100 cm, black	12*
500 640	Safety connecting lead, 100 cm, yellow/green	2*
500 59	Safety bridging plugs, black, set of 10	1*
773 075	Simatic PLC S7-1512C-1 PN +DP TP	1*
773 077	Simatic S7-1516 PN/DP TP	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

PROFI-Interface

Students will learn to connect outside devices (not from Siemens) to the SPC via the process field bus.

Educational objectives
• Operation of an SPC and a frequency converter
• Interpretation of GSD files
• Connect the devices with the TIA portal
• Creating SPC programs
• Connection of process field bus devices
• Testing the programs

Function
• SPS with a process field bus access
• Frequency converter with process field bus connection
• Process field bus cable
• Asynchronous machine
• Gearing with gearshift arm
• Limit switch

Topics
• Programming of an SPC
• Programming method KOP, FUP, AWL, S7-GRAPH
• Connection of PROCESS FIELD BUS devices
• Expanded program structure

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.

E6.7 PROCESS AUTOMATION

E6.7.1

PLANT SIMULATION

E6.7.1.1
ASIMA for
Small Logic Controllers

ASIMA for Small Logic Controllers (E6.7.1.1)

Cat. No.	Description	E6.7.1.1
773 050	ASIMA Plant Simulator II	1
700 00CBT	DVD: COM3LAB Software	1
8-2 412123-000-10-0	50-pole ribbon cable, 700 mm	1
8-5 212642-000-10-0	LIT: Control of system simulations	1*
8-2 412215-000-19-0	Mask M1 Logic basic functions	1
8-2 412216-000-19-0	Mask M2 Digital function modules	1
8-2 412217-000-19-0	Mask M3 Motor ON/OFF	1
8-2 412218-000-19-0	Mask M4 Reversing contactor	1
8-2 412219-000-19-0	Mask M5 Star-delta connection	1
8-2 412220-000-19-0	Mask M6 Reversing star-delta connection	1
8-2 412221-000-19-0	Mask M7 Pendulum table control	1
8-2 412222-000-19-0	Mask M8 Dahlander circuit	1
8-2 412223-000-19-0	Mask M9 Motor with 2 windings	1
8-2 412224-000-19-0	Mask M10 Motor self-starter	1
8-2 412225-000-19-0	Mask M11 Conveyor belt system	1
8-2 412226-000-19-0	Mask M12 Reactive-current compensation	1
8-2 412227-000-19-0	Mask M13 Heating control	1
8-2 600001-000-10-0	Transparent folder, 410 mm x 320 mm x 10 mm	2
726 10	Panel frame T150, two-level	1*
726 75	Three-phase supply unit with ELCB	1*
562 793NA	Power Adapter 6...24 V	1*
500 59	Safety bridging plugs, black, set of 10	1*
500 614	Safety connecting lead, 25 cm, black	24*
500 611	Safety connecting lead, 25 cm, red	1*
500 612	Safety connecting lead, 25 cm, blue	1*

Cat. No.	Description	E6.7.1.1
773 041	LOGO! 8 12/24	1*
773 045	LOGO! 8 12/24 TP 6 x	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

ASIMA for Small Logic Controllers

The System Simulator II (ASIMA) is optimally designed for operation with small controller LOGO! 8. ASIMA provides a total of 13 different applications (view summary table) for small controllers. The broad experiment spectrum ranges from testing of SPC functions through to controlling small controllers and facilitates universal use of ASIMA in education.

Educational objectives
- Programming simple basic circuits.
- Programming machine circuits

Topics
- Basic logic functions
- Digital function components
- etc.

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.

E6.7.1

PLANT SIMULATION

E6.7.1.2
ASIMA for PLC - Basic
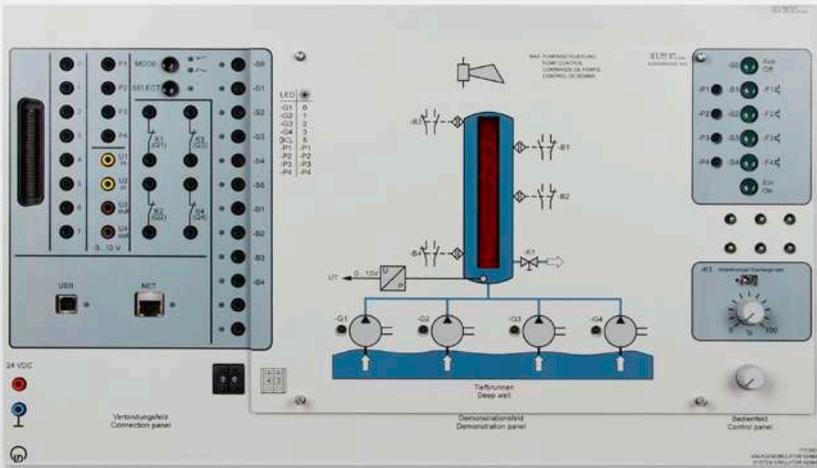
ASIMA for PLC - Basic (E6.7.1.2)

Cat. No.	Description	E6.7.1.2
773 050	ASIMA Plant Simulator II	1
700 00CBT	DVD: COM3LAB Software	1
8-2 412123-000-10-0	50-pole ribbon cable, 700 mm	1
8-5 212642-000-10-0	LIT: Control of system simulations	1*
8-2 412215-000-19-0	Mask M1 Logic basic functions	1
8-2 412216-000-19-0	Mask M2 Digital function modules	1
8-2 412217-000-19-0	Mask M3 Motor ON/OFF	1
8-2 412218-000-19-0	Mask M4 Reversing contactor	1
8-2 412219-000-19-0	Mask M5 Star-delta connection	1
8-2 412220-000-19-0	Mask M6 Reversing star-delta connection	1
8-2 412221-000-19-0	Mask M7 Pendulum table control	1
8-2 412222-000-19-0	Mask M8 Dahlander circuit	1
8-2 412223-000-19-0	Mask M9 Motor with 2 windings	1
8-2 412224-000-19-0	Mask M10 Motor self-starter	1
8-2 412225-000-19-0	Mask M11 Conveyor belt system	1
8-2 412226-000-19-0	Mask M12 Reactive-current compensation	1
8-2 412227-000-19-0	Mask M13 Heating control	1
8-2 412228-000-19-0	Mask M14 Running light	1
8-2 412229-000-19-0	Mask M15 Tablets machine	1
8-2 412231-000-19-0	Mask M17 Coal grinder	1
8-2 412232-000-19-0	Mask M18 Embossing machine	1
8-2 412234-000-19-0	Mask M20 Traffic light for road works	1
8-2 412235-000-19-0	Mask M21 Traffic lights	1
8-2 600001-000-10-0	Transparent folder, 410 mm x 320 mm x 10 mm	2
726 10	Panel frame T150, two-level	1*

Cat. No.	Description	E6.7.1.2
726 75	Three-phase supply unit with ELCB	1*
562 793NA	Power Adapter 6...24 V	1*
500 614	Safety connecting lead, 25 cm, black	30*
500 611	Safety connecting lead, 25 cm, red	3*
500 612	Safety connecting lead, 25 cm, blue	3*
500 59	Safety bridging plugs, black, set of 10	1*
500 591	Safety bridging plugs, yellow/green, set of 10	1*
773 072	Simatic PLC S7-1512C-1 PN TP	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

ASIMA for PLC – Basic

The System Simulator II (ASIMA) is optimally suited for operation with the SPC S7-1200 and S7-1512. 19 different applications (view summary table) are available in the basics setup. The broad experiment spectrum ranges from testing of SPC functions through to controlling small controllers and facilitates universal use of ASIMA in education.

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.

E6.7.1

PLANT SIMULATION

E6.7.1.3
ASIMA for PLC - Advanced
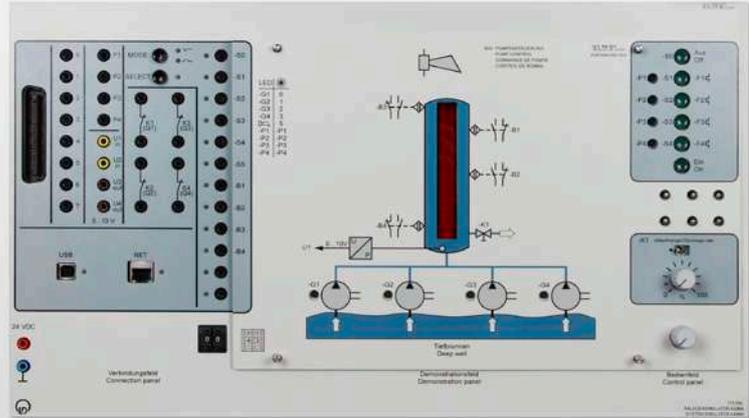
ASIMA for PLC - Advanced (E6.7.1.3)

Cat. No.	Description	E6.7.1.3
773 050	ASIMA Plant Simulator II	1
700 00CBT	DVD: COM3LAB Software	1
8-2 412123-000-10-0	50-pole ribbon cable, 700 mm	1
8-2 412215-000-19-0	Mask M1 Logic basic functions	1
8-2 412216-000-19-0	Mask M2 Digital function modules	1
8-2 412217-000-19-0	Mask M3 Motor ON/OFF	1
8-2 412218-000-19-0	Mask M4 Reversing contactor	1
8-2 412219-000-19-0	Mask M5 Star-delta connection	1
8-2 412220-000-19-0	Mask M6 Reversing star-delta connection	1
8-2 412221-000-19-0	Mask M7 Pendulum table control	1
8-2 412222-000-19-0	Mask M8 Dahlander circuit	1
8-2 412223-000-19-0	Mask M9 Motor with 2 windings	1
8-2 412224-000-19-0	Mask M10 Motor self-starter	1
8-2 412225-000-19-0	Mask M11 Conveyor belt system	1
8-2 412226-000-19-0	Mask M12 Reactive-current compensation	1
8-2 412227-000-19-0	Mask M13 Heating control	1
8-2 412228-000-19-0	Mask M14 Running light	1
8-2 412229-000-19-0	Mask M15 Tablets machine	1
8-2 412230-000-19-0	Mask M16 Tank system	1
8-2 412231-000-19-0	Mask M17 Coal grinder	1
8-2 412233-000-19-0	Mask M19 Fan control	1
8-2 412234-000-19-0	Mask M20 Traffic light for road works	1
8-2 412235-000-19-0	Mask M21 Traffic lights	1
8-2 412236-000-19-0	Mask M22 Collecting belt conveyor	1
8-2 412237-000-19-0	Mask M23 Conveyor charging system	1

Cat. No.	Description	E6.7.1.3
8-2 412232-000-19-0	Mask M18 Embossing machine	1
8-2 412240-000-19-0	Mask M40 Silo control	1
8-2 412241-000-19-0	Mask M41 Reactor	1
8-2 412242-000-19-0	Mask M42 Goods lift	1
8-2 412243-000-19-0	Mask M43 Pump control	1
8-2 412244-000-19-0	Mask M44 Dirty-water pump system	1
8-2 412245-000-19-0	Mask M45 Monitoring of 3 pumps	1
8-2 412246-000-19-0	Mask M46 Pump system (pressure)	1
8-2 412247-000-19-0	Mask M47 Drinks machine	1
8-2 412248-000-19-0	Mask M48 Mixer	1
8-2 412249-000-19-0	Mask M49 Sequence control	1
8-2 600001-000-10-0	Transparent folder, 410 mm x 320 mm x 10 mm	3
8-5 212642-000-10-0	LIT: Control of system simulations EN	1*
726 10	Panel frame T150, two-level	1*
726 75	Three-phase supply unit with ELCB	1*
562 793NA	Power Adapter 6...24 V	1*
500 59	Safety bridging plugs, black, set of 10	1*
773 075	Simatic PLC S7-1512C-1 PN +DP TP	1*
773 077	Simatic S7-1516 PN/DP TP	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended
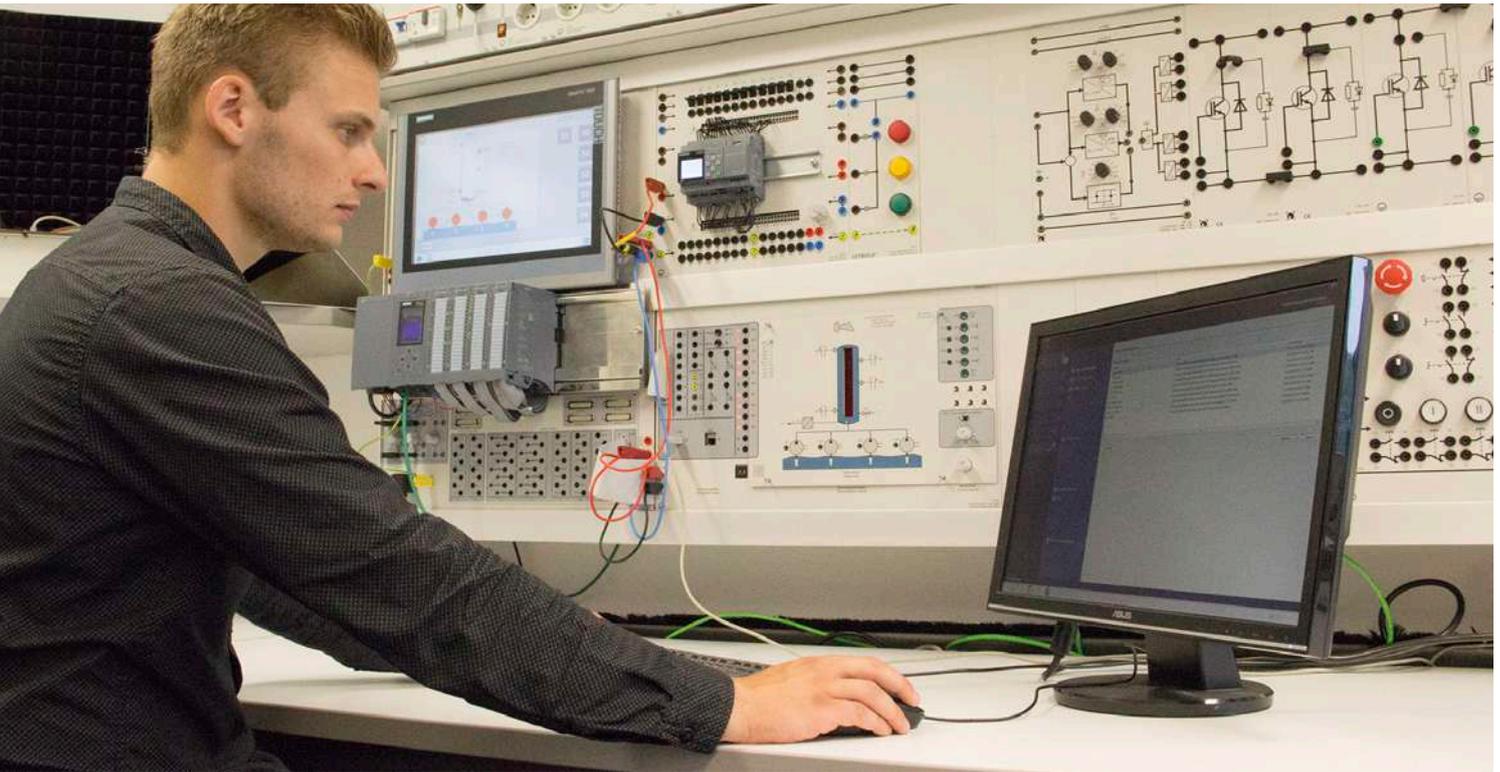
ASIMA for PLC – Advanced

ASIMA System Simulator II is the perfect addition for the SPC S7-1516. A total of 33 different systems are available. The experiment spectrum ranges from testing of SPC functions through to complex systems with controllers and facilitates universal use of ASIMA in education.

Educational objectives

- Programming simple basic circuits
- Programming machine circuits
- Programming small systems
- Programming of complex systems and devices

The set contains the basic device ASIMA System Simulator II, including a collection of tasks on CD. ASIMA is connected with the SPC via 4 mm safety connectors or a 50-pole ribbon cable (700 mm).

The following is made available:

- 12 digital inputs, 12 digital outputs
- 2 analogue inputs, 2 analogue outputs
- 4 relay with break contact
- Control and display elements:
- 6 buttons, 6 button incremental switch, 33 LEDs
- 2 potentimeter with 0 ... 10 V DC
- 1 bar graph display comprised of 24 segments

Method

The setup is designed for students and student experiments. Practical exercises require that the learner resolve the respective controller problem with their own programming. Suggested solutions are included as a file.

Target Group

Trainees studying industrial electro technology, focusing on automation engineering are the target group being addressed. The course offers experiments for beginners and intermediate learners for trade school and vocational training.

Basic knowledge of programming principles is a minimum requirement.

Topics

The topics are handled by placing different screens on the basic ASIMA device.

For example:

- Sewage pump system
- Monitoring of 3 pumps
- Pump system (pressure)
- Beverage vending machine
- Mixing system
- Sequential control
- etc.

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.

E6.7.1

PLANT SIMULATION

E6.7.1.4
Small Models &
Software Models
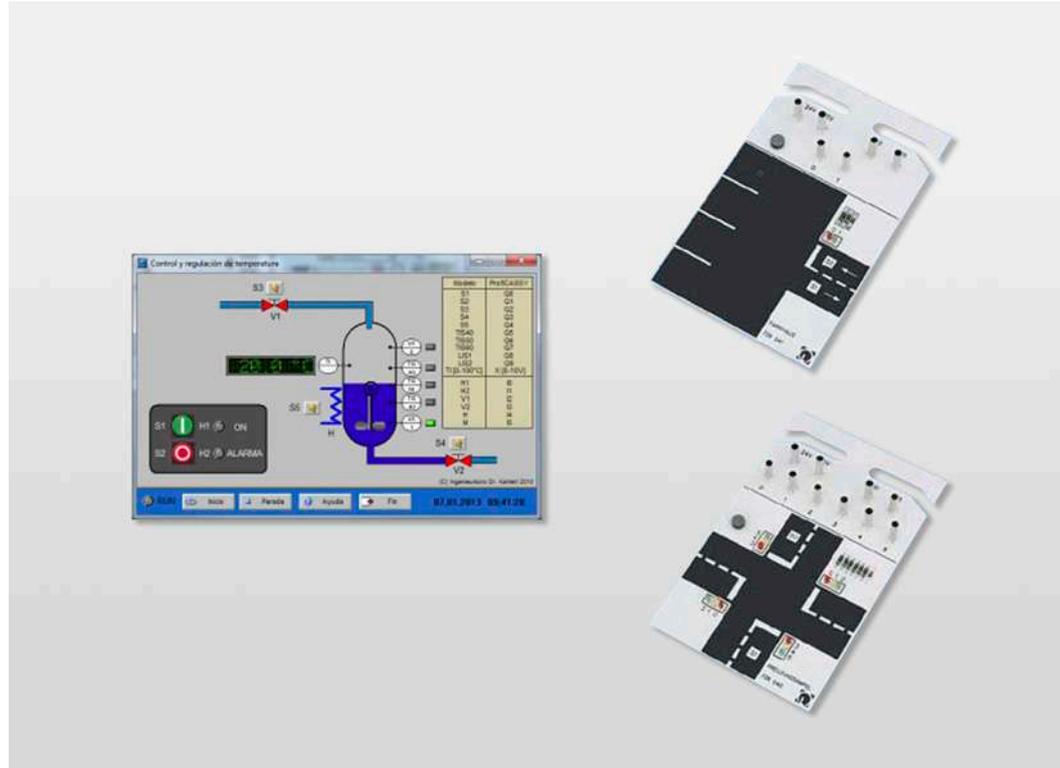
Small Models & Software Models (E6.7.1.4)

Cat. No.	Description	E6.7.1.4
728 740	Traffic Light Crossing, TM	1
728 741	Car Park, TM	1
728 871	Software: 5 Modells CBS 9 (single user)	1
730 431	Profibus Connection Cable	1
571 26	Adapter leads, 2/4 mm, 30 cm, blue, set of 5	2
524 016	Profi-CASSY	1
773 091	Simatic Step 7 Prof. Training 1x	1*
500 621	Safety connecting lead, 50 cm, red	2*
500 622	Safety connecting lead, 50 cm, blue	2*
773 075	Simatic PLC S7-1512C-1 PN +DP TP	1*
773 077	Simatic S7-1516 PN/DP TP	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Small Models & Software Models

The set works with SPC or small controllers. The processes to be controlled are real small models or software models. The software models are connected via the Profi-CASSY interface. When connected with the software models, the Profi-CASSY becomes a universal system simulator connected to the SPC via a PROCESS FIELD BUS or ribbon cable and to the PC via a USB. This means the PC has over 16 digital and 2 analogue inputs and outputs. There are process simulations for various systems that can be easily installed on the PC as software.

Educational objectives
• Operating the SPC
• Creating programs
• Connection of hardware and optimisation of the program using the model

Small models
• Crosswalk light
• Parking garage

Software models
• Motor control
• Traffic light control
• Fill level control
• Service lift
• Stamp setup

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.

E6.7.1

PLANT SIMULATION

E6.7.1.5
End Position &
Speed Control

End Position & Speed Control (E6.7.1.5)

Cat. No.	Description	E6.7.1.5
730 90	Gear w.2 Switch Arms 0.1/0.3	1
730 93	Limit Switch 1NO 1NC	1
730 95	Ind. Proximity Switch 3-DC	1
730 971	Cap. Proximity Switch	1
730 002	Operating panel	1
731 06	Coupling 0.3	1
731 081	Coupling guard 0.3 transparent	1
732 46	Motor with FCC 0.3	1
735 315USB	USB/RS 485 interface converter	1
730 431	Profibus Connection Cable	1
726 75	Three-phase supply unit with ELCB	1*
562 793NA	Power Adapter 6...24 V	1*
726 10	Panel frame T150, two-level	1*
500 59	Safety bridging plugs, black, set of 10	1*
500 640	Safety connecting lead, 100 cm, yellow/green	2*
500 644	Safety connecting lead, 100 cm, black	11*
773 075	Simatic PLC S7-1512C-1 PN +DP TP	1*
773 077	Simatic S7-1516 PN/DP TP	1*
	PC with operating system Windows 7/8/10	1

* additionally recommended

End Position & Speed Control

End positions are extreme positions that a moving workpiece can take up in a machine (electric window lifter, travelling cranes of building cranes, tool machines, etc.). In order to prevent hazards to people and machines, end positions and rotation speeds must be monitored. If the allowable limit values are exceeded, the processes are stopped by an end position switch or directly by the frequency converter.

Educational objectives
- Operating the SPC
- Connection of frequency converter to an SPC and optimisation of the program on the real system.
- Function review
- Creation of programs for machine controllers with frequency converters.
- Startup, rotation direction modification, ramp function, optimisation of SPC and frequency converter.
- Testing the programs on the hardware

Topics
- Program startup processes
- Automatic rotation direction change with frequency converters.
- Counting of revolutions during machine processes.
- etc.

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.

E6.7.2

MECHATRONICS

E6.7.2.1
MCS with PLC for 3 Stations

E6.7.2.2
MCS with PLC for 5 Stations

MCS with PLC for 5 Stations (E6.7.2.2)

Cat. No.	Description	E6.7.2.1	E6.7.2.2
8-2 412352-000-10-0	Module FMPE: Gravity-feed Magazine with testing device	1	1
8-2 412353-000-10-0	Module SU: Swivelling Object-Transfer Device	1	1
8-2 412361-000-10-0	Module LAG03: Storage Depot with 3 stacks	1	
8-2 412357-000-10-0	Control Console BP	1	1
8-2 412362-000-10-0	Manual Service Unit	1	1
8-2 412358-000-10-0	Assortment of Small Parts and Tools	1	1
8-1 530025-000-10-0	Polyamide hose, 6/4 mm, transparent, 20 m	1	1
8-2 412470-100-10-1	Power supply 24 V DC, 6.5 A, for 230 V AC	1	
744 902	Compressor Connection Hosing	1	1
744 600	Low-noise Compressor	1	1
500 59	Safety bridging plugs, black, set of 10	1	1
500 851	Safety connecting leads, 32 A, set of 32	1	1
500 852	Safety connecting leads, 32 A, yellow/green, set of 10	1	1
726 10	Panel frame T150, two-level	1	1
773 077	Simatic S7-1516 PN/DP TP	1*	1*
8-2 412374-000-10-0	STEP7 application software for MCS CD	1*	
8-2 412354-000-10-0	Module MA: Measurer / Counter, analog		1
8-2 412366-000-10-0	Module PPF02: Pick and Place, pneumatic, 2 positions		1
8-2 412355-000-10-0	Module SORT03: Sorting Station		1
8-2 412991-000-10-1	ET200S-Profibus module for two MCS-models, 4 mm safety sockets		1
730 4312	PROFIBUS cable		2

| Cat. No.	Description	E6.7.2.1	E6.7.2.2
730 4313	Bus connecting plug RS 485		2
	additionally required: 1 PC with Windows 7/8/10		

additionally recommended

Mechatronic Compact System

The MCS (Mechatronic Compact System) is comprised of three individual systems, each with a basic mechatronic function. Connecting the systems determines the interaction of mechanics, pneumatics, electronics and SPC programming.

Topics

• Programs for process control
• Creation of sequential controls
• Differentiation of manual and automatic functions in programs.
• Plans for driving pneumatic valves.
• Collision-proof provision on a tray
• Micro switch for position recognition
• etc.

Experiments require the Siemens software TIA Portal to create programs.

The equipment can require additional software modules.
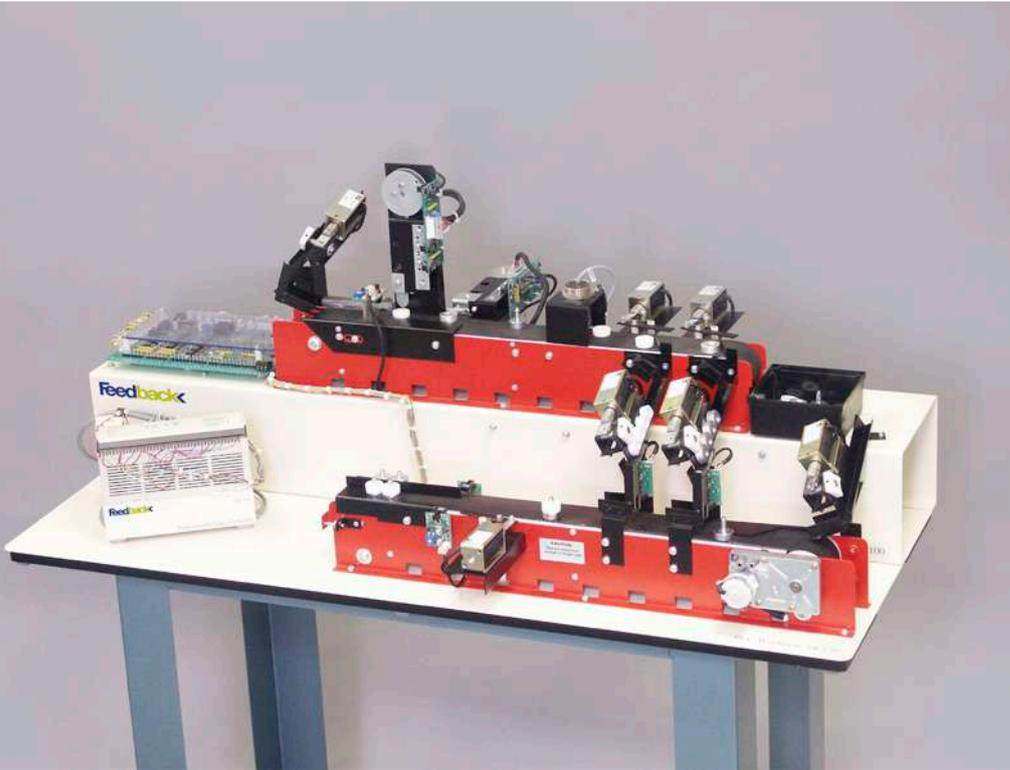
E6.7.2

MECHATRONICS

E6.7.2.3
Dual Conveyor Band with PLC

Dual Conveyor Band with PLC (E6.7.2.3)

Cat. No.	Description	E6.7.2.3
34-120-1	Dual Conveyor - PLC Application	1
34-060	Siemens PLC	1*
34-060-1	Siemens PLC I/O Pre-wired Pack	1
34-020	Mitsubishi PLC	1*
34-020-1	Mitsubishi PLC I/O Pre-wired Pack	1*
34-040	Allen Bradley PLC	1*
34-040-1	Allen Bradley PLC I/O Pre-wired Pack	1*
34-110	Diameter Gauging Unit	1*
	additionally required: 1 PC with Windows 7/8/10	

* alternative PLC

Dual Conveyor Band with PLC

Programmable Logic Controllers (PLCs) are used extensively in many manufacturing processes and control applications being readily programmed and reprogrammed when variations in the controlled process are required. This dual conveyor system allows greater study of PLCs in process control systems. More complex control scenarios can be developed using combinations of timers and counters with master and zone control functions. The self-contained unit comprises a power supply, interface board and a range of sensors and solenoid actuators and a height gauging unit. The interface circuits allow the conveyor system to be operated from any standard industrial PLC using 24 V dc logic levels.

Educational objectives
- Two complex conveying systems can be used to process complex tasks.
- Parts selection by means of logic detection and sensors.
- Test and optimize programming on a hardware

Topics
- Logic fundamentals
- Basics of PLC programming
- Developing ladder logic programs
- Programming timers
- etc.

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.

E6.7.2

MECHATRONICS

E6.7.2.4
Elevator Control with PLC

Elevator Control with PLC (E6.7.2.4)

Cat. No.	Description	E6.7.2.4
34-150-1	Elevator - PLC Application	1
34-060	Siemens PLC	1*
34-060-1	Siemens PLC I/O Pre-wired Pack	1
34-020	Mitsubishi PLC	1*
34-020-1	Mitsubishi PLC I/O Pre-wired Pack	1*
34-040	Allen Bradley PLC	1*
34-040-1	Allen Bradley PLC I/O Pre-wired Pack	1*
	additionally required: 1 PC with Windows 7/8/10	

* alternative PLC

Elevator control with PLC

Programmable Logic Controllers (PLCs) are used extensively in many manufacturing processes and control applications being readily programmed and reprogrammed when variations in the controlled process are required. This elevator illustrates the principles of PLC interfacing & control based on a real-life and easily identified application, therefore providing excellent interest for students. Starting with simple program sequences to control elevator speed, direction and floor arrival/departure, the student can progress to advanced floor request handling and continuous (analogue) control with acceleration profiling and compensation for varying car loads. The internal motor speed controller has both logic and analogue interfaces such that a basic PLC with minimal digital I/O can be used to implement control. More sophisticated control may be developed if analogue I/O is available. The load-cell and motor position feedback signals are available to develop programs for continuous control. The load-cell indicates elevator car loading and a set of weights simulates varying numbers of car occupants. The position feedback signal allows for the development possibility of advanced control of the elevator car motion.

Function
- Fully working model of an elevator with 4 floors
- Floor sensing and visual indication of travel
- Motorised elevator car door
- Brake to hold car at desired floor
- Up/down call button at each floor
- Front panel manual switch for testing
- etc.

Topics
- Logic fundamentals
- Basics of PLC programming
- Developing ladder logic programmes
- Basic sequencer control
- Advanced sequence control
- etc.

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.

Washing machine – PLC application (E6.7.2.5)

E6.7.2

MECHATRONICS

E6.7.2.5
Washing machine
– PLC application
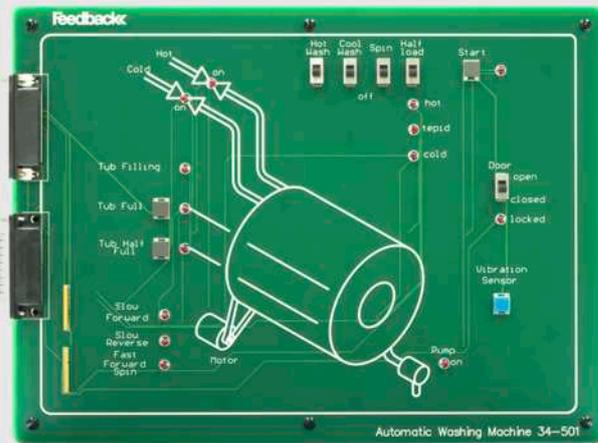
Cat. No.	Description	E6.7.2.5
34-501	Washing Machine - PLC Application	1
34-060	Siemens PLC	1*
34-060-1	Siemens PLC I/O Pre-wired Pack	1
34-020	Mitsubishi PLC	1*
34-020-1	Mitsubishi PLC I/O Pre-wired Pack	1*
34-040	Allen Bradley PLC	1*
34-040-1	Allen Bradley PLC I/O Pre-wired Pack	1*
	additionally required: 1 PC with Windows 7/8/10	

* * alternative PLC*

Washing Machine – PLC Application

In this washing machine PLC application initial program conditions can be set by switched selection. This allows the development of several different programs that can be used as conditional jumps; depending on how the initial conditions have been set. Using push-button switches to simulate interrupt conditions, such as unbalanced drum load, more complex control problems can be developed.

Function

- Real-life application
- Demonstrates sequential control
- Initial process conditions can be set
- Demonstrates to use of interrupts
- Low cost PLC application
- Used with the major PLC types
- Pre-wired or „wire your own" Mitsubishi, Allen Bradley & Siemens PLCs available (supplied separately) or use your own

Topics

- Logic fundamentals
- Basics of PLC programming
- Developing ladder logic programs
- Programming timers

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.

E6.7.2

MECHATRONICS

E6.7.2.6
Traffic light
– PLC application
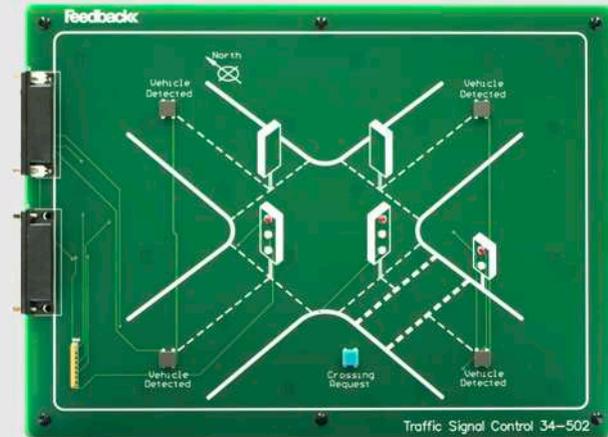
Traffic light – PLC application (E6.7.2.6)

Cat. No.	Description	E6.7.2.6
34–502	Traffic Lights – PLC Application	1
34–060	Siemens PLC	1*
34–060–1	Siemens PLC I/O Pre-wired Pack	1
34–020	Mitsubishi PLC	1*
34–020–1	Mitsubishi PLC I/O Pre-wired Pack	1*
34–040–1	Allen Bradley PLC I/O Pre-wired Pack	1*
	additionally required: 1 PC with Windows 7/8/10	

* alternative PLC

Traffic Lights – PLC Application

This simple sequence PLC application allows traffic light control of a cross-road to be implemented on a timed sequence basis. The control program can be further developed to cope with interrupts generated from pedestrian crossing requests or off-peak vehicle detector inputs.

Function
• Real-life application
• Timed sequence control
• Interrupt device control
• Easy to understand process
• Low cost application
• Operates with major PLC types
• Pre-wired or „wire your own" Mitsubishi, Allen Bradley & Siemens PLCs available (supplied separately) or use your own

Topics
• Programming counters
• Setting initial conditions
• Time-based process control
• Use of interrupts & emergency stop

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.
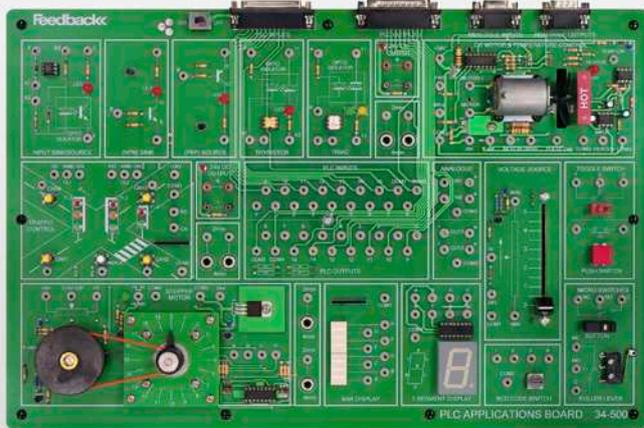
E6.7.2

MECHATRONICS

E6.7.2.7
PLC Trainer

PLC Trainer (E6.7.2.7)

Cat. No.	Description	E6.7.2.7
34-500	PLC Trainer	1
34-060	Siemens PLC	1*
34-060-1	Siemens PLC I/O Pre-wired Pack	1
34-020	Mitsubishi PLC	1*
34-020-1	Mitsubishi PLC I/O Pre-wired Pack	1*
34-040	Allen Bradley PLC	1*
34-040-1	Allen Bradley PLC I/O Pre-wired Pack	1*
	additionally required: 1 PC with Windows 7/8/10	

* alternative PLC

PLC Trainer

The Feedback PLC Trainer offers the training required to understand and apply both PLC hardware and software programming through the structured students' manual that provides a progressive level of learning. The manual deals with the fundamentals of PLC hardware and software through to basic program writing and more advanced applications, finally to motor control. The PLC Trainer is an A3 size board that is divided into many individual smaller areas.

Function
- Complete integrated range
- Plug and play with cabled system
- Traffic light control
- Stepper motor
- Micro-switches
- Pre-wired or „wire your own" Mitsubishi, Allen Bradley & Siemens PLCs available (supplied separately) or use your own
- etc.

Topics
- Stepper motor positioning to a desired point & home position
- Stepper motor device sequencing with counter & display
- DC motor speed PWM control
- etc.

Experiments require the Siemens software TIA Portal to create programs.
The equipment can require additional software modules.

E6.7.3

CHEMICAL PROCESS ENGINEERING

E6.7.3.1
Blue-Bottle Process with PLC

Blue-Bottle Process with PLC (E6.7.3.1)

Cat. No.	Description	E6.7.3.1
524 013	Sensor-CASSY 2	1
524 220	CASSY Lab 2	1
524 069	Immersion photometer S	1
666 425	Panel frame C50, two-level, for CPS	1
666 438	Woulff's bottle with manometer, CPS	1
667 3095	Screw cap, GL 45, with hole	1
667 3107	Silicone seal GL 45/26, 10 pcs	1
666 482	Aeration pump, controllable, CPS	1
501 44	Connecting leads, 19 A, 25 cm, red/blue, pair	1
667 7977	Electronic Balance 440-3N, 200 g : 0.01 g	1
664 157	Watch glass dish, 125 mm diam.	2
666 966	Spoon-ended spatula, PP, 180 mm	2
666 003	Pipetting ball (Peleus ball)	1
665 996	Graduated pipette, 5 ml	1
665 756	Measuring cylinder, 500 ml, with plastic base	1
604 501	PVC tubing, 7 mm diam., 1 m	1
604 460	Hose clamp, 8...12 mm	1
602 347	Laboratory bottle, 500 ml, GL 45 thread	1
673 2920	Methylene blue solution, 100 ml	1
673 6800	Sodium hydroxide, pellets, 100 g	1
672 1100	D(+)-Glucose, 100 g	1
675 3400	Water, pure, 1 l	1
500 441	Connecting lead 19 A, 100 cm, red	8
500 442	Connecting lead 19 A, 100 cm, blue	8
773 072	Simatic PLC S7-1512C-1 PN TP	1*

Cat. No.	Description	E6.7.3.1
773 075	Simatic PLC S7-1512C-1 PN +DP TP	1*
773 077	Simatic S7-1516 PN/DP TP	1*
	additionally required: 1 PC with Windows 7/8/10	

* additionally recommended

Blue-Bottle Process with PLC

The student learns to monitor and control a real chemical process in chemical engineering with a clear reaction.

Educational objectives

- Control and optimisation of a redox process
- Experimental transfer of the process into a controller
- Operation of an SPC and optimisation of the program for a real system.
- Function review

Topics

- Basics of SPC programming.
- Optimisation of process systems
- Controlling processes

Experiments are operated and evaluated with CASSY Lab 2.

E6.8 HYDRAULICS

E6.8.1

DIDACTICAL HYDRAULICS

E6.8.1.1
Complete Set

E6.8.1.2
Basic Set
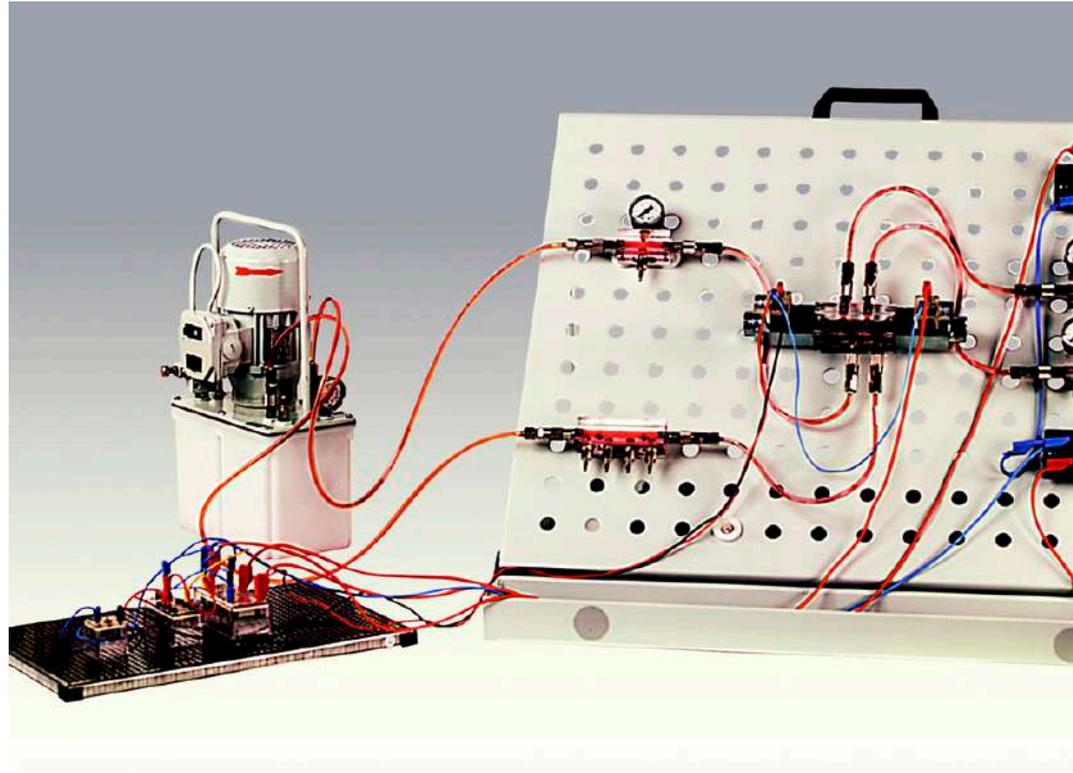
Complete Set (E6.8.1.1)

Cat. No.	Description	E6.8.1.1	E6.8.1.2
500 422	Connecting lead 19 A, 50 cm, blue	3	
500 441	Connecting lead 19 A, 100 cm, red	10	
500 442	Connecting lead 19 A, 100 cm, blue	10	
562 793NA	Power Adapter 6...24 V	1	
8-5 336022-000-10-0	LIT: Experiments electro-hydraulics with transparent components	1	
8-2 236023-000-10-0	KSS 4/2-way valve, solenoid operated	1	
8-2 236025-000-10-0	KSS 4/3-way valve, solenoid operated	1	
8-2 236029-000-10-0	KSS Pressure switch with connection cable	1	
8-2 237081-000-10-0	Limit switch with idle return roller,	1	
8-2 632057-000-10-0	Electro-power adapter, 2 sockets, yellow LED	1	
8-2 636005-100-10-0	Hydraulic power unit 8/1.0 for plexiglass units	1	1
8-2 436001-000-10-0	Hydraulics training case	1	1
8-2 632005-000-10-0	Set of plastic adapters, 25 pieces	2	2
8-2 636003-000-10-0	Transparent tube with self-locking / quick release couplings 520 mm	11	11
8-2 636004-000-10-0	Transparent Tube with self-locking / quick release couplings 350 mm	4	4
8-2 636008-000-10-0	Transparent tube with self-locking / quick release couplings 1000 mm	3	2
8-2 636016-000-10-0	6-l canister with red hydraulic oil for refilling	1	1
8-2 236038-000-10-0	KSS Double acting cylinder, stroke 100 mm	1	1
8-2 236002-000-10-0	KSS Check valve	1	1
8-2 236003-000-10-0	KSS Pressure relief valve, (poppet valve)	1	1

Cat. No.	Description	E6.8.1.1	E6.8.1.2
8-2 236004-000-10-0	KS 4/2-way valve, manually operated	1	1
8-2 236005-000-10-0	KSS Throttle valve	1	1
8-2 236006-000-10-0	KSS Manometer, 0 ... 10 bar	3	3
8-2 236007-000-10-0	KSS Distributor, 6-way	2	2
8-2 236020-000-10-0	KSS Differential-pressure valve	1	1
8-5 336002-000-10-0	LIT: Experiments hydraulics with transparent components	1	1
8-2 236009-000-10-0	KSS cylinder, single-acting	1	
8-2 236008-000-10-0	KSS Pressure relief valve (piston type valve)	1	
8-2 236010-000-10-0	KSS Pressure reducing valve, direct operated	1	
8-2 236011-000-10-0	KSS throttle check valve, manually operated	1	
8-2 236013-000-10-0	KSS Check valve, piloted	1	
8-2 236015-000-10-0	KSS Flow control valve, 2-way	1	
8-2 236012-000-10-0	KSS Shut-off valve	1	
8-2 236014-000-10-0	KSS/KS Distributor, 4-way	1	
578 51	Diode, 1N 4007, STE 2/19	4	
578 42	Capacitor (electrolytic), 1000 μF, STE 2/50	6	
579 06	Lamp holder, E10, top, STE 2/19	3	
8-5 950240-300-10-0	Incandescent lamp E 10, 24 V, 80 mA, 1.9 W	3	
649 43	Tray, 552 mm x 284 mm x 48 mm	1	
576 74	Plug-in board, DIN A4, STE	1	
500 401	Connecting lead, 19 A, 10 cm, red	14	
500 404	Connecting lead, 19 A, 10 cm, black	13	
500 402	Connecting lead, 19A, 10 cm, blue	5	
500 411	Connecting lead, 19 A, 25 cm, red	6	

Basic Set (E6.8.1.2)

Cat. No.	Description	E6.8.1.1	E6.8.1.2
500 414	Connecting lead, 19 A, 25 cm, black	27	
500 412	Connecting lead, 19 A, 25 cm, blue	3	
500 421	Connecting lead 19 A, 50 cm, red	3	
500 424	Connecting lead 19 A, 50 cm, black	6	

Didactic Hydraulics

Hydraulic elements from ELWE Technik are operated with red-coloured hydraulic oil. The white base plate further heightens the contrast. A maximum operational pressure of 10 bar (1 MPa) facilitates safe experimentation. The transparent connecting hoses and introduced air bubbles allow learners to fully follow the flow paths: from pressure connection of the pump through to the tank connection.

The learning system conveys the fundamentals of hydraulic systems on three levels. The electro-hydraulics are designed for a safe 24 V of direct current. This makes it possible to put together even simple controllers with LOGO! and SPC.

Educational objectives
- Basics of hydraulics
- Hydraulic components with special functions
- Basic hydraulic circuits

Topics
- Hydraulic unit
- Pressure limit
- Directional valve
- Cylinder
- Current regulating valve
- Pressure regulating valve
- Variables for a valve operation magnet
- Signal storage through electric catch

E6.8.1

DIDACTICAL HYDRAULICS

E6.8.1.3
Supplement Set

E6.8.1.4
Education hydraulic,
electro-hydraulics
supplement Set

Education hydraulic, electro-hydraulics supplement Set (E6.8.1.3)

Cat. No.	Description	E6.8.1.3	E6.8.1.4
8-2 236009-000-10-0	KSS cylinder, single-acting	1	
8-2 236008-000-10-0	KSS Pressure relief valve (piston type valve)	1	
8-2 236010-000-10-0	KSS Pressure reducing valve, direct operated	1	
8-2 236011-000-10-0	KSS throttle check valve, manually operated	1	
8-2 236013-000-10-0	KSS Check valve, piloted	1	
8-2 236015-000-10-0	KSS Flow control valve, 2-way	1	
8-2 236012-000-10-0	KSS Shut-off valve	1	
8-2 236014-000-10-0	KSS/KS Distributor, 4-way	1	
8-2 236023-000-10-0	KSS 4/2-way valve,solenoid operated		1
8-2 236025-000-10-0	KSS 4/3-way valve, solenoid operated		1
8-2 236029-000-10-0	KSS Pressure switch with connection cable		1
8-2 237081-000-10-0	Limit switch with idle return roller,		2
8-2 632057-000-10-0	Electro-power adapter, 2 sockets, yellow LED		3

Supplement Set
The *equipment E6.8.1.3* is part of the *complete system E6.8.1.1*. As a system, it offers the expansion modules of the manually operated hydraulics for the basic equipment.

Education hydraulic, electro-hydraulics supplement Set
The *equipment E6.8.1.4* is part of the *complete system E6.8.1.1*. As a system, it offers the expansion modules of the electro-actuated hydraulics for the basic equipment set.

Educational objectives
• Hydraulic components with special functions

E6.9 AUTOMATION SYSTEMS FOR INDUSTRY 4.0

The changes in society and the economy as a result of digitisation will dramatically affect the professional environment in many areas.

Education and training in particular are called to offer training concepts that enable trainees and skilled workers to actively follow and drive this progress. With the production system 4.0i, LD DIDACTIC offers the perfect experimental teaching and learning environment for such a concept.

A system along the production chain can perfectly illustrate the following topics within the scope of education and training:

- Material feed
- Process integration
- Process optimisation
- Service & maintenance
- Warehousing & logistics

The possibilities of digitisation will change entire corporate structures and result in completely new work requirements. Using the new production system 4.0i, this can be explained, tested, experienced and practised hands on.

PRODUCTION SYSTEM 4.0i

The modular production system has been developed for applied teaching of Industry 4.0. The system, consisting of three individual stations, focuses on the assembly of dice, from the removal from a magazine to processing and warehousing. Not only is the production system fully networked and programmable via bus systems, it also impresses with a comprehensive safety concept.

As a 3.0 system, the entire system is delivered fully assembled, installed and programmed. The 4.0 system is the expansion of this industry concept and is part of the training. (Description included with the documentation supplied.)

FUTURE-PROOF TRAINING WITH TRAINING SYSTEMS

The modular training units are a special feature of the production system 4.0i. They are precisely matched to the qualification levels of industrial and educational institutions. It covers everything around pneumatic and automation, to learn and understand all industry-relevant technologies and processes.

EXPERIENCE PRACTICE WITH SERIES COMPONENTS

This training system of mechatronics teaches

- The system is fully assembled, configured and programmed without the 4.0i extension.

- Upgrading an existing system is part of the teaching content.

- Beginners and advanced learners will gain in-depth and practical knowledge, based on industrial series components.

- Industrial controls with internationally standardised programming languages and open interfaces are ready for Industry 4.0 technology, such as Open Core Engineering.

- The production system 4.0i is a modular system that can be selected from individual assemblies, from work stations to the entire system.

PRODUCTION SYSTEM 4.0i
774 490

Would you like more informations or/and an individual offer for this product? Then send us an e-mail:

sales@ld-didactic.de

Concepted for
Industry

4.0 i

The modular production system 4.0i consists of three flexibly interchange-able and expandable stations: *Magazine, processing & warehousing* for implementation of a complete automation process.

YOUR BENEFITS WITH PRODUCTION SYSTEM 4.0i:

Original series components from the industry

- DC motors
- Servomotors
- Control technology: relays, PLC, motion control, CNC
- Linear technology
- Pneumatic drives
- Sensors and RFID
- Cartesian robot or 3-axis CNC
- Standard machine control panel
- Fieldbus and Ethernet communication

MODULAR, SCALABLE TRAINING SYSTEM – FROM SINGLE ASSEMBLIES TO THE COMPLETE SYSTEM

Industry 4.0 integrate

- HMI – Human Machine Interface
- RFID – Radio Frequency Identification

Various programming

- PLC programming (in accordance with IEC 61131-3):
  - Instruction list (IL)
  - Structured text (ST)
  - Sequential function chart (SFC)
  - Function block diagram (FBD)
  - Ladder diagram (LD)
  - Continuous function chart editor (CFC)

- Open Core Engineering
  offers more programming options
  - Java (APP)
  - C/C++
  - C#
  - Microsoft Excel, Powerpoint
  - MATLAB™/SIMULINK®
  - and more

Other Benefits

- Optional operation with smart devices over WiFi, such as tablet, smart phone, etc.
- The conversion of a conventionally controlled part system into a CNC-controlled system is possible without hardware modifications. It merely requires adaptation of the firmware and programs. Free CNC software supports programming
- Optional expansion with different PLC systems

TECHNICAL AFTER-SALES SERVICE

You may have a technical question on one of our devices or pieces of equipment.
Our service team is available by telephone at +49 2233 604-430 and
by e-mail at service@ld-didactic.de.

SPARE PARTS SERVICE

You can naturally order replacement parts for your equipment.

REPAIR SERVICE

If, despite our demanding quality standards, you should find a fault in your LEYBOLD product, we will naturally repair it as soon as possible. If you still cannot make the equipment work as intended after calling our technical service, you can find help quickly and easily through our „on-site service". Our service technicians come to you, to find the appropriate technical solution on site. Alternatively, you can of course also send your device for repair by post.

REPAIR GUARANTEE FOR A MINIMUM OF 10 YEARS

Our products stand for high quality and durability. If your device should become faulty even many years after purchase, generally we will still be able to repair it. We guarantee the repair of all our devices for 10 years from the date of purchase – and for much of our products, for much longer.

PHYSICS

CHEMISTRY
BIOLOGY

ENGINEERING

**LD DIDACTIC**

S.A.R.L.

**SYSTEMES
DIDACTIQUES**

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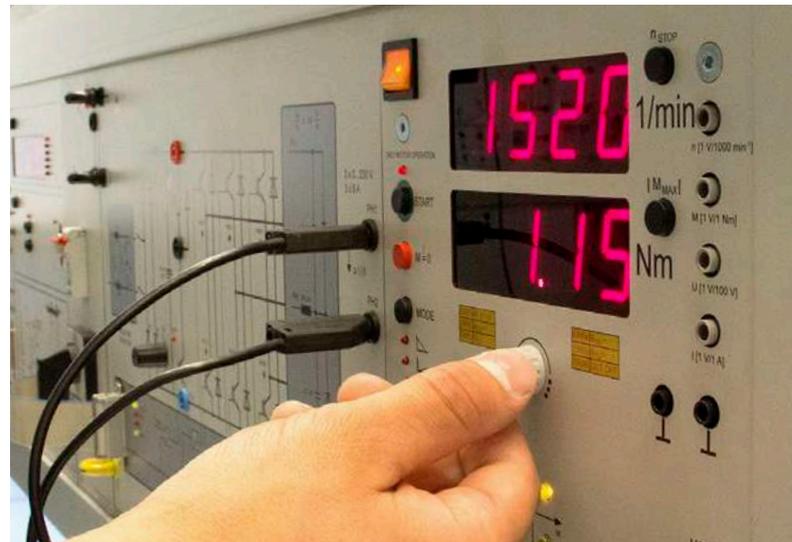
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