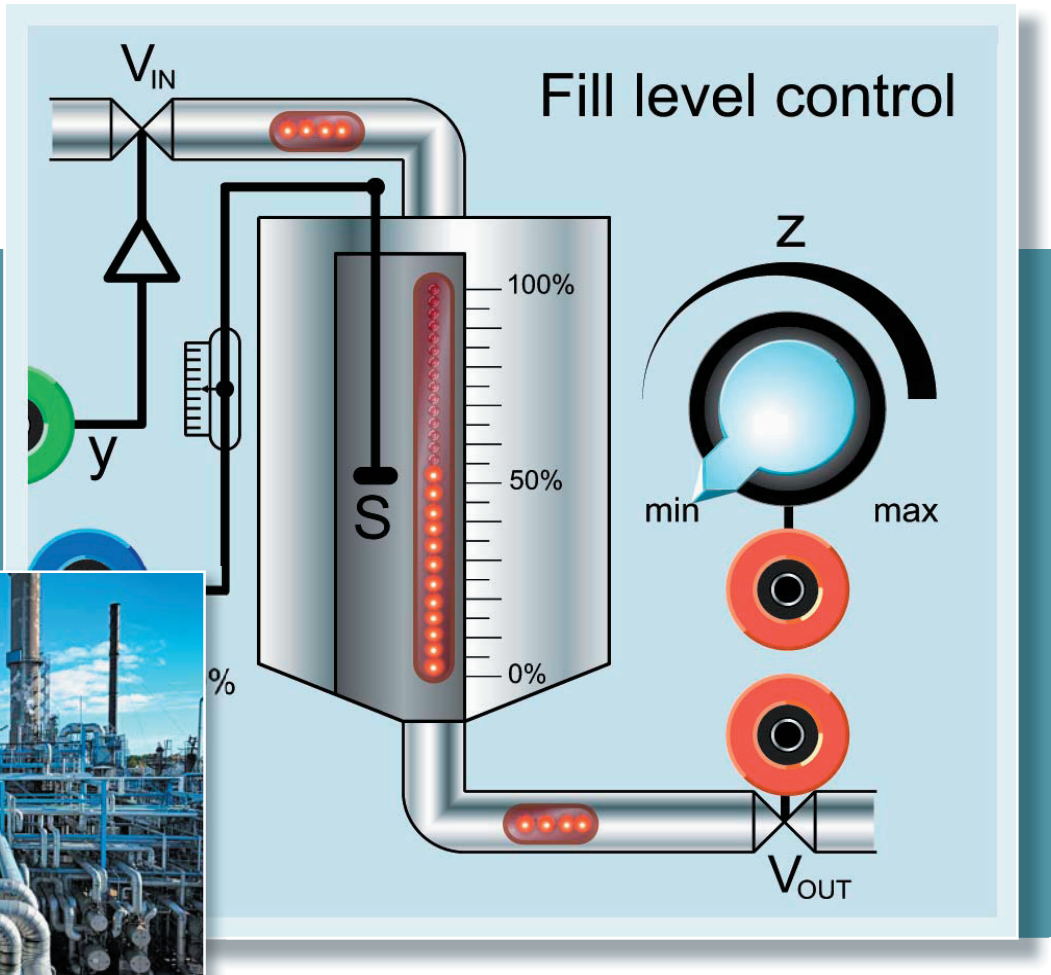
DIDACTIC GMBH
ELABO Training Systems

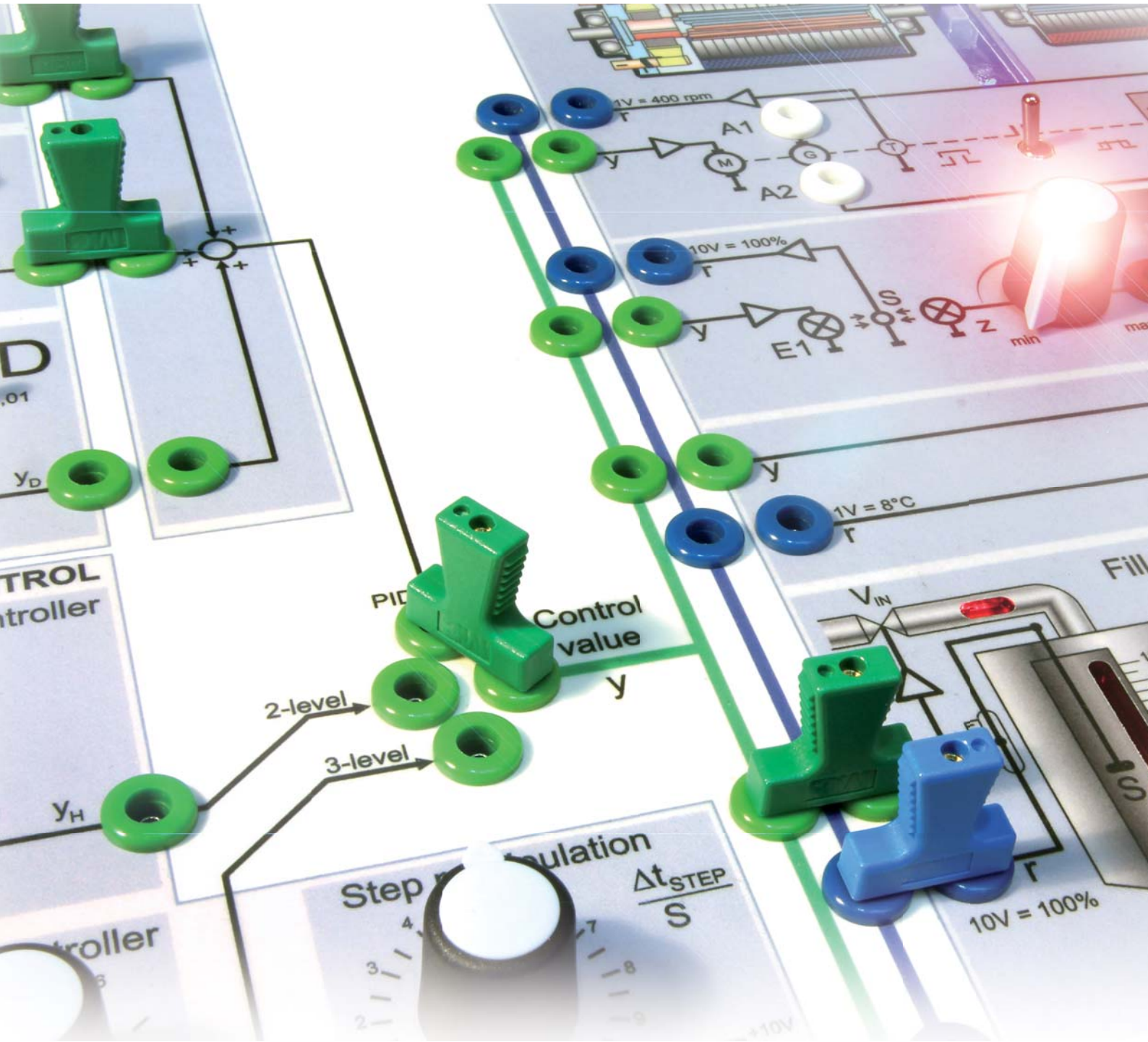


Control Engineering

Made in Germany

OPEN LOOP AND CLOSED LOOP CONTROL

Combine theory and practice with ELABO***TrainingsSysteme***



ELABO TrainingsSysteme

HARDWARE

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COURSEWARE

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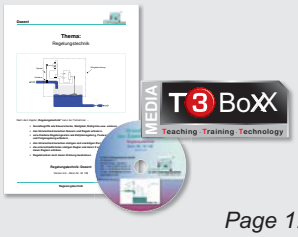

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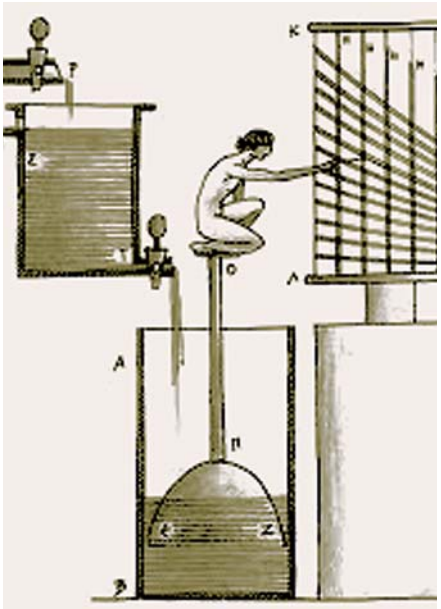
TODAY, NO MATTER WHERE WE ARE...

... we make use of some form of control techniques. Examples for this are the temperature reg charging regulator in a hybrid or electro vehicle.

IN the industrial area the applications are even more varied, such as the regulation of filling levels, temperature, speed and position regulation. Humanity uses the principles of control engineering since her early cultures. So Ctesibios, the Greek technician, inventor and mathematician, described the principle of a fill level control for a water clock about 300 years before Christ .

The era of the modern control engineering began with the development of a governor for regulating the speed of steam-driven engines. This was really the first technical control equipment to be manufactured as a series production. Since then, it is almost impossible to imagine any area of technical equipment that does not include some form of control or regulating system.

However, regulation without technology has always been a fixed part of our life.



Water clock made by Ctesibios

Consider for example, the body movements such as gripping, running or even standing upright; all these cannot function without some sort of control. Here, the human senses act as sensors, the brain is the controller and the muscles are the actuators. This functions so well that even today, a human being is undeniably an ideal form of “universal controller” in many technical processes, whereby, the principle of the regulation is qualitatively easy to imagine: Processes or events that are influenced by unexpected external interference, must be continuously checked and any deviation from the setpoint state, must be corrected accordingly.

In the area of trade training, the subject of control engineering also plays a significant role, as an important part of automation technology, supplemented by electrical engineering and mechatronics.

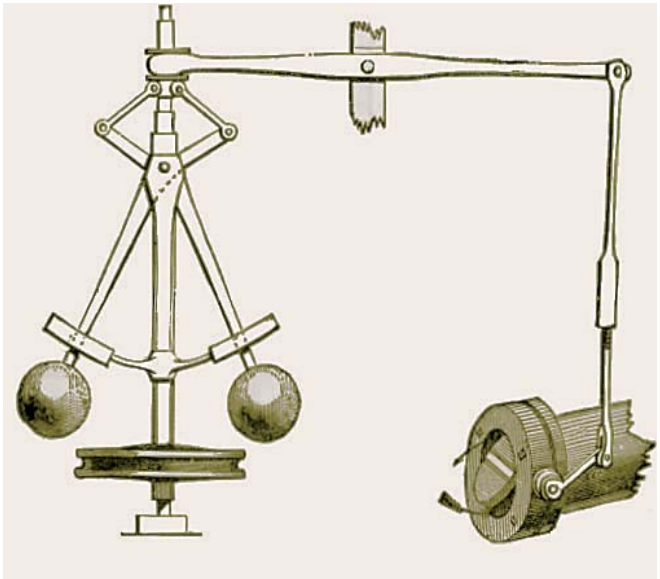
The training in this area is modelled by a methodical foundation created over the past decades. However, it must be continuously modified and expanded with sensible,

ulation for the central heating, the automatic exposure timing in a camera or the battery

effective laboratory equipment with which the theory learnt can be tested in a variety of practical exercises. The competence of skilled workers, technicians and engineers can only be improved by practical training.

The close orientation of the knowledge gained to practical application and how interesting the subject is made, depends very strongly on the concepts and functionality of the laboratory equipment.

And exactly here, with its concept of the laboratory equipment, the ELABO***TrainingsSysteme*** company sets new standards with the “Process Control Board”. In particular, when in spite of restricted time available, qualitatively high-quality training is to be practised.



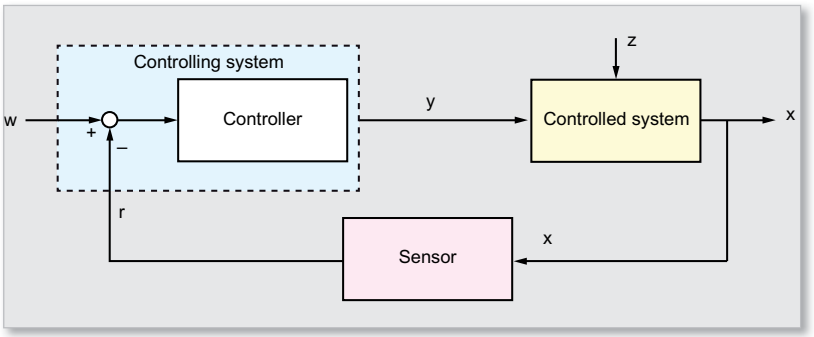
Centrifugal governor made by Watt

With the “Process Control Board”, ELABO***TrainingsSysteme*** has consciously placed emphasis on fundamental principles. The Board is ‚budget-friendly‘, interesting to use and above all practice-oriented and with respect to the system responses, oriented towards the training handbooks.

Whereas with other methods, technical regulation exercises required an extensive equipment assembly and interconnections, all measurement, test and control system components are integrated on the “Process Control Board”. Connections for these components use standard 2mm bridging plugs (‚jumpers‘). The board is supplemented by comprehensive courseware. So the students can easily perform a variety of experiments with control systems, such as calculating the controller settings and testing the closed loop control system in its steady-state. Detailed exercises, using a storage oscilloscope or PC measurement interface, are always possible, if required.

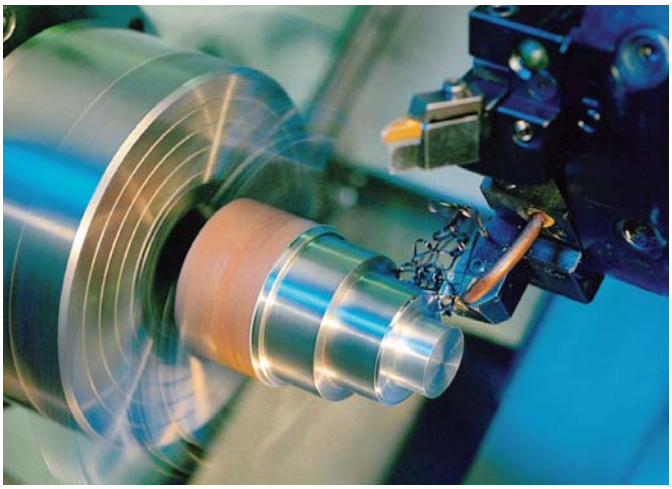
FROM THE OPEN LOOP TO CLOSED LOOP

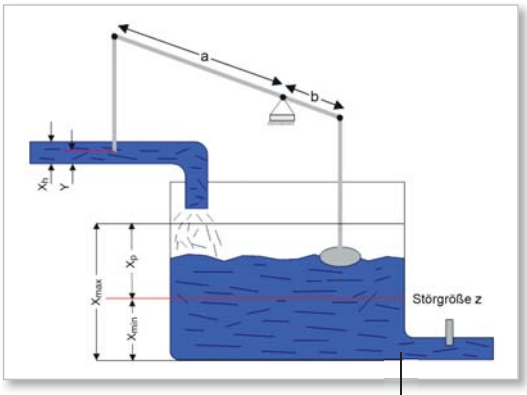
Linking theory with practice



The action plans of open and closed loop control in comparison

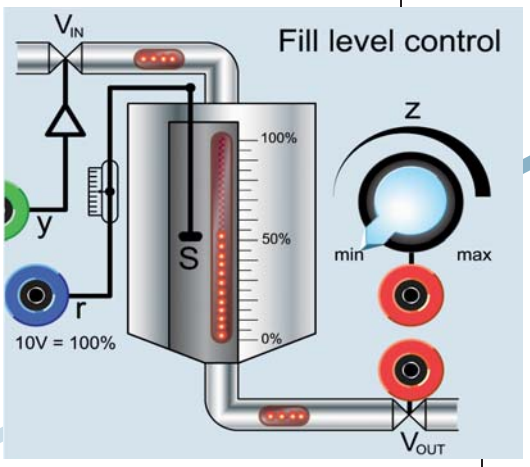
Modern industrial processes require a closed loop control rather than an open loop control to become effective



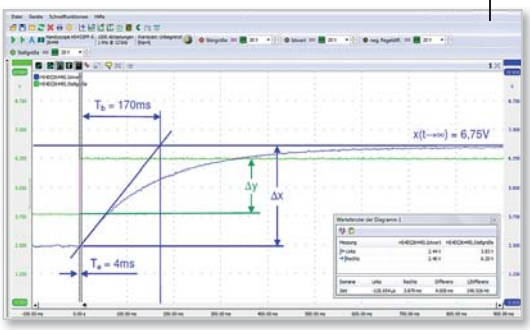


Carrying out analyses

Familiarising with and analysing controlled systems



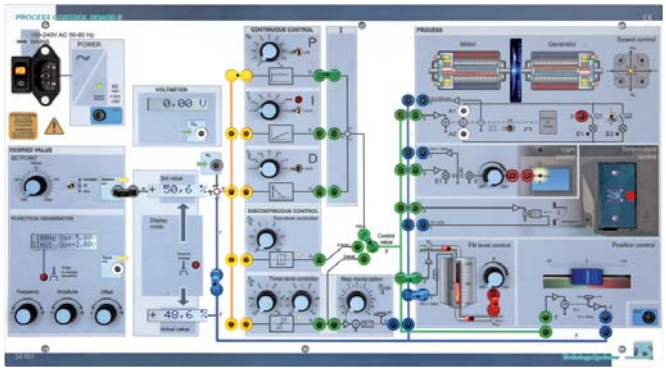
Classification of controlled systems and understanding the system boundaries



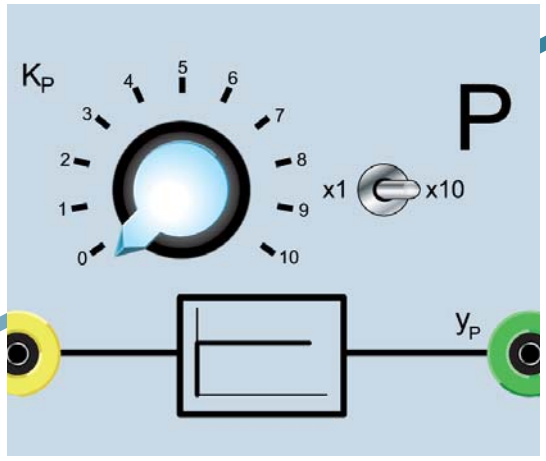
Recording step responses

ELABO TrainingsSysteme

Commissioning control circuits

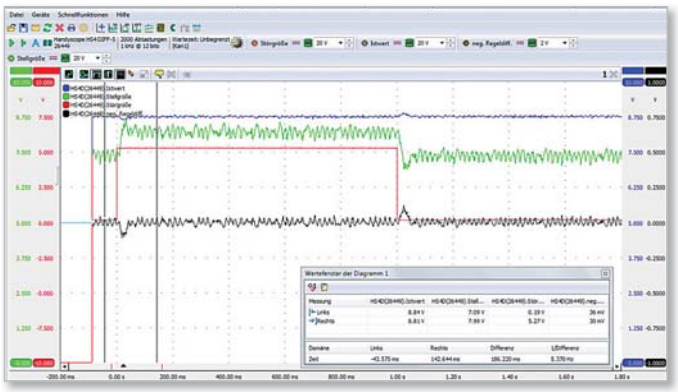


Familiarising with controlling systems

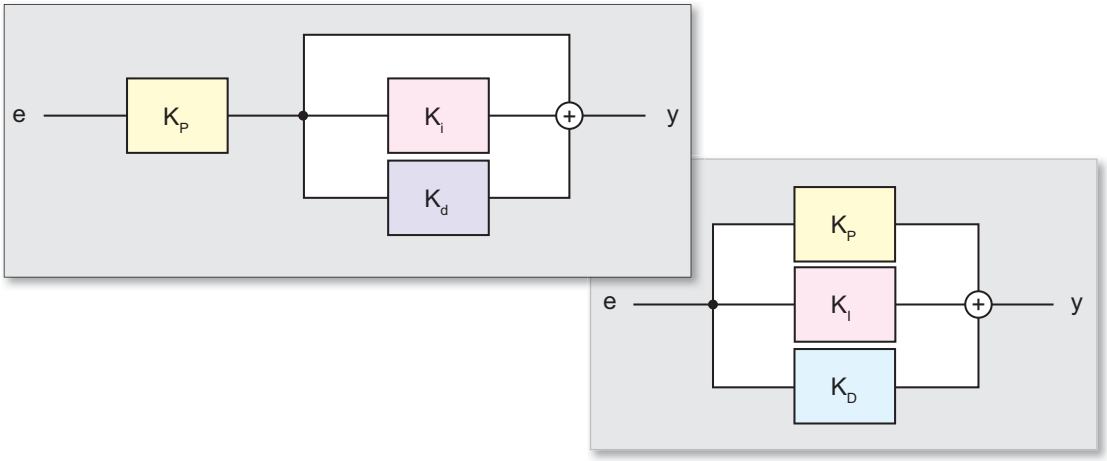


Choosing and configuring controllers

Measurement analyses

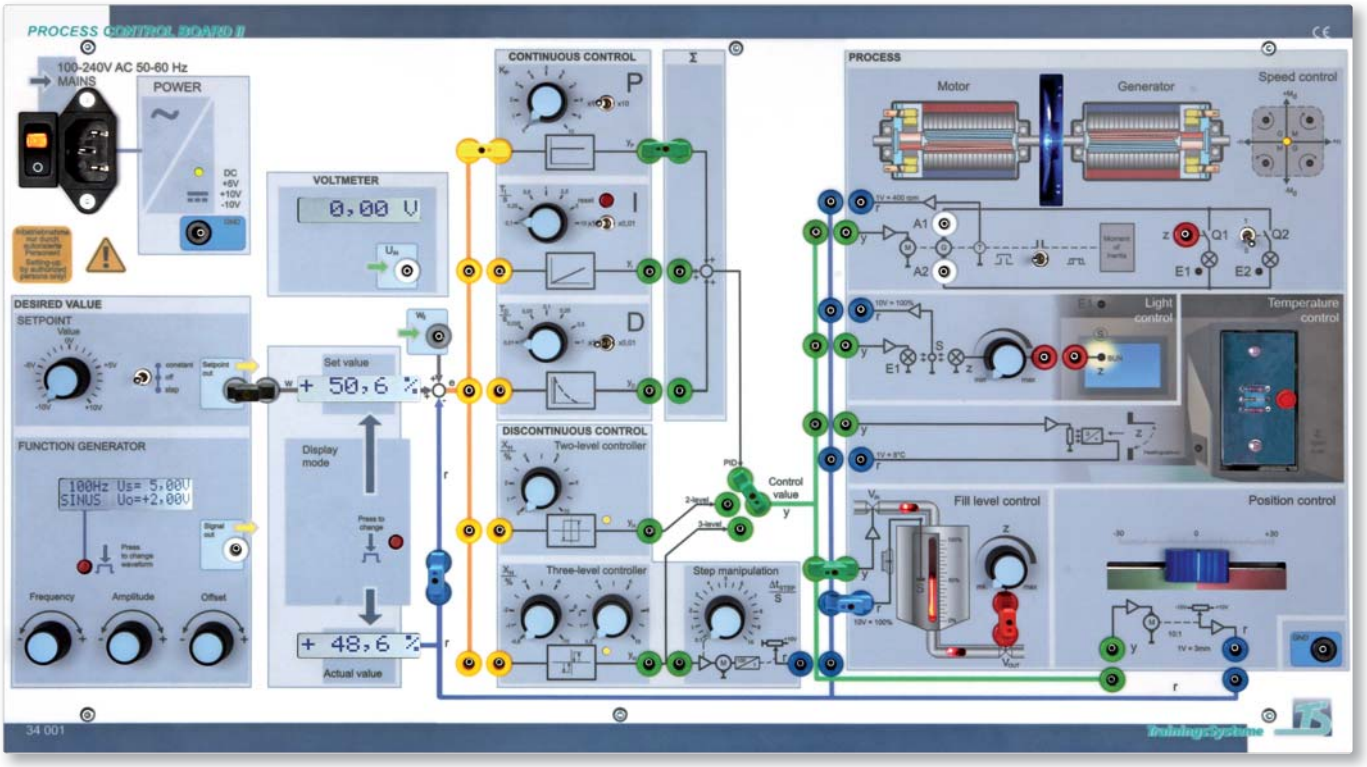


Carrying out an assessment: control quality / trouble shooting



Action plans of an ideal theoretical and a practical PID controller

Process Control Board



34 001 Process Control Board II

LEARNING OBJECTIVES

- Difference between continuous and discontinuous controllers
- Analysing controlled systems with and without selfregulation and determining the system parameters
- Examining the time-dependent behaviour of controllers and controlled systems
- Choosing and configuring controllers
- Examining control parameters and their correlations
- Explaining the function of control circuits and executing measurements

Technical Data

Power supply
- Wide range input AC 110 V … 230 V, 50 … 60 Hz

Voltage range of all signal inputs and outputs
- ± 10 V DC ± 10 %

Test signal generator
- Waveforms: DC, sine, triangle, square
- Frequency: 0.1 Hz to 1 kHz, setting via incremental encoder
- Amplitude U_s = 0 … 10 V, setting via incremental encoder
- Offset voltage U_{Offset} = - 5 … + 5 V DC, setting via incremental encoder

Integrated measurement system
- … measures the set and actual values (reference input variable and feedback variable) in real time and shows the two quantities in one display each.
- The display range can be toggled simultaneously for both displays.
- The following selection is available:
  • ± 4000 rpm • ± 80 °C • ± 100 % • ± 10.0 V • ± 30 mm
- Integrated voltmeter for individual voltage measurements in the range of ±10 V.
- Display language: English or German, selectable.

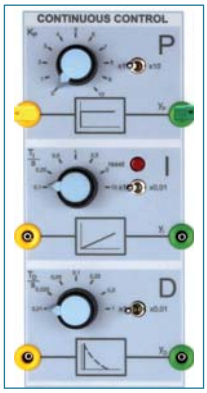
Functional groups

Controllers

P-element
Adjustment range:
- *x 1* K_P *= 0 to 10, continuously*
- *x10* K_P *= 0 to 100, continuously*

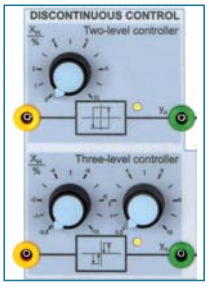
I-element
Can be connected in series or parallel to the P-controller
Adjustment range: T_I *= 0.01 to 10 s, in 14 stages*

D-element
Can be connected in series or parallel to the P-controller
Adjustment range: T_D *= 0.001 s to 1 s, in 14 stages*

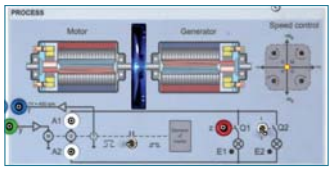


Two-level control
Adjustment range of the hysteresis:
X_H *= 0 to 10 %, continuously*

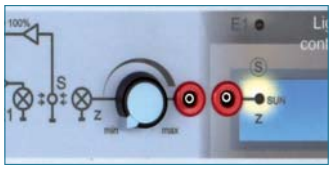
Three-level control
Adjustment range of the hysteresis:
+ X_H *0.5 to 10 %, continuously*
– X_H *0.5 to 10 %, continuously*



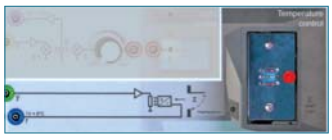
Controlled systems



Rotational speed
… consists of a DC motor that is rigidly joined to a generator via the shafts. The manipulated variable is a voltage signal in the range of ± 10 V. The motor reaches rotational speeds of ± 4000 rpm.

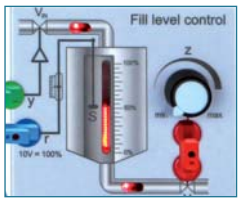


Light
… consists of a white LED, which represents the room lighting to be regulated. The manipulated variable is a voltage signal in the range of 0 ... +10 V. The illumination in the room is measured by means of a photo-transistor.



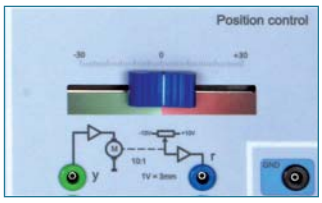
Temperature
… simulates a heating cabinet and consists of two heating elements in a small, limited air volume. The door of the heating cabinet can be opened. The manipulated variable is a voltage signal in the range of 0 ... + 10 V. The temperature in the cabinet is measured by means of a temperature sensor.

Filling level



… simulates a fluid tank with an inlet and outlet valve. The level in the tank is visualised by an LED scrollbar. The manipulated variable is a voltage signal in the range 0 … + 10 V and controls the inflow. The level of the tank is given in %. The output value is a proportional voltage 0 … + 10 V. Two red LED elements in the inflow and outflow visually display the inflow and outflow behaviour.

Position



… is a linear axis. It consists of a small, permanent magnet-excited DC motor, a linear drive and a potentiometer for forming the feedback signal from - 10 V to + 10 V.

Stepmaker

The stepmaker is a special control circuit system for the three-position regulator. The stepmaker represents a motor-driven adjusting device, which, upon receiving a positive input signal, for example, opens a valve in steps. In the case of a negative input signal, the valve is once again closed in steps. In case of an input signal of 0 V, the actuating device remains frozen in the momentary state.

COURSEWARE

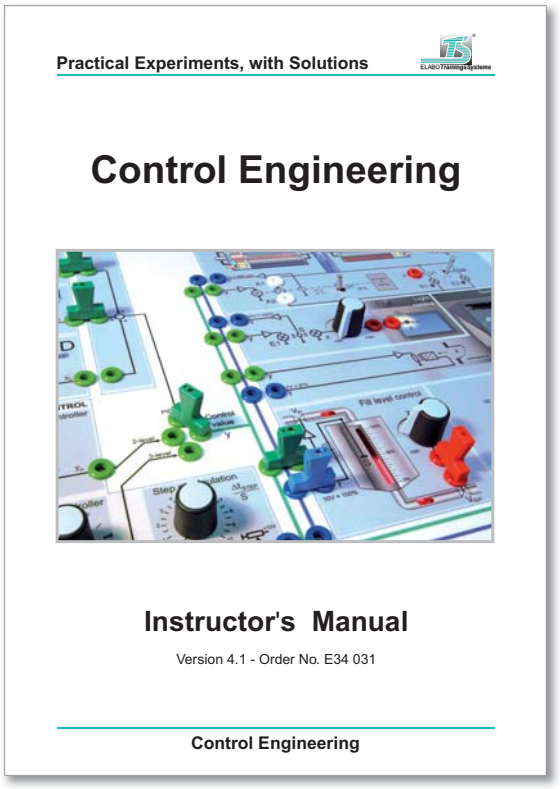
Manual

Printed and digital!

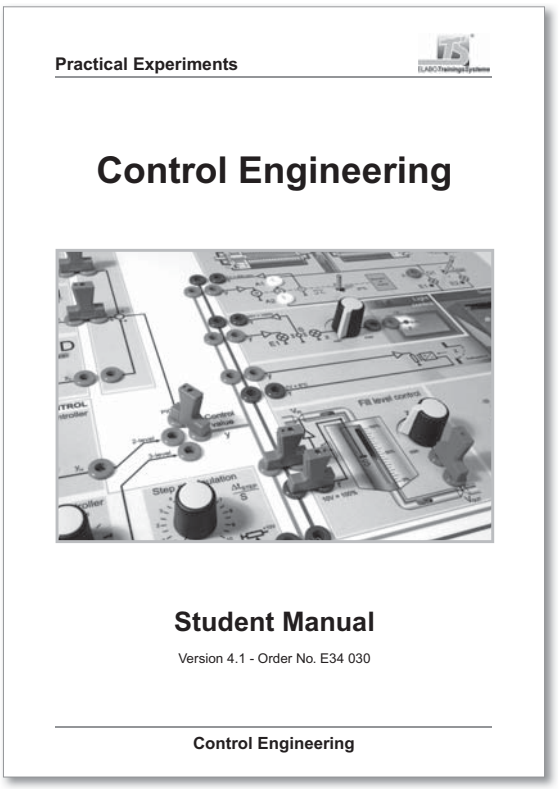
Learning objectives

Exercises:

- Introduction to control technology
- Determining the parameters of the controlled system
- Choose the controller type
- Configuring the control circuit
- Temperature control with PID-controller
- Temperature control with two-level controller
- Position control with continuous control device
- Level control with two-level controller
- Level control with PI-controller
- Rotational speed follower control
- Rotational speed fixed value control
- Light regulation with two-level controller
- Light regulation with PI-controller
- Actuator with three-level control, three-point step controller

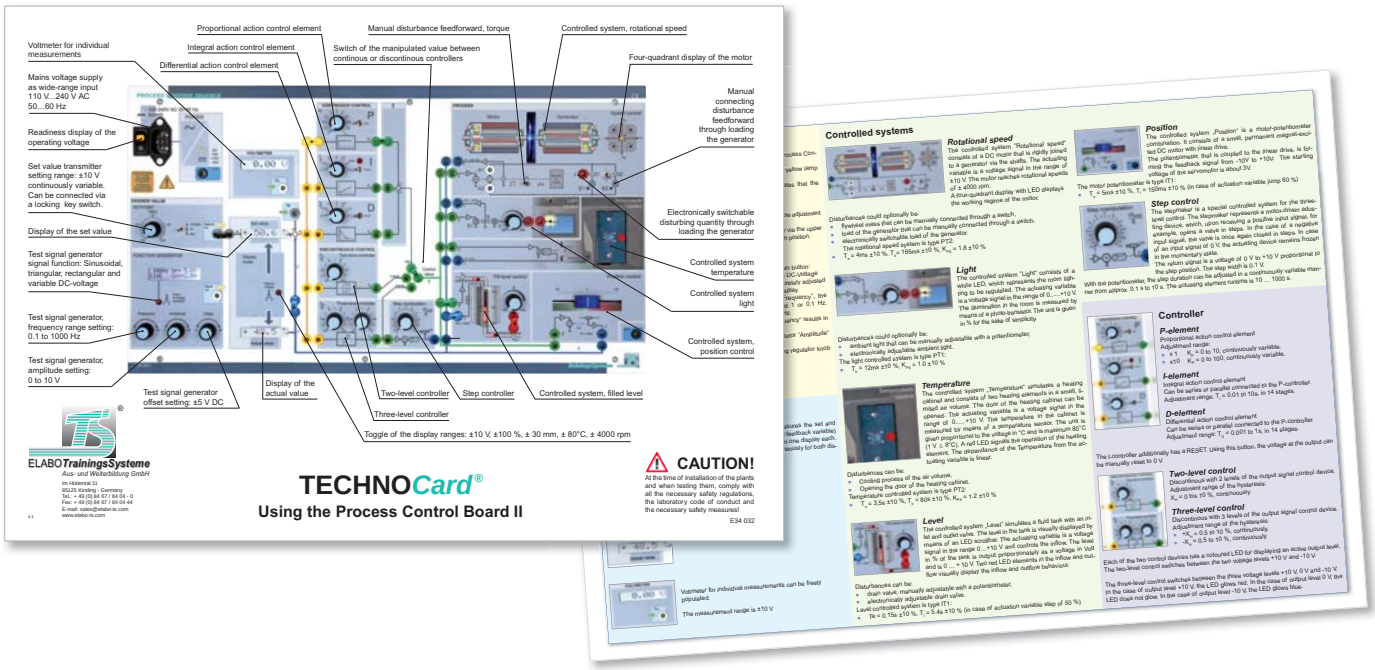


E34 031CD Instructor's Manual with method leads, incl. CD-ROM. Description of theory and guided practical experiments, color print, 156 pages

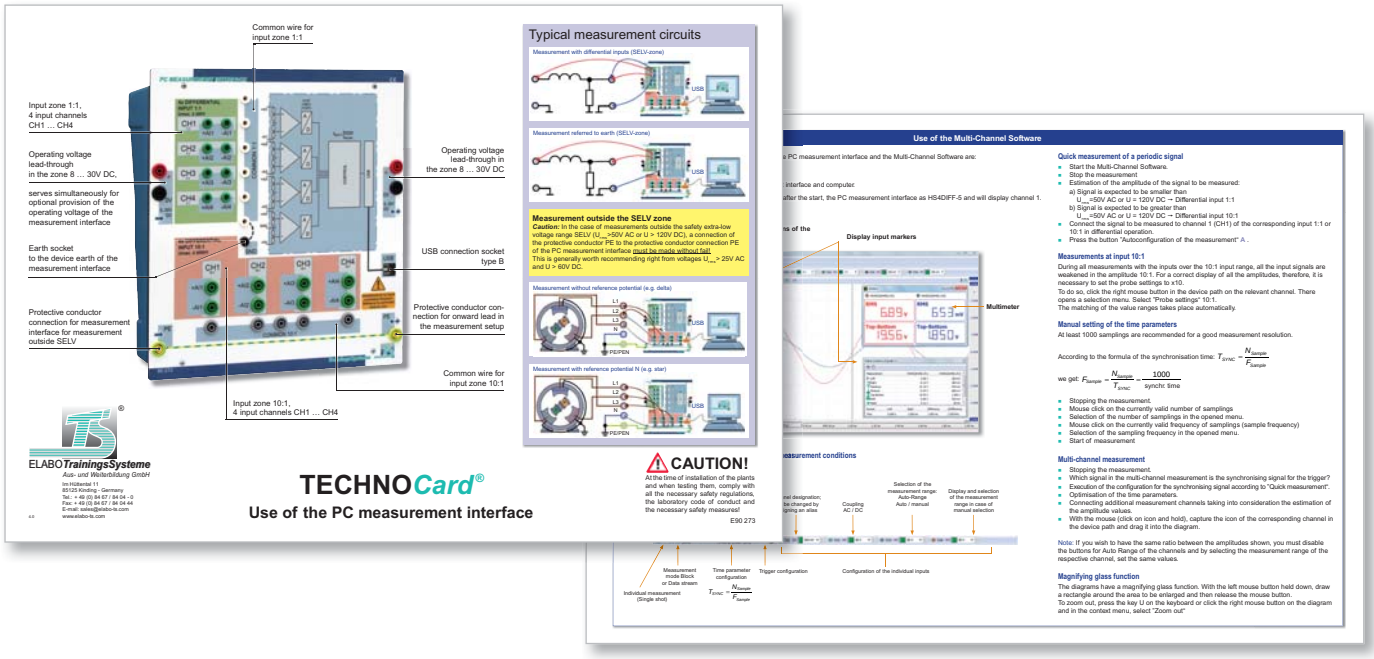


E34 030CD Student Manual incl. CD-ROM. Practical experiments for trainees and students, unrestricted copying license for educational institutions, grayscale print, 156 pages

TECHNO*Cards*®



E34 032 TECHNO*Card*® *Using the Process Control Board II*



E90 273 TECHNO*Card*® *Use of the PC measurement interface*

The TECHNOCards® are a very useful complement to the training system. They are a kind of compact, clearly laid-out knowledge store for reference during practical experiments.

- *Display sheets in format 303 mm x 426 mm*
- *Double-sided color print*
- *Rigid, durable quality*

CONTROL ENGINEERING

Manual “Fundamentals of control engineering”

Printed and digital!

Content

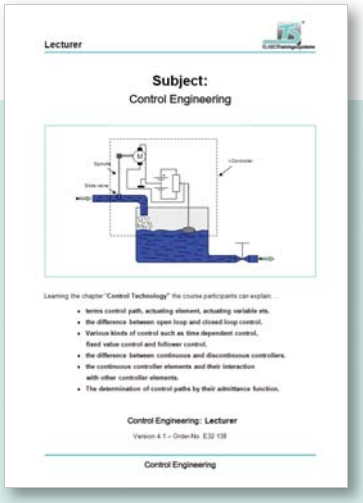
consisting of parts:

- Lecturer
- Presentation aids
- Preparation for examination
- Preparation for examination and solutions
- Examination
- Examination and solutions

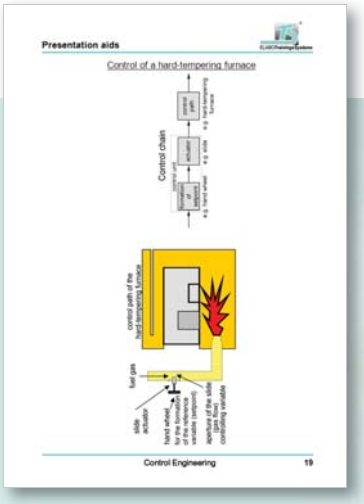
MEDIA T3 BoXX
Teaching · Training · Technology

The manual explains...

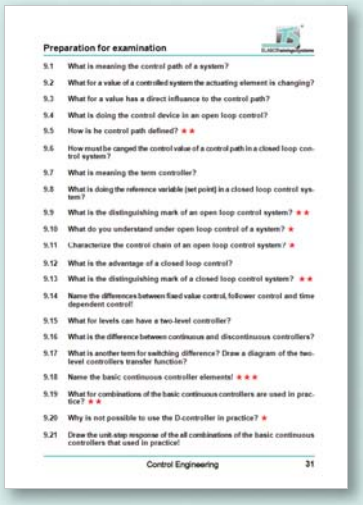
- *the terms controlled system, actuating element, manipulated variable etc.*
- *the difference between open loop and closed loop control*
- *the various kinds of control such as time dependent, fixed value control and sequential control*
- *the difference between continuous and discontinuous controllers*
- *the continuous controller elements and their interaction with other controller elements*
- *the determination of controlled systems by their unit-step response*



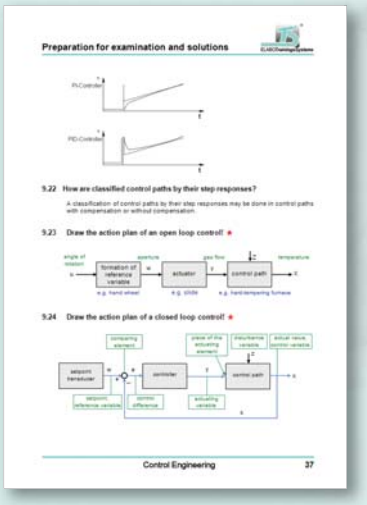
Lecturer



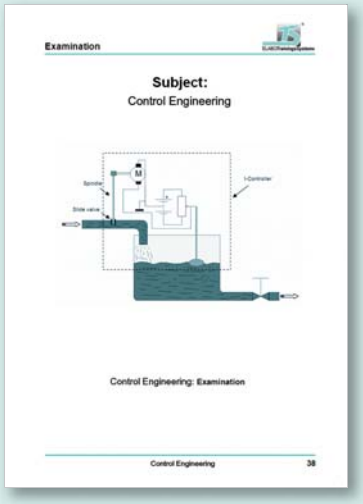
Presentation aids



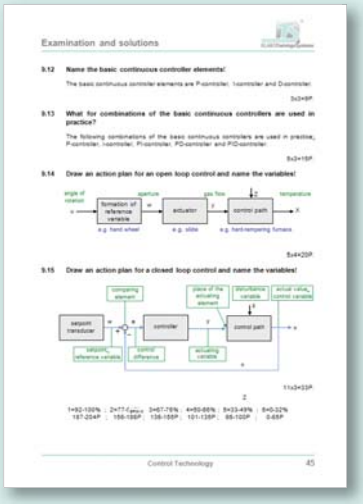
Preparation for examination



Preparation for examination and solutions



Examination



Examination and solutions

E32 138 Manual
“Fundamentals of control engineering”

THE NEW TRAINING SYSTEM FOR PROCESS

Easy – safe – complete – mobile

Control and test signals

- Setpoint
- Test signal generator

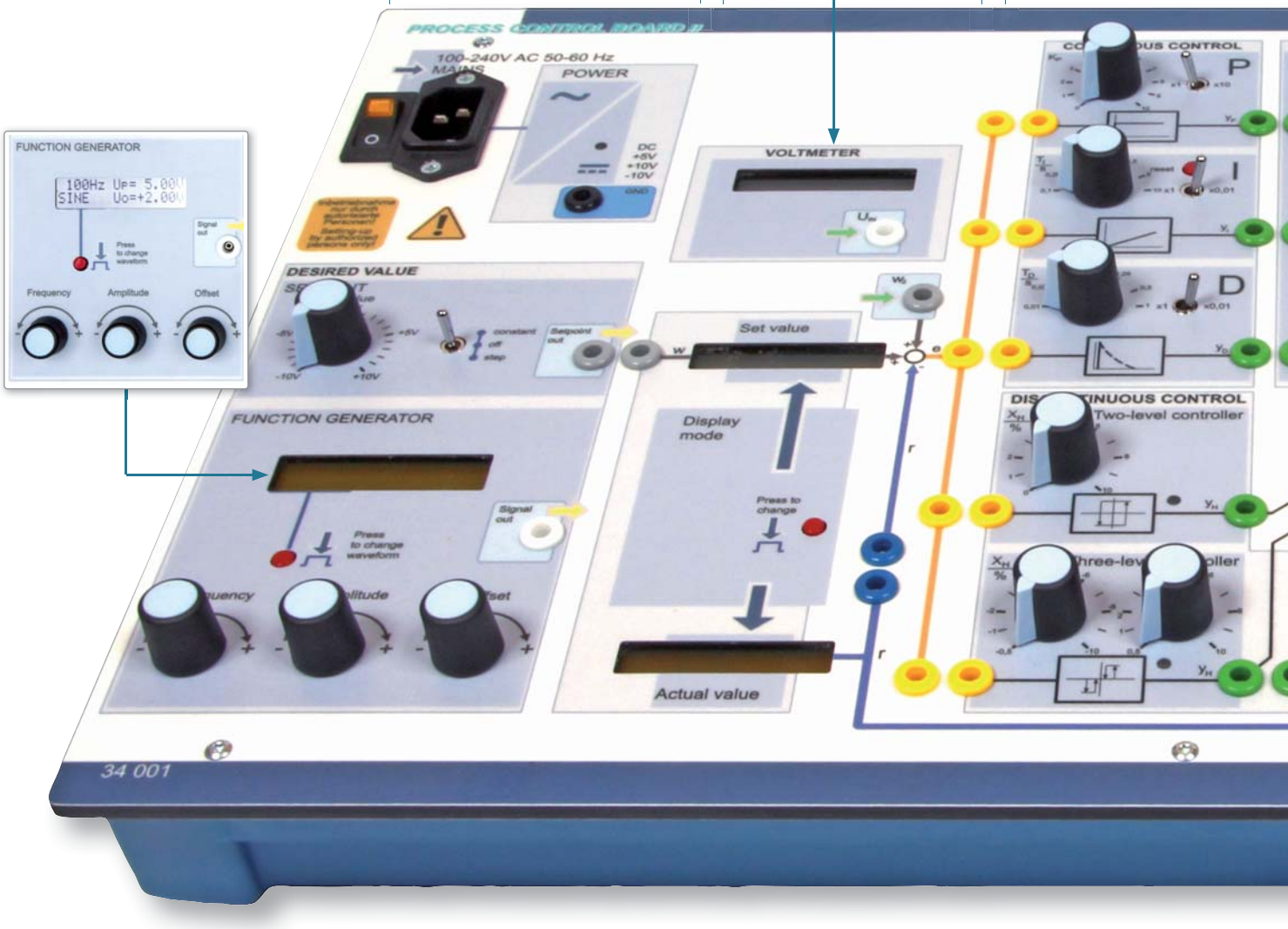
Measurement system

- Units:

  V, mm, %, ºC, rpm
- Set value
- Actual value
- Voltmeter

Controllers

- P-element
- I-element
- D-element
- Two-level controller
- Three-level controller
- Stepmaker



ELABO*TrainingsSysteme*

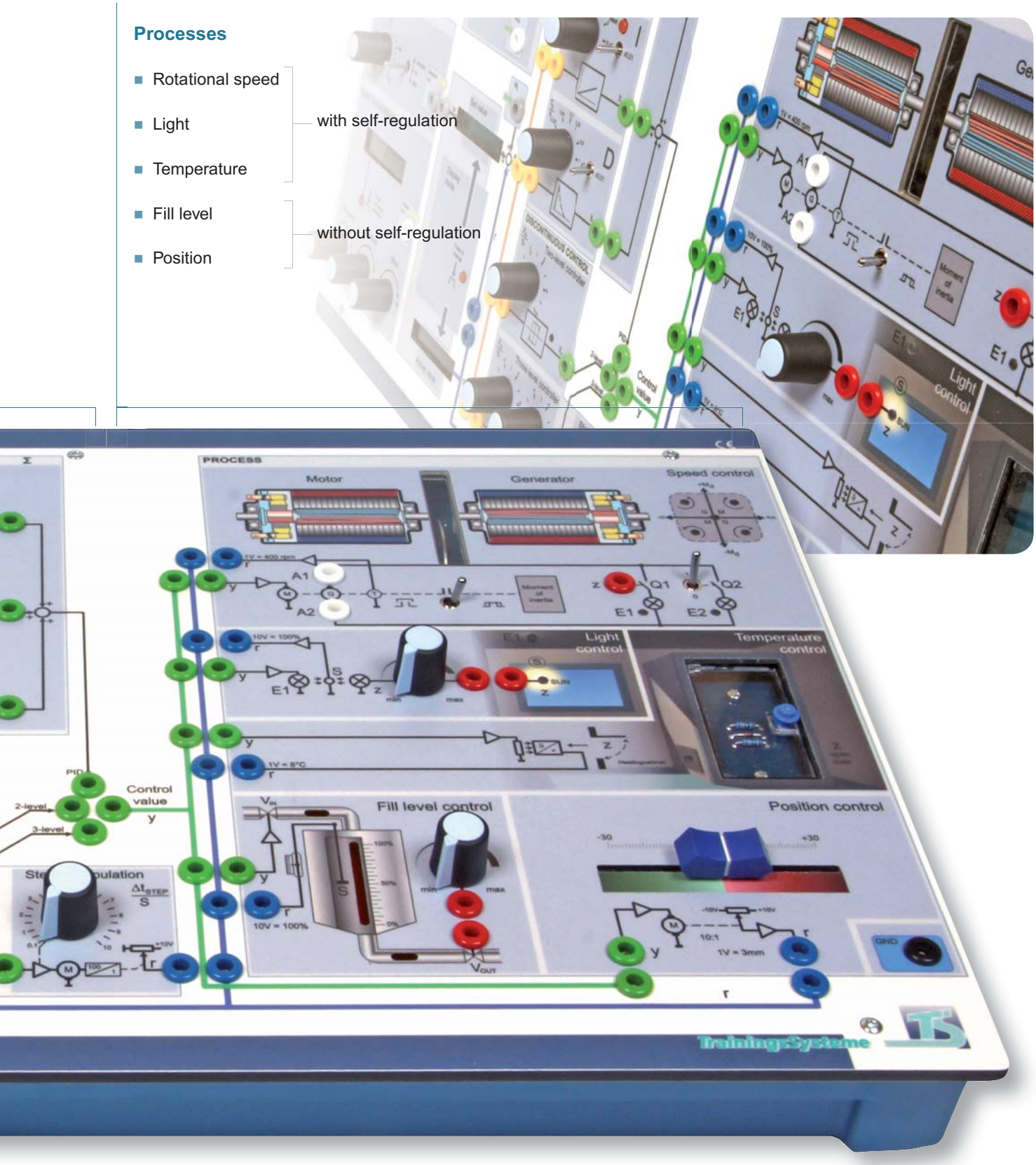
Processes

- Rotational speed
- Light
- Temperature

with self-regulation

- Fill level
- Position

without self-regulation



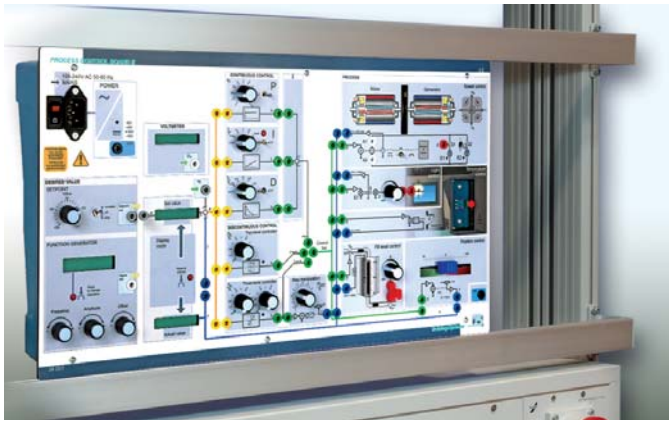
34 001 Process Control Board II

MOBILE SYSTEMS

Experimenting at any place and time!

Our Boards and accessories for teaching the subject of control engineering allows training wherever it may suit ...

... ON THE TOP OF THE TABLE



... HUNG IN A FRAME

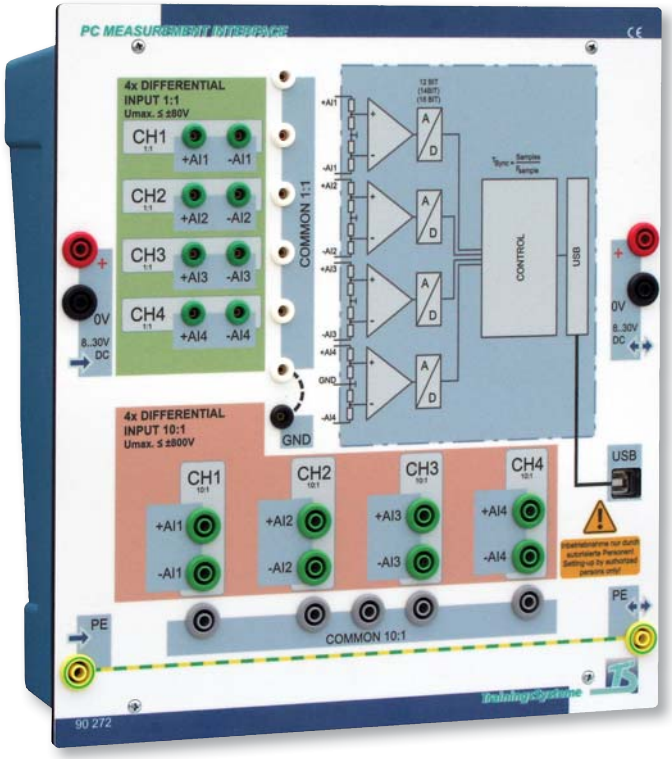
... OR IN A CASE ESPECIALLY DESIGNED FOR MOBILE TRAINING.

Our Boards are available in a lockable experimental case with removable lid and space for the set of accessories.

Its rugged, but still lightweight aluminium shell makes it suitable for transportation and guarantees safe and dust-free storage of our training systems.

91 801 Experimental case

4-channel measurement interface



90 272 PC Measurement Interface

90 272 PC Measurement Interface – Technical Data

The „PC Measurement Interface“ is a four-channel measuring instrument with differential inputs that allows safe measurement of voltages and derived quantities up to 600 V AC.
The included software allows the display and evaluation of the measurement results on the PC. The measurement results can be stored or directly printed.

- 4 analog input channels with differential input
- 5 MHz bandwidth (5 000 000 Samples/s)
- Sampling rate of up to 5 MHz per channel
  - 16 bits up to 195 kHz
  - 14 bits up to 3.125 MHz
  - 12 bits up to 5 MHz
- Input 1:1
  - Measuring ranges from ± 200 mV to ± 80 V (peak value)
  - Overvoltage protection up to 200 V AC
  - 2mm safety sockets
- Input 10:1
  - Measuring ranges from ± 2 V to ± 800 V (peak value)
  - Overvoltage protection up to 600 V AC
  - 4mm safety sockets
- All inputs touch-safe 600 V, CAT III
- All inputs allow clear and easy configuring with 19mm bridge plugs
- 4 measuring instruments in one unit
  - 12 … 16 bit 4-channel oscilloscope
  - Spectrum analyser
  - Transient recorder
  - Voltmeter (average, true RMS)
- Comprehensive trigger function
- Rapid transient recorder with 0.01 s - 500 s sampling time
- USB 2.0 High Speed (480 MBit/s)
- Optional operation voltage: 8 … 30 V DC

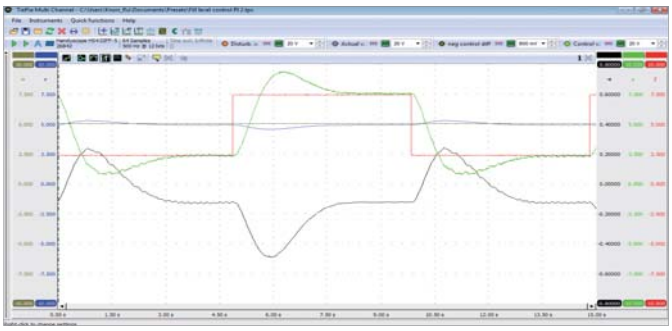
System requirements:

Processor:
Pentium processor or faster
Memory: 16 MB RAM
Hard disk: 18 MB

Operating system:
XP / Vista / Windows7 / Windows8
(32 or 64 Bit)
CD-ROM drive

Universal application beyond to control engineering

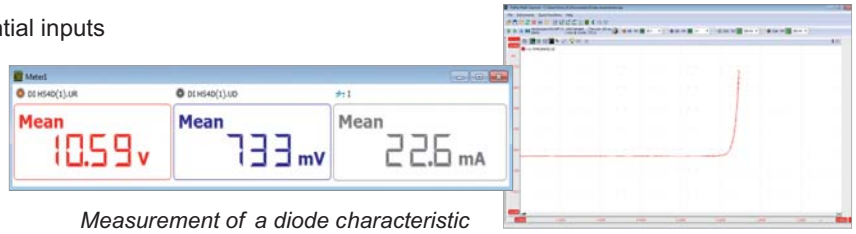
- 4-channel measurement of the control parameters
- Data recorder for evaluation of slow processes
- Use of predefined measurement profiles
- Clearly arranged wiring
- Simple print-out of the measurement results for evaluation



Fill level control with PI-controller

Measurement in electronic circuits

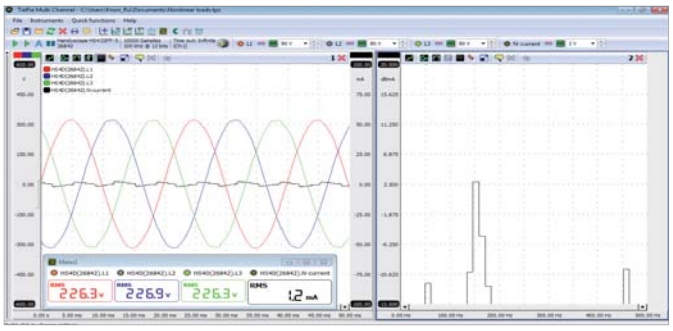
- Direct measurement of the values via differential inputs
- Display of the wave-form or values
- X-Y-depiction
- Use of predefined measurement profiles



Measurement of a diode characteristic

Measurement in supply grids

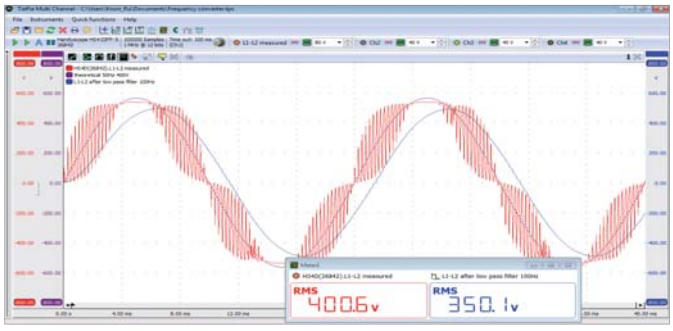
- Direct measurement of three phase voltages in star or delta circuits
- Direct measurement of voltages up to 600 V AC
- Display of the wave-form or values
- Spectrum analysis



Three phase voltages and neutral current as a result of nonlinear loads

Measurement on the load side of frequency converter

- Direct measurement of three phase voltages in star or delta load circuits
- Direct measurement of of voltages up to 600 V AC
- Display of the wave-form or values
- Spectrum analysis
- Depiction of calculated values



Measurement of the phase voltage U_{L1-L2} at the load of a frequency converter

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