

Equipment
for Engineering
Education

**PROCESS CONTROL
ENGINEERING**

C

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Your reliable and experienced partner for

- teaching and training systems for innovative technical training
- experimentation and research equipment



GUNT demonstration and experimentation equipment for

- training in technical professions
- training of technical staff in trades and industry
- studies in engineering disciplines



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This catalogue 5c **Process Control Engineering** forms part of our **Process Engineering** series.

The updated data sheets for the entire range can always be found on our website at www.gunt.de.

IMPRINT

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THE COMPLETE GUNT PROGRAMME – EQUIPMENT FOR ENGINEERING EDUCATION

ENGINEERING MECHANICS & MACHINE ELEMENTS



- › Statics
- › Strength of Materials
- › Dynamics
- › Fundamentals of Engineering Design
- › Machinery Diagnosis
- › Properties of Materials



FLUID MECHANICS



- › Fundamentals of Fluid Mechanics
- › Steady Flow
- › Steady Flow of Compressible Fluids
- › Flow around Bodies
- › Examples of Transient Flow
- › Hydraulic Fluid Energy Machines
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- › Fluidic Experimental Plants
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MECHATRONICS



- › Engineering Drawing
- › Cutaway Models
- › Dimensional Metrology
- › Fasteners and Machine Parts
- › Manufacturing Engineering
- › Assembly Projects
- › Maintenance
- › Machinery Diagnosis
- › Automation



PROCESS ENGINEERING



- › Process Control Engineering
 - › Fundamentals of Control Engineering
 - › Components and Calibration
 - › Simple and Complex Control Systems
- › Theoretical Fundamentals
- › Practical Fundamentals
- › Mechanical Process Engineering
- › Thermal Process Engineering
- › Chemical Process Engineering
- › Biological Process Engineering
- › Water Treatment



THERMAL ENGINEERING AND HVAC



- › Fundamentals of Thermodynamics
- › Applied Thermodynamics
- › Renewable Energies
- › Power Engines and Machines
- › Internal Combustion Engines
- › Refrigeration and Air Conditioning Technology
- › Heating and Ventilation in Buildings
- › Sanitary Systems



ENERGY & ENVIRONMENT



- ### ENERGY
- › Solar Energy
 - › Hydropower and Ocean Energy
 - › Wind Power
 - › Biomass
 - › Geothermal Energy
 - › Energy Systems
 - › Energy Efficiency in Building Services Engineering

- ### ENVIRONMENT
- › Water
 - › Air
 - › Soil
 - › Waste



PLANNING & CONSULTING · TECHNICAL SERVICE COMMISSIONING & TRAINING



BASIC KNOWLEDGE

THE IMPORTANCE OF PROCESS CONTROL ENGINEERING FOR PROCESS ENGINEERING

Process control engineering is vital to the automated operation and monitoring of complex technical processes. These processes represent the unit operations of material transformation. Raw materials are transformed into products, often using other materials and energy. The processes may, for example, involve the production of ethanol from biomass; the separation of petrol from mineral oil by rectification; or the treatment of waste water.

With the aid of process control engineering, processes are monitored and influenced as they happen. This is enabled by the measurement and control of variables such as flow rate, pressure, temperature, and concentration.

Process control engineering topics

■ Metrology

Sensors are used in the measurement of the variables. The variables involved may, for example, be pressure, flow rate, temperature and concentration in process engineering systems. In modern systems these variables must be converted into equivalent electrical signals for further processing.

■ Actuation systems

Actuators have direct influence on the process meaning that they can change the measured variable. Targeted manipulation of the flow rate in a pipeline by a control valve is an example of this.

■ Control engineering

The **controller** receives the measured variable (e.g. a flow rate) from the sensor as an input signal. In the controller this measured variable signal is compared against the reference variable signal pre-set by the operator. The controller sends an output signal corresponding to the control difference to the actuator. The signal processing in the controller follows a functional correlation between the input and output variables. A detailed knowledge of the process itself is necessary to allow for optimum setting of the functional correlation (e.g. via controller parameters P, I and D) within the controller.

■ Open-loop control

The signal processing sequences in process engineering systems are often repeated. Such sequence control can be implemented by **programmable logic controllers (PLCs)**.

■ Process visualisation

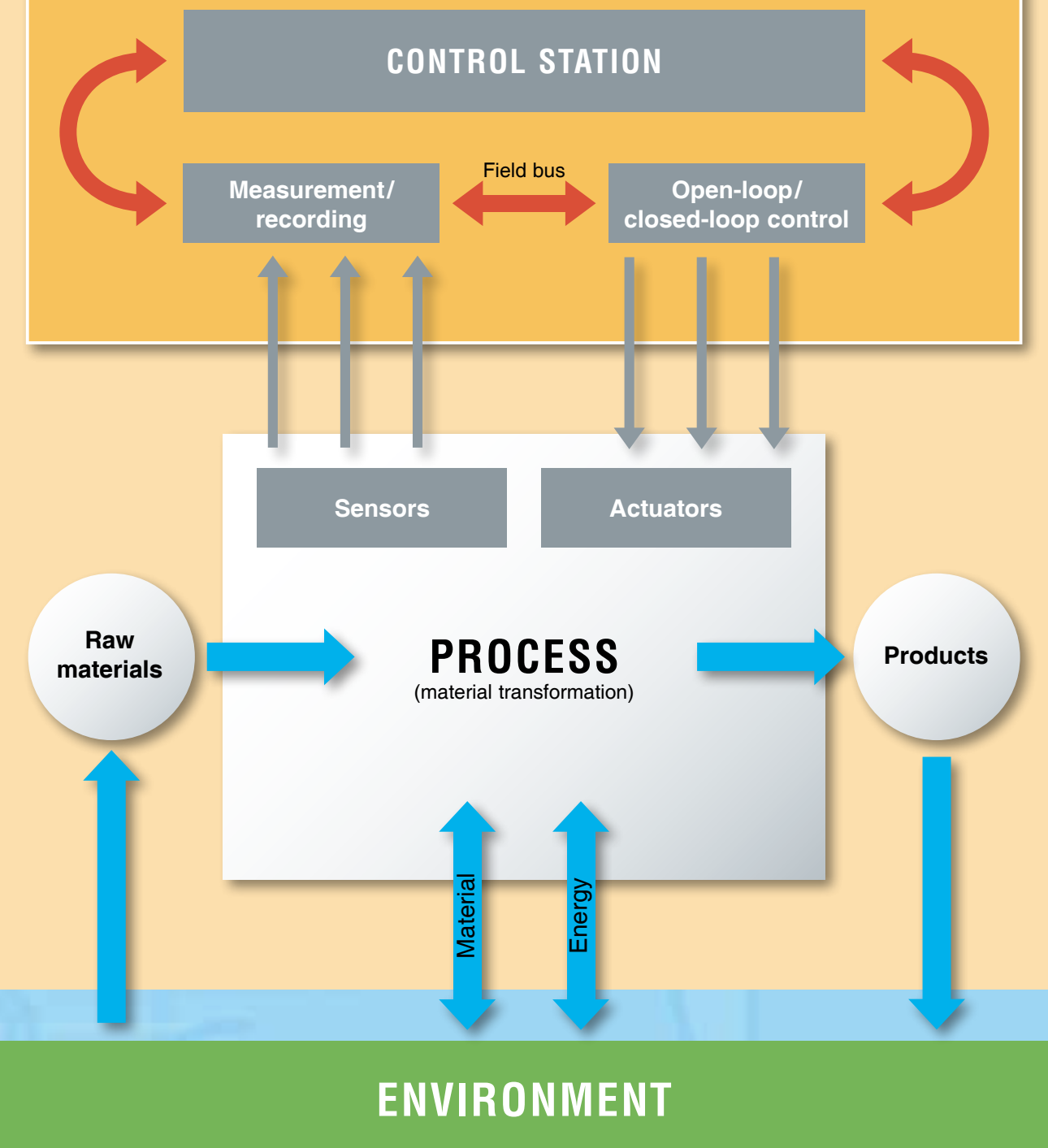
Process visualisation ensures that the operator is integrated into the technical environment. A simplified visual representation of the process is essential to increasing operator understanding of complex processes and also provides him with the necessary information on the process state. From the **control station**, operators can use the visual information to make decisions and influence the process as appropriate.

■ Communication

The safe transfer of data from the process to the control station and from the control station to the process is a key aspect of process control engineering. **Field bus systems** are employed in the interconnection of multiple devices, such as controllers, PLCs and actuators, with the control station.

PROCESS ENGINEERING

PROCESS CONTROL ENGINEERING



THE GUNT LEARNING CONCEPTS IN PROCESS CONTROL ENGINEERING

CHAPTER 1: FUNDAMENTALS OF CONTROL ENGINEERING



The experimental units contained within this chapter focus on the clear design of the control systems.

- Simple control systems with one controlled variable
- Clear layout of control loop components
- Quick learning success

CHAPTER 2: COMPONENTS AND CALIBRATION



The units dealt within this chapter focus on the individual components of control loops. The transmission behaviour of each component can be investigated in isolation. This quickly identifies the suitability of components for particular applications.

- Separate investigation of individual control loop components
- Familiarisation with standard pneumatic and electrical signals
- Calibration of control loop components

CHAPTER 3: SIMPLE PROCESS ENGINEERING CONTROL SYSTEMS



Much emphasis was placed in the use of industrial components in the development of these control systems, so as to enhance the practical relevance. As in chapter 1, clarity is ensured through the use of simple control systems. The components can be visually identified easily and assigned to their respective functions.

- Response of simple, real-world control systems
- Operation and parameterisation of industrial controllers
- Interconnection of controllers with bus systems

CHAPTER 4: COMPLEX PROCESS ENGINEERING CONTROL SYSTEMS



The practical relevance of the process under control was the principle consideration in the development of these units. These are typical process engineering applications. In practical industrial processes, more than just one variable is usually controlled. Often multiple

controlled variables influence each other. This chapter deals with such application-oriented tasks.

- Typical applications in process engineering
- Processes involving multiple controlled variables
- Using a PLC

1 FUNDAMENTALS OF CONTROL ENGINEERING

A quick and easy introduction to control engineering – the fundamentals

Control engineering is a complex subject. GUNT offers a number of simple control loops in this chapter to provide a quick and easy introduction to the subject area. Each experimental unit measures and controls just one variable. In many cases the controlled variables are being displayed in analogue format in addition to being measured electronically. This enhances understanding of the process in each case.

In conjunction with the instructional material, the experimental units enable the following learning content to be covered:

- Layout of control loops
- Familiarisation with and identification of control loop components
 - ▶ controllers
 - ▶ actuators
 - ▶ sensors
 - ▶ transducers
- Familiarisation with and identification of control engineering variables
 - ▶ controlled variables
 - ▶ manipulating variables
 - ▶ reference variables
 - ▶ disturbance variables
- Familiarisation with elementary transfer functions
- Identification of different types of controlled systems
- Familiarisation with the properties of continuous and switching controllers



TRAINING SYSTEMS, HSI

CODE	PRODUCT	PAGE
Overview	RT 010 - RT 060 Experiments in the Fundamentals of Control Engineering	12
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RT 020	Training System: Flow Control, HSI	16
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TEMPERATURE CONTROL

CODE	PRODUCT	PAGE
RT 200	Room Temperature Control	38

RT 010 – RT 060 EXPERIMENTS IN THE FUNDAMENTALS OF CONTROL ENGINEERING

RT 020 Training System: Flow Control, HSI



RT 030 Training System: Pressure Control, HSI



RT 040 Training System: Temperature Control, HSI



RT 050 Training System: Speed Control, HSI



RT 060 Training System: Position Control, HSI



Control engineering is a key area in any study of automation.

With this model series, GUNT offers six systems providing an introduction to the fundamentals of control engineering through the use of experimentation. Software plays a key role as an integral component of the equipment concept, in the sense of hardware/software integration (HSI). It relieves students from routine activities and supports interactive action when they are experimenting with new approaches.

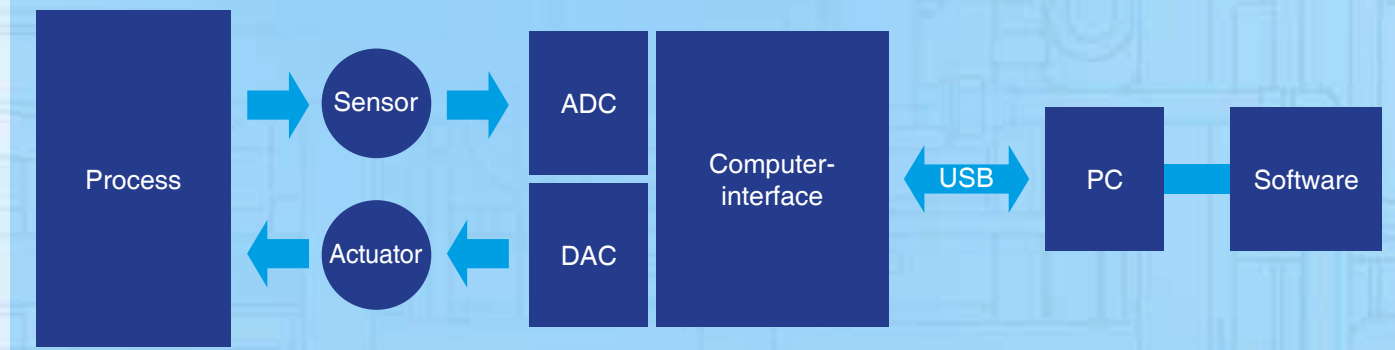
The effects of changes to controller parameters or disturbance variables on the system behaviour can be investigated quickly and easily. In contrast to purely computer-based simulation, these actual models of controlled systems provide a closer link to the real world, and so aid understanding.

The network capability of the software enables teacher/student systems to be established.

RT 010 Training System: Level Control, HSI



COOPERATION OF HARDWARE AND SOFTWARE – HARDWARE/SOFTWARE INTEGRATION (HSI)



Advantages

- Compact benchtop models
- Ideally suited to multi-user applications
- Typical controlled systems from the field of process engineering such as flow, level, pressure, temperature, speed and position
- High level of observability of processes based on transparent elements (covers, containers, lines)
- Richly featured Software
- Computer interface with USB port

Comprehensive experiment programme for each experimental unit:

- Control loop analysis
- Influence of controller parameters on control action and disturbance response
- Stability of the open and closed loop
- Controller optimisation

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

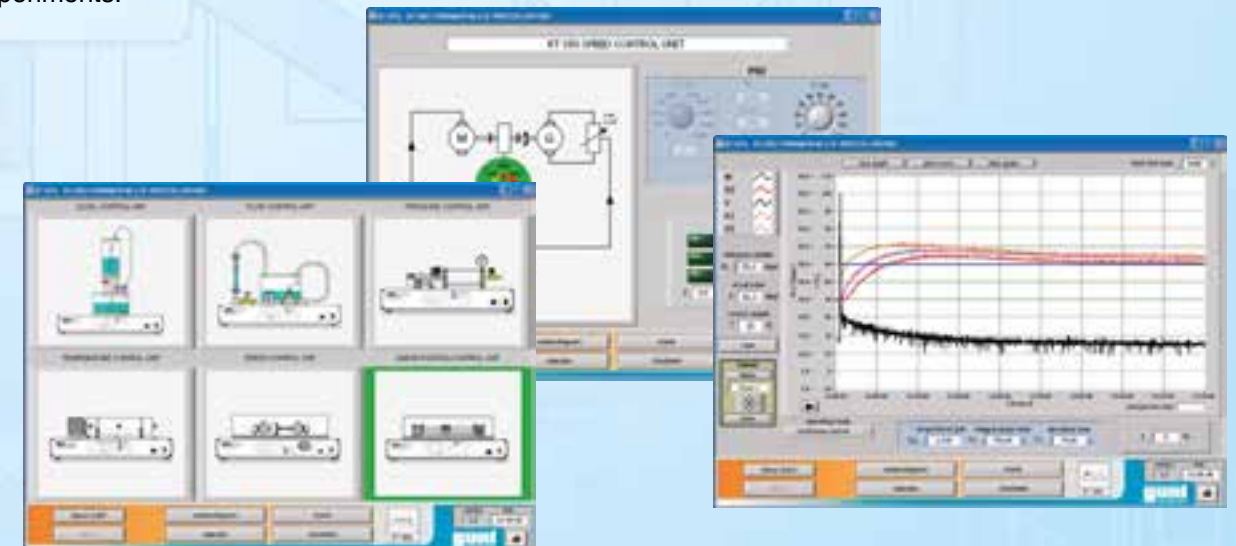
Software

State-of-the-art control and data acquisition software based on LabVIEW for Windows

- Software controller in real time, possible with real controlled system or simulation options
- Setpoint profiles (programme controller)
- Display and storage of all process variables
- Network capability
- Language switching

Software functionality

- Process schematics with online display of all process variables
- User control and parameter setting of the software controllers
- Manual control of actuators and disturbance feedforward control
- Recording of step responses for system identification
- Manual and automatic controller optimisation
- Stability tests
- Controlled system simulations for simplified system models



RT 010 Training System: Level Control, HSI**Technical Description**

This compact experimental unit offers every opportunity to learn the fundamentals of control engineering through experimentation on a level control system.

The experimental setup is mounted in a housing which also accommodates all the electronics. The transparent level-controlled tank is fed from the storage tank with the aid of a speed-controlled pump. The liquid level is measured using a pressure sensor. The sensor output signal is sent to the software controller. The controller's output signal influences the speed of the pump motor and therefore delivery flow rate. To investigate the influence of disturbance variables, an electromagnetic proportional valve in the tank outlet can be activated by the software.

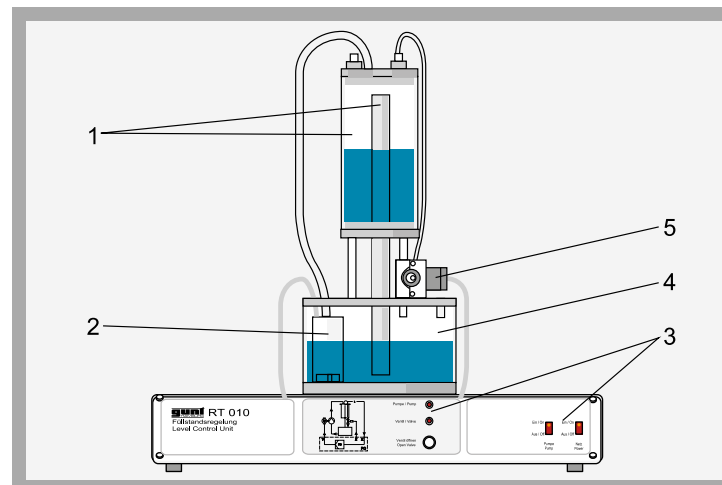
The powerful state-of-the-art software is an integral part of the training system, embodying the principle of hardware/software integration (HSI). It enables the experiments to be conducted and evaluated in a user-friendly manner. The software has network capability. The link between the experimental unit and the PC is made via a USB port.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

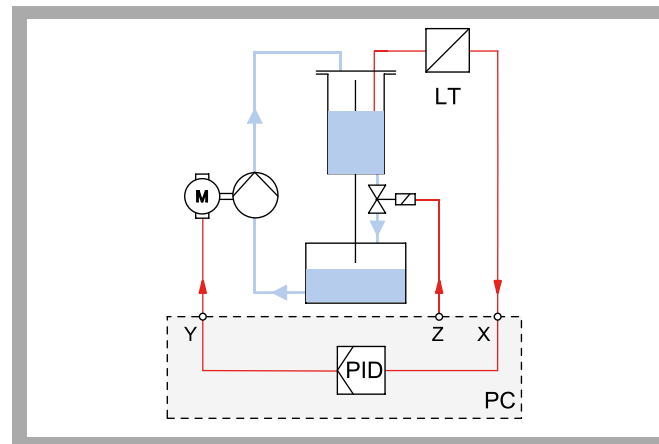
Learning Objectives / Experiments

- fundamentals of control engineering based on the example of a level control system with integral control action
- open loop control response
- investigation of a controlled system without feedback
- effects of different controller parameters and methods on the response of the closed loop system
- recording of step responses
 - * reference variable
 - * disturbance variable
- controller optimisation
- software-based controlled system simulation
 - * comparison of different controlled system parameters

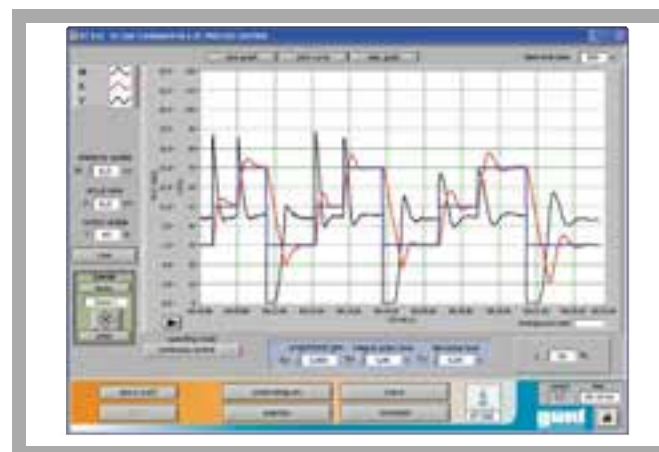
- * **Experimental unit with clear level control system**
- * **Extensive range of experiments on fundamentals of control engineering**
- * **State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**
- * **Software-based simulation of the controlled system**

RT 010 Training System: Level Control, HSI

1 level-controlled tank with overflow, 2 pump, 3 displays and controls, 4 storage tank, 5 proportional valve



Process schematic



Software screenshot: PI control of level control system: step response to change in reference variable with different values for K_p and T_n

Specification

- [1] experimental unit for control engineering experiments
- [2] level control process with transparent tank
- [3] speed-controlled pump
- [4] level measurement by pressure sensor
- [5] disturbance variables generated by electromagnetic proportional valve in tank outlet
- [6] tank with overflow and graduated scale
- [7] software-based controlled system simulation
- [8] process schematic on front panel
- [9] networkable GUNT software via USB under Windows Vista or Windows 7

Technical Data

- Level-controlled tank
 - capacity: 1200mL
- Storage tank
 - capacity: 3700mL
- Pump
 - power consumption: 18W
 - max. flow rate: 8L/min
 - max. head: 6m
- Proportional valve: K_{vs} : 0,7m³/h
- Pressure sensor: 0...30mbar (0...300mm)
- Software controller configurable as P, PI, PID and switching controller
- Software
 - process schematic with controller type selection (manual, continuous controller, two- or three-point controller, programmer)
 - time functions
 - simulation function
 - disturbance variable input

Dimensions and Weight

- LxWxH: 600x450x800mm
- Weight: approx. 22kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 GUNT software CD + USB cable
- 1 hose
- 1 handbook: fundamentals of control engineering (RT 010 - RT 060)
- 1 manual for RT 010

Order Details

- 080.01000 RT 010 Training System:
Level Control, HSI

RT 020

Training System: Flow Control, HSI



- * Experimental unit with clear flow control system
- * Extensive range of experiments on fundamentals of control engineering
- * State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions
- * Software-based simulation of the controlled system

Technical Description

This compact experimental unit offers every opportunity to learn the fundamentals of control engineering through experimentation on a flow control system. The experimental setup is mounted in a housing which accommodates all the electronics.

A piping system with two flowmeters is supplied with flow by a speed-controlled pump from the transparent storage tank. The rotameter offers the advantage that the flow rate can be observed directly at any time. The flow rate is measured by a turbine wheel flow sensor. The sensor output signal is sent to the software controller. The output signal from the controller influences the setting of an electromagnetic proportional valve. To investigate the influence of disturbance variables, the pump speed can be altered by way of the software.

The powerful state-of-the-art software is an integral part of the training system, embodying the principle of hardware/software integration (HSI). It enables the experiments to be conducted and evaluated in a user-friendly manner. The software has network capability. The link between the experimental unit and the PC is made via a USB port.

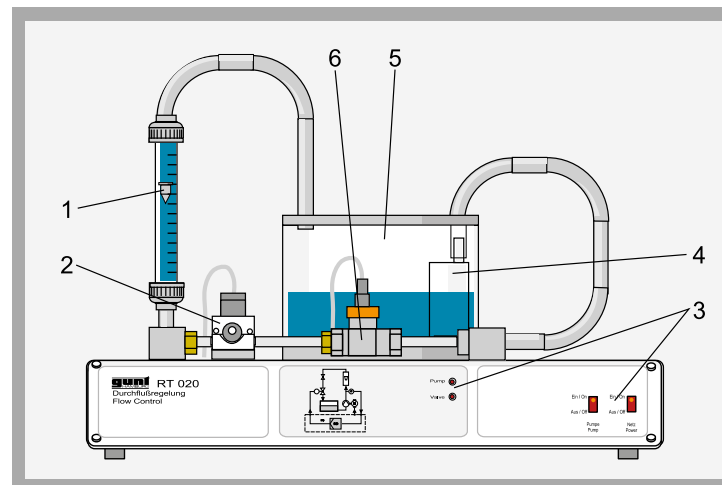
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

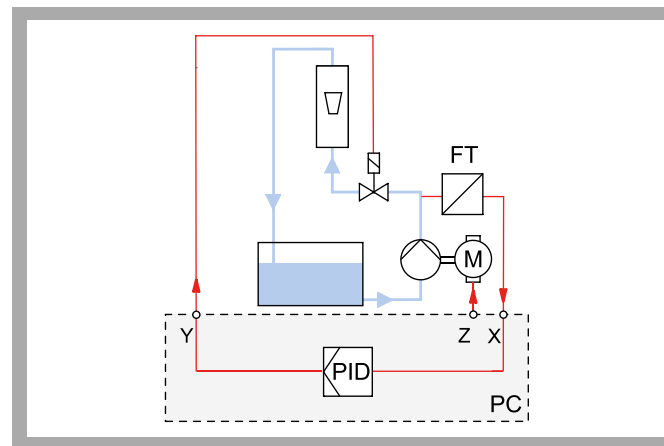
- fundamentals of control engineering based on the example of a rapid flow control system
- open loop control response
- effects of different controller parameters and methods on the response of the closed loop system
- recording of step responses
 - * reference variable
 - * disturbance variable
- controller optimisation
- software-based controlled system simulation
 - * comparison of different controlled system parameters

RT 020

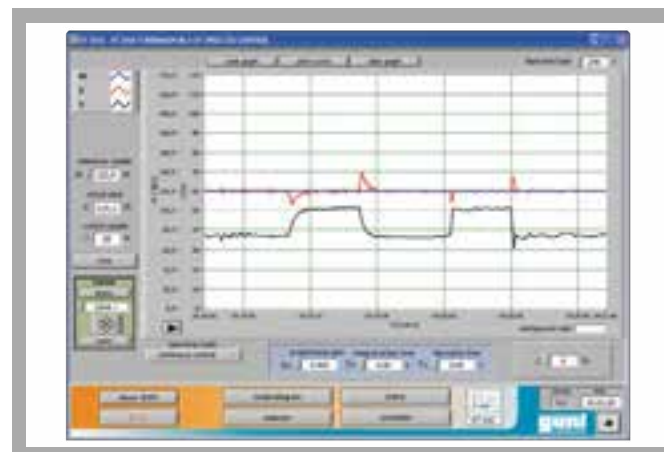
Training System: Flow Control, HSI



1 rotameter, 2 proportional valve, 3 displays and controls, 4 pump, 5 storage tank, 6 flow sensor



Process schematic



Software screenshot: flow control, controller with PI response with different values for K_p and T_n , introduction of a disturbance variable

Specification

- [1] experimental unit for control engineering experiments
- [2] flow control system with variable-area flowmeter
- [3] electromagnetic proportional valve as actuator
- [4] turbine wheel flow sensor
- [5] generation of disturbance variables by altering pump speed
- [6] software-based controlled system simulation
- [7] process schematic on front panel
- [8] networkable GUNT software via USB under Windows Vista or Windows 7

Technical Data

Storage tank

- capacity: approx. 3000mL

Pump

- power consumption: 18W

- max. flow rate: 8L/min

- max. head: 6m

Rotameter: 20...250L/h

Proportional valve: K_{vs} : 0,7m³/h

Flow sensor: 0,5...3L/min

Software controller configurable as P, PI, PID and switching controller

Software

- process schematic with controller type selection (manual, continuous controller, two- or three-point controller, programmer)
- time functions
- simulation function
- disturbance variable input

Dimensions and Weight

LxWxH: 600x450x600mm

Weight: approx. 21kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 hose
- 1 GUNT software CD + USB cable
- 1 handbook: fundamentals of control engineering (RT 010 - RT 060)
- 1 manual for RT 020

Order Details

080.02000 RT 020 Training System:
Flow Control, HSI

RT 030 Training System: Pressure Control, HSI


- * **Experimental unit with diaphragm gas pump and pressure tank**
- * **Extensive range of experiments on fundamentals of control engineering**
- * **State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**
- * **Software-based simulation of the controlled system**

Technical Description

This compact experimental unit offers every opportunity to learn the fundamentals of control engineering through experimentation on a pressure control system.

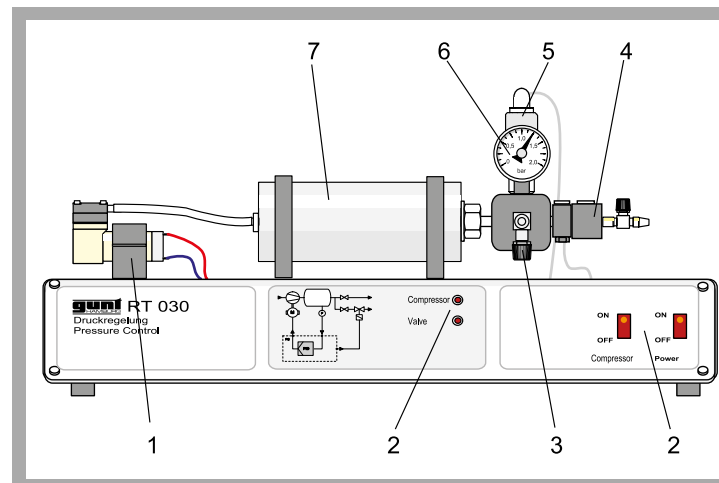
The experimental setup is mounted on a housing which accommodates all the electronics. The pressure tank is charged with compressed air by a diaphragm gas pump. The advantage of the dial-gauge manometer is that the pressure in the tank can be observed directly at any time. The pressure is measured using a pressure sensor. The sensor output signal is sent to the software controller. The output signal from the controller influences the speed of the diaphragm gas pump and hence the flow rate. An air consumer is simulated by way of a flow control valve. A solenoid valve through which air can escape can be activated by the software to investigate the influence of disturbance variables.

The powerful state-of-the-art software is an integral part of the training system, embodying the principle of hardware/software integration (HSI). It enables the experiments to be conducted and evaluated in a user-friendly manner. The software has network capability. The link between the experimental unit and the PC is made via a USB port.

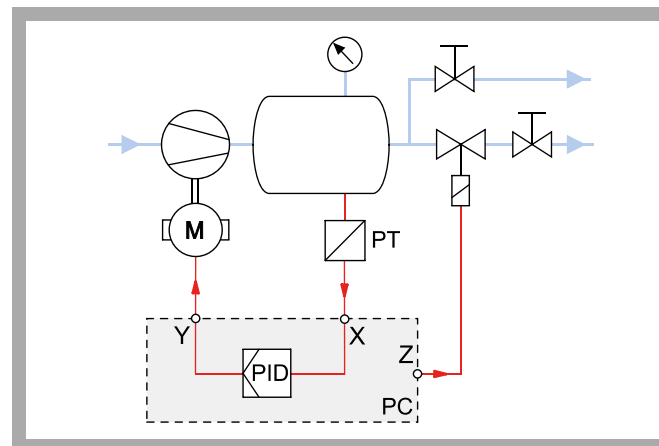
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

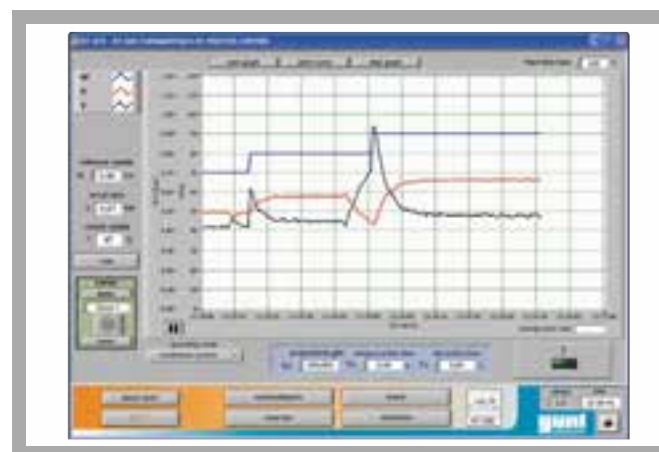
- fundamentals of control engineering based on the example of a pressure control system with PT_1 behaviour
- open loop control response
- effects of different controller parameters and methods on the response of the closed loop system
- recording of step responses
 - * reference variable
 - * disturbance variable
- controller optimisation
- software-based controlled system simulation
 - * comparison of different controlled system parameters

RT 030 Training System: Pressure Control, HSI


1 diaphragm gas pump, 2 displays and controls, 3 drain valve, 4 solenoid valve to generate disturbance variables, 5 pressure sensor, 6 manometer, 7 pressure tank



Process schematic



Software screenshot: continuous P control: a step of the reference variable results in a permanent control deviation

Specification

- [1] experimental unit for control engineering experiments
- [2] pressure control in a tank
- [3] speed controlled diaphragm gas pump
- [4] electronic pressure sensor
- [5] solenoid valve to generate disturbance variables
- [6] software-based controlled system simulation
- [7] process schematic on front panel
- [8] networkable GUNT software via USB under Windows Vista or Windows 7

Technical Data

- Diaphragm gas pump
 - max. flow rate: 3L/min
 - max. positive pressure: 1bar
 - max. negative pressure: 250mbar abs.
- Pressure tank
 - capacity: 400mL
 - operating pressure: 1bar
 - max. pressure: 10bar
- Pressure control range: 0...1bar
- Solenoid valve: Kvs: 0,11m³/h
- Pressure transducer: 0...1bar
- Manometer: 0...1bar
- Software controller configurable as P, PI, PID and switching controller
- Software
 - process schematic with controller type selection (manual, continuous controller, two- or three-point controller, programmer)
 - time functions
 - simulation function
 - disturbance variable input

Dimensions and Weight

- LxWxH: 600x450x340mm
- Weight: approx. 18kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 GUNT software CD + USB cable
- 1 handbook: fundamentals of control engineering (RT 010 - RT 060)
- 1 manual for RT 030

Order Details

- 080.03000 RT 030 Training System: Pressure Control, HSI

RT 040

Training System: Temperature Control, HSI



- * Experimental unit with temperature control system
- * Extensive range of experiments on fundamentals of control engineering
- * Heating and cooling with Peltier element
- * State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions
- * Software-based simulation of the controlled system

Technical Description

This compact experimental unit offers every opportunity to learn the fundamentals of control engineering through experimentation on a temperature control system.

The experimental setup is mounted on a housing which accommodates all the electronics. A metal bar, which is thermally insulated with cladding, is heated or cooled at one end by a Peltier element. Three temperature transducers along the axis of the bar allow the variation in temperature along the length of the bar, and hence the associated thermal lags, to be obtained for differing operating conditions. A dial-gauge thermometer offers the advantage that the temperature can be read off directly at any time. The temperature is measured using a thermal resistor (PTC). The sensor output signal is sent to the software controller. The output signal from the controller influences the operating voltage of the Peltier element and hence the heating capacity. A fan that dissipates part of the heating power can be activated by the software to investigate the influence of disturbance variables.

The powerful state-of-the-art software is an integral part of the training system, embodying the principle of hardware/software integration (HSI). It enables the experiments to be conducted and evaluated in a user-

friendly manner. The software has network capability. The link between the experimental unit and the PC is made via a USB port.

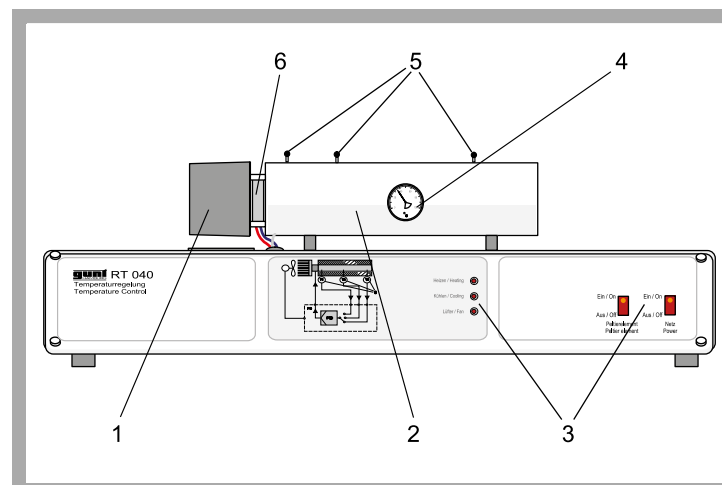
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

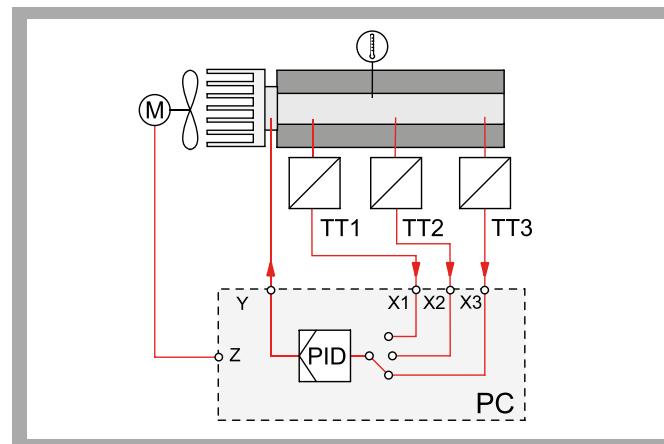
- fundamentals of control engineering based on the example of a temperature control system. System dead time can be obtained from the response
- open loop control response.
- effects of different controller parameters and methods on the response of the closed loop system
- recording of step responses
 - * reference variable
 - * disturbance variable
- controller optimisation
- software-based controlled system simulation
 - * comparison of different controlled system parameters

RT 040

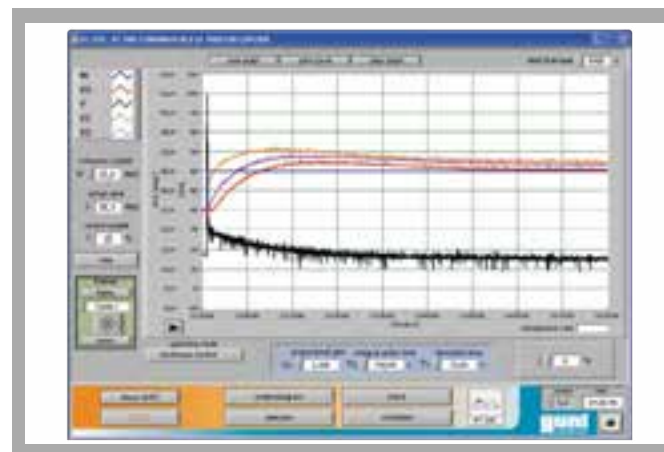
Training System: Temperature Control, HSI



1 fan, 2 bar in cladding tube, 3 displays and controls, 4 thermometer, 5 temperature sensor, 6 heater/cooler



Process schematic



Software screenshot: step response to reference variable with PID controller with non-optimised values for K_p , T_n and T_v

Specification

- [1] experimental unit for control engineering experiments
- [2] temperature control of a heated metal bar
- [3] heating and cooling by Peltier element
- [4] temperature sensors at 3 different points along axis of bar to establish thermal lags
- [5] software activated fan to generate disturbance variables
- [6] software-based controlled system simulation
- [7] process schematic on front panel
- [8] networkable GUNT software via USB under Windows Vista or Windows 7

Technical Data

- Heated bar: DxL: 20x200mm, aluminium
- Peltier element
 - power consumption depending on temperature
 - power at 300K: 38,2W
 - power at 50°C: 44,3W
 - operated by DC voltage
- Fan
 - power consumption: 2W
 - max. flow rate: 40m³/h
- Temperature sensor: 0...100°C
- Thermometer: 0...100°C
- Temperature control range: 0...100°C
- Software controller configurable as P, PI, PID and switching controller
- Software
 - process schematic with controller type selection (manual, continuous controller, two- or three-point controller, programmer)
 - time functions
 - simulation function
 - disturbance variable input

Dimensions and Weight

- LxWxH: 600x450x260mm
- Weight: approx. 16kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 GUNT software CD + USB cable
- 1 handbook: Fundamentals of control engineering (RT 010 - RT 060)
- 1 manual for RT 040

Order Details

- 080.04000 RT 040 Training System:
Temperature Control, HSI

RT 050

Training System: Speed Control, HSI



- * Experimental unit with speed control system
- * Extensive range of experiments on fundamentals of control engineering
- * State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions
- * Software-based simulation of the controlled system

Technical Description

This compact experimental unit offers every opportunity to learn the fundamentals of control engineering through experimentation on a speed control system.

The experimental setup is mounted on a housing which accommodates all the electronics. A transparent protective cover permits safe observation of the experiments. A DC motor drives a shaft with a mass flywheel. The dial gauge allows the speed to be read off directly at any time. The speed is measured inductively using a speed sensor. The output signal from the sensor is sent to the software controller. The output signal from the controller influences the motor current. A generator acting as a mechanical resistance to shaft rotation can be activated by the software to study the influence of disturbance variables.

The powerful state-of-the-art software is an integral part of the training system, embodying the principle of hardware/software integration (HSI). It enables the experiments to be conducted and evaluated in a user-friendly manner. The software has network capability. The link between the experimental unit and the PC is made via a USB port.

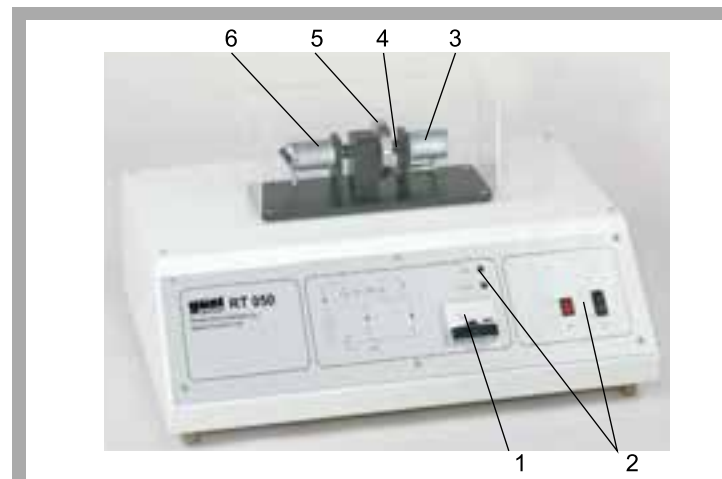
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

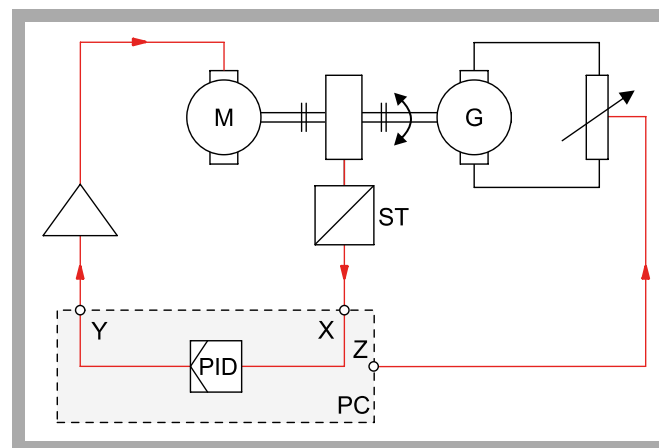
- fundamentals of control engineering based on the example of a speed control system with PT_1 behaviour
- open loop control response
- effects of different controller parameters and methods on the response of the closed loop system
- recording of step responses
 - * reference variable
 - * disturbance variable
- controller optimisation
- software-based controlled system simulation
 - * comparison of different controlled system parameters

RT 050

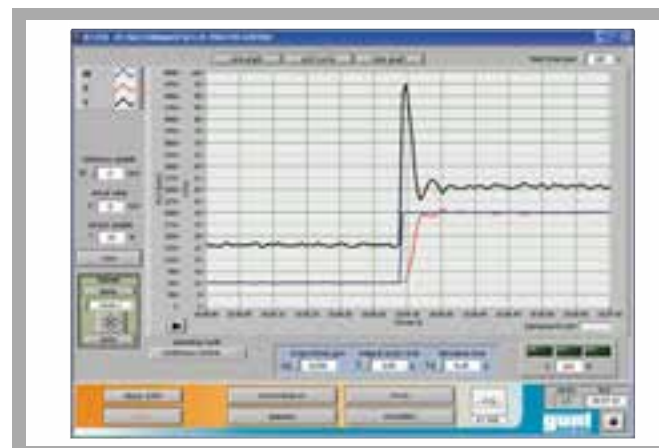
Training System: Speed Control, HSI



1 tachometer, 2 displays and controls, 3 generator, 4 speed sensor, 5 rotor, 6 motor



Process schematic



Software screenshot: step response to change in reference variable with PID controller (acceptable control quality)

Specification

- [1] experimental unit for control engineering experiments
- [2] speed control of a DC motor with shaft and flywheel
- [3] transparent protective cover for motor/generator set
- [4] inductive speed sensor
- [5] generation of disturbance variables by adjustable generator load
- [6] software-based controlled system simulation
- [7] process schematic on front panel
- [8] networkable GUNT software via USB under Windows Vista or Windows 7

Technical Data

Motor

- max. speed: 4500min^{-1}
- max. motor power output: 10W
- max. torque: $1,7\text{Ncm}$

Generator

- max. speed: 4500min^{-1}
- max. power output: 10W
- max. torque: $1,7\text{Ncm}$

Tachometer (analogue): $0 \dots 6.000\text{min}^{-1}$

Software controller configurable as P, PI and PID controller

Software

- process schematic with controller type selection (manual, continuous controller, programmer)
- time functions
- simulation function
- disturbance variable input

Dimensions and Weight

LxWxH: $600 \times 450 \times 310\text{mm}$

Weight: approx. 18kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 GUNT software CD + USB cable
- 1 handbook: fundamentals of control engineering (RT 010 - RT 060)
- 1 manual for RT 050

Order Details

080.05000 RT 050 Training System:
Speed Control, HSI

RT 060 Training System: Position Control, HSI

- * Experimental unit with clear linear position control system
- * Extensive range of experiments on fundamentals of control engineering
- * State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions
- * Software-based simulation of the controlled system

Technical Description

This compact experimental unit offers every opportunity to learn the fundamentals of control engineering through experimentation on a linear position control system.

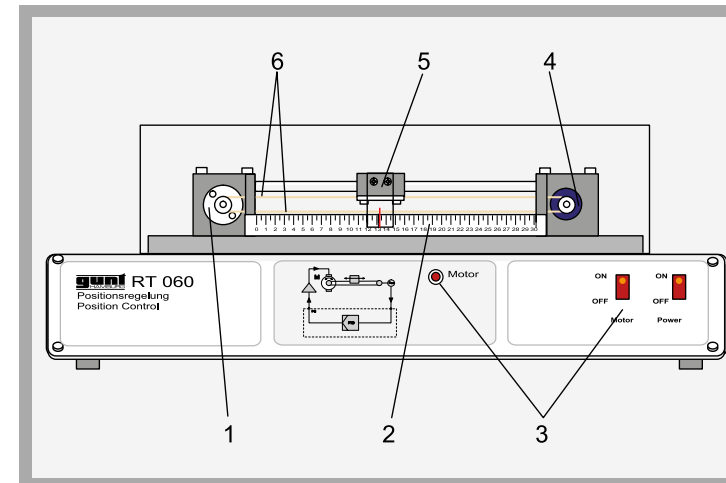
The experimental setup is mounted on a housing which accommodates all the electronics. A transparent protective cover permits safe observation of the experiments. A carriage can be moved by a DC motor via a toothed belt. The linear positioning is measured by a rotary encoder and delivered as a voltage signal. The output signal from the sensor is sent to the software controller. The output signal from the controller influences the motor current. The motor is automatically shut down if the carriage reaches one of the two end positions.

The powerful state-of-the-art software is an integral part of the training system, embodying the principle of hardware/software integration (HSI). It enables the experiments to be conducted and evaluated in a user-friendly manner. The software has network capability. The link between the experimental unit and the PC is made via a USB port.

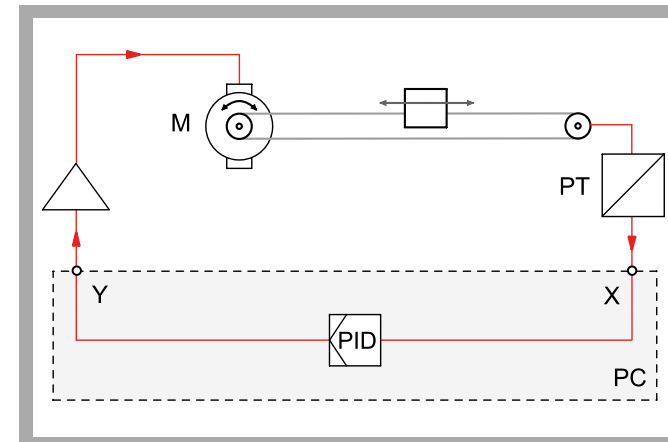
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

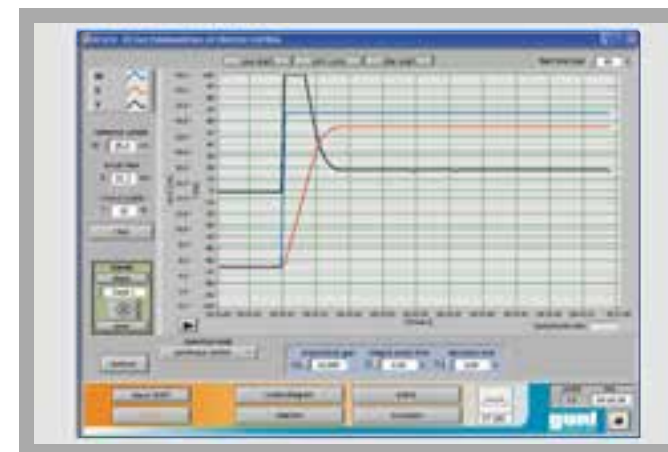
- fundamentals of control engineering based on the example of a linear position control system with integral control action
- open loop control response
- effects of different controller parameters and methods on the response of the closed loop system
- recording of step responses
 - * reference variable
- controller optimisation
- software-based controlled system simulation
 - * comparison of different controlled system parameters

RT 060 Training System: Position Control, HSI

1 motor, 2 scale, 3 displays and controls, 4 rotary encoder, 5 carriage, 6 toothed belt



Process schematic



Software screenshot: step response to change in reference variable with P controller (permanent control deviation)

Specification

- [1] experimental unit for control engineering experiments
- [2] linear position control of carriage with linear drive and gear motor
- [3] rotary encoder as displacement sensor
- [4] transparent protective cover
- [5] 2 microswitches to shut down at end positions
- [6] software-based controlled system simulation
- [7] process schematic on front panel
- [8] networkable GUNT software via USB under Windows Vista or Windows 7

Technical Data

- DC motor
- transmission ratio: $i=50$
- speed: 85min^{-1}
- torque: 200Nm
- Travel: max. 300mm
- Max. traverse rate: 45mm/s
- Scale: $0\ldots 300\text{mm}$
- Software controller configurable as P, PI, PID
- Software
- process schematic with controller type selection (manual, continuous controller, programmer)
- time functions
- simulation function

Dimensions and Weight

- LxWxH: $600 \times 450 \times 280\text{mm}$
- Weight: approx. 20kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 GUNT software CD + USB cable
- 1 handbook: fundamentals of control engineering (RT 010 - RT 060)
- 1 manual for RT 060

Order Details

080.06000 RT 060 Training System:
Position Control, HSI

INSTRUCTIONAL MATERIAL AND SOFTWARE

GUNT's policy is:

High-quality hardware and clearly laid-out instructional materials ensure the teaching and learning success of an experimental unit. The core elements of the instructional material provided to accompany the units are reference experiments conducted by ourselves. The description of the experiment incorporates the detailed set-up, through to interpretation of the results obtained. A group of experienced engineers devise and maintain the accompanying instructional material.

Our software – in our context meaning computerised data acquisition programs – always comes with comprehensive online help to explain the features offered the detailed use of the program. GUNT software is developed and written in-house by another group of experienced engineers.



FUNDAMENTALS OF CONTROL ENGINEERING



*Simple, quickly understandable controlled system models
with extensive software functions*

Temperature

Level

Flow

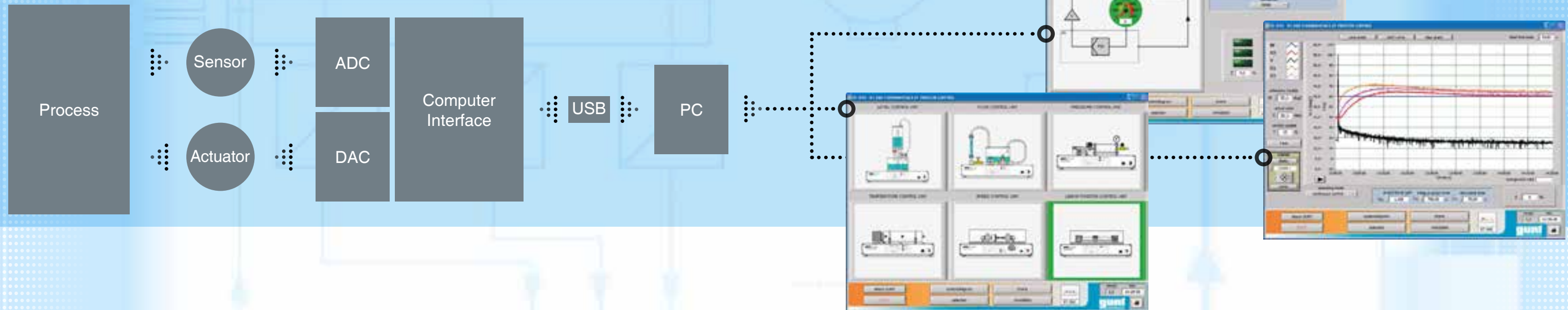
Pressure

Speed

Position

THE SERIES PROVIDING AN EASY INTRODUCTION TO A COMPLEX SUBJECT

The Equipment Concept with Hardware/Software Integration (HSI)



Hardware

- :: Compact, space-saving benchtop models
- :: Typical controlled systems from the field of process control
- :: Imprinted process schematic enables easy assignment of control parameters
- :: High level of observability of processes based on transparent elements (covers, tanks, lines)
- :: Ideally suited to multi-user applications
- :: Easy switching from unit to unit by USB connection



RT 010 Level Control

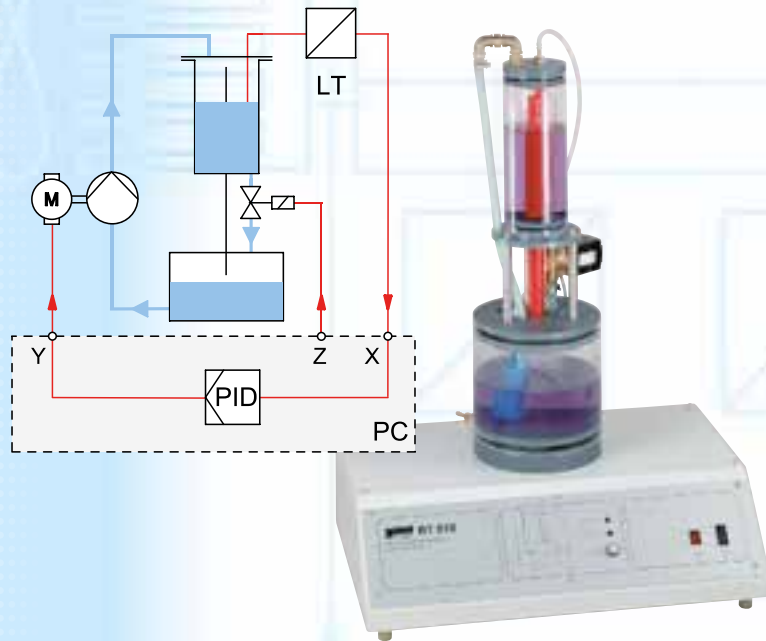
Software

- :: State-of-the-art control and data acquisition software based on LabVIEW for Windows
- :: Software controller in real time, with selection of controller type
 - :: Continuous: P, PI, PD, PID
 - :: Switching: 2-point, 3-point
- :: Display and storage of all process variables
- :: Recording and evaluation of step responses for system identification
- :: Editing of step responses by filtering and decimation
- :: Simulation of controlled systems
- :: Programmable run of reference variable with tolerance band setting
- :: Network capability
- :: Language selectable

The Hardware: Demonstration of Control Processes Based on Real Controlled System Models

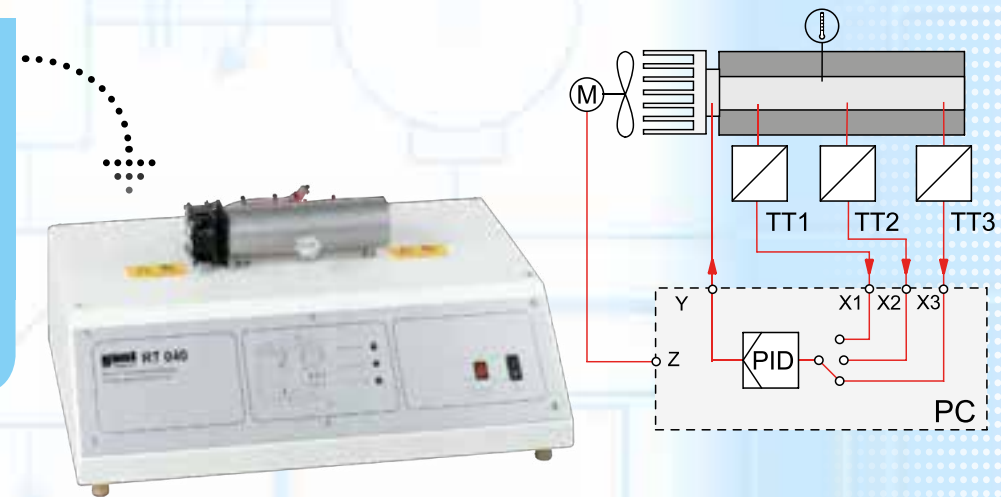
RT 010 Level Control

- Level recording by pressure sensor
- Level control by speed of pump
- Electromagnetic valve to generate disturbance variables



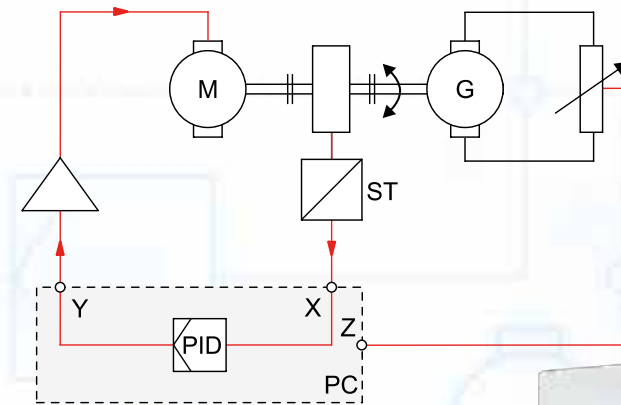
RT 040 Temperature Control

- Temperature sensors at three positions
- Heating and cooling of a metal bar by Peltier element
- Switchable fan to generate disturbance variables



RT 020 Flow Control

- Turbine wheel flow sensor
- Electromagnetic proportional valve as actuator
- Variable pump speed to generate disturbance variables



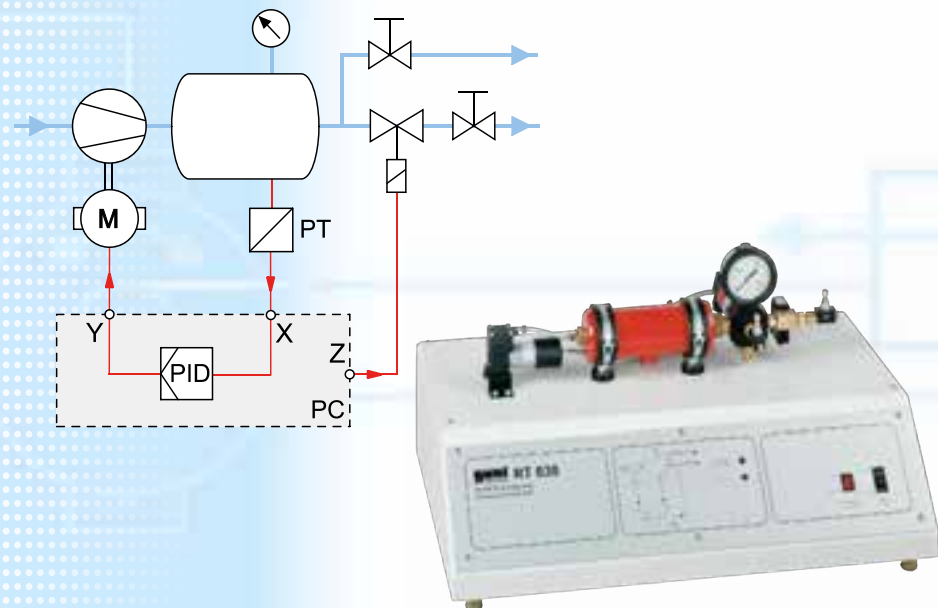
RT 050 Speed Control

- Inductive speed sensor
- Speed control by DC motor
- Adjustable load to generate disturbance variables



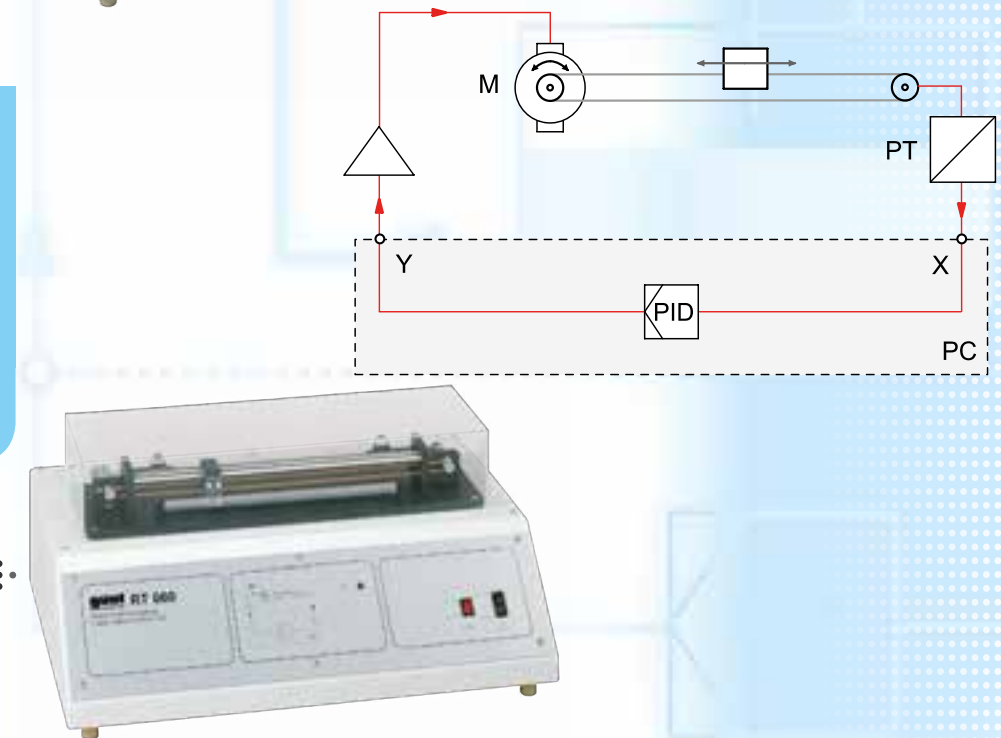
RT 030 Pressure Control

- Electronic pressure sensor
- Speed controlled diaphragm pump as actuator
- Solenoid valve to generate disturbance variables

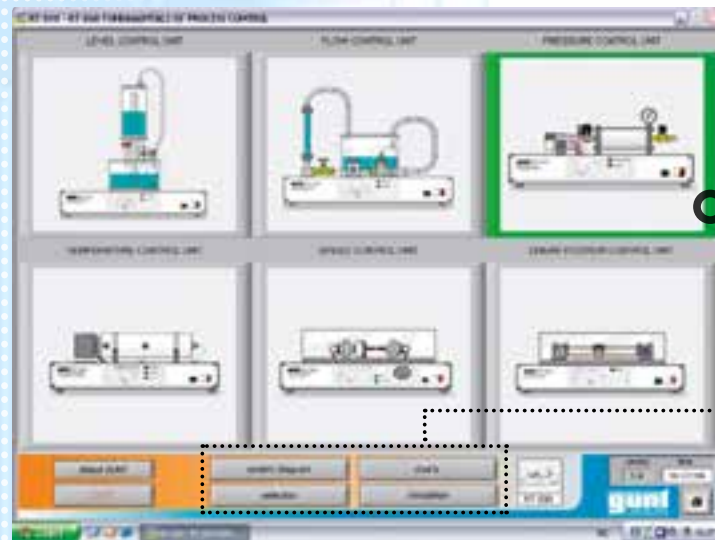


RT 060 Position Control

- Rotary encoder as displacement sensor
- Position control of a carriage by gear motor
- Two microswitches to shut down at end positions

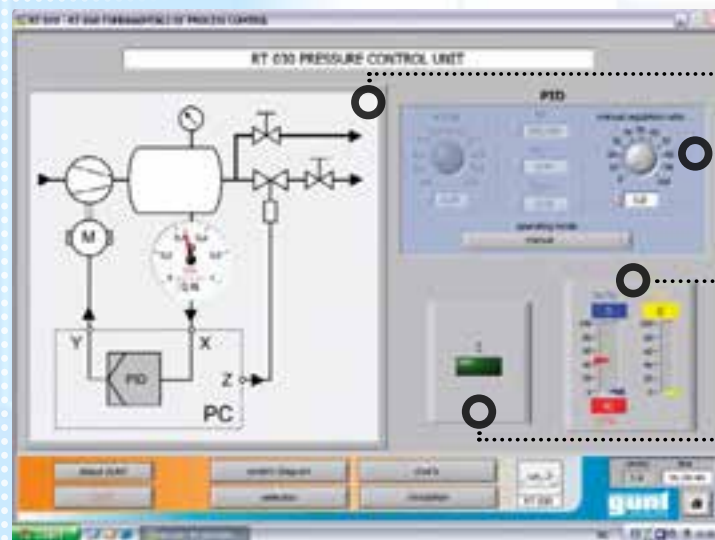


The Software: Easy Operation with Selectable User Interfaces



Unit Selection

- :: One software package for all units of the series
- :: Preferred unit selected by mouse-click
- :: Active unit indicated by green frame
- :: Selection of additional user interfaces for the active unit



Process Schematic

- :: Process schematic of selected unit
- :: Control panel for selection of controller type and input of controller parameters
- :: Display of real-time data
- :: Generation of disturbance variable



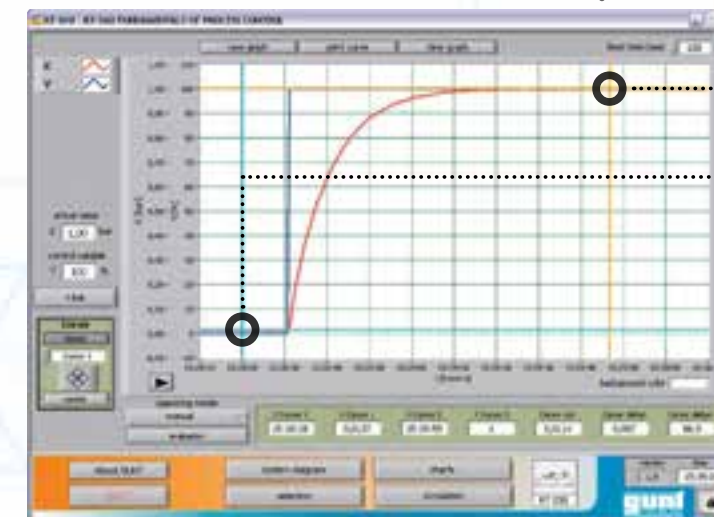
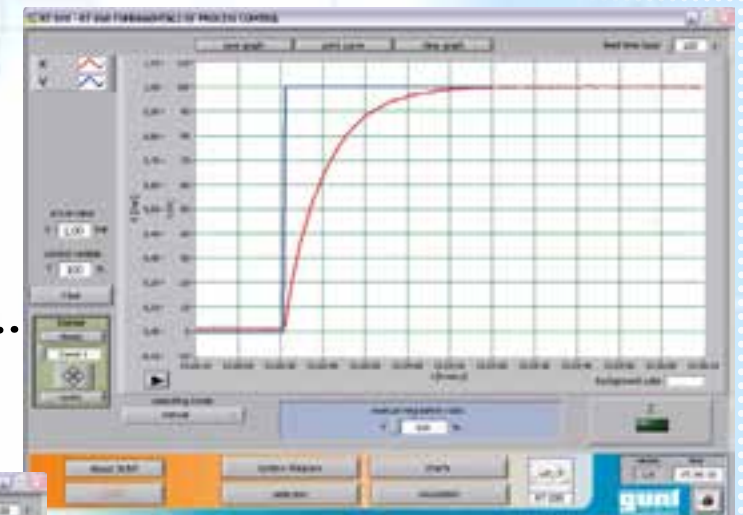
Control behaviour of a PID controller with non-optimised adaptation of controller parameters

Variations in Time

- :: Representation of control parameters as a function of time
- :: Reference variable (yellow)
- :: Controlled variable (red)
- :: Manipulating variable (green)
- :: Freely selectable colours of backgrounds and lines

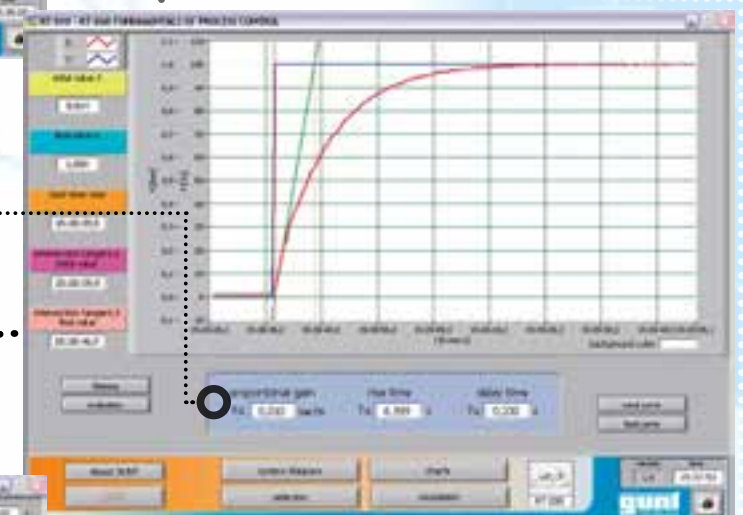
Identification of a Real Controlled System and Adaptation of Controller Parameters

- Recording of step response :: (pressure controlled system RT 030)
- :: Manipulating variable in blue
- :: Controlled variable in red



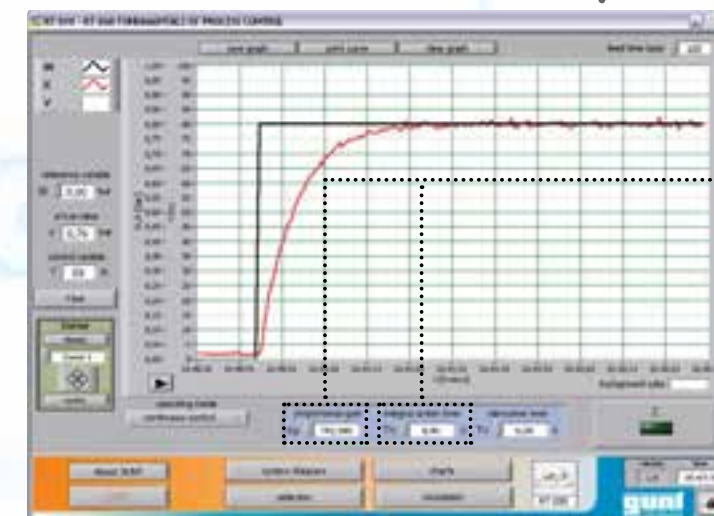
- :: Positioning of cursors before and after the controlled variable step as preparation for inflectional tangent method

- Automatic identification of controlled system :: by inflectional tangent method
- Output of controlled system parameters ::



Parameter setting of a PI controller

- :: Calculation of gain and integral-action time from determined controlled system parameters
- :: Observation of control behaviour of this controller after reference variable step
- :: Reference variable in black
- :: Controlled variable in red

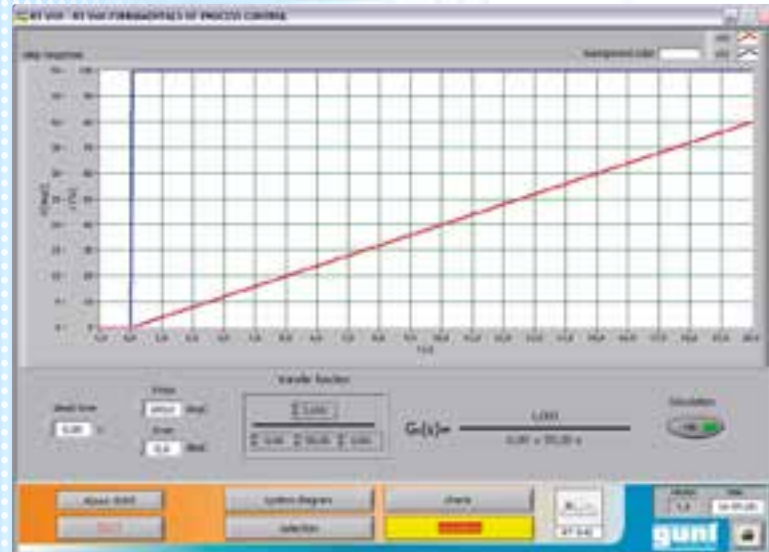


Simulation of Controlled Systems

The software features a simulation mode. This mode enables to also study controlled systems not covered by the real units.

Real controlled systems usually have complex properties. The simulation mode enables elemental transfer functions to be entered and investigated.

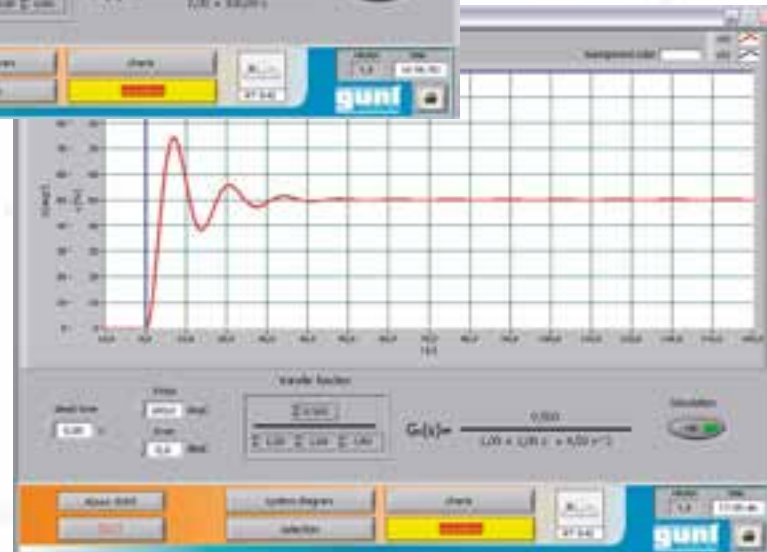
It is therefore possible to teach the fundamentals of control engineering in a simple way.



Integral behaviour



PT₁ behaviour



PT₂ behaviour

Features of the Simulation Mode

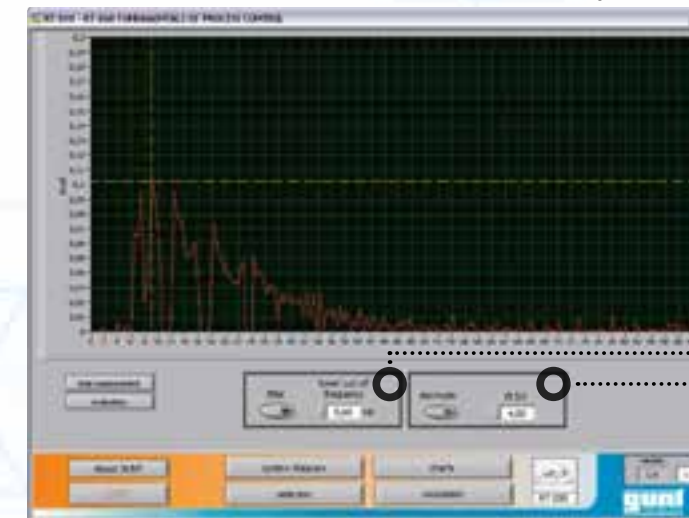
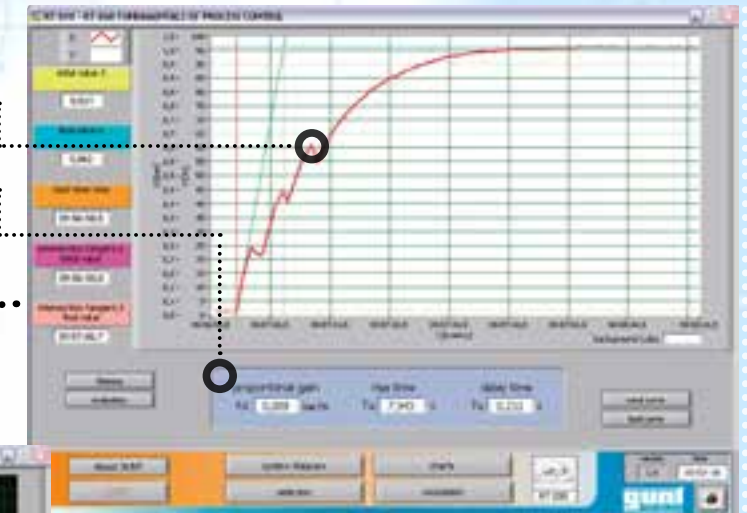
- :: In simulation mode, the controlled system is defined by input of a transfer function
- :: Step response of the simulated controlled system is automatically displayed
- :: All software controller types can be applied to the simulated controlled system
- :: The behaviour of the simulated controlled system can be investigated in the same way as that of a real controlled system

Editing of Step Responses by Filtering and Decimation

Identification of a real controlled system (RT 030) by the inflectional tangent method

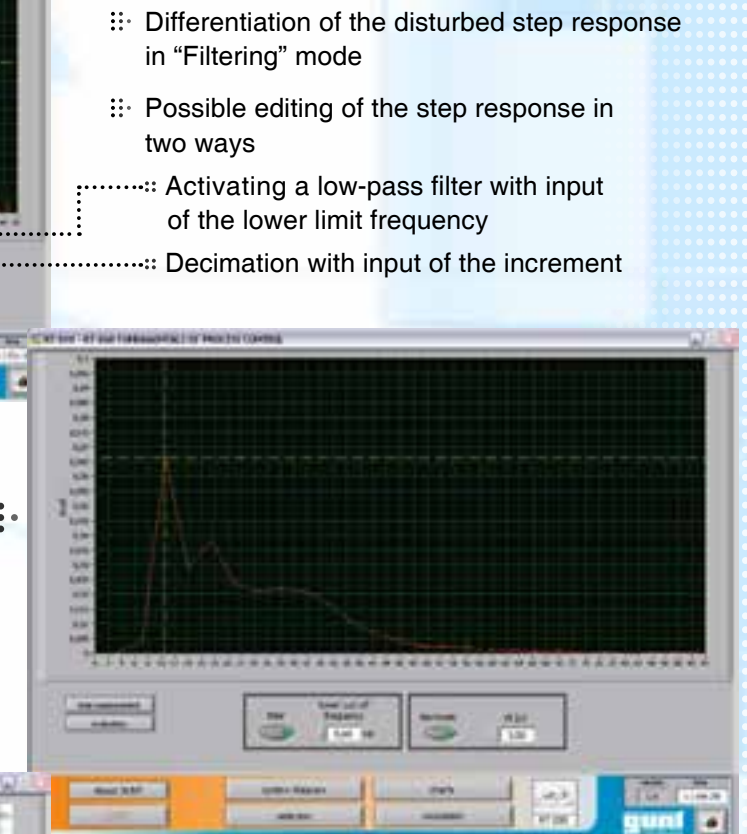
During recording of the step response a disturbance was repeatedly generated

The determined controlled system parameters characterise the disturbed controlled system



Differentiation of the step response after activating the low-pass filter and decimation

- :: Reduction of amplitudes by the low-pass filter
- :: Use of selected measured values (decimation)



Step response with inflectional tangent after activating the low-pass filter and decimation

- :: Run of a curve is smoother compared to the unedited step response
- :: The new run of a curve causes a change in the determined controlled system parameters

Easy Switching in between the Units of this Series

- ⌘ **ONE** software for **ALL** units
- ⌘ **USB** connection

The **RT 030 Pressure Control** unit is still running.



The USB cable is removed from the **RT 030** and connected to the **RT 010**.

In the software window „unit selection“, a mouse-click is all it takes to switch from **RT 030** to **RT 010**.



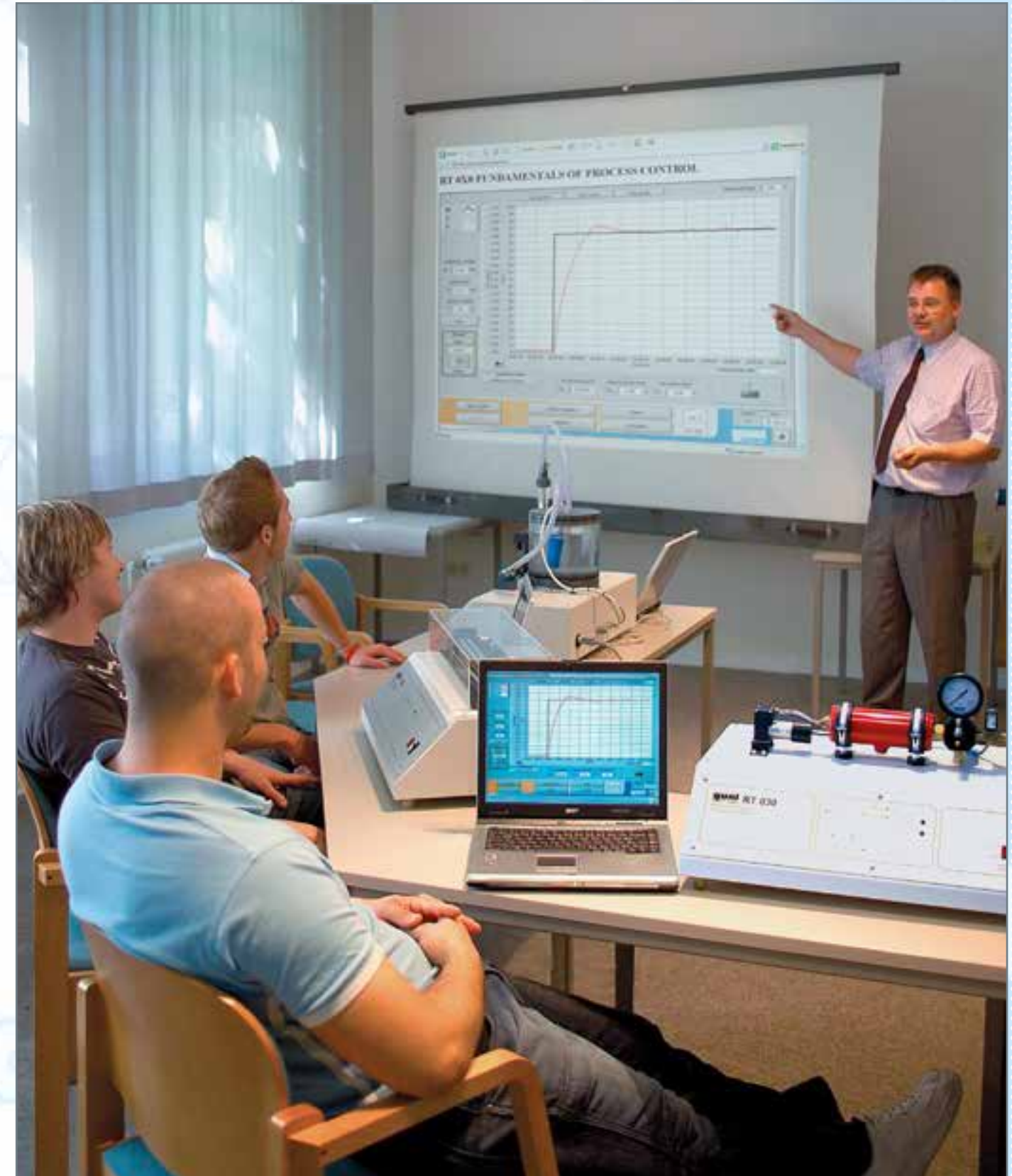
The green frame indicates the active unit.

Now the **RT 010 Level Control** unit can be used.



Access to Single-User Workstations via Local Network

- ⌘ Highlighting of Processes in the Individual Experiments
- ⌘ Possibility to Discuss Individual Results in the Group



Teaching scenario: The tutor highlights an interesting variation in time occurring on the **RT 030 Pressure Control** unit to explain it to the whole group.

RT 200

Room Temperature Control



Technical Description

This experimental unit aids introduction to industrial control engineering. The objective is to control the temperature in a virtual room. The individual components of this temperature control loop are laid out separately on panels. They are inserted in the frame and interconnected by cables.

The controlled system is a soldering iron. The soldering iron represents the heater in the virtual room. The room, with a temperature sensor, is mapped out on the panel as an aid to understanding. The real temperature sensor is a thermocouple on the tip of the soldering iron. The transducer converts the temperature signal from the thermocouple into a standard voltage signal. This signal is sent to the input of an industrial controller. There the signal is compared against the reference variable. The controller sends a signal corresponding to the variation (manipulating variable) to the actuator. The actuator is a power controller which influences the electrical power to the soldering iron.

To generate disturbance variables, metal plates with differing thermal conductivities can be attached to the soldering iron. The industrial controller is parameterisable as a P, PD, PI or PID controller. It can also function as a two-point controller. The controlled variable (virtual room temperature) and the manipulating variable are displayed digitally.

A line recorder (RT 200.01) is available as an accessory to record the control processes.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

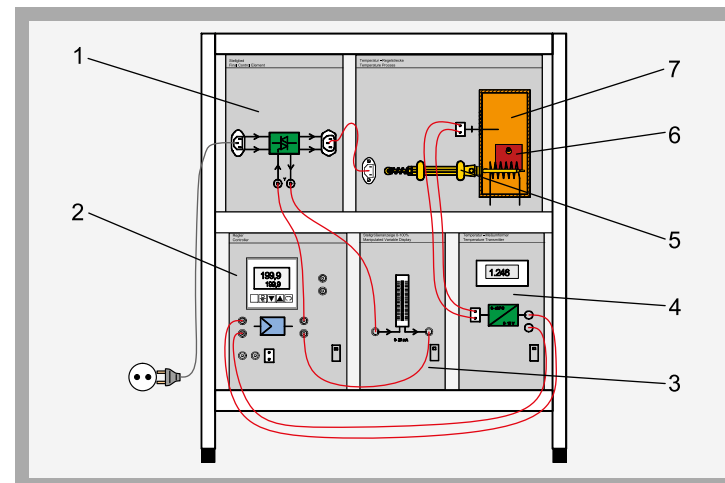
Learning Objectives / Experiments

- components of a control loop
- operation and parameterisation of an industrial controller
- comparison of various controller types
 - * P, PD, PI and PID controllers
 - * two-point controller
- layout of control loops
 - * open control loop
 - * closed control loop
- disturbance feedforward control

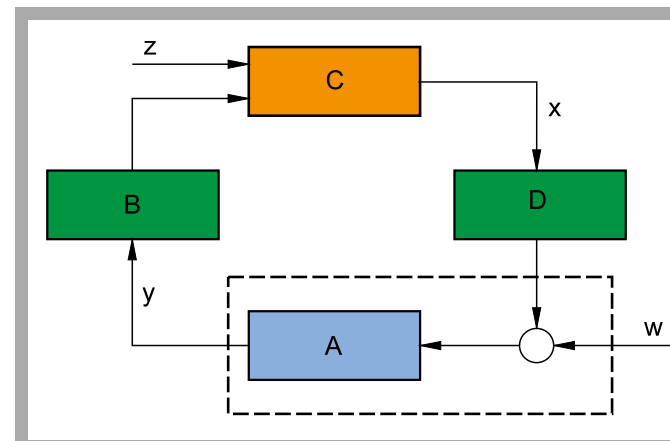
- * Introduction to industrial control engineering
- * Simple temperature control loop with parameterisable industrial controller
- * Control loop components laid out separately on panels
- * Layout of control loops

RT 200

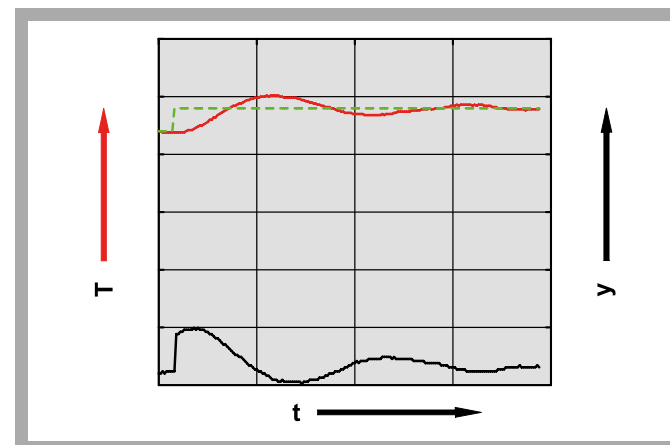
Room Temperature Control



1 power controller, 2 controller, 3 manipulating variable bar display, 4 transducer, 5 soldering iron, 6 metal plate, 7 implied heating room



A controller, B actuator (power controller), C controlled system (soldering iron), D thermocouple and transducer; y manipulating variable, w reference variable, x controlled variable, z disturbance variable



Control response with a PI controller: Characteristic curves of the controlled variable (red), reference variable (green) and manipulating variable y (black); T temperature, t time

Specification

- [1] investigation of a temperature control loop
- [2] control loop components on panels allowing for variation in installation in frame
- [3] soldering iron as controlled system
- [4] power controller as actuator
- [5] parameterisable digital industrial controller
- [6] thermocouple type K as temperature sensor
- [7] transducer for thermocouple with digital temperature display
- [8] bar display for manipulating variable
- [9] 2 metal plates with differing thermal conductivities for disturbance generation
- [10] line recorder (RT 200.01) available as accessory

Technical Data

- Soldering iron power output: 16W
Controller
- input signals: 0/4...20mA and 0...10V
 - output signals: 0...20mA
 - parameterisable as
 - P, PI or PID controller
 - 2-point controller
- Power controller
- output power: 0...16W
 - input signal: 0...20mA
- Thermocouple and transducer
- measuring range: 0...400°C
 - output signal: 0...10VDC
- 2 metal plates for disturbance generation
- stainless steel
 - copper

Dimensions and Weight

LxWxH: 800x500x840mm
Weight: approx. 38kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 frame
- 1 panel, controlled system
- 1 panel, actuator
- 1 panel, controller
- 1 panel, transducer
- 1 panel, bar display
- 2 metal plates
- 1 set of cables
- 1 set of instructional material

Order Details

080.20000 RT 200 Room Temperature Control

2 COMPONENTS AND CALIBRATION

SENSORS / METROLOGY

CODE	PRODUCT	PAGE
IA 110	Calibrating a Pressure Sensor	42
Overview	HM 500 + Accessories: Methods of Flow Rate Measurement	44
HM 500.01	Rotameter	44
HM 500.06	Venturi Nozzle	44
HM 500.03	Rotameter with Transducer	45
HM 500.04	Electromagnetic Flow Meter	45
HM 500.05	Ultrasonic Flow Meter	45
HM 500.07	Pitot Tube	45
HM 500.08	Orifice Plate Flow Meter	45
HM 500.09	Measuring Nozzle	45
HM 500.10	Paddle Wheel Flow Meter	45
HM 500.11	Vortex Flow Meter	45
HM 500.13	Orifice Plate Flow Meter with Transducer	45
HM 500.14	Turbine Wheel Flow Meter	45
HM 500.15	Bypass Flow Meter	45
HM 500.16	Baffle Plate Flow Meter	45
HM 500	Flow Meter Trainer	46

ACTUATORS

CODE	PRODUCT	PAGE
RT 395	Maintenance of Valves and Fittings and Actuators	48
RT 396	Pump and Valves and Fittings Test Stand	50
RT 390	Test Stand for Control Valves	52

CONTROLLERS, CONTROLLED SYSTEMES, NETWORKING

CODE	PRODUCT	PAGE
Overview	RT 350 - RT 380 Experimental Units for Process Automation	54
RT 350	Operation of Industrial Controllers	56
RT 360	Networking of Industrial Controllers	58
RT 370	Setup of Field Bus Systems	60
RT 380	Optimization of Control Loops	62

In focus: Control loop components

In a control loop each component is assigned its specific task:

Sensors are used to measure the controlled variables. **Transducers** transform the output variables from the sensors into standard signals which can be processed by the controller. In the **controller** the measured variable signal is compared against the reference variable signal. The controller sends a signal corresponding to the control difference to the actuator. The **actuator** directly influences the process, meaning it changes the controlled variable.

In many cases the individual control loop components may themselves have complex behaviour. In view of that, it is useful to learn and investigate the function and transmission behaviour of each individual component.

This chapter covers the following learning content:

- Mode of operation of control loop components
 - ▶ sensors
 - ▶ actuators
 - ▶ controllers
 - ▶ transducers
- Different signal types
- Different forms of auxiliary power
- Identification of the transmission behaviour of control loop components
- Calibration of control loop components

MODULAR CALIBRATION SYSTEMS

CODE	PRODUCT	PAGE
Overview	RT 310 Working with the Calibration Station	64
RT 300.02	Differential Pressure Transmitter, Pneumatic	64
RT 300.21	Differential Pressure Transmitter, Electronic	64
RT 300.26	24VDC Motorised Valve with Resistance Teletransmitter	64
RT 310	Calibration Station	66
RT 304	Calibration Trainer	68
Overview	Accessory for RT 310 and RT 304	70



IA 110

Calibrating a Pressure Sensor



- * Test-pressure generated with dead-weight piston manometer
- * Electronic pressure sensor with ceramic measuring cell
- * Plotting a calibration curve
- * Compact experimental unit for group working or demonstration

Technical Description

The experimental unit IA 110 can be used to calibrate an electronic pressure sensor under practical conditions.

The test pressure is generated with a conventional piston manometer. The piston is loaded with weight rings and generates a defined test pressure $p = F_w/A_p$, where F_w is the force due to the weights and A_p is the cross-sectional area of the piston. A hand-operated spindle is used to relieve the pressure after measurement allowing the piston to return to a rest position. The influence of friction is minimised by rotating the piston during measurement. The test pressure generated in this way is applied to the diaphragm of a pressure sensor. The pressure-dependent electrical output signal is indicated on a digital display.

The pressure sensor used is a state-of-the-art ceramic measuring cell, in which strain-dependent piezo resistors are mounted on a ceramic diaphragm. The resistors are configured to form a measuring bridge. An integrated amplifier circuit evaluates the pressure-dependent detuning of the measuring bridge and outputs a proportional voltage signal.

The kit also includes a second pressure sensor in the form of a cutaway model for enhanced clarity. The entire experimental unit is contained in a compact housing, and is easy to handle.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

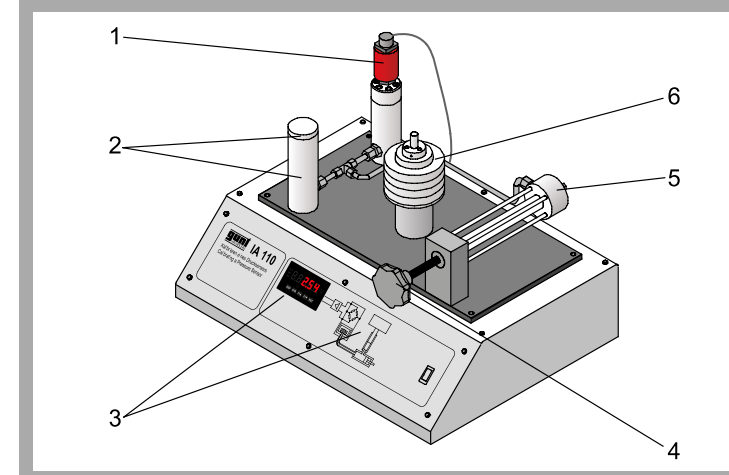
Learning Objectives / Experiments

- familiarisation with, and carrying out of the calibration of an electronic pressure sensor
- plotting the sensor output signal dependent on the pressure applied
- familiarisation with the design and operation of a piezo-resistive electronic pressure sensor
- familiarisation with the installation and connection of the pressure sensor
- information on applications, measuring ranges and accuracies of typical electronic pressure sensors

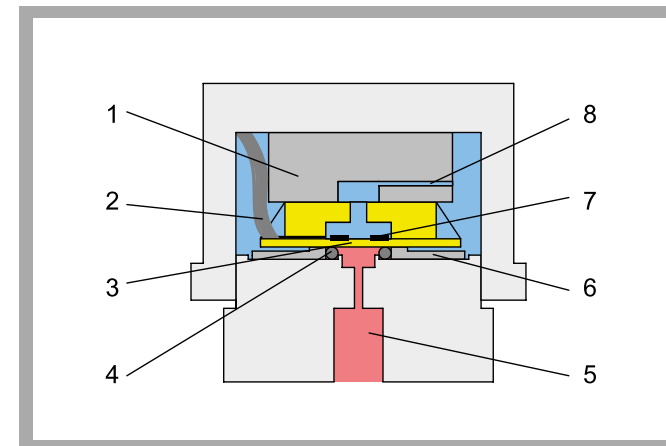
G.U.N.T. Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web <http://www.gunt.de>
We reserve the right to modify our products without any notifications.

IA 110

Calibrating a Pressure Sensor



1 pressure sensor being calibrated, 2 cylinder with cover to receive the loading device, 3 digital display for displaying the output signal and process schematic, 4 manual adjustment spindle for compensating cylinder, 5 compensating cylinder, 6 holder for weight carrier with piston and weights



1 brace, 2 connecting cable, 3 ceramic measuring cell with diaphragm, 4 sealing ring, 5 pressure connection, 6 pressure plate, 7 piezo resistors, 8 pressure equalisation bore for relative pressure measurement



Interior layout of an electronic pressure sensor

Specification

- [1] calibration unit with dead-weight piston manometer and hand-operated spindle
- [2] electronic pressure sensor with ceramic measuring cell, integrated amplifier and voltage output
- [3] digital display for output signal
- [4] additional pressure sensor as cutaway model
- [5] set of weights
- [6] transmission medium: hydraulic oil
- [7] process schematic on front panel

Technical Data

Pressure sensor
- measuring range: 0...2,5bar
- supply: 24VDC
- output signal: 0...10VDC

Piston manometer with pressure piston

- diameter: 12mm
- number of weights: 5
- pressure graduations: 0,5 - 1,0 - 1,5 - 2,0 - 2,5bar

Digital display: 4 1/2 digits

Hydraulic oil: HLP ISO 32

Dimensions and Weight

LxWxH: 600x450x450mm
Weight: approx. 20kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 set of weights
- 1L hydraulic oil
- 1 cutaway model of pressure sensor
- 1 set of instructional material

Order Details

058.11000 IA 110 Calibrating a Pressure Sensor

G.U.N.T. Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web <http://www.gunt.de>
We reserve the right to modify our products without any notifications.

HM 500 + ACCESSORIES

METHODS OF FLOW RATE MEASUREMENT

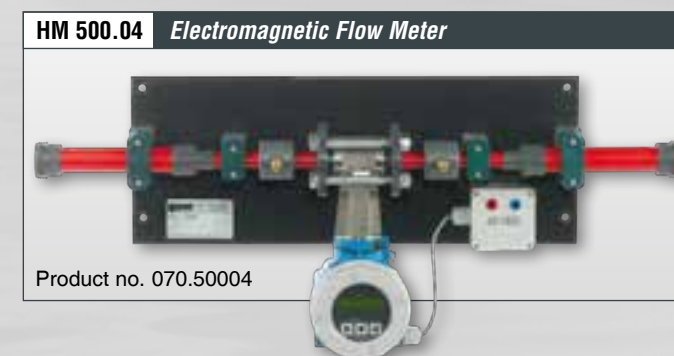
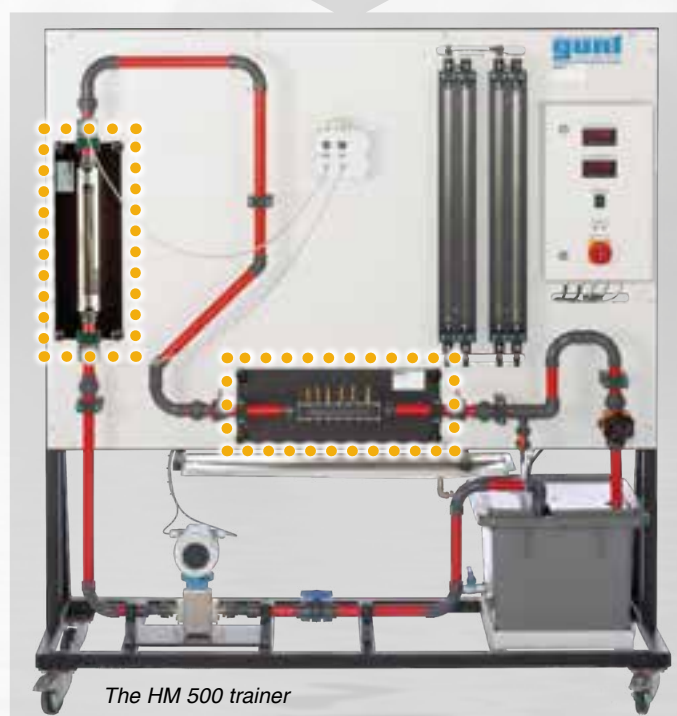
Properties and applications of different flow meters

The extensive range of accessories for the HM 500 trainer offers the opportunity to learn about many different types of flow meter. They can be quickly and easily installed in the HM 500 trainer.

Students learn about the fields of applications of the various instruments. In practice, the working medium, the accuracy demands imposed and the commercial considerations play an important role. Knowledge of the pressure losses of the different instruments is necessary for their application. Therefore, each instrument for the HM 500 trainer is equipped with connections for measuring the pressure loss. The instruments are connected to the trainer via hoses. The pressure losses are displayed on the trainer accordingly.

The comprehensive instructional materials cover the principle of operation of each flow meter including the theoretical basis. In this way students are familiarised with measurement accuracy and the differences between the measurement principles. Practical experiments make it possible to apply and review the acquired knowledge.

If required, the measuring devices can be powered by the trainer.



ALSO AVAILABLE:

- HM 500.03 Rotameter with Transducer
Product no. 070.50003
- HM 500.14 Turbine Wheel Flow Meter
Product no. 070.50014
- HM 500.15 Bypass Flow Meter
Product no. 070.50015

HM 500 Flow Meter Trainer


- * Comparison and calibration of different flow meters
- * Plotting of pressure loss curves
- * Numerous flow meters available as accessories

Technical Description

Flow measurement plays a key role in many process engineering systems. Different flow meters are used for this, depending on the medium and application.

The HM 500 trainer is used to examine different principles of operation of flow meters. The flow meters are available as accessories (HM 500.01-HM 500.16). Pressure loss curves and accuracies can be compared to determine which flow meter is suitable for which area of application.

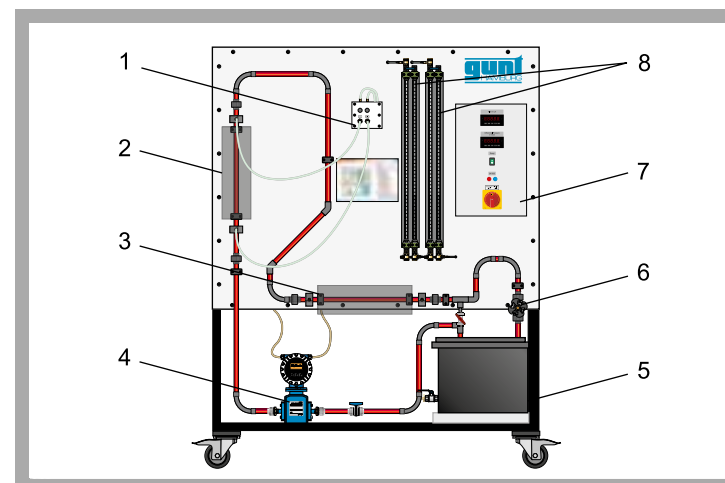
One horizontally or vertically installed flow meter can be operated in a closed water circuit. The flow rate can be adjusted via a valve. A high-precision electromagnetic flow rate sensor is available as a reference for calibrating the flow meters.

To be able to determine the pressure losses of the various flow meters, the trainer is equipped with two twin tube manometers and a differential pressure sensor. A DC voltage source ensures the power supply to the flow meters if required.

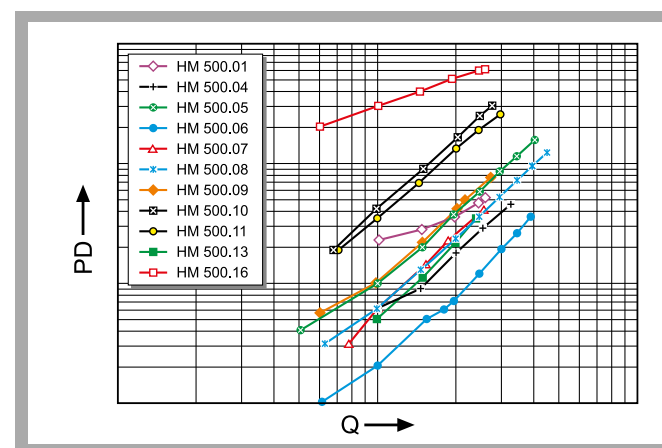
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

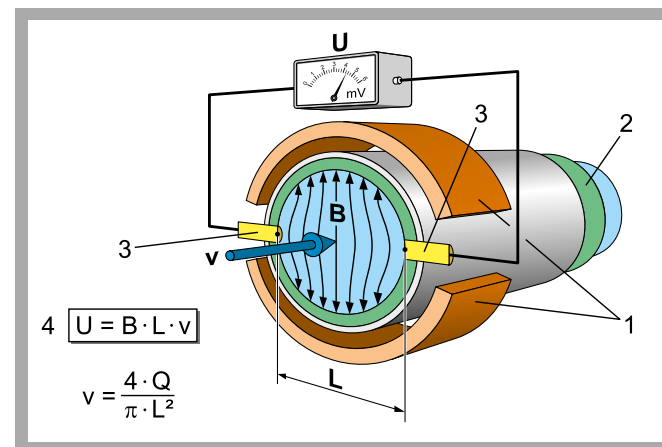
- together with different flow meters available as accessories
- different flow meters and their principles of operation
 - calibration of different flow meters
 - position dependency of flow meters
 - plotting and comparison of pressure loss curves

HM 500 Flow Meter Trainer


1 differential pressure sensor, 2 vertical measuring location with HM 500.10, 3 horizontal measuring location with empty tube, 4 electromagnetic flow rate sensor, 5 tank with pump, 6 valve to adjust flow rate, 7 switch cabinet, 8 twin tube manometers



Pressure loss (PD) dependent on the flow rate (Q) for the flow meters available as accessories



Measurement principle of the electromagnetic flow rate sensor:
1 magnet, 2 insulation, 3 electrode, 4 Faraday's Law of Induction;
B magnetic flux density, L electrode gap, Q flow rate, U induced voltage,
v flow velocity of medium (blue)

Specification

- [1] comparison and calibration of different flow meters
- [2] water circuit with tank, pump and valve to adjust flow rate
- [3] 2 measuring locations for vertical or horizontal installation of the flow meters under test
- [4] electromagnetic flow rate sensor for reference measurement
- [5] 1 differential pressure sensor and twin tube manometers for measurement of pressure losses
- [6] DC voltage source to supply the flow meters with auxiliary power
- [7] flow meters available as accessories

Technical Data

- Tank: approx. 55L
Pump
- max. flow rate: approx. 225L/min
- max. head: approx. 11m
DC voltage source
- voltage: 24VDC
- current: 2,0A
Accuracy of electromagnetic flow rate sensor
- 0.5% of final value

Measuring ranges

- flow rate (reference): 0...4760L/h
- differential pressure sensor: 0...2bar
- twin tube manometers: 0...680mmWC

Dimensions and Weight

- LxWxH: 1770x670x1880mm
Weight: approx. 110kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 trainer
- 1 set of hoses
- 1 set of cables
- 1 set of instructional material

Order Details

070.50000 HM 500 Flow Meter Trainer

RT 395 Maintenance of Valves and Fittings and Actuators

The illustration shows RT 395 with 3 of 4 fittings (segmented ball valve not shown).

- * **Trainer for maintenance work on industrial valves and fittings**
- * **Comparison of 4 different actuators**

Technical Description

Various types of valves and fittings are used in industry. They are suitable for gaseous and liquid media.

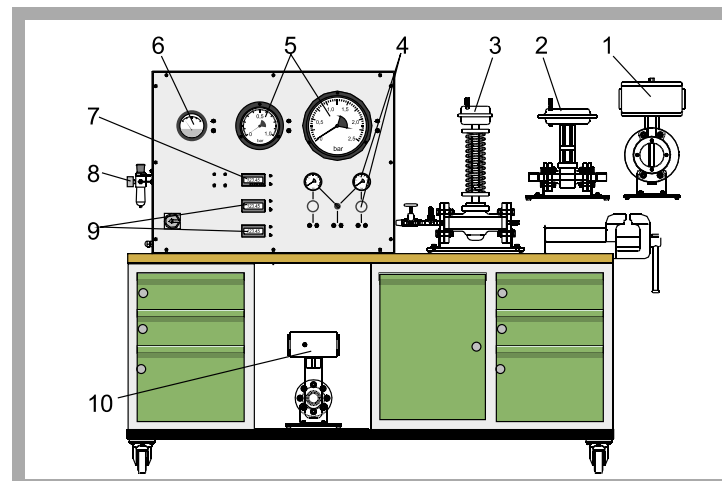
A distinction is made between valves, plug valves, gates and butterfly valves. Plug valves isolate a pipeline quickly, acting transverse to the flow. A quarter revolution is sufficient for full actuation. Valves adjust the flow rate and require several turns of the spindle for full opening or closing. Gates are not intended to seal off the pipeline completely, but serve to restrict the flow. When one of these valves and fittings is combined with a driving mechanism, the resulting control device is known as an actuator.

RT 395 presents three various types of valves and fittings. The trainer investigates the operating response of a segmented ball valve, a butterfly valve, a pneumatic control valve and a pressure reducing valve. The switch cabinet allows the necessary electrical and pneumatic parameters to be set to test and calibrate the valves and fittings. Instruments indicate pneumatic pressures, voltage and current. There is a vice on the workbench for maintenance and assembly work. The workbench also incorporates the necessary tools, and small parts such as seals, for the carrying out of testing procedures.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

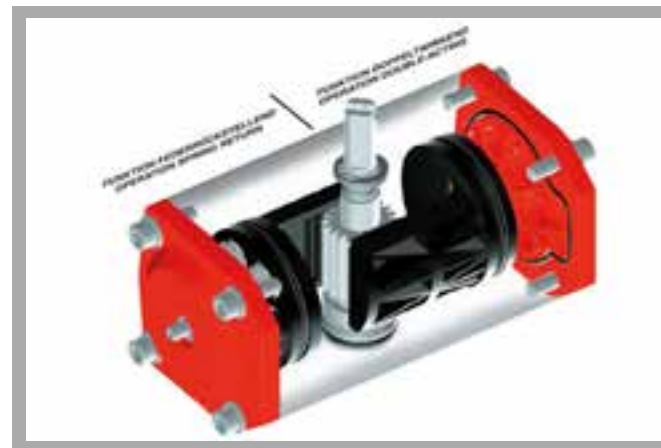
- function and mode of operation of various valves and fittings
 - * pneumatic butterfly valve
 - * pneumatic segmented ball valve
 - * pneumatic control valve with electro-pneumatic positioner
 - * pressure reducing valve
- pneumatic connection
- electrical connection
- familiarisation with linear and equal-percentage valve characteristics
- planning, execution and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

RT 395 Maintenance of Valves and Fittings and Actuators

1 butterfly valve, 2 pneumatic control valve, 3 pressure reducing valve, 4 fine pressure regulator with manometer, 5 manometer, 6 differential pressure meter, 7 display of adjustable current source, 8 compressed air maintenance unit, 9 digital displays for voltage and current, 10 segmented ball valve



Segmented ball valve with single-action pneumatic swivel drive



Principle of a swivel drive
left: spring-return; right: dual-action

Specification

- [1] maintenance work on industrial valves and fittings
- [2] pneumatic control valve with electro-pneumatic positioner DN25 / PN16
- [3] butterfly valve with swivel drive DN100 / PN16
- [4] pressure reducing valve DN15 / PN16
- [5] segmented ball valve with swivel drive DN40 / PN16
- [6] 2 compressed air ranges, adjustable by fine pressure regulator
- [7] instrumentation: analogue pressure meter, digital ammeter and voltmeter
- [8] electric signal transmitter for positioner in the form of an adjustable current source
- [9] the trainer forms part of the GUNT assembly, maintenance and repair training line

Technical Data

Pneumatic swivel drive
- single-action with spring return

Measuring ranges

- pressure (bourdon tube manometer)
 - 0...1,0bar (D=160mm)
 - 0...1,6bar (D=60mm, fine pressure regulator)
 - 0...2,5bar (D=250mm)
 - 0...6,0bar (D=60mm, fine pressure regulator)
- differential pressure: 0...10kPa
- current (digital display): 0...20mA
- voltage (digital display): 0...20VDC

Dimensions and Weight

LxWxH: 2200x750x1660mm
Weight: approx. 321kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase
Compressed air connection: 8bar

Scope of Delivery

- 1 workshop trolley with cabinets under and switch cabinet
- 1 butterfly valve
- 1 pneumatic control valve
- 1 pressure reducing valve
- 1 segmented ball valve
- 1 manometer
- 1 set of cables
- 1 set of compressed air hoses
- 1 set of tools and small parts (bolts, seals etc.)
- 1 set of instructional material

Order Details

080.39500 RT 395 Maintenance of Valves and Fittings and Actuators

RT 396 Pump and Valves and Fittings Test Stand

- * Plotting characteristics of industrial valves and fittings
- * Comparison of different valves and fittings
- * Characteristics of a centrifugal pump

Technical Description

RT 396 allows the characteristics of different valves and fittings to be compared. The typical kinds of valves and fittings are represented by a ball valve, a butterfly valve, a gate valve, a shut-off valve and a control valve. A safety valve and a dirt trap are also investigated. All valves and fittings are flanged, and can be installed in a pipe section with variable length. The pipe section is part of a closed water circuit. Pressure measurement points upstream and downstream of the valve and fitting under test are linked by a differential pressure manometer. This manometer is fitted with a pressure switch which activates a warning lamp if the pressure difference becomes excessive, such as when the filter is clogged. An electromagnetic flow rate sensor permits precise recording of the flow rates.

The closed water circuit contains three butterfly valves, to isolate the pump, and to adjust the pressure upstream and downstream of the test fitting. Differential pressures across the pump and test fitting, the power consumption and speed of the pump, and the flow rate and opening angle of the control valve are recorded and displayed. The measured data can also be used to plot pump characteristics.

A vice is included, on a separate workbench, for maintenance and assembly work. The workbench also incorporates the necessary tools and connecting hoses.

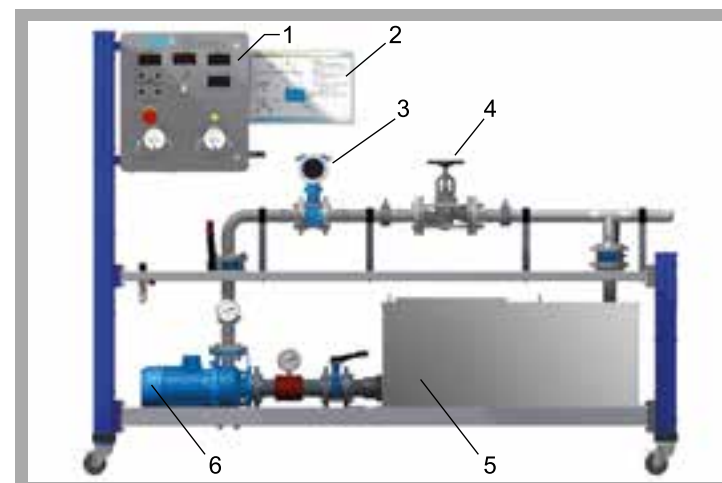
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

- characteristics of a centrifugal pump
- behaviour during operation and function of
 - * ball valve
 - * butterfly valve
 - * shut-off valve
 - * wedge gate valve
 - * control valve
 - * safety valve
 - * dirt trap
- valve characteristics
- determining the Kvs value of the control valve
- pressure losses at the dirt trap depending on the filter

and its load

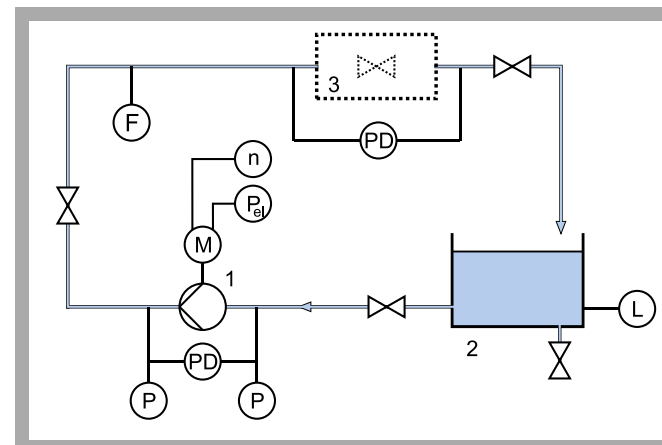
- planning, execution and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

RT 396 Pump and Valves and Fittings Test Stand

1 switch cabinet with displays and controls, 2 process schematic, 3 flow rate sensor, 4 pipe section with place for test fitting, 5 supply tank, 6 pump



Supplied valves and fittings: 1 dirt trap, 2 ball valve, 3 safety valve, 4 butterfly valve, 5 shut-off valve, 6 wedge gate valve, 7 control valve



1 pump, 2 tank, 3 test fitting; sensors: E power, F flow rate, L level, P pressure, PD differential pressure, n speed

Specification

- [1] trainer for testing various valves and fittings
- [2] installation of the test fitting in a pipe section of variable length
- [3] centrifugal pump with variable speed via frequency converter
- [4] fine pressure regulator adjusts compressed air pressure
- [5] tank cover as collecting tray under test device
- [6] manometers in intake and delivery pipe of centrifugal pump
- [7] pressure measuring points upstream and downstream of test device for differential pressure manometer with pressure switch
- [8] digital displays for flow rate, power output, speed, position of control valve

Technical Data

- Centrifugal pump
 - power consumption: 4kW
 - max. flow rate: 72m³/h
 - max. head: 26,5m
 - speed: 1450...2900min⁻¹
- Supply tank with cover: capacity: 400L
- Test valves and fittings:
 - safety valve 1", 1,5bar
 - shut-off valve DN50 / PN16
 - ball valve with pneumatic drive DN50
 - butterfly valve DN50 / PN16
 - wedge gate valve DN50 / PN16
 - electric control valve DN50 / PN16
 - dirt trap DN50 / PN16 with 2 filter elements

Measuring ranges

- differential pressure manometer: 0...2,5bar / 0...4bar
- manometer: 0...4bar / -1...0,6bar
- flow rate: 35...1100L/min
- opening range of control valve: 0...100%
- power output: 0...4000W
- speed: 0...2900min⁻¹

Dimensions and Weight

- LxWxH: 2510x790x1900mm (test stand)
- Weight: approx. 245kg (test stand)
- LxWxH: 1200x670x1100mm (workbench)
- Weight: approx. 100kg (workbench)

Required for Operation

- 400V, 50/60Hz, 3 phases
- Compressed air supply 8bar

Scope of Delivery

- 1 trainer with centrifugal pump
- 1 control valve, 1 dirt trap, 1 safety valve, 1 shut-off valve, 1 ball valve, 1 butterfly valve, 1 wedge gate valve
- 1 workbench with tools and hoses
- 1 set of instructional material

Order Details

- 080.39600 RT 396 Pump and Valves and Fittings Test Stand

RT 390 *Test Stand for Control Valves*

The illustration shows the RT 390 with accessory RT 390.01.

- * **Design and function of control valves**
- * **Determination of Kv and Kvs values**
- * **Data acquisition software to plot valve characteristics and step responses**

Technical Description

Control valves are key components of process engineering systems. They act as an actuator and create a link between the controller and the system. Control valves are generally used for regulating flows of gases or liquids. Optimum control loop design depends on a sound knowledge of control valve behaviour as well as knowledge of the controlled system response.

The mobile test stand permits investigation and testing of different control valve models. A water circuit with a pump and tank is provided for this analysis. Connections permit integration of the valve under test into the water circuit. The flow rate is adjusted by a gate valve and recorded by an electromagnetic flow rate sensor. Two pressure sensors are used to measure the pressure upstream and downstream of the control valve.

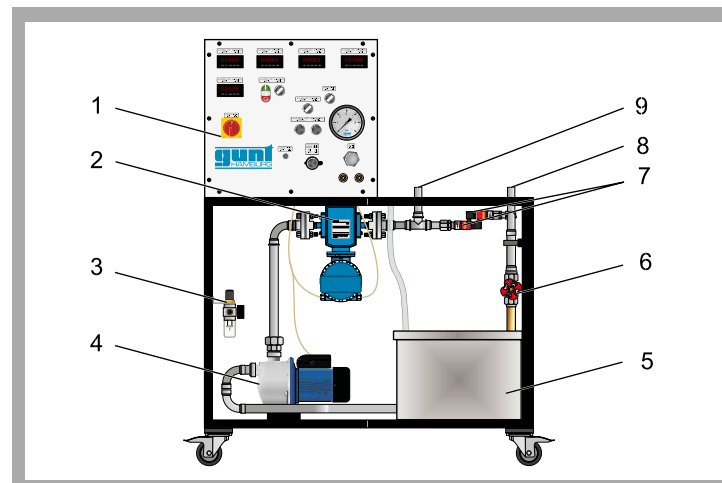
The supply pressure for electro-pneumatic valves can be adjusted by a pressure regulator on the switch cabinet. The manipulating variable can be set on potentiometers as a current signal. The position feedback from the valve is also returned as a current signal. Motorised valves are actuated by way of pushbuttons. A resistance teletransmitter measures the valve stroke.

Data acquisition software can be used to plot and evaluate valve characteristics and step responses on a PC in a user-friendly way.

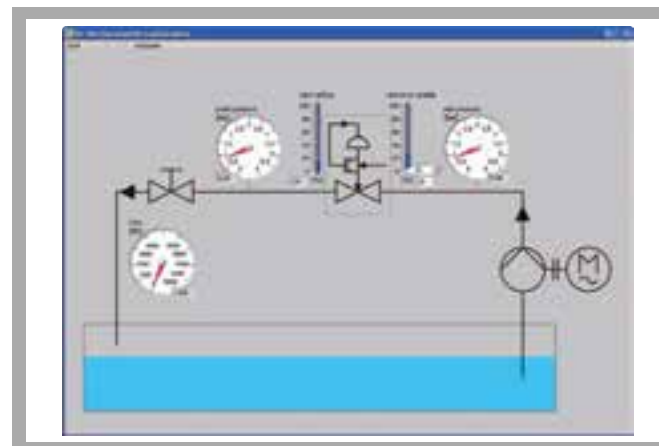
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

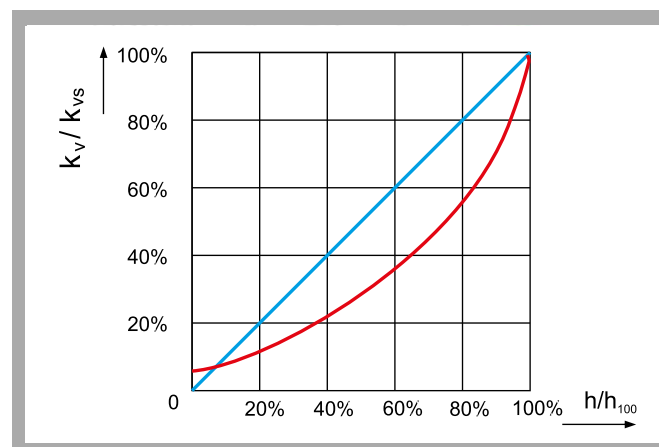
- together with control valves RT 390.01 - RT 390.06
- demonstration and functional testing of control valves
 - determination of Kv and Kvs values
 - plotting valve characteristics
 - dynamic response of control valves
 - * plotting step responses
 - influence of supply pressure on pneumatically operated valves
 - maintenance and adjustment

RT 390 *Test Stand for Control Valves*

1 switch cabinet with controls, 2 flow rate sensor, 3 pressure reducing valve for air connection, 4 pump, 5 tank, 6 adjustment of flow rate, 7 pressure sensor, 8 outlet control valve, 9 inlet control valve



Software screenshot



Theoretical characteristics of a linear (blue) and equal-percentage (red) valve curve: K_v flow coefficient, K_{vs} flow coefficient with valve fully open, h valve stroke

Specification

- [1] investigation and testing of control valves
- [2] water circuit with tank, pump and connections for control valves
- [3] electromagnetic flow rate sensor
- [4] 2 pressure sensors to measure the pressure drop over the control valve
- [5] gate valve to adjust the flow rate
- [6] potentiometer to actuate electro-pneumatic valves with a current signal
- [7] pushbuttons to actuate motorised valves
- [8] manometer and pressure regulator to adjust the working pressure for electro-pneumatic valves
- [9] position feedback via current signal (electro-pneumatic valves) or resistance teletransmitter (motorised valves)
- [10] GUNT software for data acquisition via USB under Windows Vista or Windows 7

Technical Data

- Tank: approx. 90L
Two-stage centrifugal pump
- max. head: 20m
 - max. flow rate: 4m³/h
- Signals
- DC: 4...20mA
 - resistance: 0...1000 Ohm
- Auxiliary power
- AC: 24V
 - air pressure for electro-pneumatic valves: 0...6bar

Measuring ranges

- flow rate: 0...5000L/h
- pressure (water): 2x 0...6bar
- pressure (compressed air): 0...6bar

Dimensions and Weight

LxWxH: 1250x750x1500mm
Weight: approx. 150kg

Required for Operation

230V, 50Hz, 1 phase
Compressed air connection required

Scope of Delivery

- 1 trainer
- 1 set of hoses
- 1 GUNT software CD + USB cable
- 1 set of instructional material

Order Details

080.39000 RT 390 Test Stand for Control Valves

RT 350–380

EXPERIMENTAL UNITS FOR PROCESS AUTOMATION

RT 350 Operation of Industrial Controllers



Nowadays most industrial processes are automated. Process controllers are at the heart of the automation of process applications. State-of-the-art digital process controllers offer a level of functionality which would have been inconceivable some years ago. Alongside extensive configuration and parameter setting functions to adapt to the control task, they also permit interconnected network-

RT 360 Networking of Industrial Controllers



ing. Thus, process automation by way of centralised process control systems or distributed control systems (DCS) is possible. This range of equipment provides a step-by-step introduction to process automation and process control engineering based on process controllers and field bus systems.

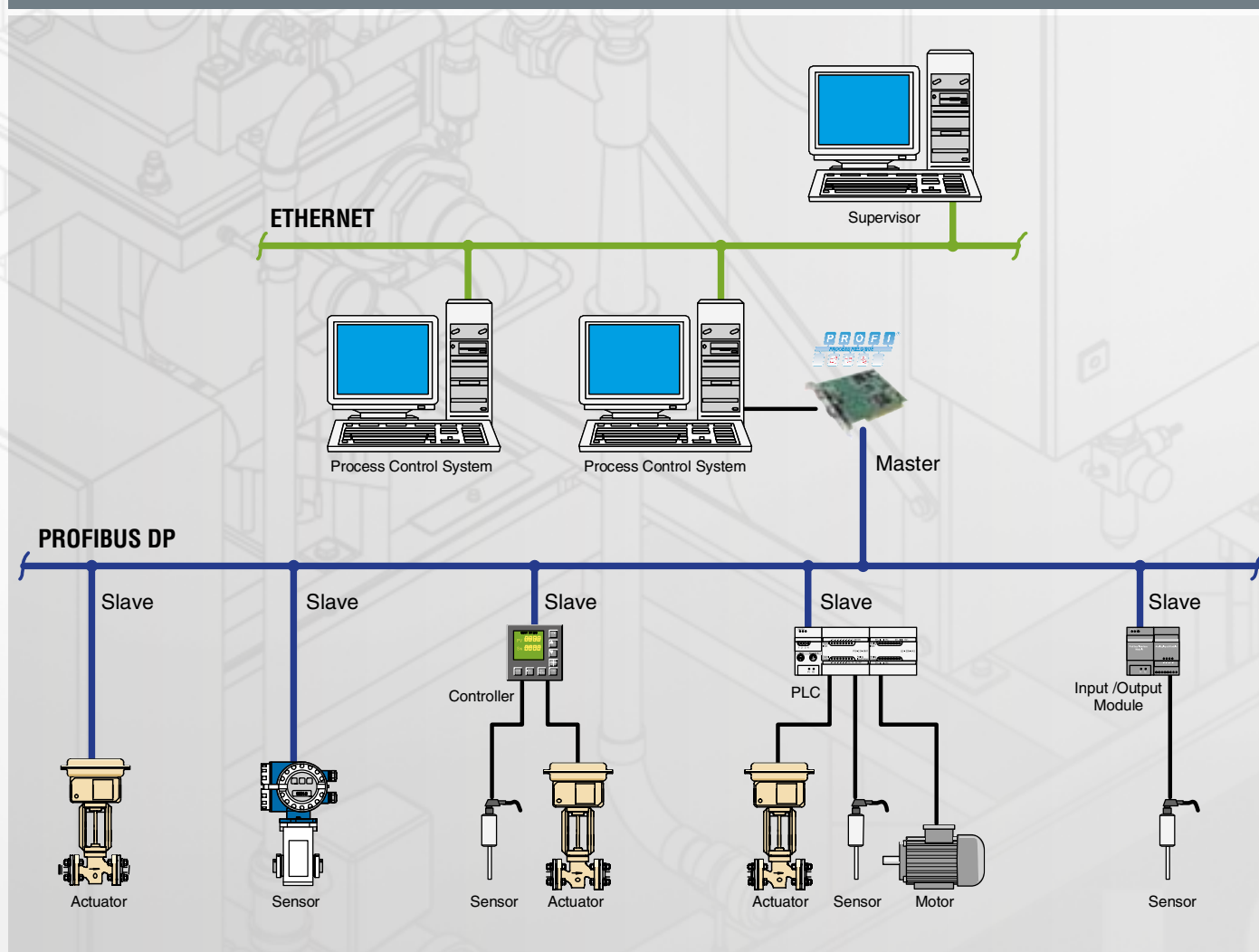
RT 370 Setup of Field Bus Systems



RT 380 Optimization of Control Loops



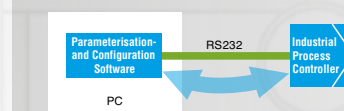
NETWORKING IN PROCESS AUTOMATION



RT 350 OPERATION OF INDUSTRIAL CONTROLLERS

The RT350 is used to practice parameter setting and configuration of a state-of-the-art process controller. This can be carried out either manually by way of

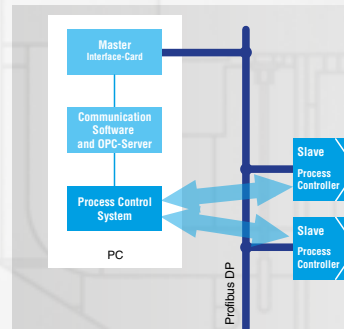
the front panel buttons or from a PC by means of a special software programme via an interface. In this case the controller is linked to the PC by a serial port.



RT 360 NETWORKING OF INDUSTRIAL CONTROLLERS

The RT 360 allows the function of a simple process control system to be demonstrated. The network interconnection is over a field bus (Profibus DP). The PC with its interface card is the master, and the two process controllers are the slaves. The trainer can be

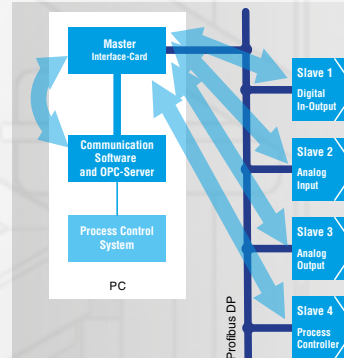
used to demonstrate how the controller parameters can be configured from the process control system (adaptive control), and how the process data can be uploaded from the controllers to the process control system and visualised.



RT 370 SETUP OF FIELD BUS SYSTEMS

The RT 370 enables a field bus (Profibus DP) to be set up with various slaves (digital input and output modules, analogue input and output module, process controllers) and a master (PC with interface card). The definitions of the topology, the variables and the protocols are shown. Subjects such as

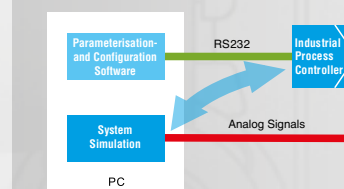
the GSD file, system configurator, OPC server and tags are dealt with in detail. The objective is to interchange data between various field bus-compatible terminal devices and the PC.



RT 380 OPTIMIZATION OF CONTROL LOOPS

Tuning of a controller for optimal controlled system performance can be practised with the RT 380. The controller works together with a simulated system model. The simulation is created on a PC using a special

software programme. A wide variety of controlled system models is available. A configuration programme enables user-friendly, intuitive parameter setting of the controller from the PC.



RT 350 Operation of Industrial Controllers



- * Familiarisation with an industrial controller
- * Digital controller with freely selectable parameters
- * Simulation of controlled systems
- * Configuration software

Technical Description

This experimental unit familiarises students with the operation and function of a state-of-the-art industrial controller.

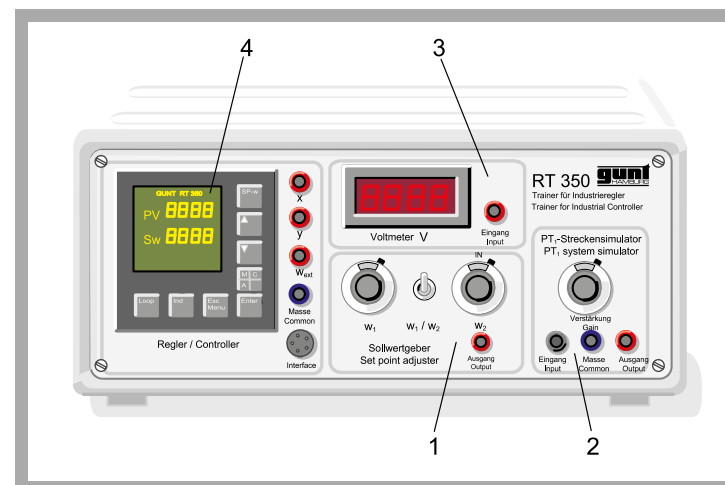
The controller has freely accessible inputs and outputs. Defined input levels and step signals can be produced with a signal generator. A digital voltmeter is used to measure the input and output signals. A simple first order lag is simulated to allow the response and stability of a closed control loop to be investigated. All signals are accessible via lab jacks so a standard x/y plotter or line recorder can be used. It is also possible to control external controlled system models with this controller. As well as manual configuration and parameter setting with keys, the controller can be configured (configuration software supplied) from a PC via USB.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

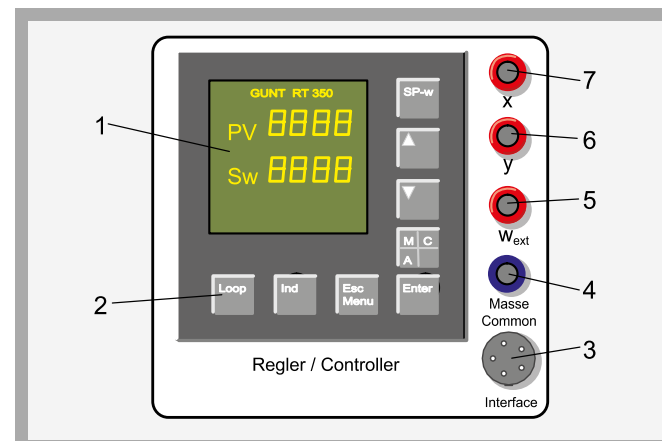
Learning Objectives / Experiments

- basic concept of a industrial controller
 - * operator control levels
 - * parameter level
 - * configuration level
- learning about basic terminology and methods of process control
 - * static and dynamic transfer function
 - * step response
 - * reference variable step
 - * closed control loop
- setting controller parameters
 - * setting input and output channels
 - * scaling displays
 - * using PC-based configuration tools

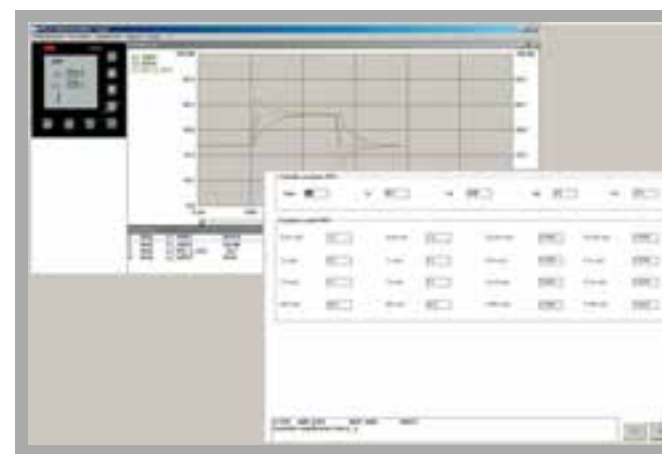
RT 350 Operation of Industrial Controllers



1 signal generator with switch between two pre-defined levels, 2 first order lag controlled system simulator with adjustable gain, 3 digital voltmeter, 4 controller



Controller: 1 LC display, 2 operating buttons, 3 configuration interface, 4 earth connection, 5 reference variable input, 6 manipulating variable output, 7 controlled variable input



Configuration software with time log window and parameter selection

Specification

- [1] experimental unit for industrial controllers
- [2] digital controller, configurable
- [3] signal generator with potentiometer
- [4] digital voltmeter
- [5] first order lag controlled system simulator
- [6] all variables accessible as analogue signals at lab jacks
- [7] configuration software via USB under Windows Vista or Windows 7

Technical Data

Controller

- configurable as P, PI or PID controller
- proportional gain X_p : 0...999,9%
- integral action time T_n : 0...3600s
- derivative time T_v : 0...1200s
- 2 inputs, 1 output

Voltmeter

- measuring range: 0...20V
- resolution: 10mV

Reference variables generator

- 2 voltages selectable

Controlled system simulator

- controlled system type: first order lag
- time constant: 20s
- controlled system gain: 1...10

- process variables as analogue signals: 0...10V

Connection of external instruments (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 370x330x150mm

Weight: approx. 5kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 configuration software CD + USB cable
- 1 set of lab cables
- 1 set of instructional material

Order Details

080.35000 RT 350 Operation of Industrial Controllers

RT 360 *Networking of Industrial Controllers*

- * Process control system
- * Networking of industrial controllers
- * Controller parameter setting via field bus system
- * Profibus DP field bus system

Technical Description

One of the aims of process automation is to monitor and control plant or plant components centrally from a computer. This task performed by a process control system.

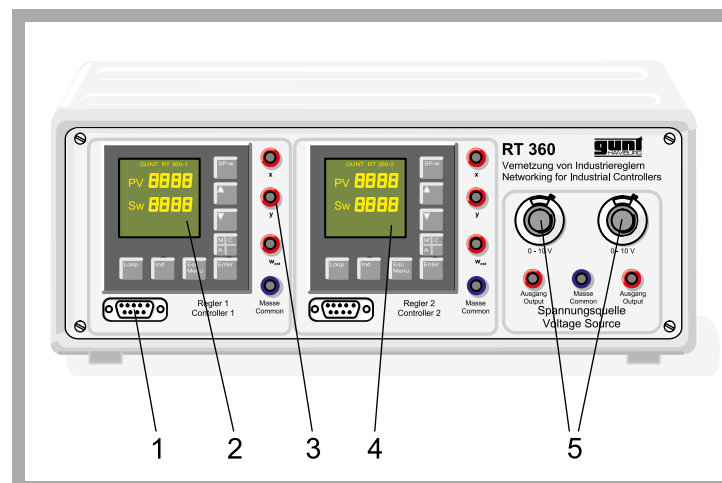
This experimental unit demonstrates the operation of a process control system based on a simple application. The experimental unit consists of two industrial controllers interconnected via a field bus interface (*Profibus DP*) and an interface card with a PC. On the PC, an OPC (*OLE for Process Control*) server makes the controller data available to other programs under *Windows* for further processing. The process control software developed by GUNT on the basis of LabVIEW accesses the process data on the controllers and enables it to be visualised. The software also allows the controllers' parameters to be set. Various functions such as recorders and alarm logs enable a simple control room function to be simulated.

Two potentiometers permit the simulation of input signals for the controllers. The controlled variable, manipulating variable and reference variable data are delivered as standard signals at lab jacks, enabling the controllers to be integrated into real processes at any time.

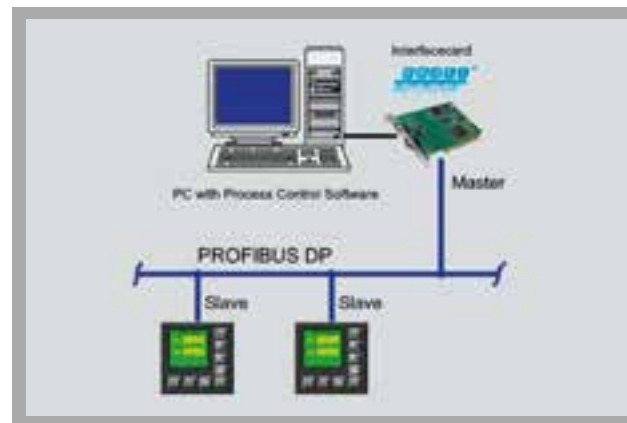
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

- function and structure of a process control system under Profibus DP
- * Profibus DP field bus system
- * OPC server function
- * master / slave assignment
- * online controller parameter setting
- * reading control variables and displaying them online
- * configuring and displaying alarms

RT 360 *Networking of Industrial Controllers*

1 interface for Profibus DP, 2 controller, 3 lab jacks for analogue process variables, 4 controller, 5 signal generator



Topology of the process control system with networking over a field bus



GUNT process control software with recorder function and controller operation

Specification

- [1] experimental unit for networking of industrial controllers
- [2] 2 digital controllers, configurable as P, PI or PID controllers, with field bus interface
- [3] 2 signal generators
- [4] Profibus DP interface card for PC
- [5] OPC server and GUNT process control software under Windows Vista or Windows 7
- [6] all process variables accessible as analogue signals at lab jacks

Technical Data**Controller**

- configurable as P, PI or PID controller
- proportional gain X_p : 0...999,9%
- integral action time T_n : 0...3.600s
- derivative time T_v : 0...1.200s

Process variables as analogue signals: 0...10V

Signal generator: 0...10V

Connection of external instruments (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 450x450x150mm

Weight: approx. 10kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 interface card
- 1 set of cables
- 1 software CD with driver software, OPC server and GUNT process control software
- 1 set of instructional material

Order Details

080.36000 RT 360 Networking of Industrial Controllers

RT 370 Setup of Field Bus Systems



- * Profibus DP field bus system
- * Networking of field bus modules
- * Communication protocols
- * Recording digital and analogue signals

Technical Description

Field bus technology plays a key role in modern-day process automation. The field bus permits networking of terminal devices such as controllers, sensors or actuators in the plant system (field level) with the higher-level control room (control level). A network of this kind can be quite extensive; line lengths of as much as 1000 metres and more are possible.

This experimental unit is used to teach the initial basic steps in field bus technology based on the example of Profibus DP. Various terminal devices (slaves) are activated and read by a PC with a Profibus DP interface (master). The required hardware is largely pre-configured. Students are able to concentrate on the software programming of the field bus system. The following specific topics can be covered: System configurator with DMF (Device Master File), bus topology, communication protocols, tags, OPC (OLE for Process Control) server, input and output of process data, and much more.

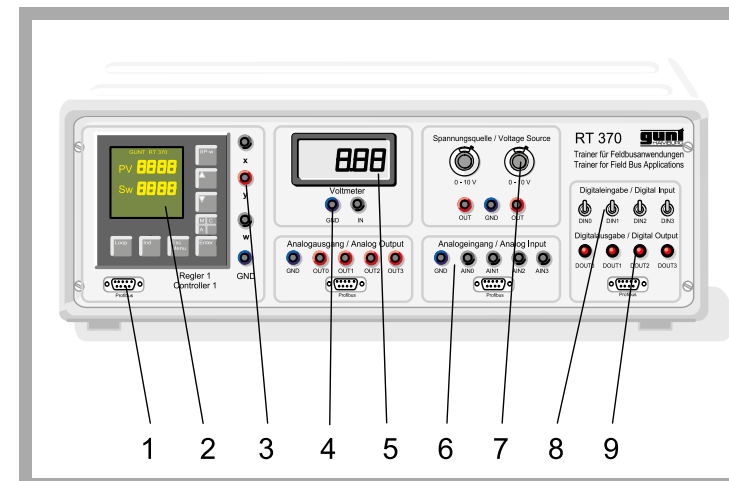
The experimental unit includes a digital controller as well as analogue and digital input and output modules with a Profibus DP interface. Two potentiometers permit the simulation of input signals for the controllers. A digital voltmeter displays the output signals. Digital signals are generated by switches and displayed by LEDs. The controlled variable, manipulating variable and reference variable data are delivered as standard signals at lab jacks, enabling the controllers to be incorporated into real processes at any time.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

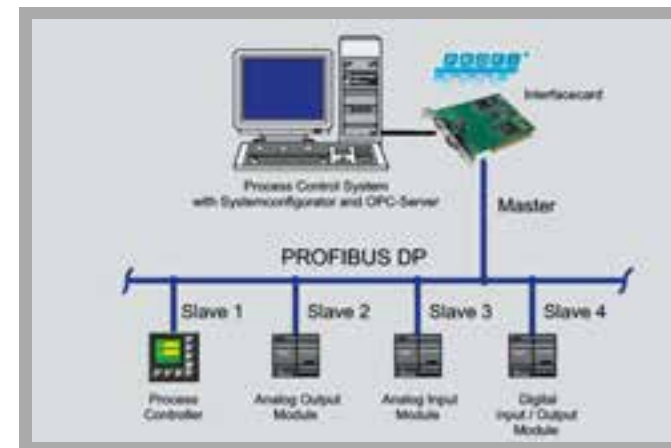
Learning Objectives / Experiments

- function and programming of a field bus system
 - * defining the bus topology with the stations
 - * writing the communication protocols
 - * familiarisation with the device master file
 - * familiarisation with the OPC server
 - * defining tags
 - * accessing the OPC database from a process control program
- familiarisation with the field bus stations
 - * function of a digital process controller
 - * function of an analogue input / output module
 - * function of a digital input / output module

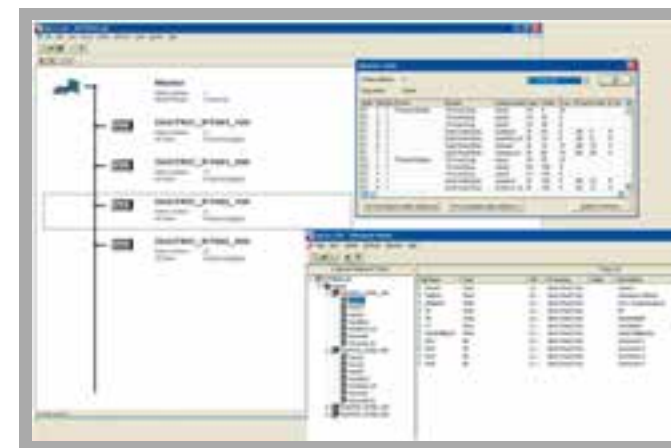
RT 370 Setup of Field Bus Systems



1 interface, 2 controller, 3 Lab jacks for process variables, 4 analogue output module, 5 voltmeter, 6 analogue input module, 7 signal generator, 8 digital input, 9 digital output



Topology of the field bus used, with master and slaves



Sycon system configuration program with topology manager, variables and tags list

Specification

- [1] experimental unit for field bus systems
- [2] digital controller, configurable as a P, PI or PID controller with Profibus DP interface
- [3] analogue Profibus DP I module
- [4] analogue Profibus DP O module
- [5] digital Profibus DP IO module
- [6] signal generator
- [7] digital voltmeter
- [8] Profibus DP interface card for PC
- [9] OPC server and GUNT process control software under Windows Vista or Windows 7
- [10] all process variables accessible as analogue signals at lab jacks 0...10V

Technical Data

Controller

- configurable as P, PI or PID controller
- proportional gain X_p : 0...999,9%
- integral action time T_i : 0...3600s
- derivative time T_d : 0...1200s

Signal generator: 0...10V

Digital voltmeter: 0...20V

Process variables as analogue signals: 0...10V

4 analogue inputs: 0...10V

2 analogue outputs: 0...10V

4 digital inputs, 4 digital outputs

Connection of external instruments (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 480x450x150mm

Weight: approx. 10kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 interface card
- 1 software CD with driver software, system configuration program, OPC server and GUNT process control software
- 1 set of cables
- 1 set of instructional material

Order Details

080.37000 RT 370 Setup of Field Bus Systems

RT 380 Optimization of Control Loops



- * Closed-loop control system response
- * Choice of optimum controller parameters
- * Tuning rules such as Ziegler-Nichols
- * Stability and transient response
- * Software simulation of controlled systems

Technical Description

This experimental unit with the interaction between controller and controlled system, the objective being for the closed control loop, comprising the controller and the controlled system, to exhibit the desired optimum response. The setting of controller parameters - a key practical aspect - can be practised safely and intensively using simulation software. Concepts such as open and closed loop control, stability, step response, disturbance and control response are clearly demonstrated.

The particular feature of this experimental unit is that no real controlled systems are used; the controlled system is simulated on a PC by a simulation program developed by GUNT. This principle is in widespread application in product development in industry and is known as *Hardware in Loop* (HIL). All major types of controlled systems can be selected in the program. The controlled system parameters can be set within broad limits so that - unlike actual controlled systems - extreme parameter situations can be investigated. The time response can be recorded and analysed using the software. The controller and the PC are connected by a data acquisition card with AD and DA converters.

The controller that is used can be easily configured from the PC across an interface using the software provided.

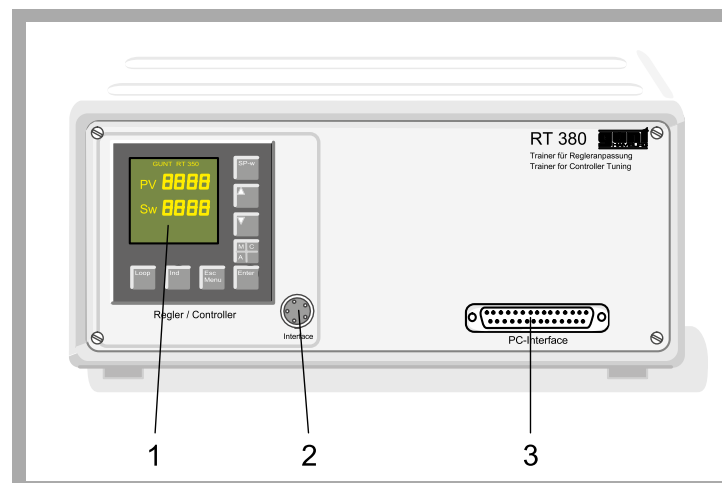
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

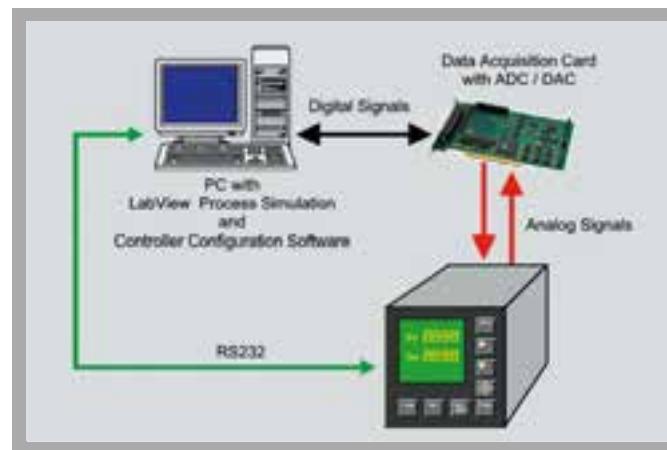
- learning basic terminology and methods involved in process control
- * control loop comprising controller and controlled system
- * difference between open and closed loop control
- adapting the controller to different controlled systems
- * determining the controlled system parameters
- * choosing optimum controller parameters
- * using commonly applied tuning rules
- * investigating control and disturbance response
- * investigating the stability of the closed control loop

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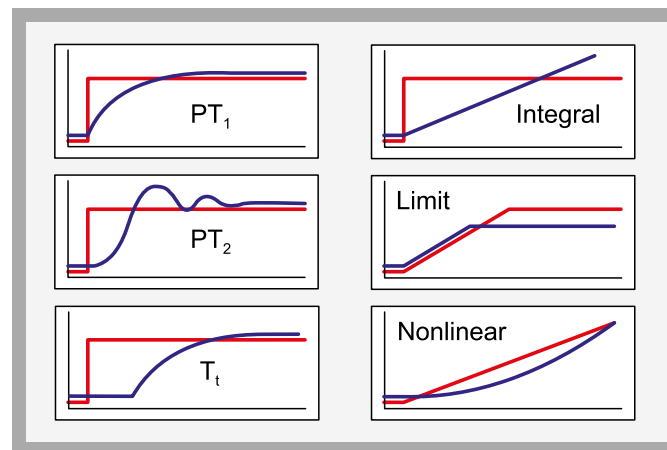
RT 380 Optimization of Control Loops



1 controller, 2 interface for controller parameter setting, 3 interface with analogue signals for data acquisition card



The real controller works together with a simulated controlled system (HIL: Hardware in Loop)



A wide range of controlled system characteristics can be simulated: PT_1 first order lag; PT_2 second order lag; T_t time-delayed process

Specification

- [1] experimental unit for controller tuning
- [2] digital controller, configurable as a P, PI or PID controller with interface
- [3] interface for PC
- [4] data acquisition card for PC
- [5] GUNT simulation software for different controlled system types, such as first and second order lags, time-delayed systems etc.
- [6] recording and evaluation of time response on PC
- [7] configuration software for process controller under Windows Vista or Windows 7

Technical Data

Controller

- configurable as P, PI or PID controller
- proportional gain X_p : 0...999,9%
- integral action time T_n : 0...3600s
- derivative time T_v : 0...1200s

Process variables as analogue signals: 0...10V

Controlled system simulation models with proportional, integral, first-order lag, second-order lag
Time-delayed response, non-linearity and limitation possible

Dimensions and Weight

LxWxH: 370x330x150mm

Weight: approx. 5kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

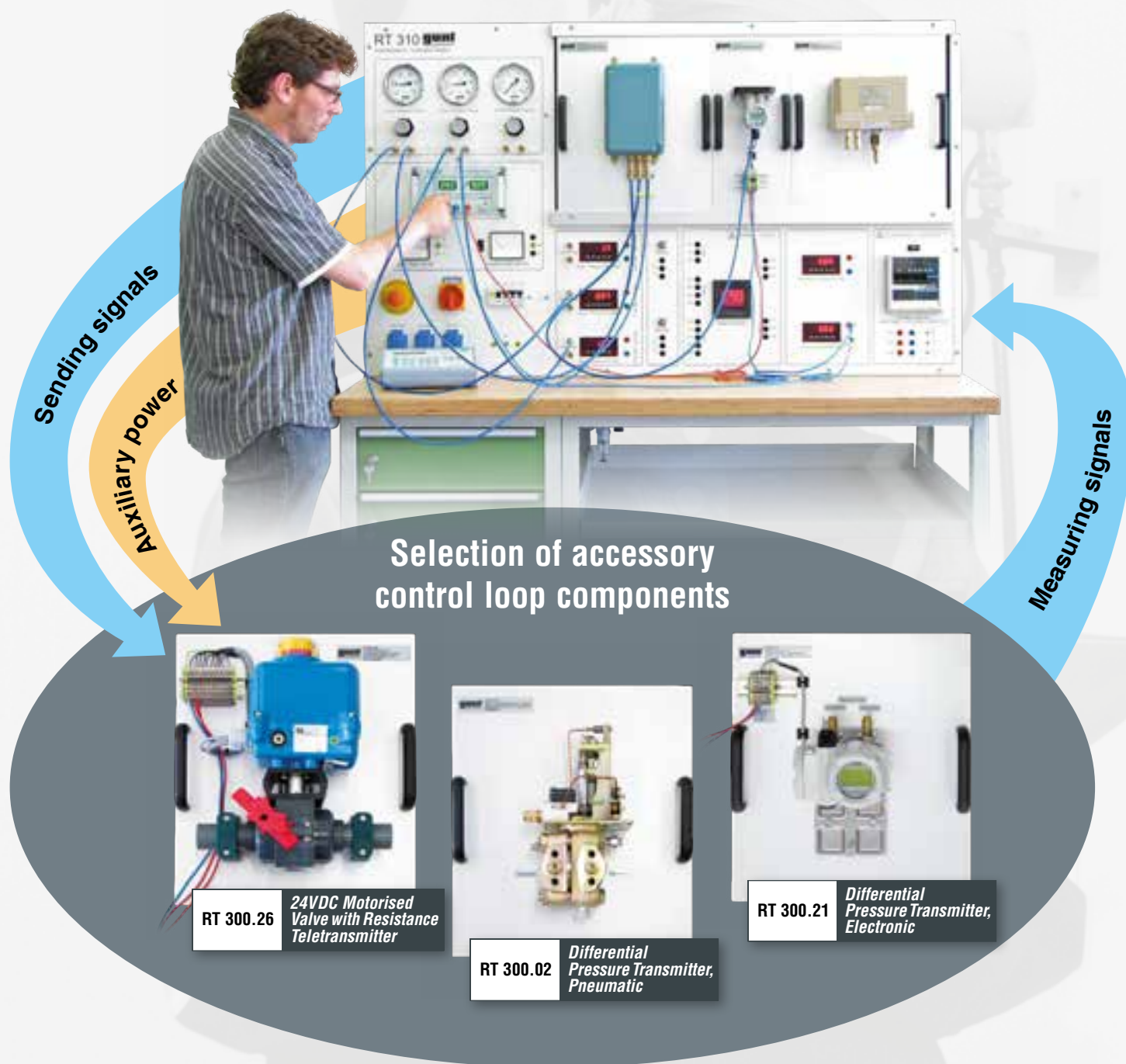
- 1 experimental unit
- 1 data acquisition card
- 1 software CD with GUNT simulation software for controlled system models and configuration software for the controller
- 1 set of cables to connect the practice unit to the PC
- 1 set of instructional material

Order Details

080.38000 RT 380 Optimization of Control Loops

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RT 310 WORKING WITH THE CALIBRATION STATION



Calibration station and control loop components – a coordinated concept

The calibration station provides everything needed for investigating the transmission behaviour of control loop components. Electrical and pneumatic signals can be generated as inputs to the individual components. The calibration station is provided with extensive measuring equipment for the recording of the output signals from the control loop components. Many control loop components, such as transducers and actuators, require auxiliary

power in order to operate. RT 310 supplies this auxiliary power in the form of pneumatic or electrical energy. A large selection of control loop components are available as accessories. They are specifically designed for use with the calibration station, and can be easily installed in the station's frame. The necessary cables and tubing are supplied.

SENDING SIGNALS AND SUPPLYING AUXILIARY POWER

Pressure	1x 0...2 bar
	2x 0...8 bar
Direct current	0...30 V
	0...5 A
Alternating voltage	24 V
	230 V
Resistance	0...100 Ohm
	0...500 Ohm
Controller outputs	0/4...20 mA
	Relays

MEASURING SIGNALS

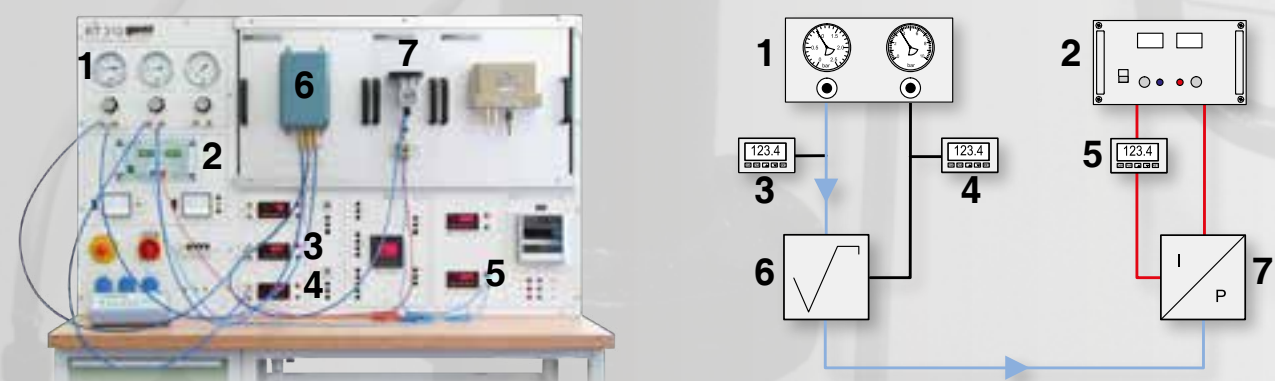
Pressure	0...0,6 bar
	0...2,5 bar
	0...8 bar
Direct current	0...20 mA
Direct voltage	0...20 V
3-channel line recorder	0/4...20 mA
	0/2...10 VDC
	0/0,2...1 VDC
Controller inputs configurable for	Thermocouples
	Resistance thermometer
	Resistance teletransmitter
	Direct current
	Direct voltage

UNIVERSAL CALIBRATOR



The RT 310 package includes a separate universal calibrator. It offers the opportunity to test and calibrate control loop components in a practical way. For example, the device facilitates the simulation of output signals from thermocouples and the measurement of the resulting output signal from a connected transducer.

...A CONCRETE EXAMPLE



RT 310 Calibration Station

Technical Description

The calibration station is used in the investigation of the transmission behaviour of electrical and pneumatic control loop components. Electrical and pneumatic signals can be generated to effect actuation of the individual control loop components. A precision measuring technique facilitates the recording of the output signals from the control loop components. The supply of auxiliary power necessary for many control loop components is also provided.

Three pressure regulators with manometers are included to generate pneumatic signals. They can also be used to supply the components with auxiliary power. A power supply unit with adjustable voltage and current serves as the DC voltage source. Two switchable AC voltage sources supply auxiliary power. Two potentiometers can be used to simulate the behaviour of various devices such as resistance teletransmitters or motorized valves.

Three digital pressure gauges, a voltmeter, an ammeter and a 3-channel line recorder are provided for recording the output signals from the control loop components.

An industrial controller can be used to generate signals in the form of functions and to measure signals. It features three input channels and two output channels which are freely configurable. A separate high-grade universal calibrator further enhances the practical value of this unit. As an example, the calibrator facilitates the simulation of output signals from thermocouples and the measurement of the resulting output signal from a connected transducer.

Various control loop components such as transducers, control valves and controllers are available as accessories. They are inserted in the calibration station frame and connected by way of the supplied hoses and cables.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

Together with the accessory control loop components

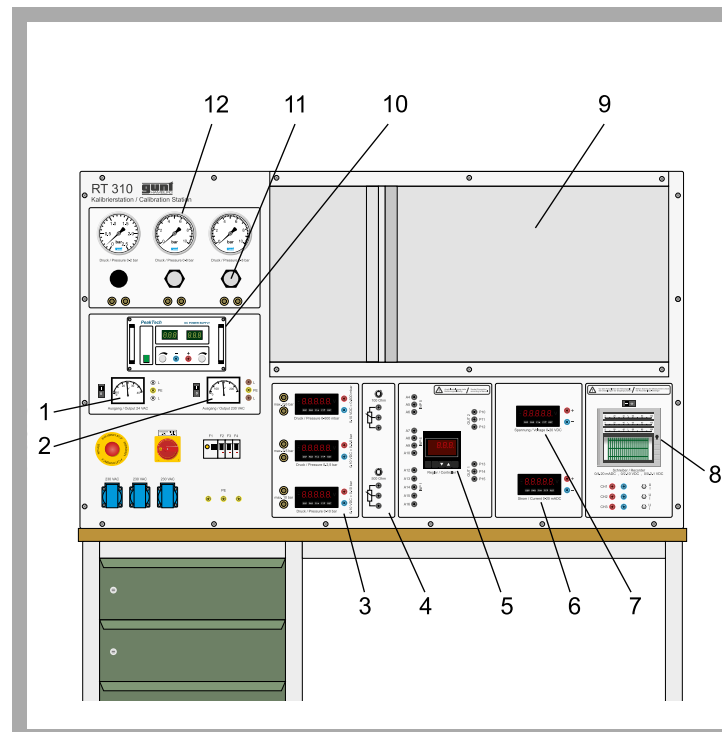
- mode of operation of control loop components

- * transducers
- * actuators
- * controllers
- familiarisation with different signals
- * pneumatic
- * electrical
- correct connection of control loop components
- transmission behaviour of control loop components

* Investigation of the transmission behaviour of actuators and transducers

* Calibration of control loop components using precision measuring technique

* Various control loop components available as accessories

RT 310 Calibration Station


1 AC source 24V, 2 AC source 230V, 3 pressure gauge, 4 potentiometer, 5 controller, 6 ammeter, 7 voltmeter, 8 3-channel line recorder, 9 frame for control loop components, 10 power supply unit, 11 pressure regulator, 12 manometer



Universal calibrator

Specification

- [1] investigation of transmission behaviour and calibration of electronic and pneumatic control loop components
- [2] sending and measuring pneumatic and electrical signals
- [3] 3 pressure regulators with manometers
- [4] adjustable power supply unit as DC voltage source
- [5] 2 switchable AC voltage sources with differing voltages
- [6] 3 digital pressure gauges with differing measuring ranges
- [7] 2 adjustable potentiometers
- [8] freely configurable industrial controller
- [9] digital voltmeter
- [10] digital ammeter
- [11] 3-channel line recorder with freely selectable measuring ranges
- [12] separate high-grade universal calibrator for voltage, current, temperature and resistance

Technical Data

- 3 pressure regulators
- 1x 0...2bar
- 2x 0...8bar
- Power supply unit
- voltage: 0...30VDC
- current: 0...5A
- 2 AC voltage sources
- 24VAC
- 230VAC
- Pressure gauge measuring ranges
- 0...0,6bar
- 0...2,5bar
- 0...10bar
- 2 potentiometers
- 0...100Ohm
- 0...500Ohm
- Voltmeter: 0...20VDC
- Ammeter: 0...20mA

Dimensions and Weight

- LxWxH: 1520x750x1800mm
- Weight: approx. 220kg

Required for Operation

- 230V, 50/60Hz, 1 phase
- Compressed air connection: 6...8bar

Scope of Delivery

- 1 calibration station
- 1 universal calibrator
- 1 set of cables
- 1 set of compressed air hoses
- 1 set of instructional material

Order Details

080.31000 RT 310 Calibration Station

RT 304

Calibration Trainer



The illustration shows the RT 304 with accessories.

- * **Investigation of the transmission behaviour of actuators and transducers**
- * **Calibration of control loop components and measuring instruments using precision measuring technique**
- * **Various control loop components and measuring instruments available as accessories**

Technical Description

The calibration trainer is used to investigate the transmission behaviour of electrical and pneumatic control loop components such as transducers and control valves. Electrical and pneumatic signals can be generated to effect actuation of the individual control loop components. A precision measuring technique facilitates the recording of the output signals from the control loop components.

Two pressure regulators with manometers are included to generate pneumatic signals and supply the control loop components with auxiliary power. A height-adjustable tank with a level tube and scale is used to set low pressures for manometer calibration. The pressure regulators can also be used to calibrate at higher pressures.

Two direct voltage sources are included as auxiliary power sources for components requiring an electrical supply. Direct current signals can be sent and measured with two controllers. Two precision manometers permit measurement of pneumatic output signals from control loop components.

Various control loop components such as transducers, control valves and controllers are available as accessories. They are mounted on the calibration trainer and connected by way of the supplied hoses and cables.

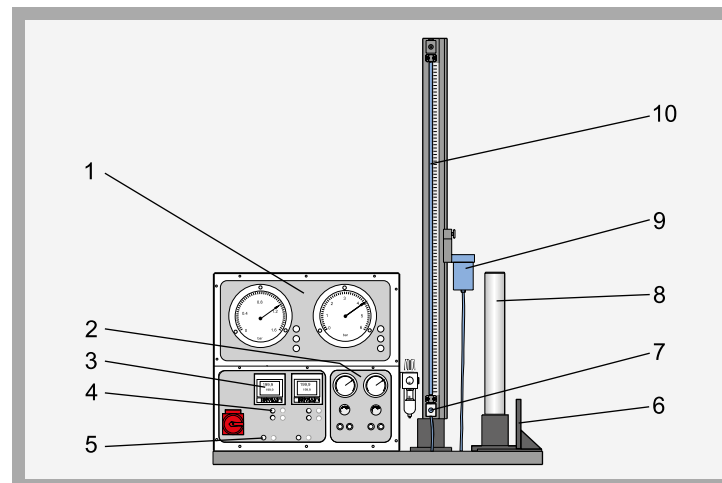
Learning Objectives / Experiments

Together with the accessory control loop components

- mode of operation of control loop components
- * transducers
- * actuators
- * controllers
- familiarisation with different signals
- * pneumatic
- * electrical
- correct connection of control loop components
- transmission behaviour of control loop components
- calibration of manometers

RT 304

Calibration Trainer



1 precision manometer, 2 pressure regulator, 3 controller, 4 connections for current signals, 5 DC voltage sources, 6 fixture for control loop components, 7 connection for low pressures, 8 assembly tube for control loop components, 9 height-adjustable tank, 10 level tube with scale for low pressures



Available accessories: RT 305.03 Differential Pressure Transmitter (left) and RT 305.05 Pneumatic Control Valve with Electro-Pneumatic Positioner (right)



Available accessories: RT 305.02 Pressure Transmitter, Electronic (left) and RT 305.07 Thermocouple Type K and Calibrator (right)

Specification

- [1] investigation of transmission behaviour and calibration of control loop components and measuring instruments
- [2] sending and measuring pneumatic and electrical signals
- [3] 2 pressure regulators with manometers
- [4] height-adjustable tank and scale to set low pressures
- [5] 2 controllers to send and measure current signals
- [6] 2 DC voltage sources to supply control loop components with auxiliary power
- [7] 2 precision manometers
- [8] control loop components and meters available as accessories

Technical Data

- 2 pressure regulators
- 0...1,6bar
- 0...6bar
- Pressure range, height-adjustable tank
- 0...1000mm head
- 2 controllers
- 1 output each: 4...20mA
- 1 input each: 4...20mA
- 2 DC voltage sources
- each 24VDC
- 2 precision manometers
- 0...1,6bar, D=160mm
- 0...6bar, D=160mm

Dimensions and Weight

- LxWxH: 1000x750x2150mm
- Weight: approx. 110kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase
- Compressed air connection: 6...8bar

Scope of Delivery

- 1 calibration trainer
- 1 set of cables
- 1 set of compressed air hoses
- 1 set of instructional material

Order Details

080.30400 RT 304 Calibration Trainer

RT 310 Calibration Station
Available accessories
Product no. Order details

080.30001	RT 300.01	Pressure Transmitter, Pneumatic
080.30002	RT 300.02	Differential Pressure Transmitter, Pneumatic
080.30003	RT 300.03	Square Root Extractor, Pneumatic
080.30006	RT 300.06	Current-to-Pressure Converter
080.30020	RT 300.20	Pressure Transmitter, Electronic
080.30021	RT 300.21	Differential Pressure Transmitter, Electronic
080.30027	RT 300.27	Transmitter for Pt100, Electronic
080.30028	RT 300.28	Transmitter for Thermocouple Type K
080.30029	RT 300.29	Transmitter for Thermocouple Type J
080.30014	RT 300.14	Pneumatic Control Valve with Pneumatic Positioner
080.30025	RT 300.25	Pneumatic Control Valve with Electro-Pneumatic Positioner
080.30026	RT 300.26	24VDC Motorised Valve with Resistance Teletransmitter
080.30009	RT 300.09	Pneumatic PID-Controller

RT 304 Calibration Trainer
Available accessories
Product no. Order details
TRANSDUCERS

080.30502	RT 305.02	Pressure Transmitter, Electronic
080.30503	RT 305.03	Differential Pressure Transmitter, Electronic
080.30504	RT 305.04	Current-to-Pressure Converter

ANALOGUE PRESSURE MEASURING

080.30508	RT 305.08	Bourdon Tube Pressure Gauge
080.30509	RT 305.09	Diaphragm Pressure Gauge

TEMPERATURE MEASURING

080.30507	RT 305.07	Thermocouple Type K and Calibrator
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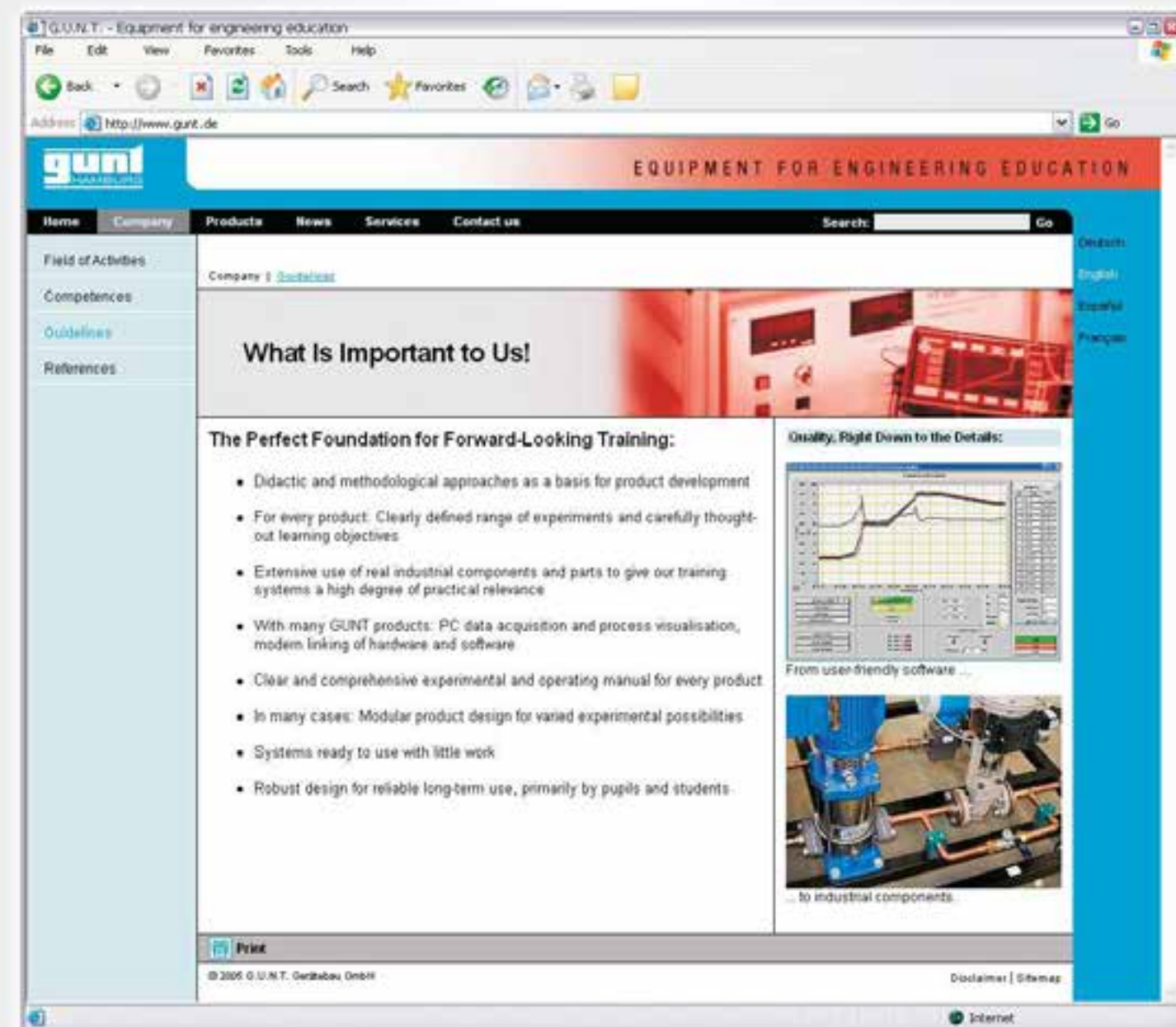
CONTROL VALVES

080.30505	RT 305.05	Pneumatic Control Valve with Electro-Pneumatic Positioner
080.30506	RT 305.06	Control Valve, Electric

CONTROLLERS

080.30501	RT 305.01	Controller, Electronic
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080.30510	RT 305.10	Tool Set
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3 SIMPLE PROCESS ENGINEERING CONTROL SYSTEMS

Simple control systems with industrial components

The control systems featured in this chapter provide for coverage across two key areas:

- Experimental investigation of control engineering fundamentals
- Familiarisation with modern-day control engineering components in practice

The control systems are simple and are laid out in a clear logical manner. In most cases just one variable is being controlled. The components are easily accessible. These attributes make the devices particularly well suited to experimental investigation of the fundamentals. This also provides beginners with a quick and straight-forward introduction to the subject area. The components used are very similar to those employed in practical systems and therefore this platform provides an ideal teaching resource.

We can recommend the control systems covered in this chapter for training in the following fields in addition to process engineering:

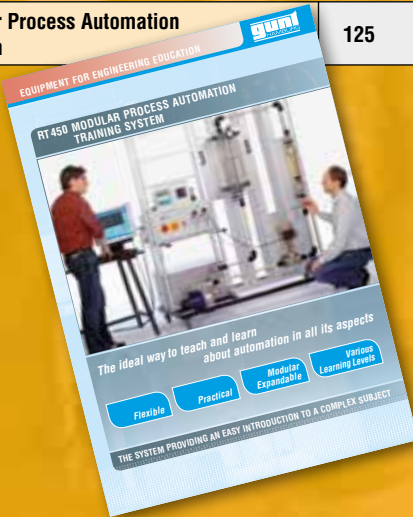
- Mechanical engineering
- Electrical engineering/automation
- Mechatronics
- Supply engineering
- Environmental engineering

CONTROL ENGINEERING TRAINERS

CODE	PRODUCT	PAGE
Overview	Three Equipment Series Featuring Simple Control Systems	74
Overview	RT 614 - RT 674 Introduction to Industrial Control Engineering	76
RT 614	Level Control Demonstration Unit	78
RT 624	Flow Control Demonstration Unit	80
RT 634	Pressure Control Demonstration Unit	82
RT 644	Temperature Control Demonstration Unit	84
RT 674	Flow / Level Control Demonstration Unit	86
RT 650.40	I&C Software for RT 614 - RT 674 Series	88
Overview	RT 512 - RT 552 Control Engineering Trainers with Process Control System	90
RT 512	Level Control Trainer	92
RT 522	Flow Control Trainer	94
RT 532	Pressure Control Trainer	96
RT 542	Temperature Control Trainer	98
RT 552	pH Value Control Trainer	100
RT 650.50	Process Control Software for RT 512 - RT 552 Series	102

MODULAR PROCESS AUTOMATION TRAINING SYSTEM

CODE	PRODUCT	PAGE
Overview	RT 450 The Modular Process Automation Training System: Closed-Loop and Open-Loop Control	104
RT 450	Process Automation Training System: Base Module	106
Overview	RT 450 Moduls	108
RT 450.01	Controlled System Module: Level	110
RT 450.02	Controlled System Module: Flow	111
RT 450.03	Controlled System Module: Pressure	112
RT 450.04	Controlled System Module: Temperature	114
RT 450.10	Continuous Controller Module	116
RT 450.14	Software for Controller Configuration	117
RT 450.42	PLC Module with Software	118
RT 450.12	Chart Recorder Module	119
RT 450.20	Control Valve, Pneumatically Driven, Kvs 0,4	120
RT 450.34	Flow Rate Sensor: Electromagnetic	121
RT 450.40	Visualisation Software	122
Leaflet	RT 450 Modular Process Automation Training System	125



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THREE EQUIPMENT SERIES FEATURING SIMPLE CONTROL SYSTEMS

Much emphasis was placed on the use of industrial components in the development of these control systems. This enhances the practical relevance and industrial applicability of these systems. These are simple control loops. The components can be easily identified visually and assigned to their respective functions.

It is revealed that the actual response from the controlled system in many cases differs from that of the theoretical, elementary transfer elements. Training in the operation and parameterisation of industrial controllers and interconnection of the controllers with bus systems is included. These exercises prepare students for the tasks they will typically encounter in their future career.

In this chapter you can choose between three equipment series, each of varying complexity. For each series, software tailored to the relevant experimental units is available. The software handles routine tasks for the students and supports interaction when experimenting with new and differing approaches.

RT 614 - RT 674 INTRODUCTION TO INDUSTRIAL CONTROL ENGINEERING

Industrial controller

Software controller

- Operation and parameterisation
 - ▶ of an industrial controller
 - ▶ of a software controller
- Trainer and PC connected via USB box

RT 512 - RT 552 CONTROL ENGINEERING TRAINERS WITH PROCESS CONTROL SYSTEM

RT 512

RT 522

RT 532

RT 542

RT 552

RT 650.12 Profibus card

PC

RT 650.50 Process control software

- Construction of a process control system from multiple trainers via Profibus
- Operation and parameterisation of an industrial controller
 - ▶ directly on the controller
 - ▶ with the process control software

RT 450 MODULAR PROCESS AUTOMATION TRAINING SYSTEM

RT 450.10
Continuous
Controller Module

or

RT 450.42
PLC Module with
Software

RT 450.02
Controlled System
Module: Flow

+

RT 450.34
Flow Rate
Sensor:
Electromagnetic

or

RT 450.01
Controlled System
Module: Level

+

RT 450.21
Control Valve,
Pneumatic

or

RT 450.24
Control Valve,
Electric

RT 450.35
Level
Sensor:
Capacitive

- Wide-ranging options for combination of various controlled systems, controllers, actuators and sensors
- Use of a PLC
- Interconnection of multiple control engineering components via Profibus
- Operation, parameterisation and configuration of an industrial controller
 - ▶ directly on the controller
 - ▶ by software

RT 614–674 INTRODUCTION TO INDUSTRIAL CONTROL ENGINEERING

RT 614 Level Control Demonstration Unit



RT 624 Flow Control Demonstration Unit



RT 634 Pressure Control Demonstration Unit



RT 674 Flow/Level Control Demonstration Unit



The experimental units in this equipment series provide a broad-based introduction to the fundamentals of control engineering. Familiarisation with control engineering components as they currently occur in industrial applications is a further key aspect of the learning. The relevant control loop is displayed clearly on the vertical panel. The student's understanding is further aided by a large-scale process schematic.

Each unit in itself represents a complete course in the fundamentals of control engineering, with differing process behaviour being observed in each. Level, flow and pressure control systems display rapid changes in the process variable, while a temperature control represents a slow control process.

Key process variables are delivered as analogue signals on lab jacks, enabling external recording devices such as a chart recorder or oscilloscope to be connected.

Every experimental unit can be connected with ease to the instrumentation and control software RT 650.40 (accessory), enabling all the advantages of computer-aided data acquisition and processing to be utilised.

The units are suitable for two learning situations: demonstration by the tutor or independent laboratory experimentation by the students.

RT 644 Temperature Control Demonstration Unit

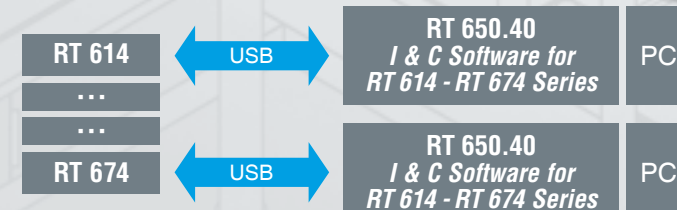


Didactic goals and exercises

- Fundamentals of control engineering based on experimentation
- Familiarisation with different types of controlled system (if multiple experimental units are available)
- Familiarisation with current industrial control engineering components: controllers, transducers, actuators
- Operation and parameterisation of a state-of-the-art digital industrial controller
- Multi-variable control (cascade control with RT 674)
- Downstream processing of process variables with external recording devices: chart recorder, oscilloscope
- Familiarisation with and use of instrumentation and control software (accessory RT 650.40)

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

RT 650.40 Instrumentation and Control Software for RT 614 - RT 674 Series



- Chart recorder function with storage of measured data
 - Recording and storage of time functions
 - Evaluation of step responses
- Software controller with PID and 2-step action
- 4 pre-selectable languages and 1 user-defined language possible
- Easy connection to PC via USB port



RT 614

Level Control Demonstration Unit



Technical Description

This experimental unit provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of level control.

All components are clearly laid out on a vertical panel. The large-format process schematic provides an aid to understanding. A pump delivers water from a storage tank into the transparent level-controlled tank. The level is measured by a pressure sensor installed at the base of the level-controlled tank. The controller used is a state-of-the-art digital industrial controller. The actuator in the control loop is an electromagnetic proportional valve. A ball valve in the outlet enables defined disturbance variables to be generated. The controlled variable X and the manipulating variable Y can be tapped as analogue signals at lab jacks. This enables external recording equipment, such as a plotter or an oscilloscope, to be connected.

An instrumentation and control software (RT 650.40) with interface module (USB) is available as an accessory. This enables the key process variables to be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

- fundamentals of control engineering
- latest industrial control engineering components: controllers, transducers, actuators
- operation and parameter setting of a multi-functional state-of-the-art digital controller: e.g. parameter setting as P, PI and PID controller
- investigation of disturbance and control response
- influence of different controller parameters on stability and control quality
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. plotter or oscilloscope
- together with accessory RT 650.40: familiarisation with and use of I&C software

* Experimental introduction to control engineering using an example of level control

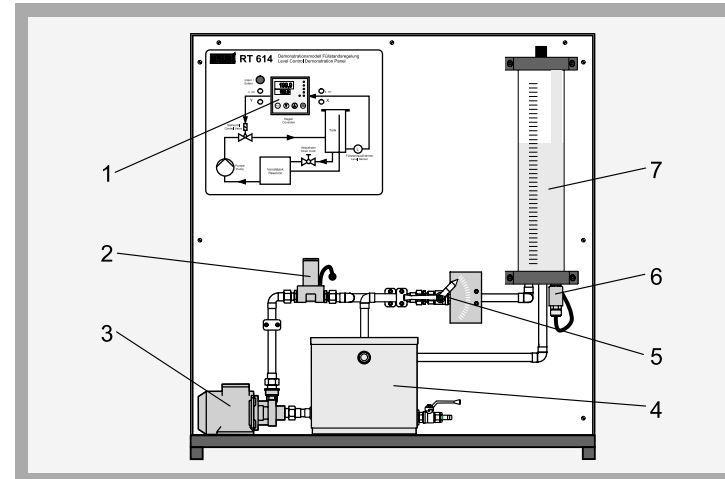
* Construction of the system with components commonly used in industry

* Digital controller with freely selectable parameters: P, I, D and all combinations

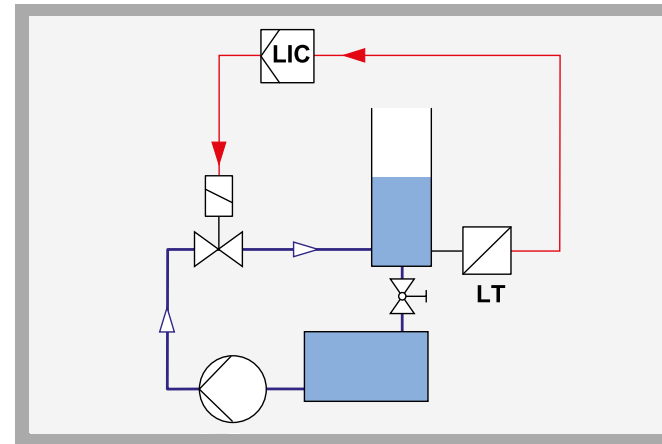
* Optional I&C software RT 650.40 via USB

RT 614

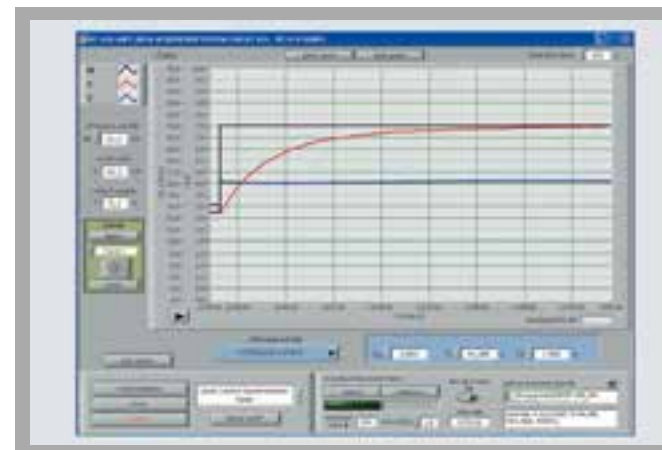
Level Control Demonstration Unit



1 controller, 2 control valve, 3 pump, 4 storage tank, 5 ball valve with scale, 6 pressure sensor for level measurement, 7 level-controlled tank



Process schematic



Screenshot of optional I&C software RT 650.40: step response to change in reference variable, with PID controller

Specification

- [1] experimental unit for control engineering experiments
- [2] level control with transparent tank
- [3] level measurement by pressure sensor
- [4] generation of disturbance variables by ball valve with scale in outlet
- [5] level-controlled tank with overflow and graduated scale
- [6] control valve: electromagnetic proportional valve
- [7] multi-functional digital industrial controller
- [8] large process schematic on front panel
- [9] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- Storage tank
 - stainless steel
 - capacity: 15L
- Pump, 3-stage
 - power consumption: 100W
 - max. flow rate: 70L/min
 - max. head: 5,6m
- Pressure sensor: 0...100mbar
- Electromagnetic proportional valve: Kvs: 1,1m³/h
- Controller: parameterisable as P, PI or PID controller
- Process variables as analogue signals: 0...10V
- Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

- LxWxH: 1000x500x1070mm
- Weight: approx. 73kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 set of laboratory cables
- 1 set of instructional material

Order Details

080.61400 RT 614 Level Control
Demonstration Unit

RT 624 Flow Control Demonstration Unit

Technical Description

This experimental unit provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of flow control.

All components are clearly laid out on a vertical front panel. The large-format process schematic provides an aid to understanding. A pump delivers water from a storage tank into the pipe section. The flow rate is measured by a paddle-wheel sensor. The transparent rotameter enables the control process to be observed very clearly. The controller used is a state-of-the-art digital industrial controller. The actuator in the control loop is an electric control valve. A ball valve in the pipe section enables defined disturbance variables to be generated. The controlled variable X and the manipulating variable Y can be tapped as analogue signals at lab jacks. This enables external recording equipment, such as a plotter or an oscilloscope, to be connected.

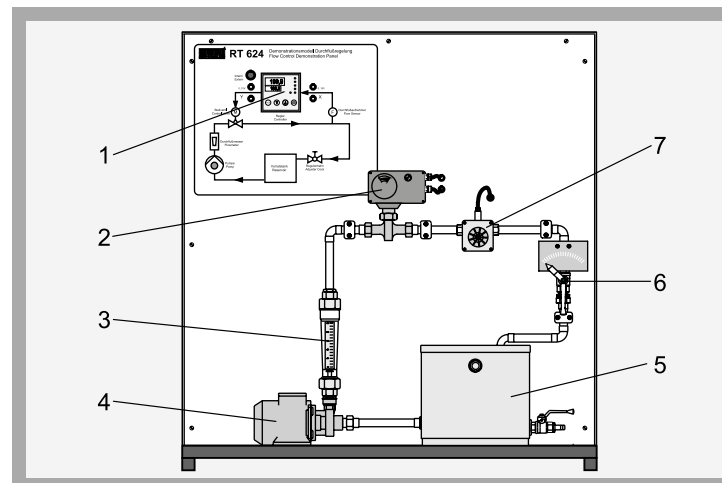
An instrumentation and control software (RT 650.40) with interface module (USB) is available as an accessory. This enables the key process variables to be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

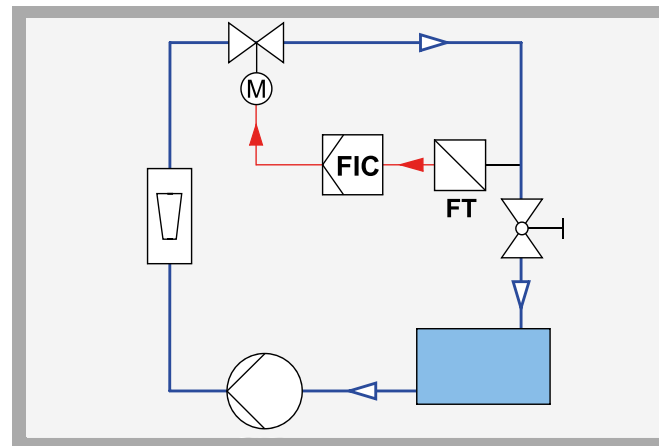
Learning Objectives / Experiments

- fundamentals of control engineering
- latest industrial control engineering components: controllers, transducers, actuators
- operation and parameter setting of a multi-functional state-of-the-art digital controller: e.g. parameter setting as P, PI and PID controller
- investigation of disturbance and control response
- influence of different controller parameters on stability and control quality
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. plotter or oscilloscope
- together with accessory RT 650.40: familiarisation with and use of I&C software

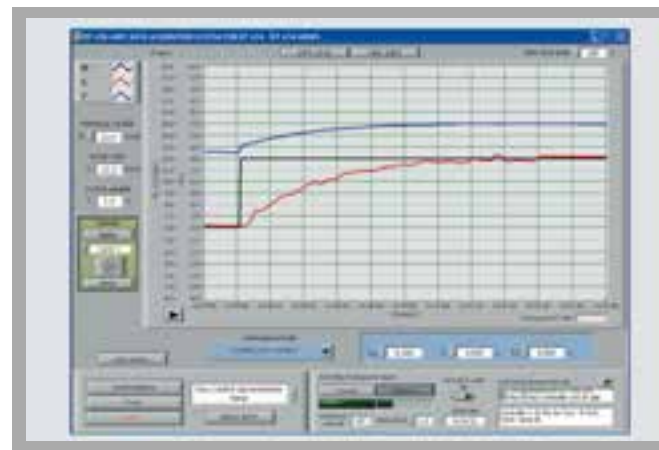
- * Experimental introduction to control engineering using an example of flow control
- * Construction of the system with components commonly used in industry
- * Digital controller with freely selectable parameters: P, I, D and all combinations
- * Optional I&C software RT 650.40 via USB

RT 624 Flow Control Demonstration Unit


1 controller, 2 control valve, 3 rotameter, 4 pump, 5 storage tank, 6 ball valve with scale, 7 paddle-wheel sensor



Process schematic



Screenshot of optional I&C software RT 650.40: step response to change in reference variable with slow PI controller

Specification

- [1] experimental unit for control engineering experiments
- [2] flow control in a pipe section
- [3] rotameter to visualise the flow
- [4] flow measurement by paddle-wheel sensor
- [5] generation of disturbance variables by ball valve with scale in pipe section outlet
- [6] control valve: electric control valve
- [7] digital industrial controller, parameterisable as a P, PI or PID controller
- [8] large process schematic on front panel
- [9] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- Storage tank
 - stainless steel
 - capacity: 15L
- Pump, 3-stage
 - power consumption: 90W
 - max. flow rate: 83L/min
 - max. head: 6m
- Paddle-wheel sensor: 3...50L/min
- Electric control valve: Kvs: 5,7m³/h
- Controller parameterisable as P, PI or PID controller
- Process variables as analogue signals: 0...10V
- Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

- LxWxH: 1000x500x1070mm
- Weight: approx. 72kg

Required for Operation

- 230V, 50Hz, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 set of laboratory cables
- 1 set of instructional material

Order Details

- 080.62400 RT 624 Flow Control Demonstration Unit

RT 634 Pressure Control Demonstration Unit

Technical Description

This experimental unit provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of pressure control.

All components are clearly laid out on a vertical front panel. The large-format process schematic provides an aid to understanding. The controlled system is operated by compressed air, which must be provided by the laboratory. The use of two in-line pressure tanks permits a 2nd order controlled system to be constructed. Disturbances can be generated by alternate air tapping by way of a hand-operated valve. Both pressure tanks are fitted with manometers. A pressure sensor measures the pressure. The controller used is a state-of-the-art digital industrial controller. The actuator in the control loop is an electro-pneumatic control valve. The controlled variable X and the manipulating variable Y can be tapped as analogue signals at lab jacks. This enables external recording equipment, such as a plotter or an oscilloscope, to be connected.

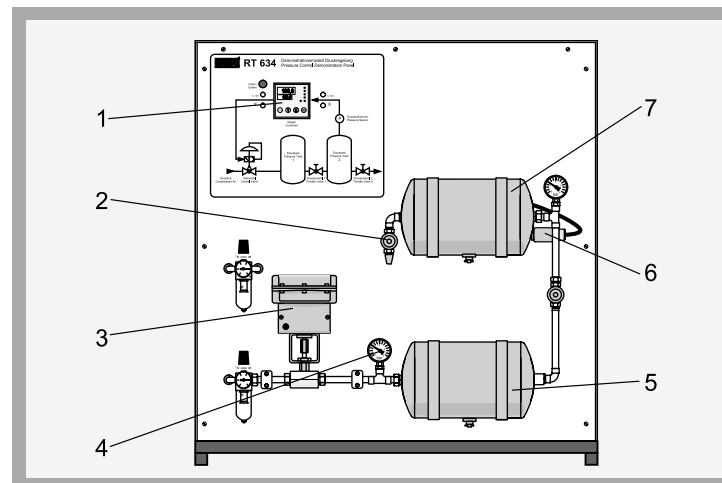
An instrumentation and control software (RT 650.40) with interface module (USB) is available as an accessory. This enables the key process variables to be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

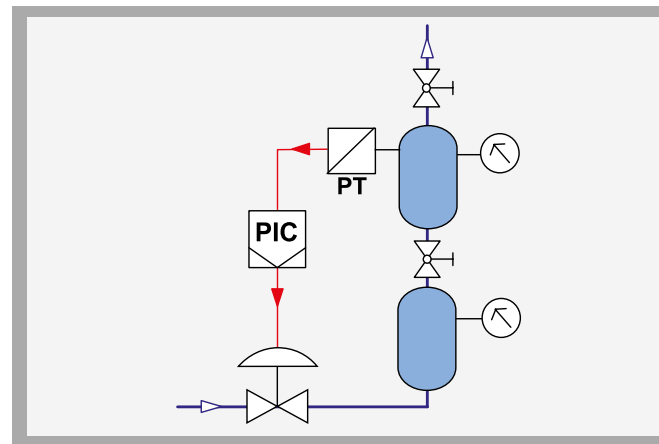
Learning Objectives / Experiments

- fundamentals of control engineering
- latest industrial control engineering components: controllers, transducers, actuators
- operation and parameter setting of a multi-functional state-of-the-art digital controller: e.g. parameter setting as P, PI and PID controller
- investigation of disturbance and control response
- influence of different controller parameters on stability and control quality
- investigation of the properties of the open and closed control loop
- processing of process variables using external equipment, e.g. plotter or oscilloscope
- together with accessory RT 650.40: familiarisation with and use of I&C software

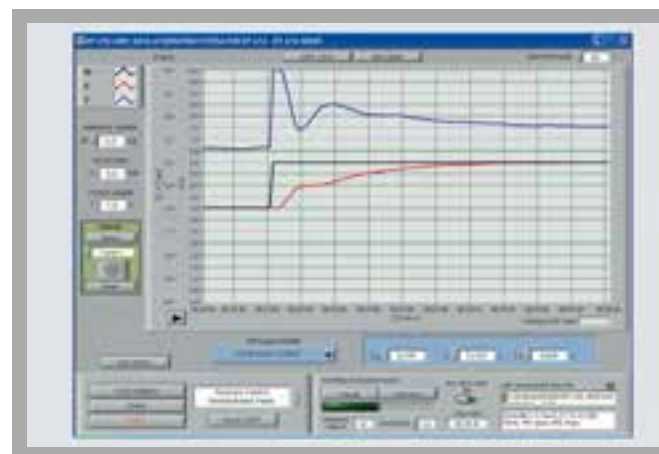
- * **Experimental introduction to control engineering using an example of pressure control**
- * **Construction of the system with components commonly used in industry**
- * **Digital controller with freely selectable parameters: P, I, D and all combinations**
- * **Optional I&C software RT 650.40 via USB**

RT 634 Pressure Control Demonstration Unit


1 controller, 2 needle valve with sound absorber for air tapping, 3 control valve, 4 manometer, 5 pressure tank, 6 pressure sensor, 7 pressure tank



Process schematic



Screenshot of optional I&C software RT 650.40: step response to change in reference variable with PI controller

Specification

- [1] experimental unit for control engineering experiments
- [2] pressure control of a 2nd order controlled system with 2 pressure tanks
- [3] pressure measurement by pressure sensor
- [4] generation of disturbance variables by needle valve
- [5] 2 Manometers
- [6] control valve: electro-pneumatic control valve
- [7] digital industrial controller, parameterisable as a P, PI or PID controller
- [8] large process schematic on front panel
- [9] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

Operating pressure: 6bar
 Pressure tanks
 - capacity: 10L
 - pressure: max. 10bar
 Pressure sensor: 0...6bar
 Manometers: 0...10bar
 Electro-pneumatic control valve
 - reference variable: 4...20mA
 - nominal valve stroke: 6mm
 Controller: parameterisable as P, PI or PID controller
 Process variables as analogue signals: 0...10V
 Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 1000x500x1070mm
 Weight: approx. 57kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz, 1 phase
 Compressed air connection: 7...10bar

Scope of Delivery

- 1 experimental unit
- 1 set of laboratory cables
- 1 set of instructional material

Order Details

080.63400 RT 634 Pressure Control
 Demonstration Unit

RT 644 Temperature Control Demonstration Unit

Technical Description

This experimental unit provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of temperature control.

All components are clearly laid out on a vertical front panel. The large-format process schematic provides an aid to understanding. The system comprises two water circuits. In the secondary circuit fresh water is heated up by a heat exchanger. The temperature is measured by a temperature sensor at the fresh water outlet. The outlet temperature of the fresh water is controlled by the flow rate of warm water in the primary circuit. The primary circuit comprises an electrically heated tank, a pump and an electromagnetic proportional valve as the actuator. Both circuits include rotameters. The controller used is a state-of-the-art digital industrial controller. A ball valve in the secondary circuit enables defined disturbance variables to be generated. The controlled variable X and the manipulating variable Y can be tapped as analogue signals at lab jacks. This enables external recording equipment, such as a plotter or an oscilloscope, to be connected.

An instrumentation and control software (RT 650.40) with interface module (USB) is available as an accessory. This enables the key process variables to be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

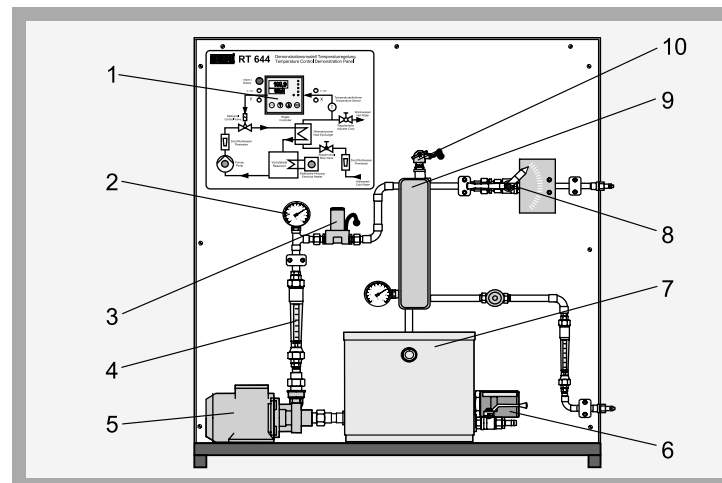
- fundamentals of control engineering
- latest industrial control engineering components: controllers, transducers, actuators
- operation and parameter setting of a multi-functional state-of-the-art digital controller: e.g. parameter setting as P, PI and PID controller
- investigation of disturbance and control response
- influence of different controller parameters on stability and control quality
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. plotter or oscilloscope
- together with accessory RT 650.40: familiarisation with and use of I&C software

* Experimental introduction to control engineering using an example of temperature control

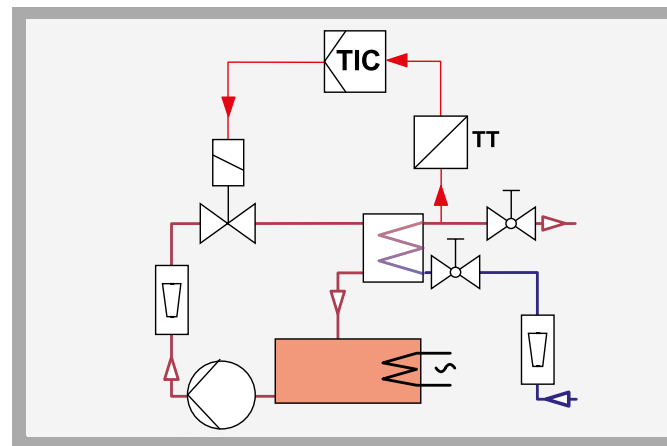
* Construction of the system with components commonly used in industry

* Digital controller with freely selectable parameters: P, I, D and all combinations

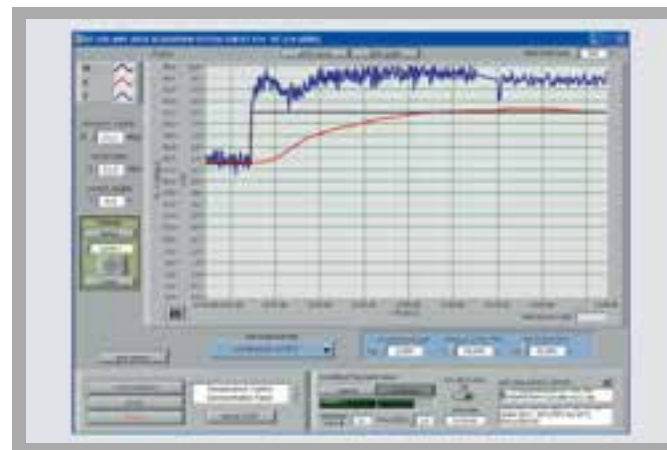
* Optional I&C software RT 650.40 via USB

RT 644 Temperature Control Demonstration Unit


1 controller, 2 thermometer, 3 control valve, 4 rotameter, 5 pump, 6 heater with thermostat, 7 tank, 8 ball valve with scale, 9 plate heat exchanger, 10 temperature sensor at fresh water outlet



Process schematic



Screenshot of optional I&C software RT 650.40: step response to change in reference variable with PID controller (acceptable control quality)

Specification

- [1] experimental unit for control engineering experiments
- [2] temperature control with plate heat exchanger and 2 water circuits
- [3] primary circuit with electrically heated tank, pump control valve, rotameter
- [4] secondary circuit with fresh water connection, temperature transducer, rotameter
- [5] ball valve to generate disturbance variables in fresh water circuit
- [6] plate heat exchanger, 30 plates
- [7] control valve: electromagnetic proportional valve
- [8] digital industrial controller, freely parameterisable
- [9] large process schematic on front panel
- [10] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- Tank
 - stainless steel
 - capacity: 15L
- Heater
 - power output: 2kW
 - thermostat: 20...80°C
- Pump, 3-stage
 - power consumption: 90W
 - max. flow rate: 83L/min
 - max. head: 6m
- Temperature sensor: Pt100: -50...400°C
- 2x dial-gauge thermometers (bimetal type): 0...80°C
- 2x rotameters: 30...320L/h
- Electromagnetic proportional valve: Kvs: 0,8m³/h
- Digital controller, can be parameterised as P, PI or PID controller
- Process variables as analogue signals: 0...10V
- Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

- LxWxH: 1000x500x1070mm
- Weight: approx. 85kg

Required for Operation

- 230V, 50/60Hz, 1 phase
- Fresh water connection approx. 100L/h

Scope of Delivery

- 1 experimental unit
- 1 set of laboratory cables
- 1 set of instructional material

Order Details

- 080.64400 RT 644 Temperature Control Demonstration Unit

RT 674 Flow / Level Control Demonstration Unit

Technical Description

The experimental unit provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of combined flow and level control. The level and flow rate can be controlled individually and as a cascade. In cascade mode the level is the primary controlled variable. The flow control then provides optimum adjustment of the controlled variable to the reference variable (setpoint).

All components are clearly laid out on a vertical panel. The large-format process scheme provides an aid to understanding. A pump delivers water from a storage tank into a piping system which contains a rotameter. From there the water passes into the transparent level-controlled tank. The level is measured by a pressure sensor installed at the base of the level-controlled tank. The controllers used are two state-of-the-art digital industrial controller. The actuator in the control loop is an electromagnetic proportional valve. Ball valves in the tank outlet and in the pipe system enable defined disturbance variables to be generated. The controlled variable X and the manipulating variable Y can be tapped as analogue signals at lab jacks. This enables external recording equipment, such as a plotter or an oscilloscope, to be connected.

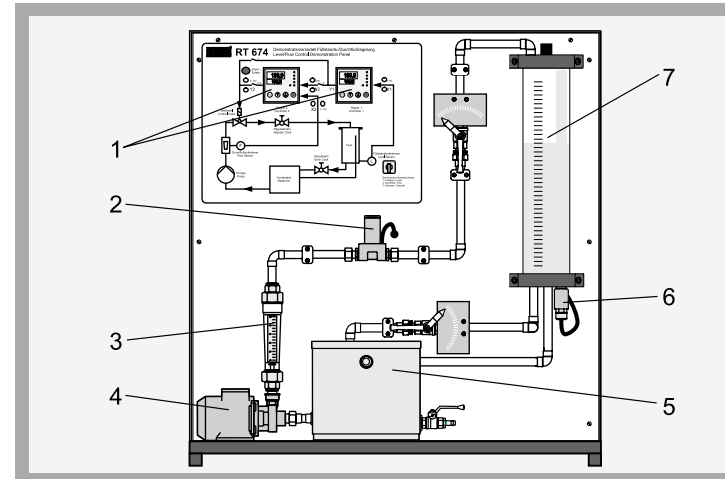
An instrumentation and control software (RT 650.40) with interface module (USB) is available as an accessory. This enables the key process variables to be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

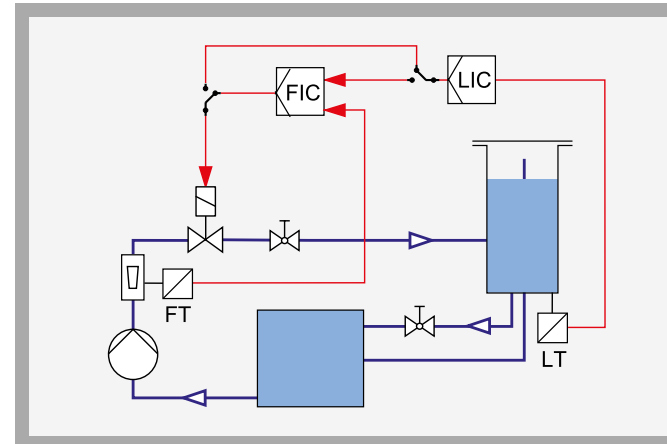
Learning Objectives / Experiments

- fundamentals of control engineering
- latest industrial control engineering components: controllers, transducers, actuators
- operation and parameter setting of a multi-functional state-of-the-art digital controller: e.g. parameter setting as P, PI and PID controller
- investigation of disturbance and control response
- influence of different controller parameters on stability and control quality
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. plotter or oscilloscope
- investigating the response of the various controlled systems
- control of
 - * flow
 - * level
 - * level via flow (cascade)
- together with accessory RT 650.40: familiarisation with and use of I&C software

- * **Experimental introduction to control engineering using an example of flow and / or level control**
- * **Two controllers permit control in cascade mode**
- * **Construction of the system with components commonly used in industry**
- * **Digital controllers with freely selectable parameters: P, I, D and all combinations**
- * **Optional I&C software RT 650.40 via USB**

RT 674 Flow / Level Control Demonstration Unit


1 controller, 2 control valve, 3 rotameter with electrical output, 4 pump, 5 storage tank, 6 pressure sensor for level measurement, 7 level-controlled tank with overflow



Process schematic



Screenshot of optional I&C software RT 650.40: step response to change in level reference variable with PID controller (acceptable control quality)

Specification

- [1] experimental unit for control engineering experiments
- [2] level and flow control individually, and cascaded
- [3] level measurement by pressure sensor
- [4] flow measurement by rotameter with electrical output
- [5] generation of disturbance variables by ball valves with scale
- [6] tank with overflow and scale
- [7] control valve: electromagnetic proportional valve
- [8] 2 digital industrial controllers, parameterisable as P, PI or PID controllers, cascade
- [9] large process schematic on front panel
- [10] key process variables accessible as analogue signals at lab jacks

Technical Data

Storage tank
- stainless steel
- capacity: 15L
Pump, 3-stage
- power consumption: 90W
- max. flow rate: 83L/min
- max. head: 6m
Pressure sensor: 0...100mbar
Rotameter with electrical output: 0...600L/h
Electromagnetic proportional valve: Kvs: 1,1m³/h
2x controllers: parameterisable as P, PI or PID controller
Process variables as analogue signals: 0...10V
Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 1000x500x1080mm
Weight: approx. 73kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz, 1 phase

Scope of Delivery

- 1 experimental unit
- 1 set of laboratory cables
- 1 set of instructional material

Order Details

080.67400 RT 674 Flow / Level Control Demonstration Unit

RT 650.40 I&C Software for RT 614 - RT 674 Series


- * **Software controller with freely settable parameters**
- * **Continuous and switching controller selectable**
- * **Language freely selectable**
- * **Process schematic with display of real-time data**
- * **Recorder functions**

Technical Description

The software ideally supports the experimentation and learning process of demonstration models RT 614 - RT 674. Its key features are the software controller and the recorder function. The controller can operate as a configurable PID controller and as a 2-point controller. In the latter case, as well as the setting of the reference variable, the hysteresis can also be pre-set. The recorder function provides continuous recording of controlled, manipulating and reference variables. It plots responses to changes in the reference (e.g. step input) and disturbance variables. Measured values can be printed out and saved to data media. Connection to a PC is by a USB port. The supplied USB interface module provides an adequate number of analogue inputs and outputs, enabling even complex circuits, such as a cascade (RT 674), to be controlled.

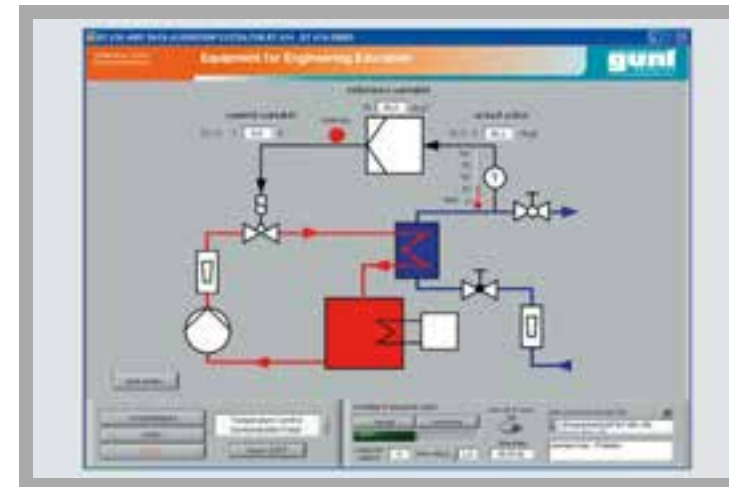
The controller included with each demonstration unit can also be used instead of the software controller. In this case, controlled, manipulating and reference variables can be plotted, displayed and saved by the program's recorder function.

Choosing different program windows makes it possible to display the relevant process schematic with locally assigned real-time data and the time functions of these parameters.

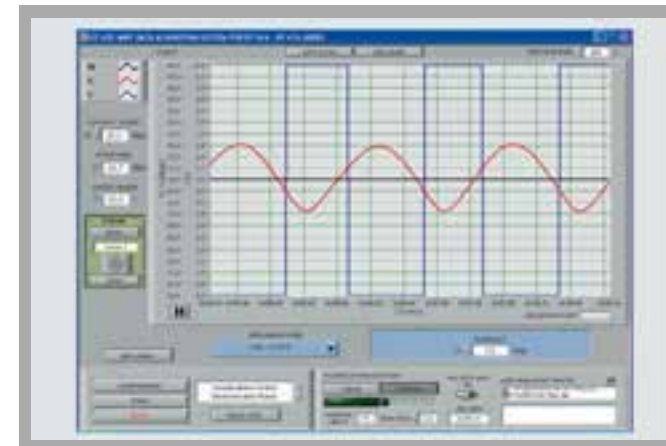
The learning process is assisted by the well structured manual, with its description of the software functions and instructions for use with the control engineering demonstration models RT 614 - RT 674.

Learning Objectives / Experiments

- familiarisation with and use of software-aided control systems
- connection of a PC to the port and correct interfacing to different control processes
- saving data
- different control methods: switching or continuous
- configuring a continuous controller
- recording and evaluating step responses
- Investigation of disturbance and control response

RT 650.40 I&C Software for RT 614 - RT 674 Series


Screenshot: process schematic window of temperature control demonstration model (RT 644)



Screenshot: 2-point temperature control



USB interface module

Specification

- [1] instrumentation and control software to present relevant data on a PC
- [2] selectable continuous or switching software controller mode
- [3] continuous controller parameters settable
- [4] the controller included in the demonstration model can be replaced by a software controller
- [5] the controller included in the demonstration model can also be used with the software recorder function
- [6] real-time data can be displayed in different windows
- [7] language freely selectable
- [8] easy connection to PC via USB port with 4 analogue inputs and 2 analogue outputs

Technical Data

- Software controller (continuous mode)
 - configurable as P, PI or PID controller
 - cascade control
- Software controller (switching mode)
 - 2-point response
 - input of reference variable and hysteresis
- Recorder function with data saving
 - recording and saving of time functions
 - evaluation of step responses with automatically generated inflectional tangent
- Language selection
 - 4 pre-selectable languages
 - 1 user-defined language possible
- Software basis
 - LabVIEW
 - system requirements: Windows Vista or Windows 7, USB port

Scope of Delivery

- 1 GUNT software CD
- 1 USB interface module
- 1 set of cables
- 1 manual with description of software functions and instructions for use with demonstration models RT 614 - RT 674

Order Details

080.65040 RT 650.40 I&C Software for RT 614 - RT 674 Series

RT 512 – RT 552 CONTROL ENGINEERING TRAINERS WITH PROCESS CONTROL SYSTEM

RT 512 Level Control Trainer



RT 522 Flow Control Trainer



RT 532 Pressure Control Trainer



RT 542 Temperature Control Trainer



RT 552 pH Value Control Trainer



Didactic goals and exercises

Comprehensive programme of experiments with each trainer:

- introduction to the fundamentals of control engineering based on experimentation
- familiarisation with real industrial components such as controllers, chart recorders, actuators and sensors
- demonstration of a wide variety of types of control systems (e.g. temperature, pressure)
- familiarisation with different controlled system characteristics
- investigation of disturbance and control response
- controller optimisation
- parameterisation of the local industrial controller
 - manually
 - automatically
 - via process control software
- downstream processing of process variables with external recording devices: chart recorder, oscilloscope
- familiarisation with and use of a process control software (with accessory RT 650.50)

The trainers in this equipment series provide a comprehensive and practical introduction to the fundamentals of control engineering. The trainers are fully practice-based in design: only controls and process components currently deployed in industrial applications are used.

Each trainer in itself represents a complete course in the fundamentals of control engineering. The special feature of these units is that two or more trainers can be interconnected via a Profibus interface to a state-of-

the-art process control software to form a networked complete system.

The trainers are suitable for two learning situations: demonstration by the tutor or independent laboratory experimentation by the students.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.



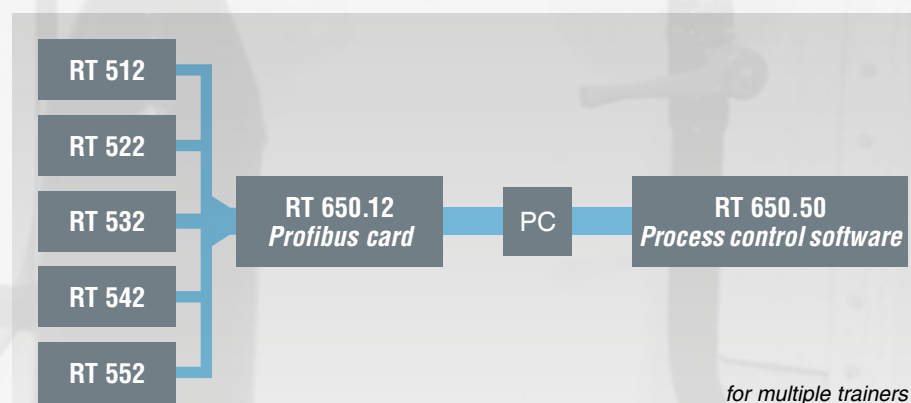
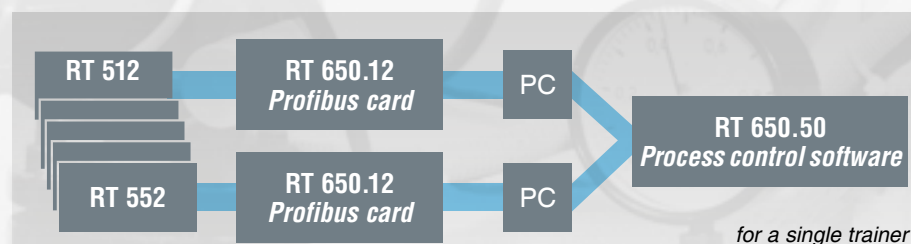
Process Control Software

State-of-the-art LabVIEW-based process control software for Windows, featuring extensive monitoring and visualisation functionality:

- for stand-alone trainers or networking of multiple trainers
- network capability
- process schematics with online display of all process variables
- parameterisation of the individual controllers
- control station function for multiple training rig configurations
- chart recorder function with storage of measured data
- alarm function with logging
- 4 pre-selectable languages and 1 user-defined language possible

Communication between PC and local controllers and networking of the individual trainers via field bus system (Profibus DP):

- Profibus interface card for PC with driver software (RT 650.12)
- Profibus interface for controllers provided as standard



RT 512 Level Control Trainer

Technical Description

This trainer provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of level control.

A pump delivers water from a storage tank to the transparent level-controlled tank. The liquid level is measured by a pressure transducer installed at the base of the level-controlled tank. The controller used is a state-of-the-art digital industrial controller. The actuator in the control loop is a pneumatically operated control valve with an electro-pneumatic positioner. A ball valve in the outlet line enables defined disturbance variables to be generated. The controlled variable X and the manipulating variable Y are plotted directly on an integrated 2-channel line recorder. Alternatively, the variables can be tapped as analogue signals at lab jacks on the switch cabinet. This enables external recording equipment, such as an oscilloscope or a flatbed plotter, to be connected.

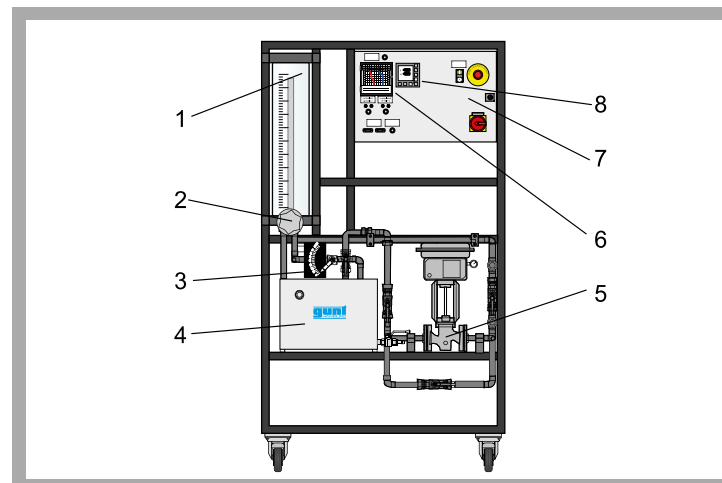
A process control software (RT 650.50) is optionally available. The software permits the construction of a complete networked system comprising multiple trainers from the RT 512 - RT 552 series. The key process variables can also be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

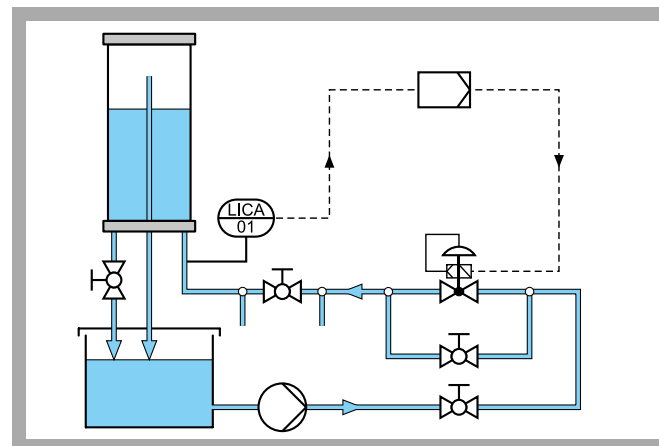
Learning Objectives / Experiments

- fundamentals of control engineering
- real industrial control engineering components: controllers, transducers, actuators
- operation and parameterisation of the local industrial controller
 - * manually (by keyboard)
 - * using the RT 650.50 process control software
- investigation of disturbance and control response
- controller optimisation
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. oscilloscope or plotter
- together with accessory RT 650.50 and other trainers (RT 522 - RT 552): familiarisation with and use of process control software (SCADA)

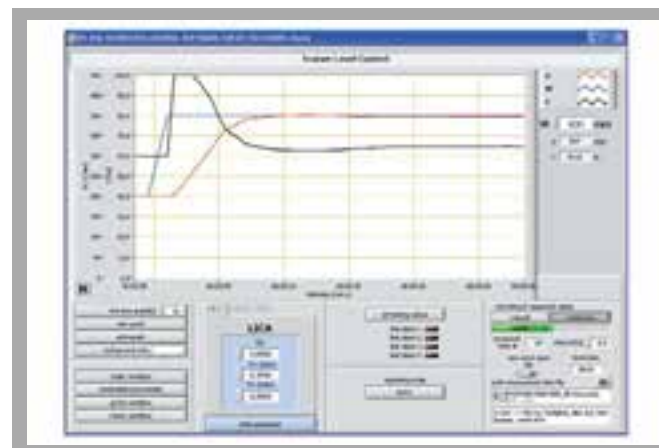
- * **Experimental introduction to control engineering using an example of level control**
- * **Construction of the system with components commonly used in industry**
- * **Digital controller with freely selectable parameters: P, I, D and all combinations**
- * **Integrated 2-channel line recorder**
- * **Optional process control software RT 650.50 available**
- * **Construction of a complete networked system via Profibus interface possible**

RT 512 Level Control Trainer


1 transparent level-controlled tank, 2 pressure sensor, 3 ball valve with scale, 4 storage tank with pump, 5 pneumatic control valve, 6 line recorder, 7 switch cabinet, 8 controller



Process schematic



Screenshot of optional process control software RT 650.50: step response to change in reference variable, PI controller

Specification

- [1] trainer for control engineering experiments
- [2] level control process, equipped with standard industrial components
- [3] level measurement by pressure sensor
- [4] generation of disturbance variables by ball valve with scale in outlet
- [5] transparent level-controlled tank with overflow and graduated scale
- [6] pneumatically operated control valve with electro-pneumatic positioner
- [7] digital controller, parameterisable as a P, PI or PID controller
- [8] 2-channel line recorder
- [9] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- Storage tank: 30L
- Centrifugal pump
 - power consumption: 250W
 - max. flow rate: 150L/min
 - max. head: 7m
 - speed: 2800min⁻¹
- Level-controlled tank
 - max. 7L
 - level: 0...0,6m
- Pressure sensor: 0...100mbar
- Pneumatically operated control valve DN 20
 - Kvs: 4,0m³/h
 - reference variable: 4...20mA
 - nominal stroke: 15mm
 - characteristic curve equal-percentage
- Line recorder
 - 2x 4...20mA
 - feed rate 0...7200mm/h, stepped
- Controller
 - process variables X , Y as analogue signals: 4...20mA

Dimensions and Weight

- LxWxH: 1000x700x1750mm
- Weight: approx. 124kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase
- Compressed air: 3...8bar

Scope of Delivery

- 1 trainer
- 1 set of cables
- 1 set of hoses
- 1 set of instructional material

Order Details

080.51200 RT 512 Level Control Trainer

RT 522 Flow Control Trainer

Technical Description

This trainer provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of flow control.

A pump delivers water from a storage tank through a piping system. The flow rate is measured by an electromagnetic sensor, which permits further processing of the measured value by outputting a standardised current signal. A rotameter indicates the flow. The controller used is a state-of-the-art digital industrial controller. The actuator in the control loop is a control valve with electric motor operation. A ball valve in the outlet line enables defined disturbance variables to be generated. The controlled variable X and the manipulating variable Y are plotted directly on an integrated 2-channel line recorder. Alternatively, the variables can be tapped as analogue signals at lab jacks on the switch cabinet. This enables external recording equipment, such as an oscilloscope or a flatbed plotter, to be connected.

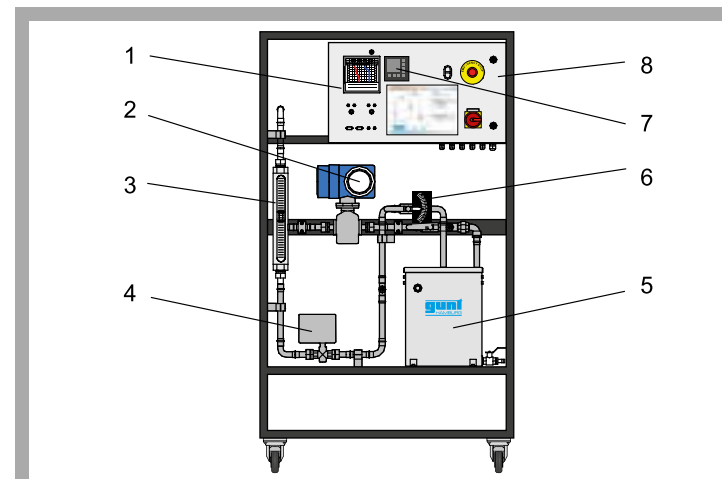
A process control software (RT 650.50) is optionally available. The software permits the construction of a complete networked system comprising multiple trainers from the RT 512 - RT 552 series. The key process variables can also be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

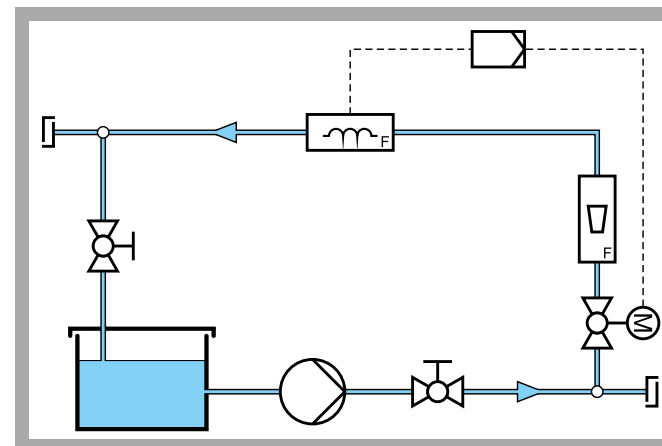
Learning Objectives / Experiments

- fundamentals of control engineering
- real industrial control engineering components: controllers, transducers, actuators
- operation and parameterisation of the local industrial controller
 - * manually (by keyboard)
 - * using the RT 650.50 process control software
- investigation of disturbance and control response
- controller optimisation
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. oscilloscope or plotter
- together with accessory RT 650.50 and other trainers (RT 512, RT 532 - RT 552): familiarisation with and use of process control software (SCADA)

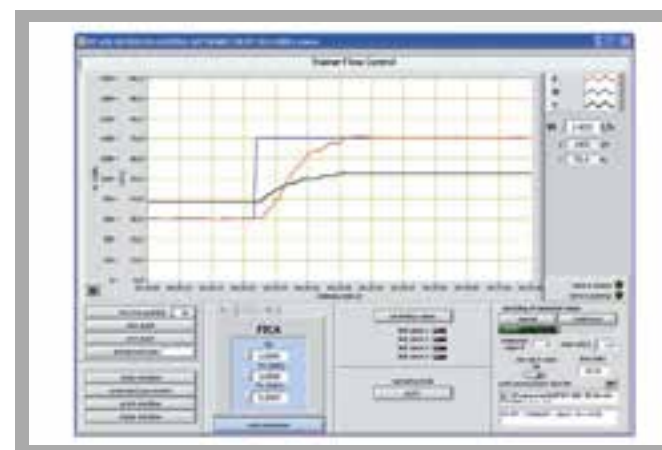
- * **Experimental introduction to control engineering using an example of flow control**
- * **Construction of the system with components commonly used in industry**
- * **Digital controller with freely selectable parameters: P, I, D and all combinations**
- * **Integrated 2-channel line recorder**
- * **Optional process control software RT 650.50 available**
- * **Construction of a complete networked system via Profibus interface possible**

RT 522 Flow Control Trainer


1 line recorder, 2 electromagnetic flow rate sensor, 3 rotameter, 4 control valve, 5 storage tank with pump, 6 ball valve with scale, 7 controller, 8 switch cabinet



Process schematic



Screenshot of optional process control software RT 650.50: step response to change in reference variable, PI controller

Specification

- [1] trainer for control engineering experiments
- [2] flow control process, equipped with standard industrial components
- [3] flow rate measurement by electromagnetic sensor
- [4] rotameter for direct observation of the flow
- [5] generation of disturbance variables by ball valve with scale in outlet line
- [6] control valve with electric motor
- [7] digital controller, parameterisable as a P, PI or PID controller
- [8] 2-channel line recorder
- [9] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- Storage tank: 30L
- Centrifugal pump
 - power consumption: 250W
 - max. flow rate: 150L/min
 - max. head: 7m
 - speed: 2800min⁻¹
- Rotameter: 0...1960L/h
- Electromagnetic flow rate sensor: 0...6000L/h
- Control valve with electric motor
 - Kvs: 5,7m³/h
 - stroke: 5mm
 - characteristic curve equal-percentage
 - valve-opening position sensor: 0...1000 Ohm
- Line recorder
 - 2x 4...20mA
 - feed rate 0...7200mm/h, stepped
- Controller
 - process variables X, Y as analogue signals: 4...20mA

Dimensions and Weight

- LxWxH: 1000x700x1750mm
- Weight: approx. 110kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 trainer
- 1 set of cables
- 1 hose
- 1 set of instructional material

Order Details

080.52200 RT 522 Flow Control Trainer

RT 532

Pressure Control Trainer



Technical Description

This trainer provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of pressure control.

The air pressure control system is a 2nd order system. It comprises two in-line pressure tanks interconnected by a flow control valve. An additional valve on the second tank makes air tapping possible and so can be used to simulate a disturbance variable. A pressure sensor measures the pressure in the second vessel. The controller used is a state-of-the-art digital industrial controller. The actuator in the loop is a pneumatically operated control valve with a standardised current signal input. The controlled variable X and the manipulating variable Y are plotted directly on an integrated 2-channel line recorder. Alternatively, the variables can be tapped as analogue signals at lab jacks on the switch cabinet. This enables external recording equipment, such as an oscilloscope or a flatbed plotter, to be connected.

A process control software (RT 650.50) is optionally available. The software permits the construction of a complete networked system comprising multiple trainers from the RT 512 - RT 552 series. The key process variables can also be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

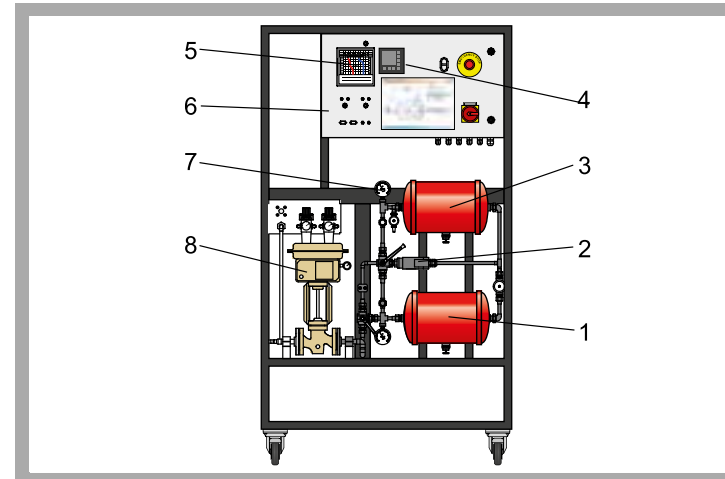
Learning Objectives / Experiments

- fundamentals of control engineering
- real industrial control engineering components: controllers, transducers, actuators
- operation and parameterisation of the local industrial controller
 - * manually (by keyboard)
 - * using the RT 650.50 process control software
- control response to
 - * 1st order controlled system
 - * 2nd order controlled system
- investigation of disturbance and control response
- controller optimisation
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. oscilloscope or plotter
- together with accessory RT 650.50 and other trainers (RT 512, RT 522, RT 542, RT 552): familiarisation with and use of process control software (SCADA)

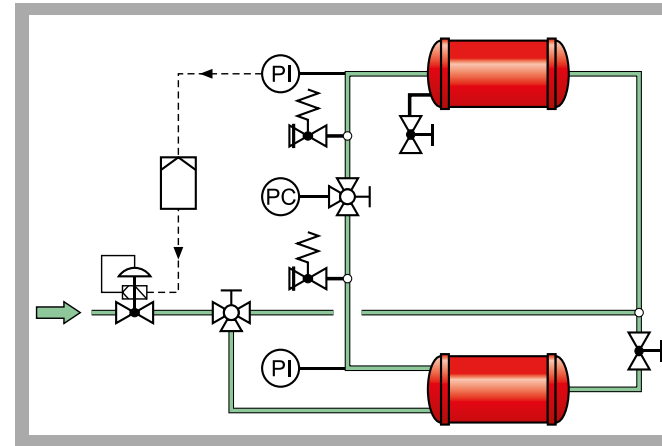
- * Experimental introduction to control engineering using an example of pressure control
- * Construction of the system with components commonly used in industry
- * Digital controller with freely selectable parameters: P, I, D and all combinations
- * Integrated 2-channel line recorder
- * Optional process control software RT 650.50 available
- * Construction of a complete networked system via Profibus interface possible

RT 532

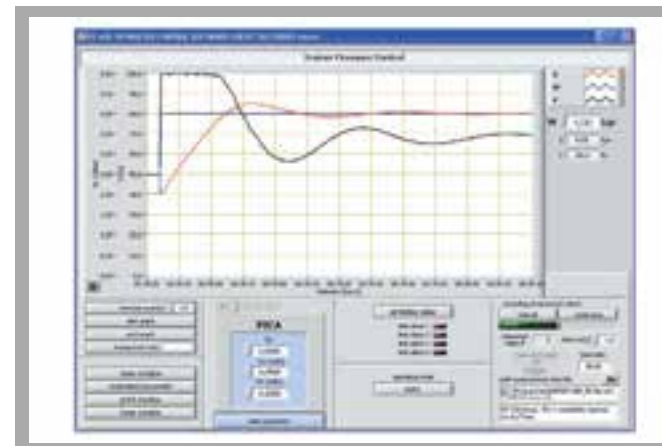
Pressure Control Trainer



1 pressure tank, 2 pressure sensor, 3 pressure tank, 4 digital controller, 5 line recorder, 6 switch cabinet, 7 manometer, 8 pneumatically operated control valve



Process schematic



Screenshot of optional process control software RT 650.50: step response to change in reference variable, PI controller

Specification

- [1] trainer for control engineering experiments
- [2] pressure control process, equipped with standard industrial components
- [3] pressure measurement by pressure sensor
- [4] generation of disturbance variables by drain valve
- [5] 2 pressure tanks with pressure relief valve and manometer for direct observation of the tank pressure
- [6] valves permit investigation of a 1st order controlled system (1 tank) or 2nd order controlled system (2 in-line tanks)
- [7] pneumatically operated control valve with electro-pneumatic positioner
- [8] digital controller, parameterisable as a P, PI or PID controller
- [9] 2-channel line recorder
- [10] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- 2 pressure tanks
 - capacity: each 10L
 - max. pressure: 10bar
 - operating pressure: 6bar
- Pressure sensor: 0...6bar
- Pneumatically operated control valve
 - connecting flanges: DN15
 - Kvs: 0,1m³/h
 - reference variable: 4...20mA
 - stroke: 15mm
 - characteristic curve equal-percentage
- Line recorder
 - 2x 4...20mA
 - feed rate 0...7200mm/h, stepped
- Controller
 - process variables X, Y as analogue signals: 4...20mA

Dimensions and Weight

LxWxH: 1000x700x1750mm
Weight: approx. 110kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase
Compressed air: 3...8bar

Scope of Delivery

- 1 trainer
- 1 set of cables
- 1 hose
- 1 set of instructional material

Order Details

080.53200 RT 532 Pressure Control Trainer

RT 542 Temperature Control Trainer

Technical Description

This trainer provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of temperature control.

A circulating pump delivers water within a closed circuit. The flow rate of water can be adjusted by a hand-operated valve. The loop also contains a screw-in heater, a heat exchanger with fan, and three integrated thermocouples for temperature measurement. Dead times can be represented by the use of different lengths of process delay. A thyristor power controller is used as the actuator. The controller used is a state-of-the-art digital industrial controller. It can be configured as a continuous or a switching device, and can activate the heater via the actuator and / or the fan. The controlled variable X and the manipulating variable Y are plotted directly on an integrated 2-channel line recorder. Alternatively, the variables can be tapped as analogue signals at lab jacks on the switch cabinet. This enables external recording equipment, such as an oscilloscope or a flatbed plotter, to be connected.

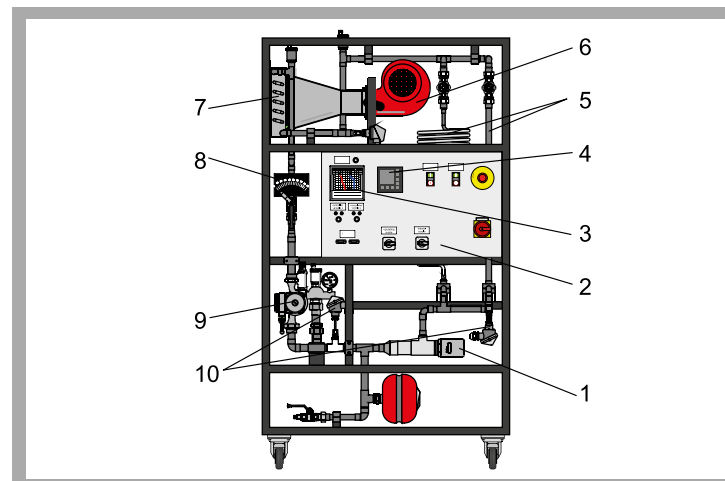
A process control software (RT 650.50) is optionally available. The software permits the construction of a complete networked system comprising multiple trainers from the RT 512 - RT 552 series. The key process variables can also be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

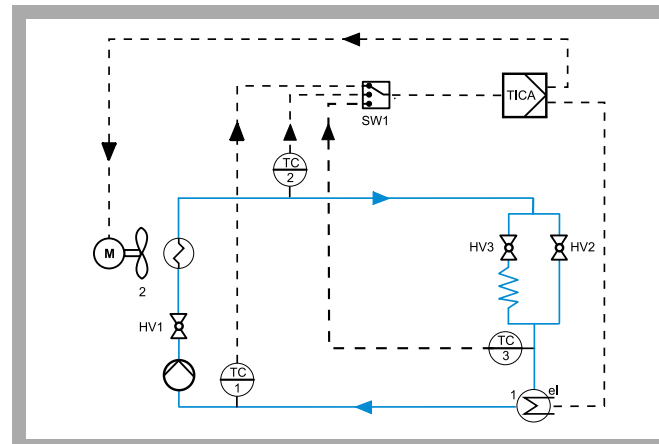
Learning Objectives / Experiments

- fundamentals of control engineering
- real industrial control engineering components: controllers, transducers, actuators
- operation, configuration and parameterisation of the local industrial controller
 - * manually (by keyboard / controller software RT 450.14)
 - * using the RT 650.50 process control software
- control response to
 - * switching control (2-point / 3-point controller)
 - * continuous control
 - * dead times
- investigation of disturbance and control response
- controller optimisation
- investigation of the properties of the open and closed control loops
- processing of process variables using external equipment, e.g. oscilloscope or plotter
- together with accessory RT 650.50 and other trainers (RT 512 - RT 532, RT 552): familiarisation with and use of process control software (SCADA)

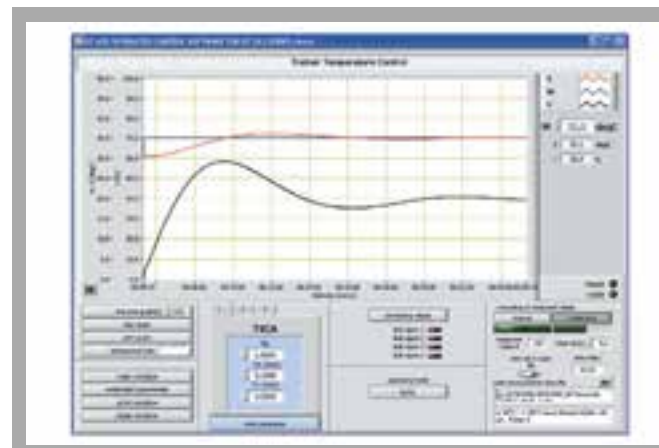
- * **Experimental introduction to control engineering using an example of temperature control**
- * **Construction of the system with components commonly used in industry**
- * **Digital controller with freely selectable parameters: P, I, D and all combinations**
- * **Controllers configurable: Continuous controller, 2-point or 3-point controller**
- * **Integrated 2-channel line recorder**
- * **Optional process control software RT 650.50 available**
- * **A complete networked system can be constructed with Profibus interface**

RT 542 Temperature Control Trainer


1 screw-in heater, 2 switch cabinet, 3 line recorder, 4 controller, 5 process delays, 6 fan, 7 heat exchanger, 8 ball valve with scale, 9 pump, 10 thermocouples



Process schematic: controller can activate heater power controller (continuous or switching) and/or fan (switching) according to mode



Screenshot of optional process control software RT 650.50: step response to change in reference variable, PI controller

Specification

- [1] trainer for control engineering experiments
- [2] temperature control process, equipped with standard industrial components
- [3] water circuit with pump, heater and 2 different lengths of process delay
- [4] screw-in heater with dry-running protection and temperature limiter
- [5] air/water heat exchanger with fan
- [6] temperature measurement with thermocouples at multiple points
- [7] generation of disturbance variables by ball valve with scale in water circuit
- [8] thyristor power controller as actuator
- [9] digital controller, configurable as switching or continuous controller
- [10] 2-channel line recorder
- [11] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- Pump, 3-stage
 - max. power consumption: 70W
 - max. flow rate: 3,6m³/h
 - max. head: 4m
- Screw-in heater: 2kW
- Heat exchanger: approx. surface area 2,8m²
- Fan
 - power output: 250W
 - max. flow rate: 780m³/h
 - max. differential pressure: 430Pa
- speed: 2880min⁻¹
- Thermocouple: type J: 0...200°C
- Thyristor power controller max. load current: 25A
- Line recorder
 - 1x 4...20mA, 1x 0...20mA
 - feed rate 0...7200mm/h, stepped
- Controller
 - process variables X, Y as analogue signals: 4...20mA

Dimensions and Weight

- LxWxH: 1000x700x1750mm
- Weight: approx. 120kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 230V, 60Hz/CSA, 3 phases

Scope of Delivery

- 1 trainer
- 1 set of cables
- 1 hose
- 1 set of instructional material

Order Details

080.54200 RT 542 Temperature Control Trainer

RT 552 pH Value Control Trainer


The illustration shows a similar unit.

Technical Description

This trainer provides a comprehensive experimental introduction to the fundamentals of control engineering using an example of continuous pH control.

A caustic solution is added to fresh water by way of a metering pump. The pH value of this solution is measured. The acid is then added to the solution as a neutralising reagent by way of a second metering pump. The chemical reaction occurs in a pipeline system. The pH value is then remeasured. A state-of-the-art digital industrial controller controls the second metering pump with reference to this pH value. The neutralised solution flows into the product tank. A third manual measurement of the pH value in the product tank permits disposal of solution with a neutral pH value. The pH value of the input solution can be varied by manually adjusting the metering pump or by varying the quantity of fresh water. This enables disturbances to be simulated. The controlled variable X and the manipulating variable Y are plotted directly on an integrated 2-channel line recorder. Alternatively, the variables can be tapped as analogue signals at lab jacks on the switch cabinet. This enables external recording equipment, such as an oscilloscope or a flatbed plotter, to be connected.

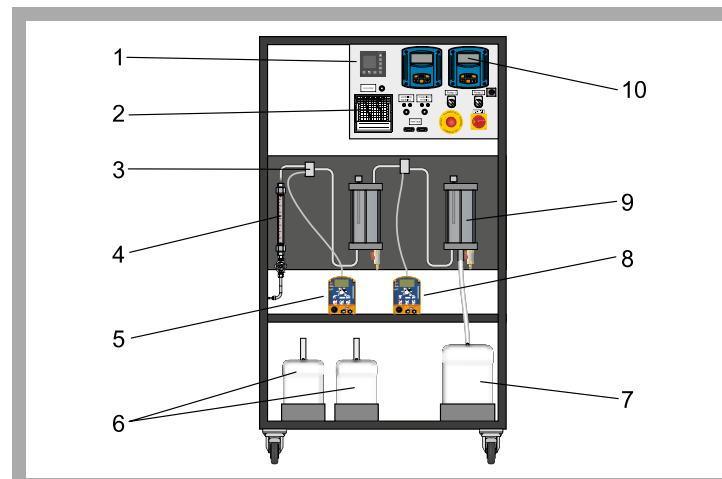
A process control software (RT 650.50) is optionally available. The software permits the construction of a complete networked system comprising multiple trainers from the RT 512 - RT 552 series. The key process variables can also be represented, and control functions executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

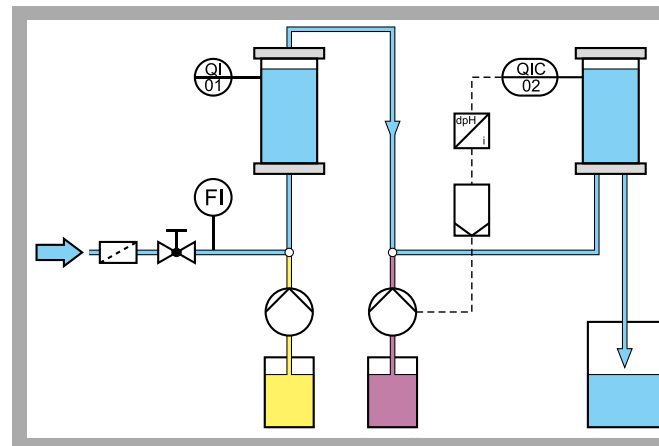
Learning Objectives / Experiments

- fundamentals of control engineering
- real industrial control engineering components
- operation and parameterisation of the local controller
 - * manually
 - * using the RT 650.50 process control software
- pH value control
 - * influence of dead time
- ratio control
- investigation of disturbance and control response
- controller optimisation
- properties of the open and closed control loops
- processing of process variables using external equipment, e.g. oscilloscope or plotter
- together with accessory RT 650.50 and other trainers (RT 512 - RT 542): familiarisation with and use of process control software (SCADA)

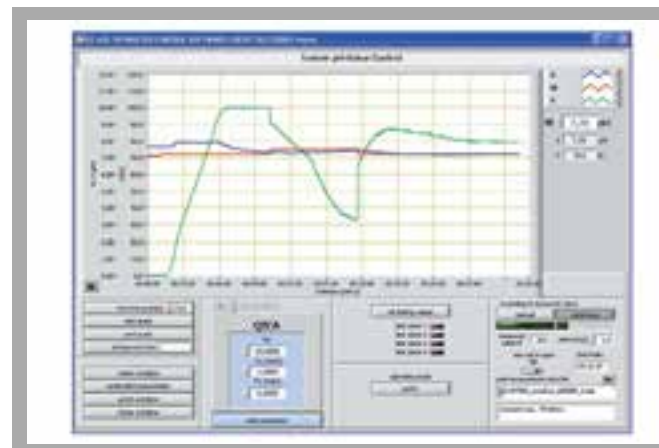
- * **Experimental introduction to control engineering using an example of continuous pH value control**
- * **Construction of the system with components commonly used in industry**
- * **Digital controller with freely selectable parameters: P, I, D and all combinations**
- * **Integrated 2-channel line recorder**
- * **Optional process control software RT 650.50 available**
- * **Construction of a complete networked system via Profibus interface possible**

RT 552 pH Value Control Trainer


1 controller, 2 line recorder, 3 mixing nozzle, 4 rotameter (fresh water), 5 manually adjustable caustic metering pump, 6 chemicals tank, 7 product tank, 8 controller-adjusted acid metering pump, 9 product tank, 10 pH value display



Process schematic



Screenshot of optional process control software RT 650.50: step response to change in reference variable, PI controller

Specification

- [1] trainer for control engineering experiments
- [2] pH value control process, equipped with standard industrial components
- [3] neutralisation of a caustic solution with an acid
- [4] 2 pH value sensors in transparent measuring tanks with overflow
- [5] digital controller, parameterisable as a P, PI or PID controller
- [6] product tank and 2 chemicals tanks
- [7] 2 metering pumps: adjustable manually or via controller
- [8] water connection with control valve and rotameter
- [9] corrosion-resistant piping system
- [10] hand-held pH-meter for product control
- [11] 2-channel line recorder
- [12] process variables X and Y accessible as analogue signals via lab jacks

Technical Data

- Product tank: 20L
- Chemicals tank: 2x 5L
- Metering pumps
 - max. flow rate: each 2,1L/h
 - max. head: each 160m
- pH value sensor
 - filled with solid electrolyte
 - with glass shaft and PTFE diaphragm
- Line recorder
 - 2x 4...20mA
 - feed rate 0...7200mm/h, stepped
- Controller
 - process variables X, Y as analogue signals: 4...20mA

- Measuring ranges
 - pH value: 1...12
 - temperature: 0...80°C

Dimensions and Weight

- LxWxH: 1000x700x1750mm
- Weight: approx. 105kg

Required for Operation

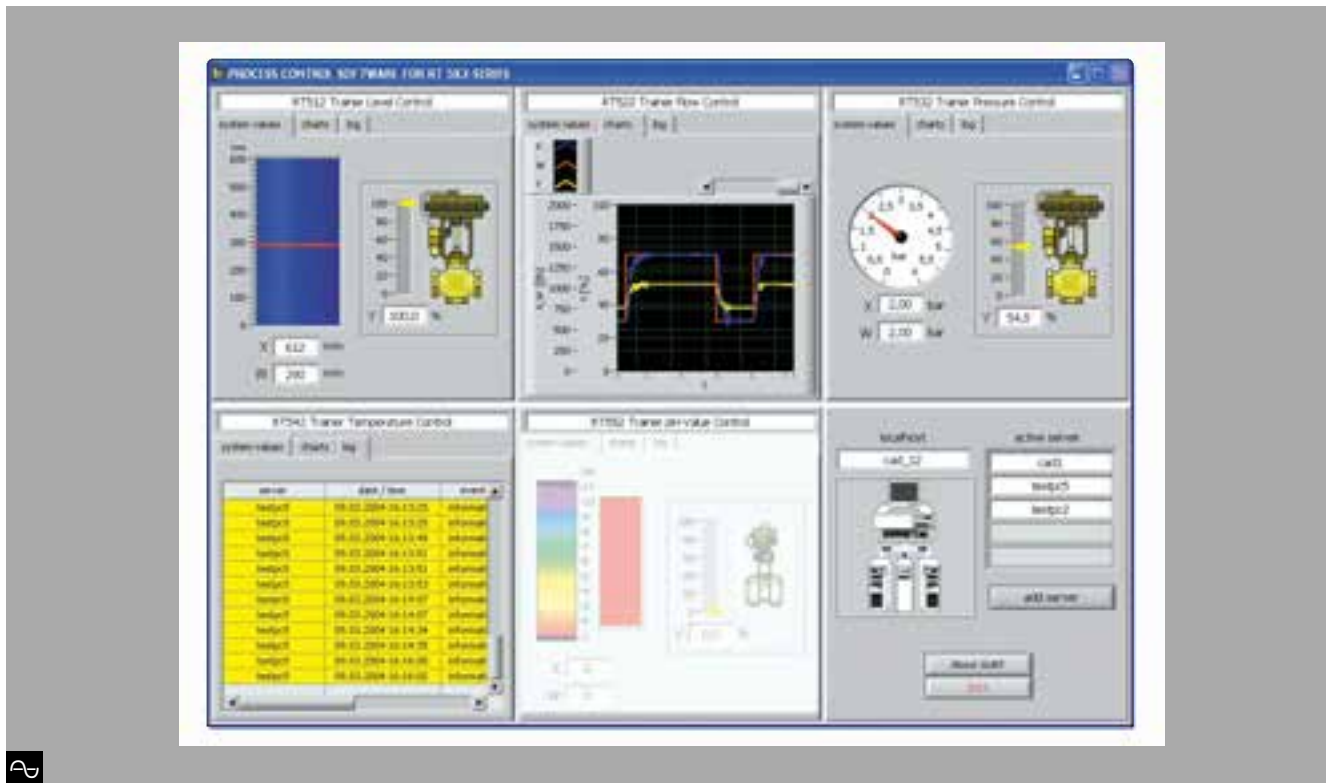
- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase
- Water connection
- Caustic soda NaOH 45%; hydrochloric acid HCl 30%, technically pure; buffer solution pH 4,0 (red), buffer solution pH 7,0 (green), buffer solution pH 10,0 (blue)

Scope of Delivery

- 1 trainer
- 1 hand-held pH-meter
- 3 measuring cups
- 1 set of cables
- 1 hose
- 1 set of instructional material

Order Details

080.55200 RT 552 pH Value Control Trainer

RT 650.50 Process Control Software for RT 512 - RT 552 Series


- * **Control station for up to 5 trainers working simultaneously**
- * **Autonomous detection of connected units**
- * **Programmer**
- * **Alarm function with four limit values for triggering an alarm or message**

Technical Description

The RT 650.50 process control software (SCADA) was developed specially for the RT 512 - RT 552 series of trainers. It can automatically detect which units are connected for operation. Up to five units can be connected simultaneously. The program and the trainers communicate via Profibus DP modules. Changes to the software are transmitted to the controller of the relevant trainer.

Alongside the process schematic, controller configuration and recorder functions, the software also provides programmer, messaging and control station functions. The process schematics display the process variables and the reference, controlled and manipulating variables in real time. They also allow the reference variable, the controller parameters and controller mode to be changed. There are also status displays for the alarms.

The "Charts" menu item offers features including controller parameter setting and mode selection, setting of the reference variable and limit values for the alarm function, as well as display of the controlled and manipulating variables. The characteristic of the reference variable over time (e.g. step input, ramp etc.) is specified in the programmer. A total of three programs are available, each with 15 software modules, and each including their own custom controller parameters. The messages are divided into alarms (status indicators, over/under limit) and information (status monitoring, approaching the limit). The message status is colour-

coded. The control room function permits simultaneous monitoring and, where appropriate, accessing of all connected trainers.

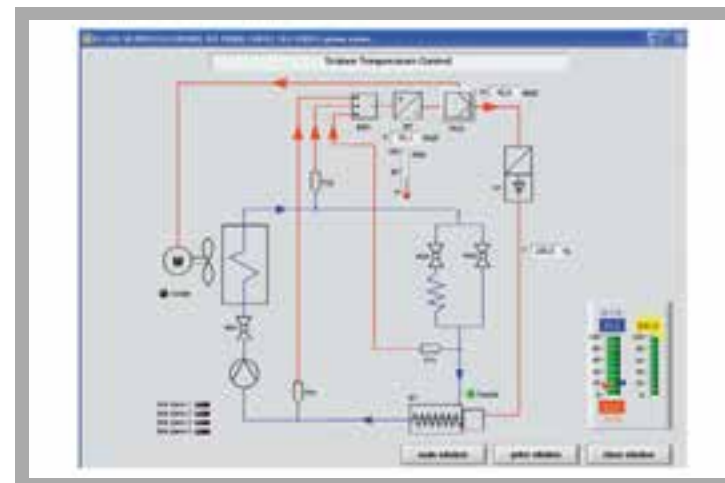
Learning Objectives / Experiments

- familiarisation with and use of a process control system

- Stand-alone operation with a single trainer
- process schematics with online display of all process variables
 - alarm function with logging
 - parameterisation for the individual controllers
 - manual or automatic controller mode
 - controller configuration for temperature control (continuous / 2-point / 3-point controller)
 - software system allows multiple trainers to be controlled/monitored from one PC
 - mode of operation of a programmer

additionally in combinations of multiple trainers on one PC

- control station function
- autonomous detection of the connected units

RT 650.50 Process Control Software for RT 512 - RT 552 Series


Process schematic for temperature control: reference variable W (setpoint) is settable directly; manipulating variable Y and controlled variable X (actual value) are displayed directly; controller can be accessed to change the parameters



Controller operation via process schematic: reference variable, controller parameters and controller mode (manual or automatic) selectable



Programming the notifications and alarms for temperature control

Specification

- [1] interactive, menu-driven process control software (SCADA) for operation and monitoring of control processes
- [2] control station function for simultaneous operation of multiple trainers
- [3] alarm function
- [4] programmer
- [5] display of relevant data on PC
- [6] data communication via Profibus DP
- [7] use together with Profibus card RT 650.12; one Profibus card RT 650.12 per PC workstation required

Technical Data

Operation and parameterisation of hardware controllers

Recorder function with data saving

- recording and saving of time functions
- evaluation of step responses with automatically generated inflectional tangent

Language selection

- 4 pre-selectable languages
- 1 user-defined language possible

Programmer

- up to 3 programs with 15 values in each
- custom controller parameters for each program
- looping possible

Alarm function with 4 programmable values

- upper and lower alarm limit
- upper and lower message limit
- comments about alarms/messages can be entered

Software basis: LabVIEW

System requirements: Windows Vista or Windows 7

Scope of Delivery

- 1 CD with LabVIEW process control software
- 1 manual with description of software functions and instructions for use with control engineering trainers RT 512 - RT 552

Order Details

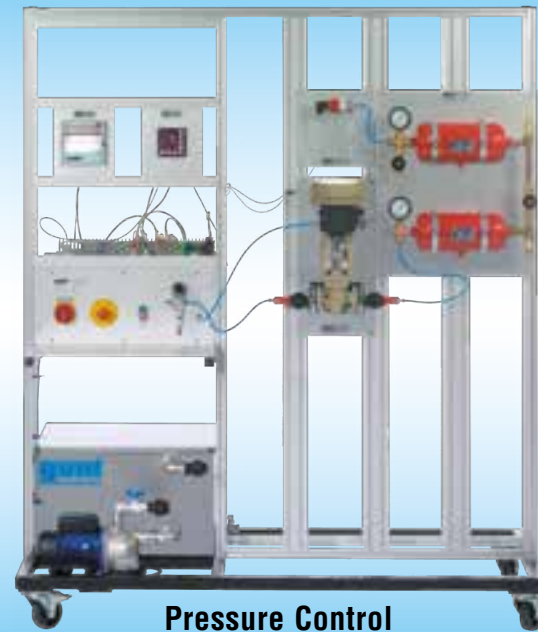
080.65050 RT 650.50 Process Control Software for RT 512 - RT 552 Series

RT 450 THE MODULAR PROCESS AUTOMATION TRAINING SYSTEM: CLOSED-LOOP AND OPEN-LOOP CONTROL

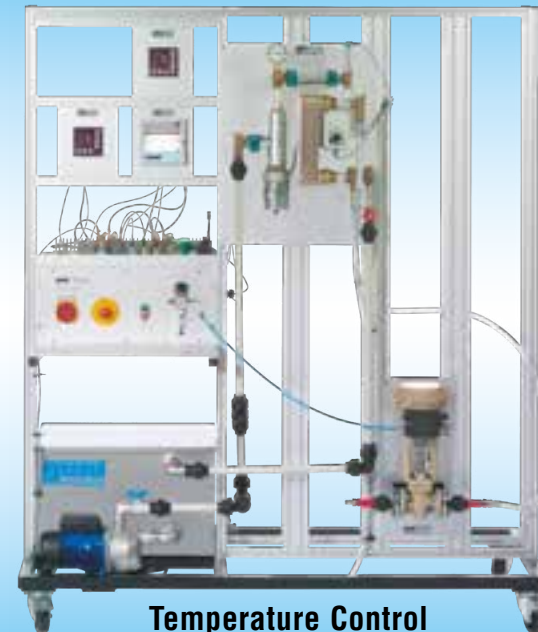
PROCESSES



Level Control



Pressure Control



Temperature Control



Flow Control

PROCESSES

COMPONENTS

RT 450.34 Flow Rate Sensor: Electromagnetic



RT 450.12 Chart Recorder Module



RT 450.42 Part of the PLC Module



The technological structure of the system



This is the versatility the training system offers...
...you create the custom combinations!

A highly expandable system

Looking to teach automation in the metalworking or electrical and electronics engineering sectors? Use this highly versatile and flexible process control training system. It offers everything you require to provide your students with a clearly ordered, wide-ranging introduction to the field of automation.

Keywords:

Sensors; 2- and 3-wire systems; standard signals; displays; chart recorder; graphical display; Profibus; process control system; closed-loop control; open-loop control; controlled systems; controllers; continuous; switching; PLC; actuators; valves; heaters; wiring; testing; planning; parameter setting; programming; errors; faults; maintenance... and much more.

The overall set-up is completely flexible, modular and expandable in any direction. The structural elements are mounted on panels, ready to connect up. This results in quick assembly and a clear layout. The only other work required is the piping and the electrical wiring. We employ the latest state-of-the-art industrial technology in the training system.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

DETAILS



All modular in design – only the latest components from actual practice

RT 450

Process Automation Training System: Base Module



Technical Description

Together with its wide-ranging accessory components, the RT 450 base module provides a modular, fully flexible and open-design system for learning the fundamentals of process automation by means of experimentation. The accessory components are pre-installed on panels. The base module provides an extensive frame for quick and safe mounting of the components required for the various experiments. It includes a water supply with tank and pump, a switch cabinet for power supply as well as connections, maintenance units, and a pressure regulator for an external compressed air supply.

Connecting up the measuring and control cables and the process lines, as well as connection to the electricity supply, form key elements of the programme of exercises. Alongside the purely systematic technical learning content involved, key aspects of the teaching goals are pre-planning, modification, testing, commissioning and optimisation.

Optimal learning is achieved when two or three students work together on a training system as a group.

An instrumentation and control software (RT 450.40) with an interface module for Profibus DP (RT 450.41) is available as an accessory. This enables the key process variables to be displayed and control functions to be executed.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

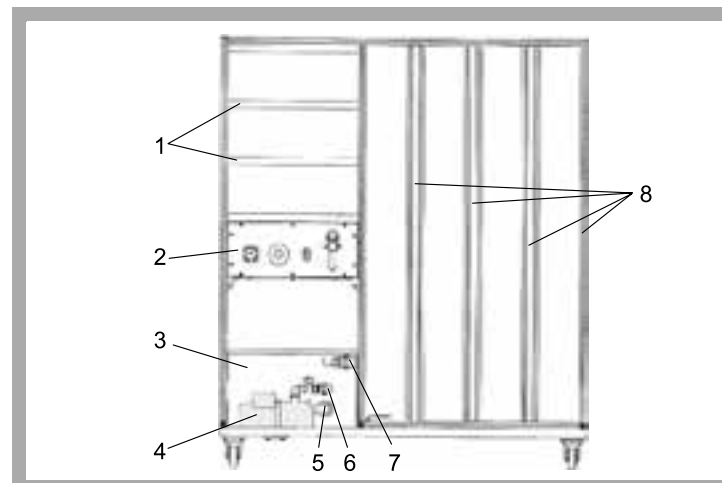
Together with accessory components, the following learning content and exercises are possible

- planning and construction of different process applications
- planning and construction of different automation solutions for the control systems
- familiarisation with the design, function and behaviour of industrial automation components, such as controllers, PLCs, actuators and measuring devices
- commissioning and optimisation of automated process applications
- making process connections (via pipes/hoses), connecting up the electricity supply and the instrumentation and control components
- fundamentals of the use of data acquisition, system control and parameter setting using the RT 450.40 software

- * **Modular training system providing an introduction to the fundamentals of process automation**
- * **Base module with large frame for preassembled components**
- * **Extensive range of accessories available: process application modules, sensors, actuators, controllers, PLCs etc.**
- * **Software for data acquisition, operator control and parameter setting optionally available**

RT 450

Process Automation Training System: Base Module



1 frame for electrical modules, 2 switch cabinet with power supply and maintenance and pressure control unit for compressed air, 3 storage tank, 4 centrifugal pump, 5 pump outlet, 6 pump inlet, 7 system water return, 8 aluminium frame



The illustration shows the layout of a level control system. In addition to the base module RT 450, it includes the following components: RT 450.01 (controlled system module: level), RT 450.10 (controller), RT 450.12 (recorder), RT 450.21 (control valve) and RT 450.35 (level sensor).



RT 450.10 (controller), RT 450.12 (recorder) and RT 450.42 (PLC module)

Specification

- [1] base module for a flexible process automation training system
- [2] large frame with aluminium rails
- [3] frame for electrical modules
- [4] water circuit with centrifugal pump and tank
- [5] switch cabinet with 24V power supply
- [6] practice-oriented terminal blocks for wiring of the instrumentation and control signals
- [7] 2x maintenance unit and a pressure regulator for compressed air
- [8] installation and connecting material including tools for connecting accessory modules

Technical Data

Stainless steel storage tank: 75L
Centrifugal pump
- max. head: 20m
- max. flow rate: 5,4m³/h
- power consumption: 370W
24VDC supply for components

Dimensions and Weight

LxWxH: 1650x850x1950mm
Weight: approx. 120kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase
Compressed air supply for RT 450.03, RT 450.20 or RT 450.21: 6...10bar

Scope of Delivery

- 1 base module with pump, tank and switch box
- 1 accessory set (tools, compressed air hose, plastic tube, single-core non-sheathed cable, connecting elements)
- 1 set of instructional material

Order Details

080.45000 RT 450 Process Automation Training System: Base Module

RT 450 Process Automation Training System: Base Module

Available Accessories:

CONTROLLED SYSTEM MODULES:

Product no. Order details

080.45001	RT 450.01	Controlled System Module: Level
080.45002	RT 450.02	Controlled System Module: Flow
080.45003	RT 450.03	Controlled System Module: Pressure
080.45004	RT 450.04	Controlled System Module: Temperature

CONTROLLER AND RECORDER MODULES:

Product no. Order details

080.45010	RT 450.10	Continuous Controller Module
080.45011	RT 450.11	Switching Controller Module
080.45012	RT 450.12	Chart Recorder Module
080.45013	RT 450.13	Digital Display
080.45042	RT 450.42	PLC Module with Software

recommended accessory for controller modules:

080.45014	RT 450.14	Software for Controller Configuration
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CONTROL VALVES:

Product no. Order details

080.45020	RT 450.20	Control Valve, Pneumatically Driven, Kvs 0,4
080.45021	RT 450.21	Control Valve, Pneumatically Driven, Kvs 1,0
080.45023	RT 450.23	Control Valve, Electrically Driven, Kvs 0,4
080.45024	RT 450.24	Control Valve, Electrically Driven, Kvs 1,0

SENSORS:

Product no. Order details

080.45030	RT 450.30	Pressure Sensor, 0...6bar
080.45031	RT 450.31	Pressure Sensor, 0...2bar
080.45032	RT 450.32	Pressure Sensor, 0...100mbar
080.45033	RT 450.33	Orifice with Differential Pressure Sensor
080.45034	RT 450.34	Flow Rate Sensor: Electromagnetic
080.45035	RT 450.35	Level Sensor: Capacitive
080.45036	RT 450.36	Temperature Sensor Pt100
080.45037	RT 450.37	Thermocouple (K) with Head Transmitter

PC CONNECTION:

Product no. Order details

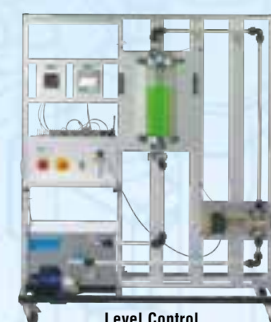
080.45040	RT 450.40	Visualisation Software
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required accessory for usage of Visualisation Software:

080.45041	RT 450.41	Profibus DP Module for Controller
or		
080.45043	RT 450.43	Profibus DP Module for PLC

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RT 450 MODULAR TRAINING SYSTEM: PROCESS AUTOMATION SELECTION OF COMPONENTS, ACCESSORIES, ALTERNATIVES



Level Control



Pressure Control



Flow Control



Temperature Control

LEVEL CONTROL

RT 450.01 Controlled System Module: Level

RT 450	Process Automation Training System: Base Module
RT 450.10	Continuous Controller Module
RT 450.11	Switching Controller Module
RT 450.42	PLC Module with Software
RT 450.21	Control Valve, Pneumatically Driven, Kvs 1,0
RT 450.24	Control Valve, Electrically Driven, Kvs 1,0
RT 450.35	Level Sensor: Capacitive
RT 450.31	Pressure Sensor, 0...2bar
RT 450.32	Pressure Sensor, 0...100mbar

FLOW CONTROL

RT 450.02 Controlled System Module: Flow

RT 450	Process Automation Training System: Base Module
RT 450.10	Continuous Controller Module
RT 450.11	Switching Controller Module
RT 450.42	PLC Module with Software
RT 450.21	Control Valve, Pneumatically Driven, Kvs 1,0
RT 450.24	Control Valve, Electrically Driven, Kvs 1,0
RT 450.34	Flow Rate Sensor: Electromagnetic
RT 450.33	Orifice with Differential Pressure Sensor

PRESSURE CONTROL

RT 450.03 Controlled System Module: Pressure

RT 450	Process Automation Training System: Base Module
RT 450.10	Continuous Controller Module
RT 450.11	Switching Controller Module
RT 450.42	PLC Module with Software
RT 450.20	Control Valve, Pneumatically Driven, Kvs 0,4
RT 450.23	Control Valve, Electrically Driven, Kvs 0,4
RT 450.30	Pressure Sensor, 0...6bar

TEMPERATURE CONTROL

RT 450.04 Controlled System Module: Temperature

RT 450	Process Automation Training System: Base Module
RT 450.10	Continuous Controller Module
RT 450.11	Switching Controller Module
RT 450.42	PLC Module with Software
RT 450.21	Control Valve, Pneumatically Driven, Kvs 1,0
RT 450.24	Control Valve, Electrically Driven, Kvs 1,0
RT 450.36	Temperature Sensor Pt100
RT 450.37	Thermocouple (K) with Head Transmitter

OPTIONAL ACCESSORIES

RT 450.12	Chart Recorder Module
RT 450.13	Digital Display
RT 450.40	Visualisation Software
RT 450.41	Profibus DP Module for Controller
RT 450.43	Profibus DP Module for PLC

RECOMMENDED ACCESSORY

RT 450.14	Software for Controller Configuration
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RT 450.01 Controlled System Module: Level

Specification

- [1] level control loop setup (in conjunction with other modules from the RT 450 series)
- [2] ready-to-install compact panel assembly
- [3] transparent glass tank with overflow, drain valve and manometer
- [4] glass tank can be hermetically sealed
- [5] plexiglass protective sleeve
- [6] PVC tank base and cover
- [7] adjustable safety valve
- [8] fitting for attaching pressure sensor or level sensor
- [9] water as the working medium, supply via base module RT 450
- [10] cascade control option in conjunction with RT 450.02

Technical Data

Tank

- capacity: max. 7L
- filling level: max. 475mm
- operating pressure: max. 2bar

Manometer: 0...2,5bar
Safety valve: 1...4bar adjustable

Dimensions and Weight

LxWxH: 510x330x800mm
Weight: approx. 30kg

Scope of Delivery

1 level tank mounted on panel, complete with valves, taps, rapid action couplings for fitting sensors, protective sleeve and manometer

*** Main element in constructing a level control loop**
Technical Description

The RT 450.01 consists of a clear plastic level tank as the principle element and uses water as the working medium. The tank is set up in such a way that it is hermetically sealed if all taps and valves are closed. This enables experiments to be performed with the tank under internal pressure. For safety, the level tank is fitted with a safety valve and is enclosed in a transparent plastic protective sleeve. The tank includes fittings for the attachment of a pressure sensor (RT 450.31) or a level sensor (RT 450.35). It is installed in the base module RT 450. A control valve (e.g. RT 450.21) and a controller (RT 450.10) complete the control loop.

Learning Objectives / Experiments

- setting up a level control loop
- comparison of different sensors for level measurement
- level control against trapped-air cushion
- level / flow cascade control (with RT 450.02)

Order Details

080.45001 RT 450.01 Controlled System
Module: Level

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RT 450.02 Controlled System Module: Flow

Specification

- [1] flow control loop setup (in conjunction with other modules from the RT 450 series)
- [2] ready-to-install compact panel assembly
- [3] rotameter with scale
- [4] stop valve in the inlet section
- [5] water as the working medium, supply via base module RT 450
- [6] optional cascade control in conjunction with RT 450.01

Technical Data

Rotameter: 0...2,5m³/h

Dimensions and Weight

LxWxH: 250x180x700mm
Weight: approx. 10kg

Scope of Delivery

1 rotameter mounted on panel, complete with stop valve and connections

*** Main element in constructing a flow control loop**
Technical Description

The RT 450.02 consists of a rotameter as the principle element and uses water as the working medium. A valve can be used to adjust the flow resistance and thus change the flow properties of the controlled system.

A major advantage of this controlled system is that the rotameter allows all changes in the flow rate caused by faults or responses to a control action to be directly observed.

A control loop for flow control experiments is set up using the base module RT 450, a control valve (RT 450.2x), the RT 450.10 controller and a sensor (e.g. RT 450.34).

Learning Objectives / Experiments

- setting up of a flow control loop
- comparison of different sensors for flow measurement
- level / flow cascade control (with RT 450.01)

Order Details

080.45002 RT 450.02 Controlled System
Module: Flow

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RT 450.03 Controlled System Module: Pressure

Technical Description

The RT 450.03 controlled system module is a panel-mounted ready-to-install element. In conjunction with other modular control components, it enables pressure control systems with different characteristic features to be constructed and investigated.

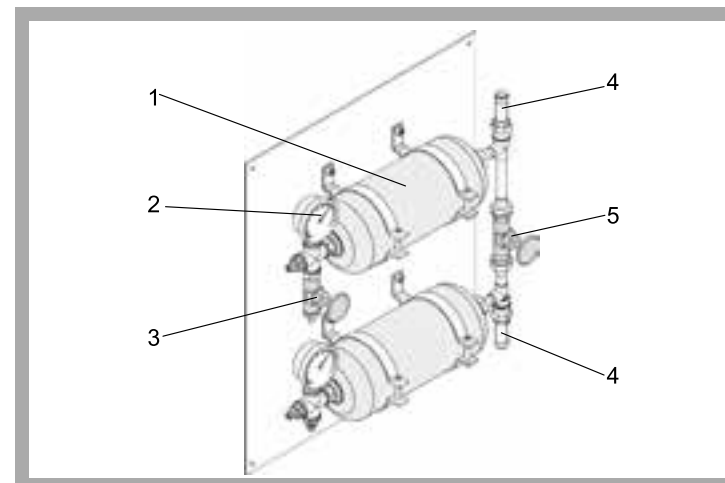
The panel is mounted on the frame of the base module RT 450. RT 450.03 consists of two steel pressure tanks and is operated with compressed air as the working medium. Each tank is fitted with a manometer and a safety valve. One tank also has a drain valve. Both tanks can be fitted with a pressure sensor. The tanks are interconnected by a vent valve and can therefore be connected in series. This makes it possible to represent both first and second order pressure control systems.

The RT 450 base module supplies the controlled system module with its working compressed air. Pneumatic hoses with quick-release couplings connect all the modules to a pressure control loop.

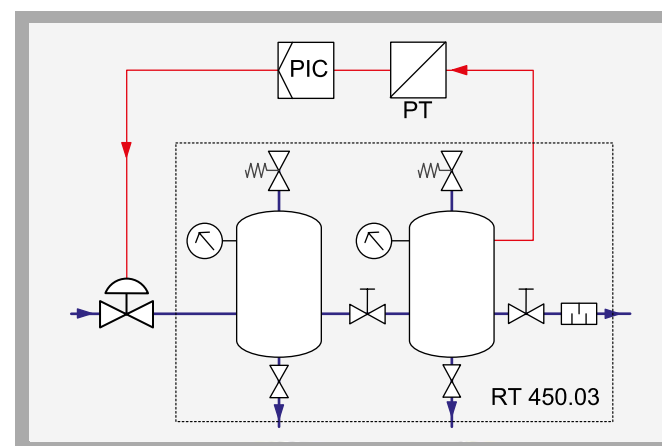
Learning Objectives / Experiments

- planning, setting up, testing, optimising and assessing pressure control loops with different objectives and components
- * constructing a 1st order pressure control system
- * constructing a 2nd order pressure control system
- design and function of different instrumentation and control components
- technical terminology and symbols in industrial control engineering
- practical exercises: Implementing process and signal lines
- commissioning and troubleshooting of process engineering systems

- * **Main element in constructing a pressure control loop**
- * **Rapid installation into the RT 450 base module by modular panel assembly**

RT 450.03 Controlled System Module: Pressure


1 pressure tank, 2 manometer, 3 drain valve, 4 safety valve, 5 vent valve



Process schematic



The illustration shows the layout of a pressure control system. In addition to the base module RT 450, it includes the following components: RT 450.03 (controlled system module: pressure), RT 450.10 (controller), RT 450.12 (recorder), RT 450.20 (control valve) and RT 450.30 (pressure sensor).

Specification

- [1] construction of a pressure control loop (in conjunction with other modules of the RT 450 series)
- [2] ready-to-install compact panel assembly
- [3] 2 pressure tanks with safety valves
- [4] direct pressure indication by 2 manometers
- [5] valve permits series configuration of both pressure tanks
- [6] series configuration of pressure tanks: investigation of coupled controlled system response compared to single-tank operation
- [7] 2 valves: 1x drain, 1x vent
- [8] copper piping
- [9] compressed air as working medium, supply via base module RT 450

Technical Data

Pressure tank
- capacity: 3L
- operating pressure: max. 6bar
- manometer: 0...10bar
Safety valve: adjustable to max. 10bar

Dimensions and Weight

LxWxH: 510x175x600mm
Weight: approx. 15kg

Required for Operation

Compressed air supply via RT 450

Scope of Delivery

2 pressure tanks mounted on panel, complete with valves and manometers

Order Details

080.45003 RT 450.03 Controlled System Module: Pressure

RT 450.04 Controlled System Module: Temperature

Technical Description

The RT 450.04 controlled system module is a panel-mounted ready-to-install element. In conjunction with other modular control components, it enables temperature control systems with different characteristic features to be constructed and investigated.

The panel is mounted on the frame of the base module RT 450. The main elements of the controlled system module are: an electric heater installed in a section of pipe, and a plate heat exchanger between the primary and secondary water circuits. The heater can either be operated by a switching controller and so act as the control loop actuator, or can operate in continuous duty as a pure energy source. In operation as a continuous controller, with the heater as the energy source, a choice of two different valves (pneumatic or electric) can be used as actuators in the primary circuit.

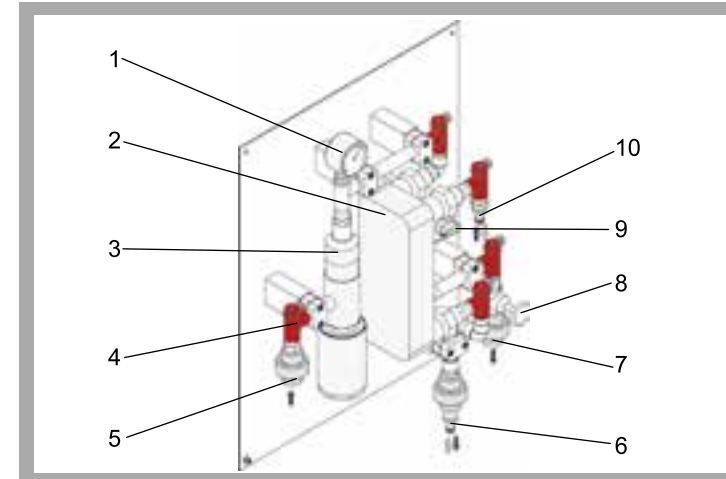
For safety, the heater features a thermostat and a device to protect it from running dry. The primary circuit (with heater) is connected by pipelines to the water supply of the base module RT 450, while the secondary circuit requires a laboratory water supply for cooling. Counterflow or parallel flow cooling is possible. The connection to the laboratory network is made by quick-release couplings and hoses.

Learning Objectives / Experiments

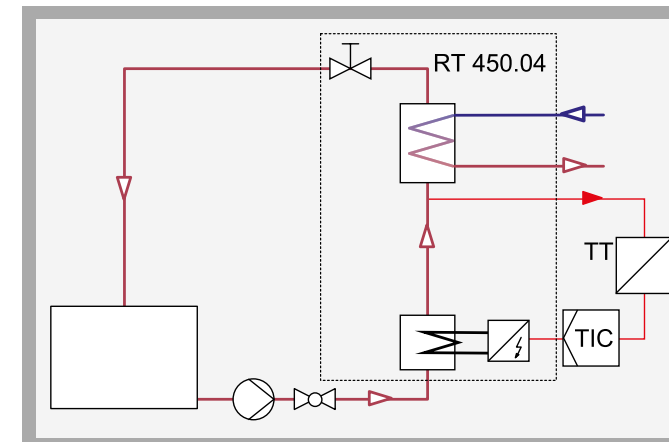
- planning, setting up, testing, optimising and assessing temperature control loops with different objectives and components
- design and function of different instrumentation and control components
- technical terminology and symbols in industrial control engineering
- practical exercises: implementing process and signal lines
- commissioning and troubleshooting of process engineering systems

* **Main element in constructing a temperature control loop**

* **Rapid installation into the RT 450 base module by modular panel assembly**

RT 450.04 Controlled System Module: Temperature


1 thermometer, 2 plate heat exchanger, 3 heater, 4 temperature measurement points, 5 RT 450 inlet, 6 external water circuit connection, 7 return to RT 450, 8 Regulating valve, 9 heater switch, 10 external water circuit connection



Process schematic for controlled system with heater as actuator and switching controller



The illustration shows the layout of a temperature control system. In addition to the base module RT 450, it includes the following components: RT 450.04 (controlled system module: temperature), RT 450.11 (controller), RT 450.12 (recorder), RT 450.21 (control valve) and RT 450.36 (temperature sensor).

Specification

- [1] construction of a temperature control loop (in conjunction with other modules of the RT 450 series)
- [2] ready-to-install compact panel assembly
- [3] electric heater with thermostat and dry-running protection
- [4] direct temperature display at heater outlet with bimetallic thermometer
- [5] heater is either an actuator or a continuous heater
- [6] plate heat exchanger, operating in counter-flow or parallel-current mode
- [7] primary circuit with heater and heat exchanger, connected to water supply of base module RT 450
- [8] flow of primary circuit controlled by hand-operated valve
- [9] secondary circuit of heat exchanger connected to laboratory water supply

Technical Data

Plate heat exchanger

- number of plates: 20
- heat transfer surface: 0,72m²
- flow rate: max. 3m³/h

Heater with thermostat and dry-running protection

- power output: 2kW
- temperature limitation by thermostat: 65°C

Thermometer at heater outlet: 0...100°C

Dimensions and Weight

LxWxH: 510x200x650mm
Weight: approx. 20kg

Required for Operation

Water connection: max. 3m³/h

Scope of Delivery

1 heater and 1 plate heat exchanger mounted on panel, complete with piping, valve, safety elements, temperature sensor fixtures, connections to RT 450 piping system

Order Details

080.45004 RT 450.04 Controlled System Module: Temperature

RT 450.10 Continuous Controller Module


- * Digital process controller with extensive functionality
- * Operation and parameterisation optionally via keyboard, configuration software or visualisation software (Profibus)

Technical Description

The digital process controller is pre-installed on a panel. The panel can be attached quickly and easily to the frame of the RT 450 base module. The connections for the process controller are pre-configured on connector assemblies for plugging-in to terminals on the rear of the panel.

The process controller is configured, parameterised and operated by way of the keyboard. Configuration and parameterisation can also be carried out by computer, using the RT 450.14 software.

The process controller can additionally be fitted with the RT 450.41 Profibus module. This enables communication with the RT 450.40 visualisation software.

Learning Objectives / Experiments

- functional range of a digital process controller
- configuration, parameterisation and operation via keyboard
- familiarisation with an industry-standard configuration software (RT 450.14, available as an option)
- signal links and standard current signals
- profibus communication (RT 450.41, available as an option)

Scope of Delivery

1 controller module

Specification

- [1] universal continuous controller module, optimised for the RT 450 modular system
- [2] fixed assignment of inputs and outputs
- [3] programmable controller: P, PI, PD, PID
- [4] configuration and parameterisation of the digital process controller manually or computer-assisted (with RT 450.14) via a TTL interface

Technical Data

2 analog inputs: 4...20mA
2 analog outputs: 4...20mA
2 binary inputs
2 relay outputs

Dimensions and Weight

LxWxH: 180x240x240mm
Weight: approx. 2kg

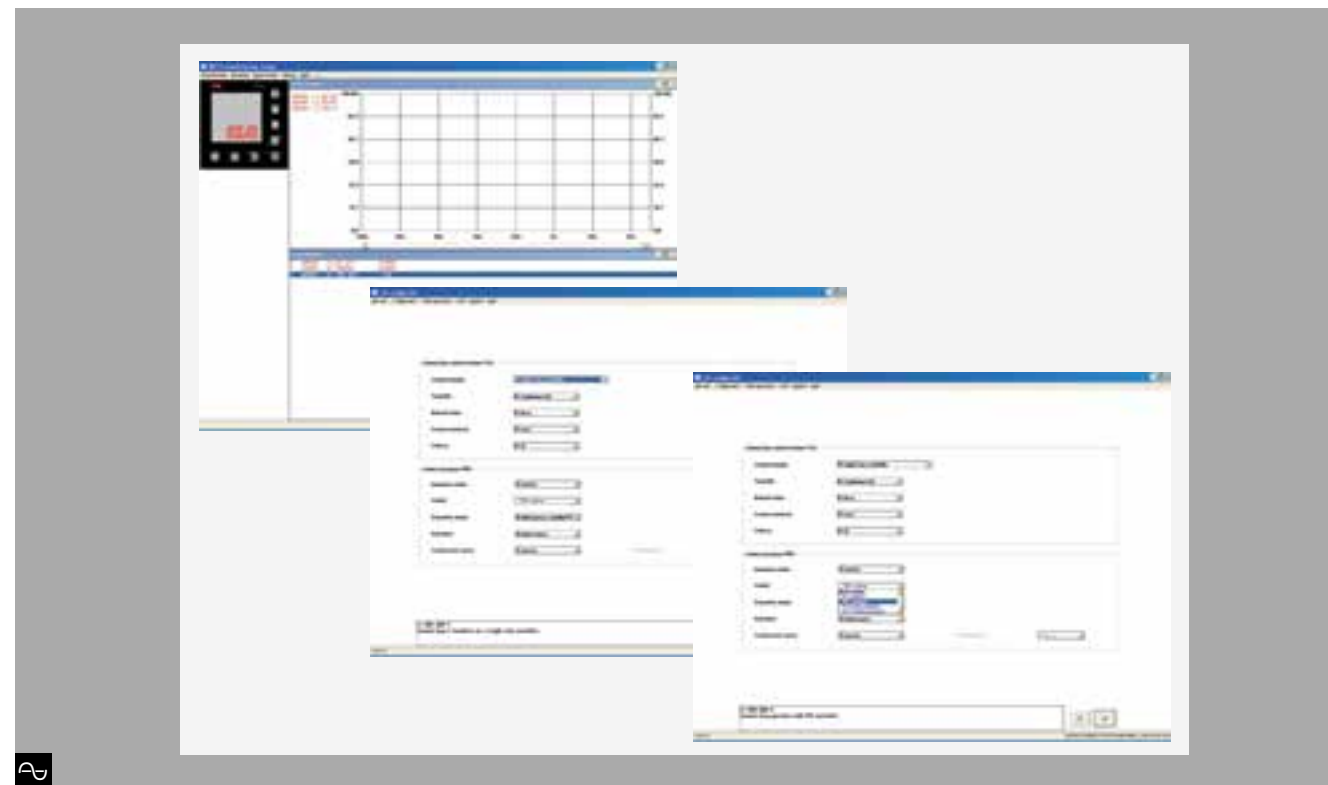
Required for Operation

24VDC

Order Details

080.45010 RT 450.10 Continuous Controller Module

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RT 450.14 Software for Controller Configuration


- * Configuration software for controller modules RT 450.10 and RT 450.11

- * User-friendly menu guidance and systematic project management

Technical Description

All the functions which can be realized by way of the keyboard of a process controller can also be realized using the IBIS-R+ configuration software.

The software's user-friendly menu guidance enables assured configuration and parameterisation of the controller modules. Completed projects are saved, managed and reloaded as required.

Controller operation, hardware status polling and chart recording can also be facilitated using the software.

The software can be installed on almost any computer. A V24 adapter to the computer's RS232 port enables connection with the controller module.

Learning Objectives / Experiments

- functional range of an industrial controller and a configuration software
- creation and documentation of projects

Scope of Delivery

1 IBIS-R+ software CD
1 adapter cable
1 manual in German and English

Specification

- [1] software for configuration of controller modules RT 450.10, RT 450.11
- [2] parameterisation of pre-defined device functions such as controller parameters and limit values
- [3] selection of functions from function lists contained in the controller module, e.g.: measurement method, measuring range, output, control structure, etc.
- [4] representation of front of unit, measured value trends and parameters on-screen for commissioning purposes

Technical Data

IBIS-R+ software
- recommended as from 486 CPU
- at least 4 MB RAM
- at least 18 MB available capacity on hard disk
- system requirements: Windows Vista or Windows 7

Order Details

080.45014 RT 450.14 Software for Controller Configuration

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RT 450.42 PLC Module with Software


- * **PLC with included programming software**
- * **Module for Profibus communication available**

Technical Description

The programmable logic controller (PLC) is pre-installed on a panel which can be quickly and easily attached to the frame of the RT 450 base module. All the connections for the PLC are pre-configured on connector assemblies ready for plugging-in to terminals on the rear of the panel.

The PLC package also includes programming software supplied by the PLC manufacturer.

The PLC can be fitted with the Profibus module RT 450.43. This enables the PLC to communicate over the Profibus network. An input/output module is supplied.

Learning Objectives / Experiments

- functional range of a PLC
- programming a PLC using included programming software
- electrical connections and signal links
- Profibus communication

Scope of Delivery

- 1 PLC module
- 1 CD containing PLC programming software
- 1 input/output module
- 1 interface cable for digital signals

Specification

- [1] module for exercises using a programmable logic controller (PLC)
- [2] expansion of analog inputs and outputs
- [3] RS232 port for programming on computer
- [4] PLC programming software
- [5] programming languages: Statement List (STL), Ladder Diagram (LD), Structured Text (ST), Function Block Diagram (FBD)
- [6] Profibus module (RT 450.43) for communication with network available as an option

Technical Data

- PLC
- 8 digital inputs: 24VDC
- 4 analog inputs: 10-bit, 4...20mA
- 6 digital outputs: 24VDC, max. 100mA
- 2 analog outputs: 12-bit, 4...20mA
- program memory: 24kB
- Software
- programming language conforming to IEC61131-3

Dimensions and Weight

- LxWxH: 215x86x110mm
- Weight: approx. 1kg

Required for Operation

- 24VDC

Order Details

080.45042 RT 450.42 PLC Module with Software

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RT 450.12 Chart Recorder Module


The illustration shows a similar unit.

*** Colour 3-channel process recorder**
*** Analog recording of process variables conforming to the variables being measured or in the range 0...100%**
Technical Description

The recorder module is pre-installed on a panel which can be quickly and easily attached to the frame of the RT 450. The connections for the recorder module are pre-configured on connector assemblies for plugging-in to terminals on the rear of the panel.

Signals are recorded by a line recorder which continuously plots these signals as coloured lines.

The recorder module features a keypad and a display, used to program individual channels as well as the paper feed rate.

Learning Objectives / Experiments

- functional range of a line recorder
- adjusting and changing pens and graph paper
- operation, parameterisation and configuration via keyboard
- signal links and standard current signals

Specification

- [1] recorder module to record control and process variables
- [2] continuous recording of three independent standard analog signals as coloured lines
- [3] interchangeable pens
- [4] programmable paper feed rates
- [5] drive controlled by stepper motor

Technical Data

Recorder module

- 3 channels
- measuring range: 4...20mA
- sampling time: 240ms per channel
- basic accuracy: +/- 0,1% of final value
- Paper
- recorder drum
- feed rate: 0, 5, 10, 20, 60, 120, 240, 300, 360, 600, 720, 1800, 3600, 7200mm/h; also freely programmable
- Pens
- blue, red, green

Dimensions and Weight

- LxWxH: 240x144x144mm
- Weight: approx. 4kg

Required for Operation

- 24VDC

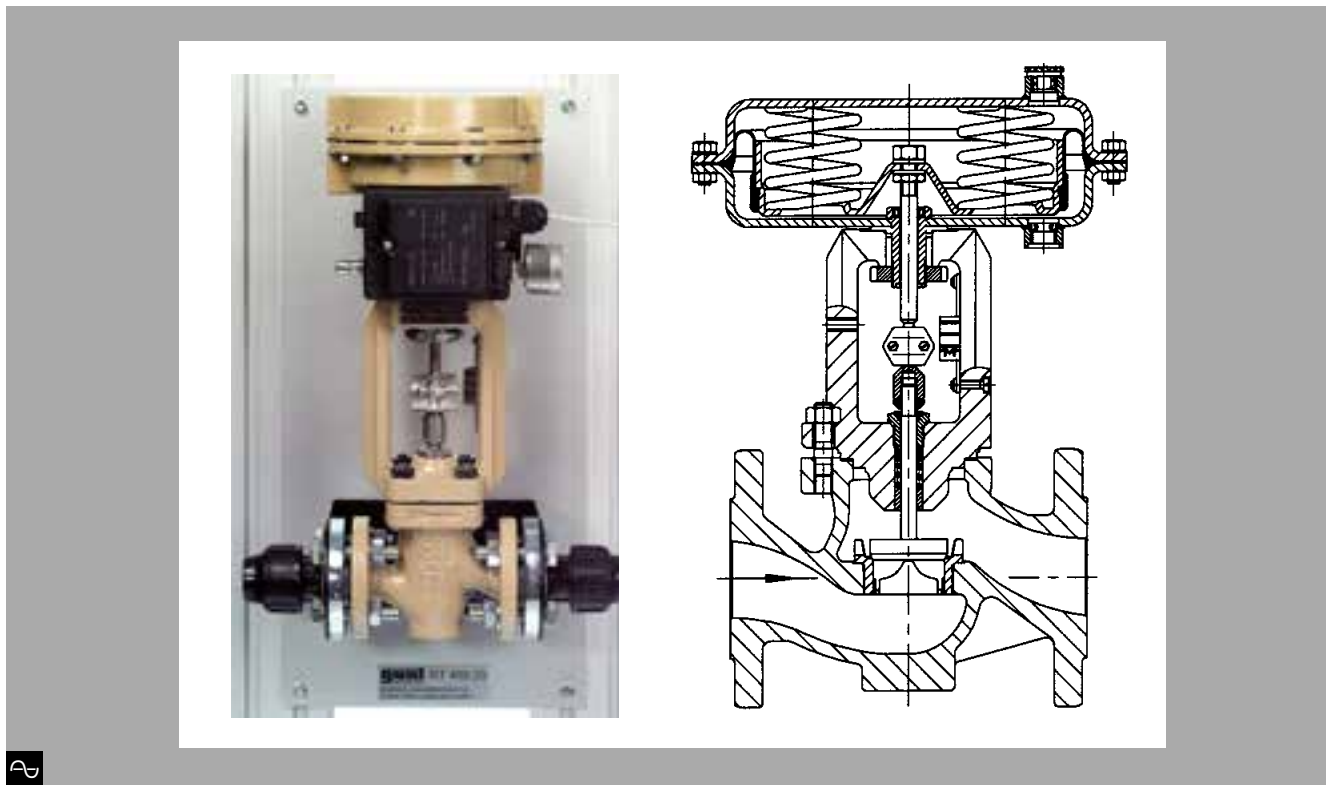
Scope of Delivery

- 1 recorder module

Order Details

080.45012 RT 450.12 Chart Recorder Module

G.U.N.T Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web <http://www.gunt.de>
We reserve the right to modify our products without any notifications.

RT 450.20 Control Valve, Pneumatically Driven, Kvs 0,4

* Industrial control valve with electro-pneumatic positioner

* Used in the construction of level and flow rate control systems

Technical Description

The electro-pneumatic control valve is used primarily as the actuator in a level or flow rate control loop.

The control valve is installed on a panel which can be quickly and easily attached to the frame of the RT 450 base module. An electrical signal input (identical to the controller output) is pre-configured and routed to the base module terminal array which is specific to the particular application.

The control valve is fitted with an electro-pneumatic positioner which requires a supply of compressed air. The valve rod is driven by a pneumatically operated membrane. The electro-pneumatic control valve is set to the safe "closed" position when no auxiliary power is applied.

Learning Objectives / Experiments

- functional range of an electro-pneumatically operated control valve
- recording of the flow rate characteristic during the experiment (flow rate dependent on degree of opening)
- standard current signals and correct electrical wiring and interconnection

Scope of Delivery

1 control valve with electro-pneumatic positioner

Specification

- [1] control valve as actuator in control loop
- [2] electro-pneumatic positioner to actuate the pneumatic control valve drive by an electrical signal
- [3] operating direction: rising
- [4] safety position: closed
- [5] adapter with quick-coupling for experiments with air

Technical Data

Control valve: DN 15; PN 16; Kvs value: 0,4;
characteristic: linear
Actuator drive: membrane area: 120cm²;
stroke: max. 15mm; nominal signal range: 0,2...1bar;
electro-pneumatic positioner: input signal: 4...20mA

Hydraulic connection, control valve
- clamp connector type PA: D=25mm
- adapter with quick-coupling: 6mm

Dimensions and Weight

LxWxH: 426x168x326mm
Weight: approx. 6kg

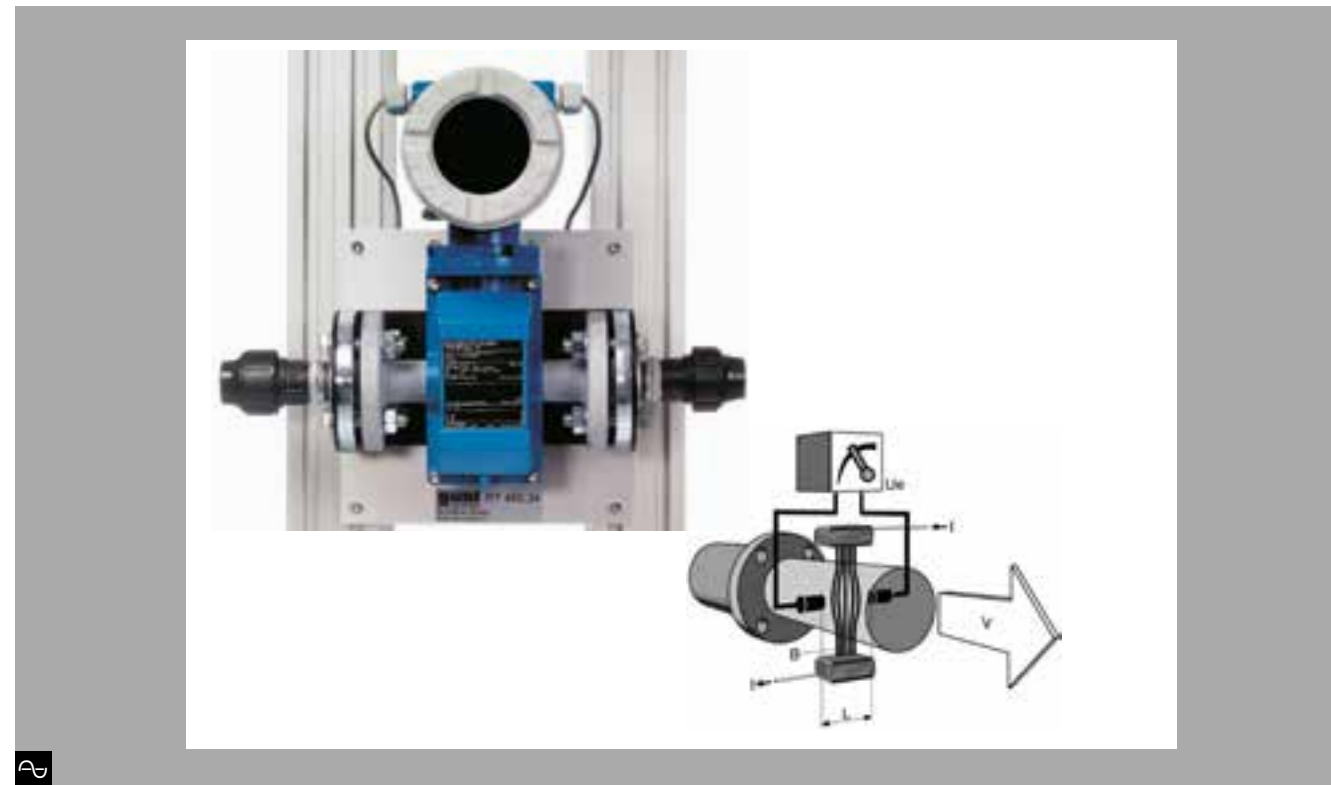
Required for Operation

Compressed air supply via RT 450

Order Details

080.45020 RT 450.20 Control Valve,
Pneumatically Driven, Kvs 0,4

G.U.N.T Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web <http://www.gunt.de>
We reserve the right to modify our products without any notifications.

RT 450.34 Flow Rate Sensor: Electromagnetic

* Industrial flow rate sensor with measurement based on electromagnetic induction

* Negligible pressure loss

Technical Description

The flow rate sensor is a compact unit comprising a measurement sensor and a transducer. This compact unit is required in the construction of a flow rate control loop. It can also be used as an auxiliary instrument in a level control loop.

The flow rate sensor is installed on a panel which can be quickly and easily attached to the frame of the RT 450 base module. The signal output and voltage supply are pre-wired, and are connected to the terminals on the base module.

Negligible pressure loss occurs for flow through the sensor's measuring tube.

Learning Objectives / Experiments

- principle of an electromagnetic flow rate sensor
- electrical connections: voltage supply and measurement signal
- standard current signals and correct electrical wiring and interconnection

Scope of Delivery

1 flow rate sensor

Specification

- [1] compact unit for flow rate measurement
- [2] all electrical connections pre-wired
- [3] flow rate sensor connected by plastic pipes and clamp fittings or pipe adapters
- [4] no pressure loss due to flow resistance

Technical Data

Flow rate sensor
- measurement principle: electromagnetic
- measuring range: 0...2,5m³/h
- output signal: 4...20mA
- measuring tube diameter: D=24mm
- temperature range: 0...60°C
Measuring medium
- pressure of measuring medium: max. 16bar
- minimum conductivity of medium: 50µS/cm

Dimensions and Weight

LxWxH: 200x180x350mm
Weight: approx. 10kg

Required for Operation

24VDC

Order Details

080.45034 RT 450.34 Flow Rate Sensor:
Electromagnetic

G.U.N.T Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web <http://www.gunt.de>
We reserve the right to modify our products without any notifications.

RT 450.40 Visualisation Software


Master	
Station address	1
FMS/DP	CIF50-PB
RT45010	
Station address	10
DP Slave	Protronic/ Digitric
RT45011	
Station address	11
DP Slave	Protronic/ Digitric
RT45042	
Station address	20
DP Slave	LE4-504-BT1

* **Field bus integration for a computerised automation system**

* **Profibus card as field bus master**

* **Communication with controllers and PLC**

* **User-friendly GUNT visualisation software**

Technical Description

Computer-assisted communication between automation components over a field bus is a standard approach in industrial control systems.

The RT 450 training system works with Profibus DP. A Profibus card performs the function of the field bus master and serves as the communications interface (CIF). The field bus slaves – in this case the controller module and the PLC module – must likewise be field bus-compatible. The components must be equipped with a Profibus module to facilitate this operation.

One of the key features of the visualisation software, based on LabVIEW, is a chart which is used to present visuals of time functions. The software can also be used to operate and parameterise process controllers (RT 450.10 and RT 450.11). The communications interface (CIF) controls the data interchange between the software and the slaves.

Communication is bidirectional: changes made in the software are transmitted directly to the slaves. Controller settings made on the controller's keypad are also transmitted to the software.

Data interchange between the software and the CIF is provided by way of an OPC server. An OPC server is the standard interface for interchange of process data.

Learning Objectives / Experiments

- principles of communication when using computerised automation over field bus
- familiarisation with the hardware components and wiring
- installation and configuration routines
- using an application
 - * closed-loop and open-loop control visualisation software
- familiarisation with the system elements
 - * Profibus card as communications interface
 - * OPC server
 - * system configurator

RT 450.40 Visualisation Software


GUNT visualisation software: start menu

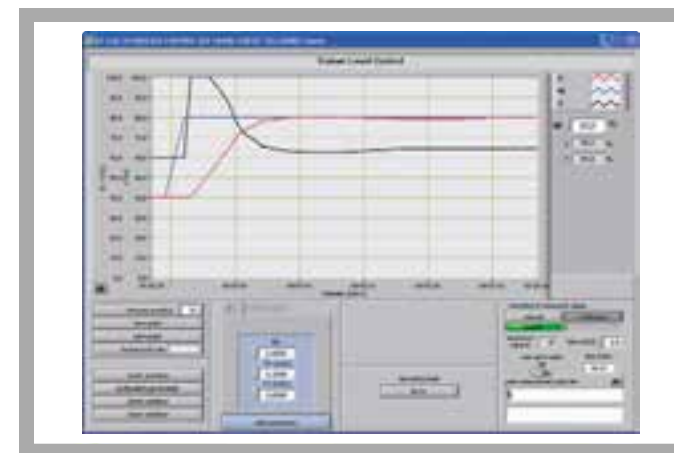
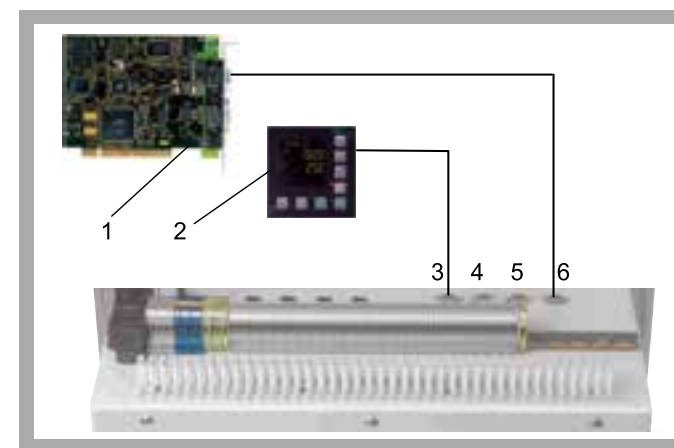


Chart feature to represent time functions in a control system



Profibus connections on RT 450
1 Profibus card, 2 controller module with Profibus module (RT 450.10),
3, 4, 5, 6 connections on base system control cabinet

Specification

- [1] software for computerised automation
- [2] Profibus card as communications interface (CIF)
- [3] communications interface as field bus master
- [4] controller module RT 450.10 or RT 450.11 with Profibus module RT 450.41 as slave
- [5] PLC module RT 450.42 with Profibus module RT 450.43 as slave
- [6] GUNT visualisation software
- [7] Profibus connections pre-configured on control cabinet of RT 450 base module

Technical Data

- Profibus card
 - Profibus DP
 - 125 slaves
 - 7168 bytes I/O data
 - dual-port memory
 - RS232 port, diagnostic PCI
 - SyCon configuration software
 - OPC server

System requirements: Windows Vista or Windows 7

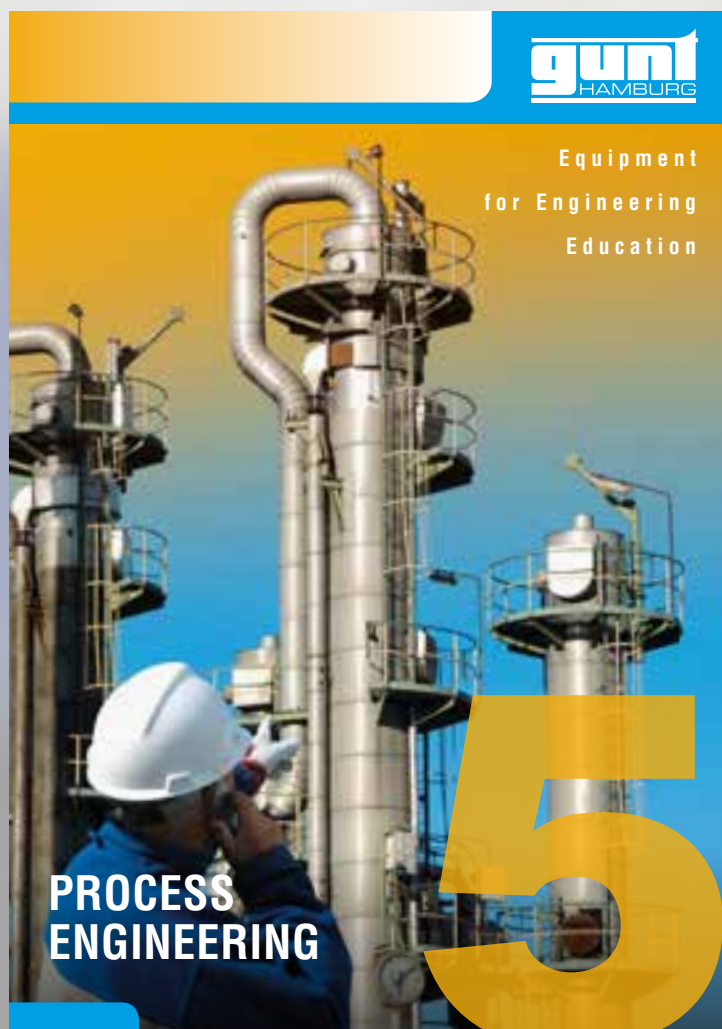
Scope of Delivery

- 1 Profibus card
- 1 software CD with GUNT visualisation software
- 1 D-Sub data cable

Order Details

080.45040 RT 450.40 Visualisation Software

ALSO AVAILABLE:



PROCESS ENGINEERING

- Fundamentals of Control Engineering
- Components and Calibration
- Simple Process Engineering Control Systems
- Complex Process Engineering Control Systems
- Fundamentals of Process Engineering
- Mechanical Process Engineering
- Thermal Process Engineering
- Chemical Process Engineering
- Biological Process Engineering
- Water Treatment

RT450 THE MODULAR TRAINING SYSTEM FOR PROCESS AUTOMATION: CLOSED-LOOP AND OPEN-LOOP CONTROL



*The ideal way to teach and learn
about automation in all its aspects*

Flexible

Practical

**Modular
Expandable**

**Various
Learning Levels**

THE SYSTEM PROVIDING AN EASY INTRODUCTION TO A COMPLEX SUBJECT

Teaching Concept and Learning Content

RT450 offers you a flexible and versatile learning platform to provide school and college students with a practical introduction to a wide range of topics and issues in the field of process automation. The close interlinking of practical skills with theoretical/analytical aspects promotes thorough learning.

You can teach systematically categorised learning content or just as well combine complex material into integrated project work. For successful deployment of RT 450 the fundamentals of the subject should already have been taught in advance.

LEARNING TOPICS	SPECIFIC LEARNING CONTENT	Page
Industrial Automation Components	- Controllers (open/closed loop) - Recorders, displays - Actuators, sensors	
Learning the Fundamentals of Control Engineering by Experimentation	- Controller, controlled system, control loop, actuators - Control response: - continuous, switching - P, I, D components of the control response - Step response to change in manipulating/disturbance variable	
Familiarisation with Set-Up Procedures	- Operation, configuration and parameterisation of a digital industrial controller: manually via keypad or using configuration software - Setting a 3-channel line recorder with digital menu guidance - Programming a PLC	
Specific Control Applications	- Pressure, level, flow, temperature - Cascade control	
Planning and Displaying	Reading, editing and creating - Circuit diagrams - Wiring diagrams and plans of terminal connections - Work and process schematics - Plant installation diagrams	
Practical Exercises	- Making pipe connections - Making electrical connections, particularly signal links - Preparing plant for operation - Troubleshooting	
Familiarisation with Communication and Visualisation Systems	Parameterisation and configuration of controllers by software - Profibus interconnection of automation components - Data acquisition cards - Interfaces - Data management: save, export	

Learning Topics: Industrial Automation Components



Digital industrial controller



Programmable logic control (PLC)



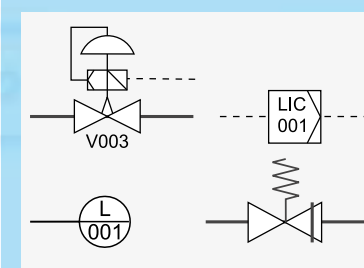
Pneumatic control valve with electro-pneumatic positioner



3-channel line recorder



Temperature sensor, Pt100



Process engineering symbols

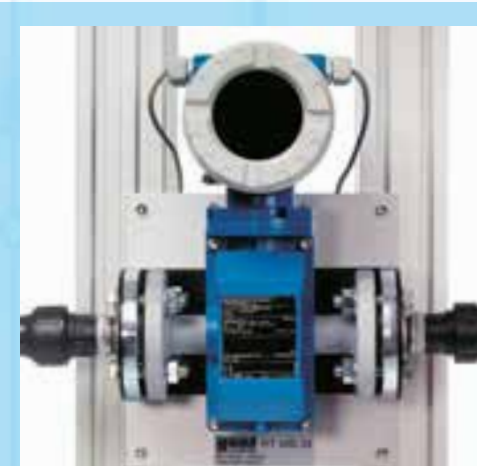
Typical questions:

- What are the functions of the components in an automation system?
- What are the functional principles underlying the various transducers?
- Is an alimentation needed to operate the unit?
- What signals are put out?
- What input signals are accepted?
- How are the components symbolically represented?

...and much more.



Pressure sensor



Flow rate sensor, electromagnetic

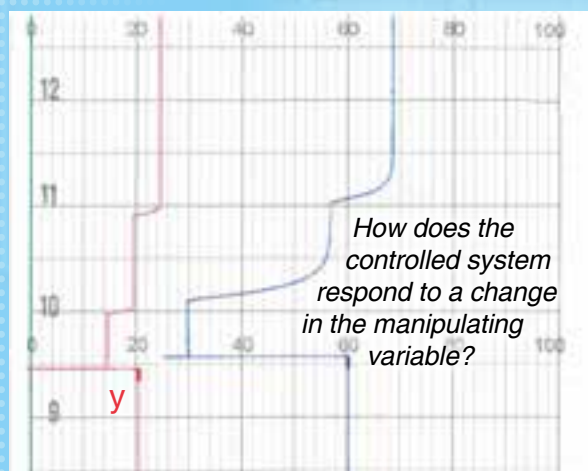


Level sensor, capacitive

Learning Topics: Learning the Fundamentals of Control Engineering by Experimentation

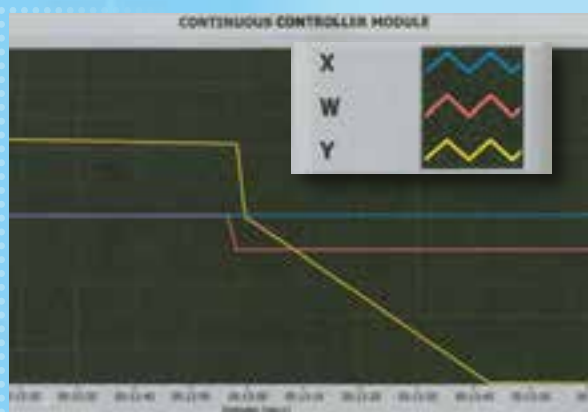


Operation and parameterisation of a digital controller via keypad



Paper feed rate 600 mm/h

1. $y: 15\% \rightarrow 20\%$ *Pressure control: We have a controlled system with compensation*
2. $y: 20\% \rightarrow 25\%$



PI controller: Change in reference variable (w)

Examples of learning content

(all taught by experimentation)

- ∴ Response of the controlled system
 - ∴ How does the controlled variable respond to a step change in the manipulating variable?
 - ∴ Controlled system with compensation
 - ∴ Controlled system without compensation
 - ∴ Control action in manual or automatic mode
 - ∴ Various levels of intervention in an industrial digital controller
 - ∴ Operating level
 - ∴ Parameter level
 - ∴ Configuration level
 - ∴ Controller settings via keypad
 - ∴ Effects of the elementary transfer elements of a controller on the manipulating variable
 - ∴ P/I/D component and the various combinations of them (parameter settings)
 - ∴ Critical controller settings
 - ∴ Oscillation
 - ∴ Recording the step response to a change of
 - ∴ Manipulating variable
 - ∴ Disturbance variable
 - ∴ Permanent control deviation of P controller as a function of controller gain
 - ∴ Controller with switching or continuous function
- ...and much more

NOTE

To prepare the learning success with the RT 450 system, we recommend first conducting experiments with our RT 010, RT 030 and RT 350 training systems.

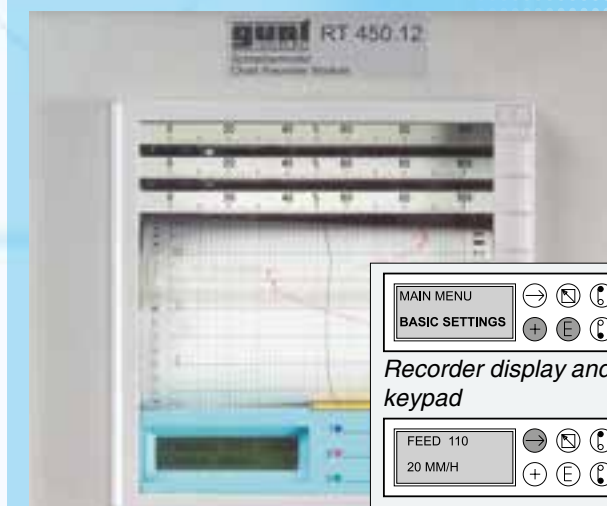
Learning Topics: Familiarisation with Set-Up Procedures

Digital process engineering instruments such as controllers, recorders and transducers offer wide-ranging options for customisation to specific tasks. The necessary set-up and configuration can often be carried out by way of a keypad or using dedicated software. It is important for students to practise and understand the process of manual set-up by way of a keypad. Later they can learn about the more user-friendly method of set-up and configuration by software.

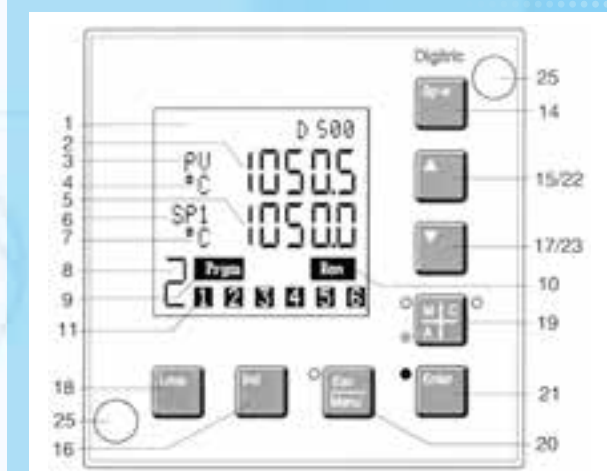
Examples of learning content

(all taught by practical exercise)

- ∴ Basic concepts of set-up
 - ∴ Operating level
 - ∴ Parameter level
 - ∴ Configuration level
- ∴ Setting an industrial digital controller
 - ∴ Operation
 - manual/automatic, setpoint changes
 - ∴ Parameterisation
 - e.g. select P, I and D components of the controller
 - ∴ Configuration
 - e.g. set controller mode: switching, continuous
 - ... and much more
- ∴ Setting a digital 3-channel line recorder, e.g.
 - ∴ Paper feed rates
 - ∴ Input definitions for the individual channels
 - ∴ Setting display ranges
- ∴ Familiarisation with a software solution for user-friendly setting of industrial digital controllers
 - ∴ Parameterisation
 - ∴ Configuration
 - ∴ Saving and managing projects
 - ∴ Data transfer between controller and PC



Setting a 3-channel line recorder via keypad



Operation, parameterisation and configuration of a digital industrial controller via keypad



Parameterisation and configuration of an industrial digital controller using the RT 450.14 configuration software

Learning Topics: Specific Control Applications

The flexibility of the system enables a large number of specific control applications to be set up and tested by way of experiment.

For a level control system, for example, the control device may be an industrial digital controller with continuous output or a PLC for example. The actuator may be a pneumatically operated valve with an electro-pneumatic positioner or a motorised valve featuring a range of actuation options.

You can measure the level using a capacitive sensor or a pressure sensor to record the hydrostatic pressure on the tank bottom.

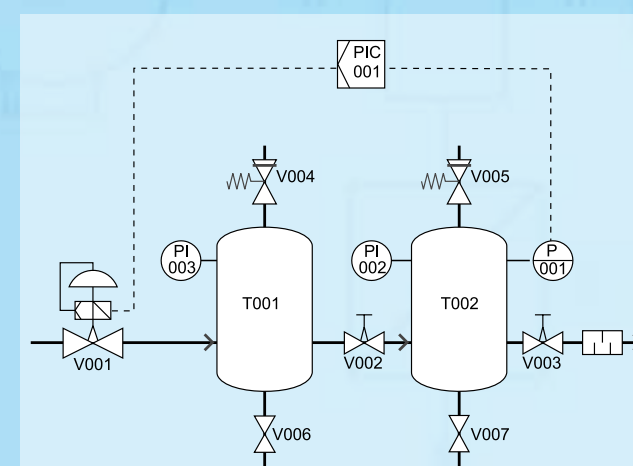
...and of course you can analyse your own ideas and issues by way of experiment.

Examples of learning content

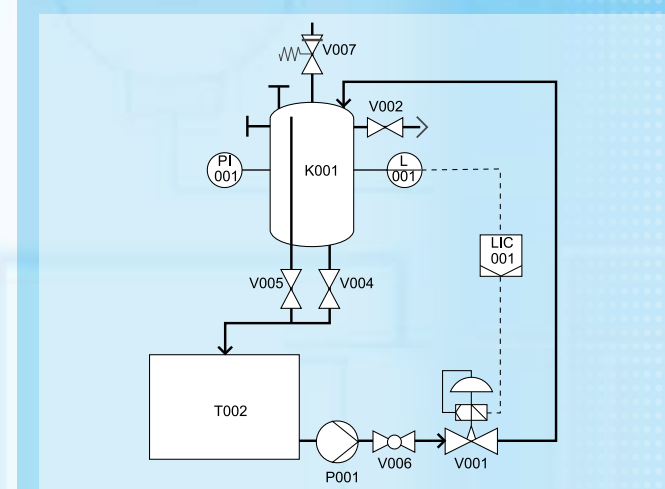
(all taught by experimentation)

- ∴ Pressure control with two pressure tanks connected in series
- ∴ Level control with an open or closed tank also: program control with an industrial digital controller or with a PLC
 - ∴ With a capacitive level sensor or with a pressure sensor
 - ∴ With a motorised valve or electro-pneumatic control valve
- ∴ Flow control
 - ∴ With many variants
- ∴ Temperature control
 - ∴ With an electric heater, switching mode or with an electro-pneumatically operated control valve and electric heater in continuous operation
- ∴ Cascade control
 - ∴ Level / flow
- ∴ Flow characteristic for an electro-pneumatically operated control valve dependent on valve position
- ∴ Flow characteristic for an electric motorised valve with position detection

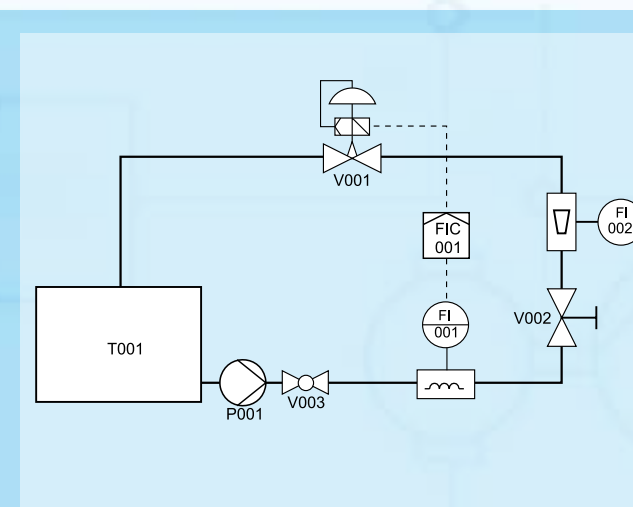
RT 450: Level control with a continuous controller or with a PLC
Windhoek Polytechnic, Namibia



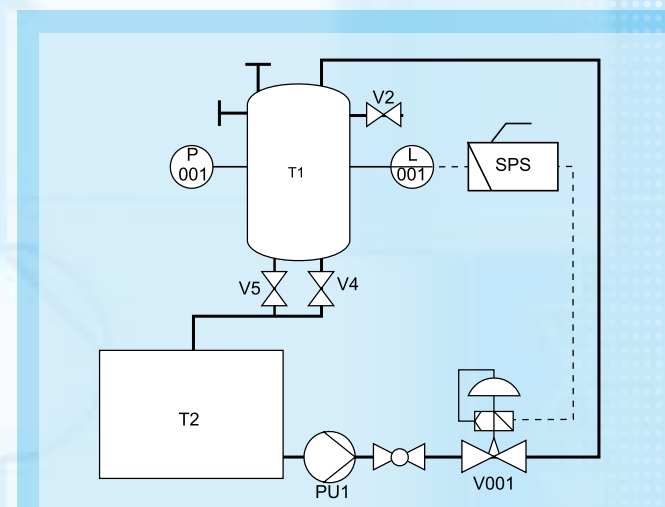
Pressure control



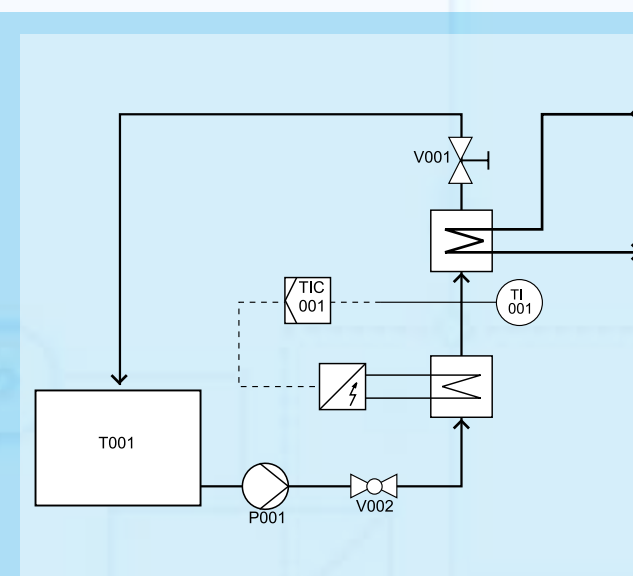
Level control with a continuous controller



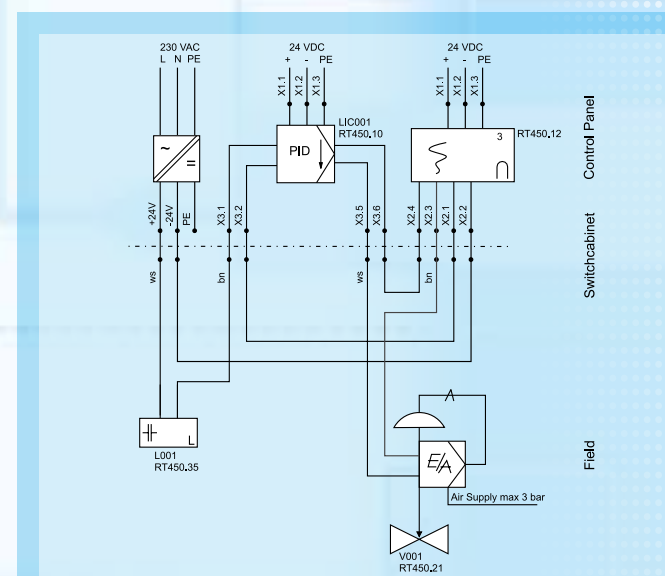
Flow control



Level control with a PLC



Temperature control with a switching controller



Electrical circuit diagram of a level control system



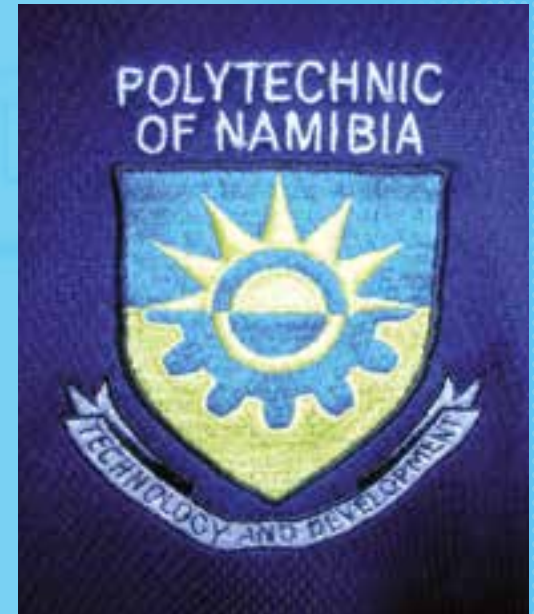
Polytechnic of Namibia: a Satisfied Customer



Inspection of a recorder chart



Temperature control



School of Engineering,
Department of Electrical Engineering
Dean: Z. Oyedokun
Windhoek, Republic of Namibia



Level control with a continuous controller or PLC



Temperature control



Setting on a digital controller

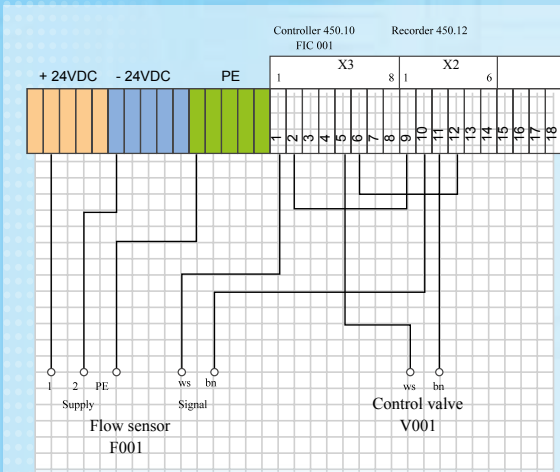
The Polytechnic of Namibia provides courses in core areas of automation based on experimentation using the GUNT RT 450 system.

Its laboratory houses six complete experimental set-ups. Of them, four are prepared for experiments relating to pressure, level, flow and temperature. Two systems are used by students to develop and realise their own projects.

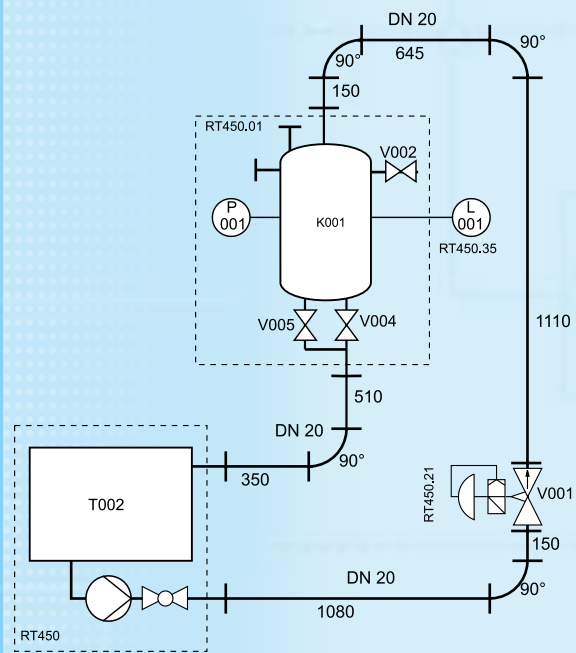
All systems have a Profibus computer communications interface.

The G.U.N.T. local agent in Namibia – A. Hüster Machinetool (PTY) Ltd. – provides technical service, installs updates and supplies consumables.

Learning Topics: Planning and Displaying



Plan of terminal connections for flow control



Pipework diagram for level control

For all skilled staff, technicians and engineers, the planning and displaying of process and piping systems, electrical circuits, signal and communication structures etc. is a key part of their professional qualification.

The exercises which students can conduct with the RT 450 training system offer wide-ranging options to develop and advance those skills.

Examples of learning content

(all taught by practical exercise)

- ✺ Read, edit, understand and create a PI flow diagram for a control loop. Understand the standardised symbols.
- ✺ Create a draft design for assembling a specific control application on the RT 450 frame
- ✺ Create a pipework diagram and the associated component list
- ✺ Create an electrical measurement and control location diagram for electrical integration of the control components
- ✺ Create circuit, wiring diagrams and plan of terminal connections
- ✺ Display and explain the communications concept: e.g. Profibus

Component parts list: Level control system				
Cons. no.	I&C number	Designation	Measuring range, variable	RT 450 component
1	K001	Level tank, transparent	6,9dm³	RT 450.01
2	T002	Supply tank	75dm³	RT 450 Basic Module
3	P001	Pump	Hmax=20m, Qmax=4m³/h	RT 450 Basic Module
4	L001	Level sensor, capacitive	0 - 47cm	RT 450.35
5	PI001	Pressure gauge	0 - 2.5bar	RT 450.01
6	LIC001	Continuous controller	Digitric 500	RT 450.10
7	V001	Control valve, pneumatically operated, I/P positioner	kv = 1.0	RT 450.21
8	V002	Ventilation valve	1/4"	RT 450.01
9	V003	Drain valve	1/2"	RT 450.01
10	V004	Overflow shutoff valve	1/2"	RT 450.01
11	V005	Safety valve	1/8", 2bar	RT 450.01
12	V006	Pump delivery side stop valve	1"	RT 450 Basic Module

Example of a component list

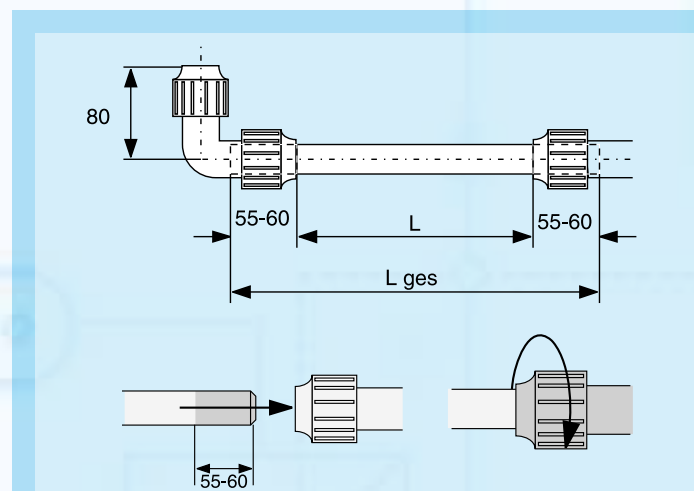
Learning Topics: Practical Exercises

The basic idea underlying the RT 450 training system is not to create a permanent set-up which will remain the same for all time. On the contrary: the system enables a wide range of adaptations to be made very easily. The set-up can be customised to users' specific ideas and projects. Consequently, a range of skills are repeatedly required which can be intensively practised through to their professional execution. Few tools are needed.

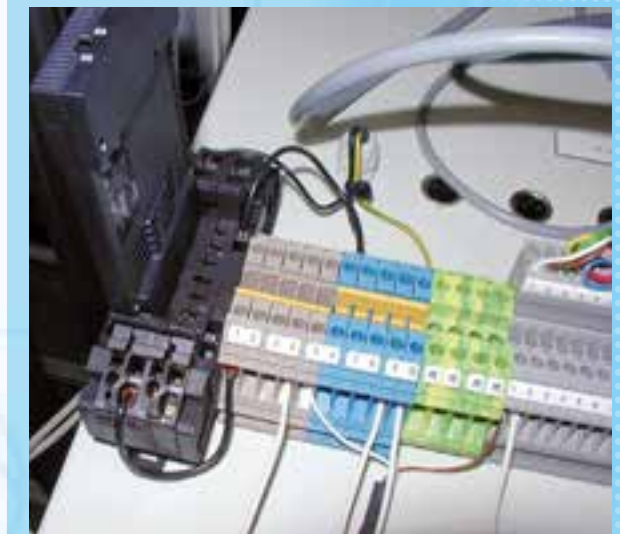
Examples of learning content

(all taught by practical exercise)

- ✺ Mounting the module panels on the mounting profiles of the RT 450 frame
- ✺ Making the pipework connection for the water circuit
 - ✺ Cutting to length and preparing the pipes
 - ✺ Fixing together using clamp fittings
- ✺ Cutting to length, laying and connecting compressed air hoses
- ✺ Cutting to length and stripping electrical cables, and fitting ferrules to them
- ✺ Connecting the electrical wiring
- ✺ Testing the electrical connections

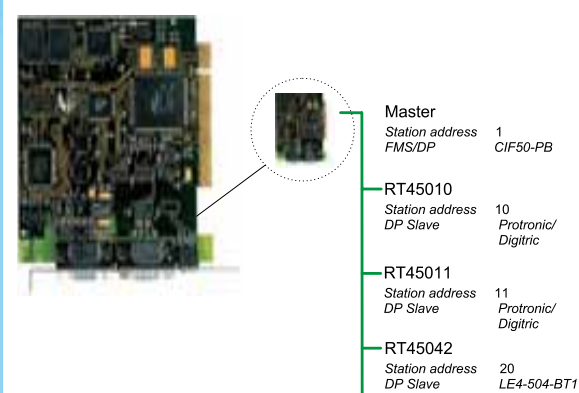


Making connections by plastic pipes

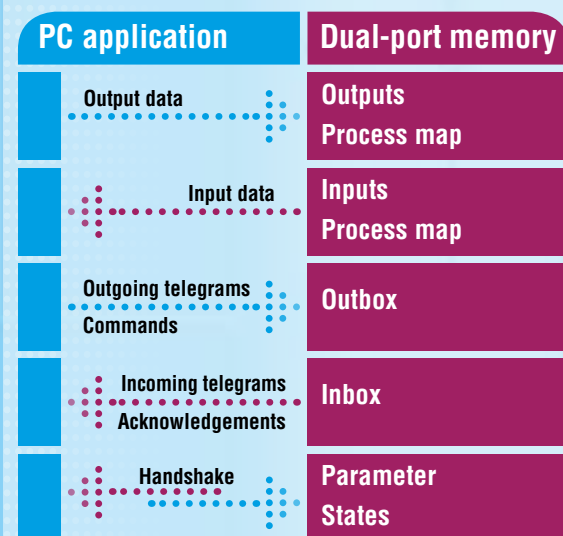


Electrical wiring and connections

Learning Topics: Familiarisation with Communication and Visualisation Systems



RT450.40 is pre-set for two controllers and the PLC over Profibus. Changes can be made at any time.



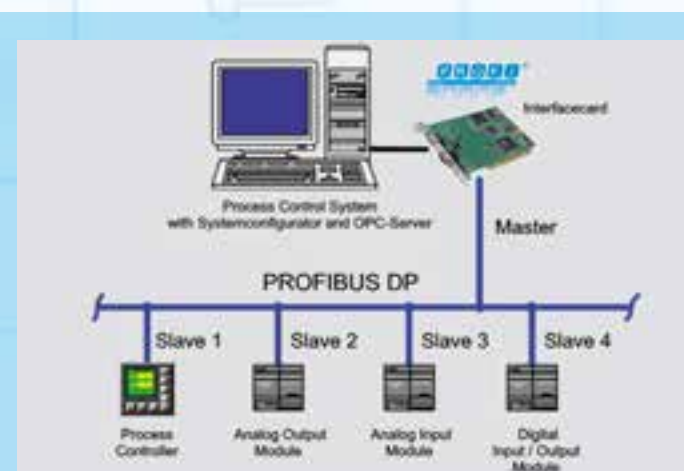
Data interchange between the application and the communications interface is run via a dual-port memory.

State-of-the-art automation is characterised in that data can be interchanged between system components. The data are carried over bus systems.

Automation components (controllers, sensors) are highly variable in their setting and configuration. These set-up procedures are usually carried out by dedicated software.

Examples of learning content

- ✚ Basic concept of a networked automation system
- ✚ Communication over bus systems
- ✚ Integration of a software application
- ✚ Familiarisation with hardware: Profibus PC cards, Profibus plug-in modules on controllers, PLC, PLC Profibus module and measurement sensors
- ✚ Interfaces, installation procedures, errors, faults
- ✚ Dedicated configuration software for controllers, recorders, PC cards etc.



Topology of the field bus used, with master and slaves

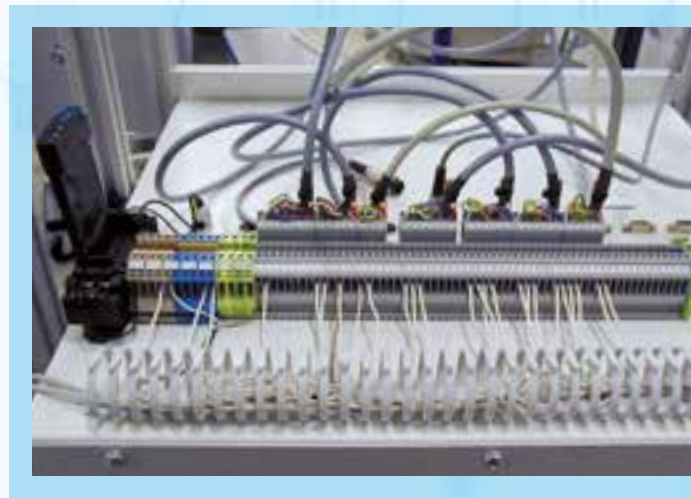


In preparation for covering the topic of **communication networks** in **automation**, we recommend our training systems:

- ✚ RT 360 Networking of Industrial Controllers and
- ✚ RT 370 Set-Up of Field Bus Systems.

This enables students to develop the fundamental knowledge which will then make it easier to work with the RT 450 training system.

Technical Details



Electrical connections – signal connections



The instruments assembled on individual panels are pre-wired on the rear.

As a teaching aid, the connections are categorised and separated accordingly on the various connector assemblies: analog inputs, analog outputs, binary outputs, 24V supply, etc.

These prepared connectors are routed to the corresponding terminal arrays on the control cabinets.

The electrical connections made by the students are limited to those routed to the process (sensors, valves, etc.) and to those necessary to teach correct construction of the electrical current loops.



Process connections

The process connections – in this case only water – are normally made by plastic pipes, ensuring that a correct, industrial-standard system is established. This procedure takes time, and of course consumes material. If you need to reconfigure more often and quickly, the water connections can very well be made by hoses. This has no influence on the functionality or the data acquired.

The compressed air is supplied via hoses.

The Instructional Material

We have compiled a comprehensive range of instructional material for the RT 450 training system which will greatly assist you in getting to know the system and in preparing your lessons and laboratory experiments and exercises.

The instructional material comprises

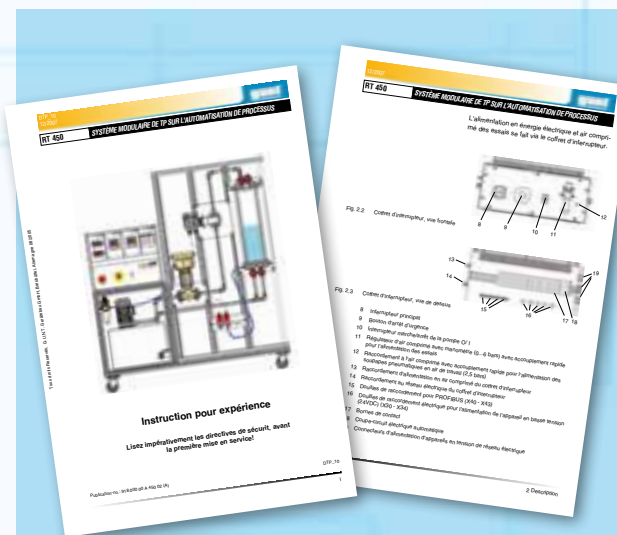
- ∴ Manual: RT 450 system description, approx. 130 pages
- ∴ Manual: fundamentals of control engineering, approx. 20 pages
- ∴ All electrical diagrams for the overall system and for all components
- ∴ Completed reference experiments and sample exercises, approx. 25 worksheets and relevant answers
- ∴ Materials as paper printouts in a folder and additionally as PDF files on a CD

Updates

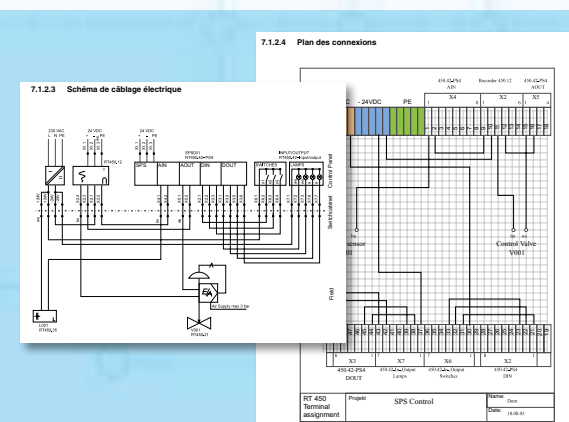
When any updates or additions to the RT 450 system are made – in particular with regard to the instructional material and the software – you, as a GUNT customer, will be notified accordingly.

Training

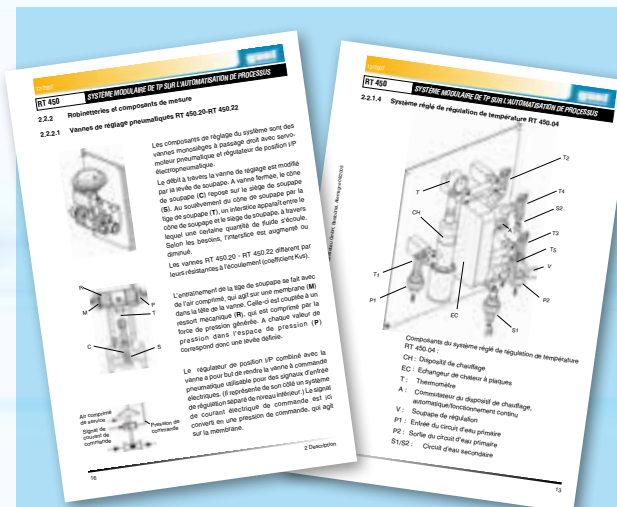
If you require installation or training services for the training system, we will be glad to help.



Manuals: RT 450 system description and fundamentals of control engineering



Electrical circuit diagrams for the overall system and all components



Worksheets for reference experiments and sample exercises

also
available:



GUNT-CATALOGUE No. 2, "MECHATRONICS", COVERS THE FOLLOWING PROGRAM GROUPS

Basic principles	Engineering Drawing	More detailed learning content	Assembly Projects
	Cutaway Models		Maintenance
	Dimensional Metrology		Machinery Diagnosis
	Fasteners and Machine Parts		Automation
	Manufacturing Engineering		

Catalogue 2 covers systems for teaching in the field of metalwork as well as key areas of learning in the electrical trades and mechatronics. It is not a conventional product catalogue, but rather a tool to help you plan your teaching most efficiently.

4 COMPLEX PROCESS ENGINEERING CONTROL SYSTEMS

PLC APPLICATIONS

CODE	PRODUCT	PAGE
RT 800	PLC Application: Mixing Process	142
IA 130	PLC Module	144

COMBINED MULTIVARIABLE SYSTEMS

CODE	PRODUCT	PAGE
RT 586	Control of Water Quality	146
RT 578	Control of 4 Variables from Process Engineering	148
RT 580	Fault Finding in Control Systems	150
Overview	RT 590 Process Control Engineering Experimentation Plant	152
RT 590	Process Control Engineering Experimentation Plant	154

COUPLED MULTIVARIABLE SYSTEMS

CODE	PRODUCT	PAGE
RT 681	Multivariable Control: Vacuum Degassing	156
RT 682	Multivariable Control: Stirred Tank	158
RT 650.60	Process Control Software for RT 681 - RT 682 Series	160



Complex control systems to meet the highest demands

The control systems featured in this chapter are not merely used to teach the fundamentals. Their aim extends beyond that scope, seeking to map real process engineering tasks in a manner as similar as possible to actual industrial practice. The demands placed on students are significantly higher than those imposed by the other units in this catalogue. These control systems are intended for training of advanced students of process engineering and operating and maintenance personnel in industry. These complex units can of course also be used in the teaching of fundamentals. They also involve setup, parameterisation and configuration procedures aimed at teaching maintenance and fault finding skills.

The complexity of the units covered in this chapter in many cases demands detailed training by experienced GUNT engineers. If you have any questions on this matter, please consult us. We will be glad to advise you.

RT 800

PLC Application: Mixing Process



Technical Description

This trainer for PLC applications can be used to create complex PLC control functions from the field of process engineering, particularly for processes involving metering and mixing. The system consists of the base frame with a storage tank, a centrifugal pump and a demonstration panel on which all components are clearly laid out. A pump delivers water to three tanks, controlled via solenoid valves. The level of water in the three tanks is monitored by capacitive proximity switches with adjustable sensitivity. The fluid from the three tanks can be mixed together in the downstream mixing tank. The mixing tank is also equipped with three proximity switches. A stirring machine assists the mixing process. All the tanks are transparent, so the conveying and mixing processes are clearly observable.

The trainer features a lab jack panel by which the signals from the capacitive proximity switches can be processed by PLC, and all the solenoid valves can be individually controlled. PLC systems from different manufacturers can be used. A rail on the model's front panel is provided so as to allow for connection of the PLC. Although a PLC is not included in the package, the operation of the system can be checked without one. We recommend the use of PLC module IA 130.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

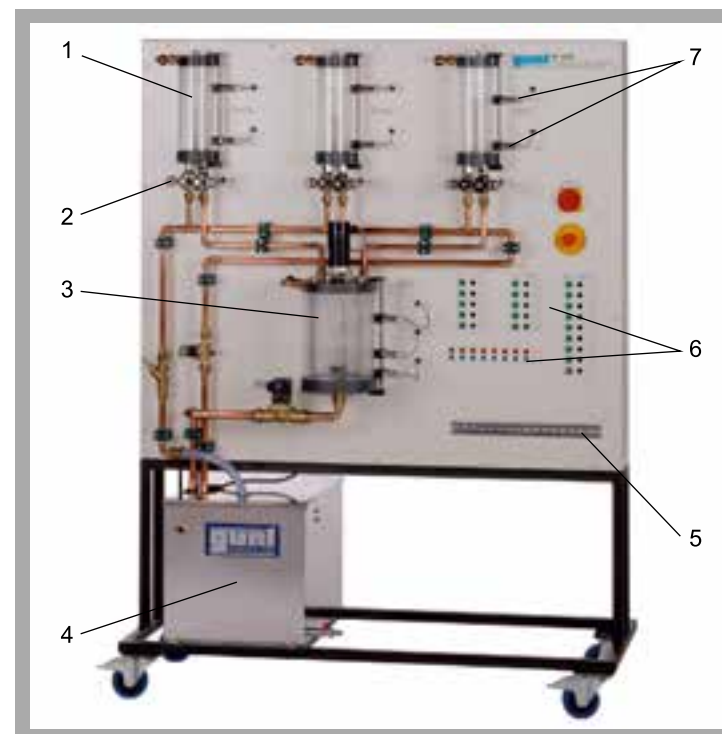
Learning Objectives / Experiments

- planning and implementation of a PLC controlled mixing process
- familiarisation with terms and symbols
- presentation of circuits
- functionality test of all sensors and actuators
- sensitivity adjustment of the capacitive proximity switches
- procedure for connecting up the PLC
- together with PLC module: performance of complex PLC control functions using a complex example from the field of process engineering
- discontinuous metering and mixing

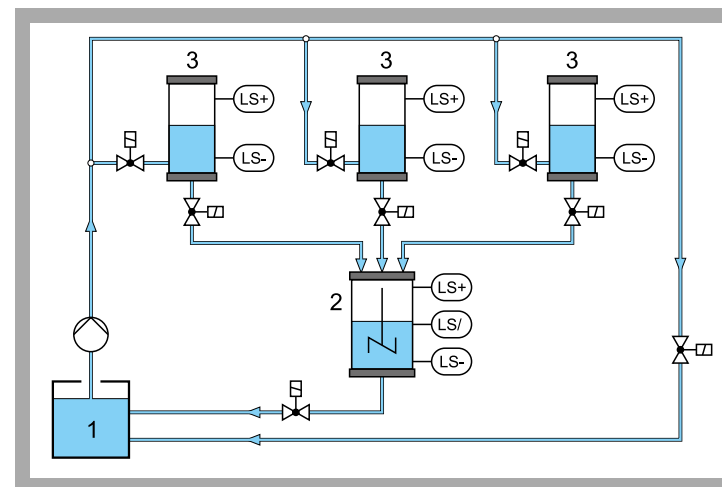
- * **Trainer for control of discontinuous mixing processes by PLC**
- * **Use of standard industrial components**
- * **Capacitive proximity switches as level sensors**
- * **Built-in power supply unit to power all the components and the PLC**

RT 800

PLC Application: Mixing Process



1 measuring tank, 2 solenoid valve, 3 mixing tank with stirring machine, 4 storage tank, 5 rail for mounting of a PLC system, 6 lab jack panel for connection of a PLC, 7 level sensor



Process schematic: 1 storage tank, 2 mixing tank, 3 measuring tank; LS level sensors (+: high, /: middle, -: low)

Specification

- [1] clearly laid out trainer as basis for the use of a PLC in a process control application involving mixing processes
- [2] transparent mixing tank with 3 capacitive proximity switches to monitor the level
- [3] 3 transparent measuring tanks, each with 2 capacitive proximity switches
- [4] metering from the 3 measuring tanks into the mixing tank via solenoid valves
- [5] mixing assisted by stirring machine in mixing tank
- [6] proximity switch signals processed by PLC via lab jack panel
- [7] control of the 8 solenoid valves, the pump and the agitator also by PLC via lab jack panel
- [8] capacitive proximity switches with adjustable sensitivity
- [9] closed water circuit with centrifugal pump and stainless steel storage tank
- [10] power supply to all components and to PLC by built-in power supply unit

Technical Data

- Centrifugal pump (submersible pump)
- power consumption: 430W
- max. flow rate: 150L/min
- max. head: 7m

Tanks

- storage tank: 70L
- 3 measuring tanks: each 1500mL
- mixing tank: 7L

Capacitive proximity switches, NO contacts
2/2-way solenoid valves DN 8 and DN 20
Power supply unit: 24VDC, 8A

Dimensions and Weight

LxWxH: 1380x610x1850mm
Weight: approx. 145kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 trainer
- 1 set of instructional material

Order Details

080.80000 RT 800 PLC Application:
Mixing Process

IA 130

PLC Module



- * **Self-contained PLC module for basic exercises**
- * **Suitable for use in complex applications**
- * **Programming software to IEC 61131-3**

Technical Description

The IA 130 can be used to perform basic exercises on a PLC (programmable logic controller). A PLC is essentially a computer adapted to the needs of industry. Its inputs and outputs are not designed for humans, but for use in the control of machines. Machine and operator interact solely by way of limit switches, momentary-contact switches or photoelectric switches.

The front panel is designed as a laboratory patchboard, where the input ports and output ports of the PLC can be connected to switches and displays via laboratory cables. In order to write programs the PLC must be connected to a PC (not supplied) via an RS232 interface.

The PLC programming software conforms to the international standard IEC 61131-3, and permits programming in the following languages: Statement List (STL), Ladder Diagram (LD), Structured Text (ST) and Function Block Diagram (FBD). Ladder Diagrams are based on graphical representations with contacts, coils and boxes, as per the circuit diagrams. Function Block Diagram language is based on graphical representation of the interlinking of logical function blocks, analogous to the logic diagrams. Statement List is an assembler-type language with a small, standardised non-hardware-dependent command set. Structured Text is a language similar to PASCAL, with mathematical expressions, assignments, function calls, iteration, condition selection, and PLC-specific add-ons. An example program is included in the module.

IA 130 can be used as a control element in conjunction with electrical, pneumatic or hydraulic applications, such as with the handling device IA 210 or the mixing process RT 800.

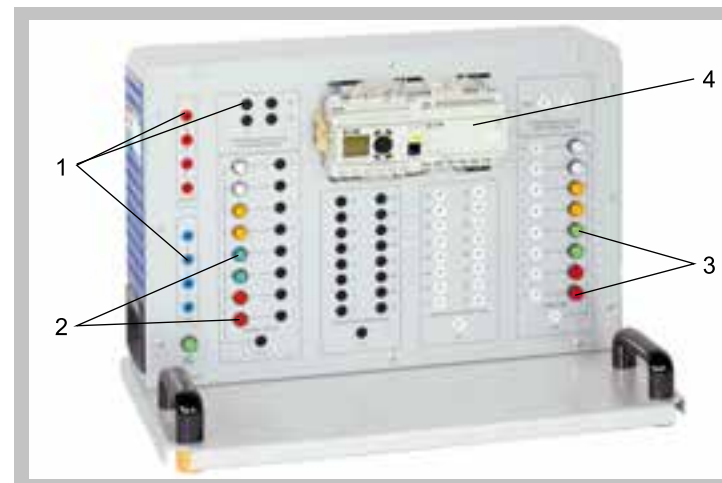
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

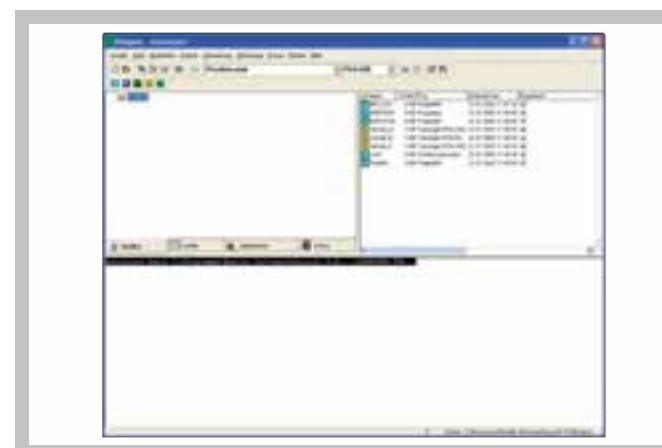
- familiarisation with a PLC
- familiarisation with the essential fundamentals such as
 - * Boolean algebra
 - * compiling statement lists
 - * interconnection diagrams and block diagrams
- exercises in
 - * programming
 - * logical "AND" / "OR" gates
 - * logic relays
 - * output and input
- configuration of program sequences by way of connectors, incorporating
 - * timers
 - * counters
 - * cascade circuits
 - * higher-order monitoring relays etc.
- fault finding

IA 130

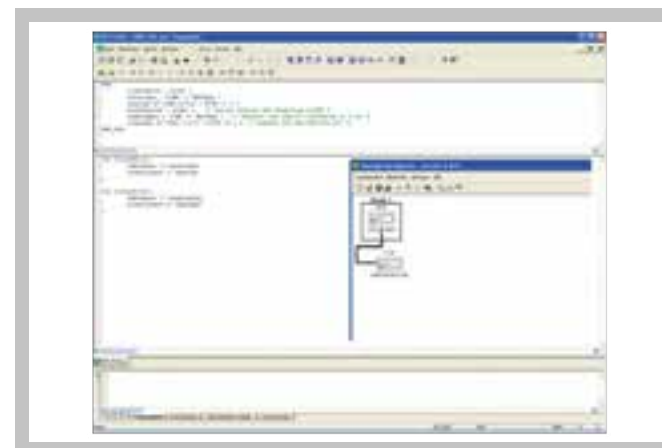
PLC Module



1 PLC, 2 lab jacks, 3 pushbutton, 4 lamps



Screenshot of PLC software: start screen



Screenshot of PLC software: POU editor (POU = Program Organisation Unit) and topology configurator

Specification

- [1] module for basic exercises on a programmable logic controller (PLC)
- [2] self-contained PLC module, usable as part of a complex system
- [3] integrated patchboard for creating circuits with input and output elements
- [4] PLC with 2 integrated setpoint encoders
- [5] programming software to IEC 61131-3
- [6] example program supplied

Technical Data

PLC

- connections
 - * 16 digital inputs
 - * 14 digital outputs
 - * 2 analogue inputs
 - * 1 analogue output
- memory type: PLC back-up battery for 32kByte RAM and clock
- Rated voltage: 24VDC

Software

- graphical user interfaces
- programming languages to IEC/EN 61131-3:
 - * statement list (STL)
 - * ladder diagram (LD)
 - * function block diagram (FBD)
 - * structured text (ST)
- multiple dialogue languages (German, English, French, Spanish)
- graphical topology configurator
- system requirements: Windows XP or Windows Vista

Dimensions and Weight

LxWxH: 520x100x370mm

Weight: approx. 16kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

- 1 PLC Module
- 1 PLC software with programming cable
- 1 set of laboratory cables
- 1 set of instructional material

Order Details

058.13000 IA 130 PLC Module

RT 586

Control of Water Quality



* **Control of pH value, redox potential, oxygen concentration and electrical conductivity**

* **4 control loops with industrial controllers**

Technical Description

Adequate water quality is essential to many production processes. With RT 586 key water parameters can be monitored and controlled.

Water flows into a transparent tank which contains a stirrer. A sensor allows for measurement of the conductivity of the water. It is displayed on a meter and transmitted as an electrical signal to a controller. The desired conductivity is preset as the reference variable on the controller. The controller influences the conductivity of the water by adding diluted caustic soda with a metering pump.

The addition of caustic soda causes the pH value of the water to rise. It flows into a second transparent tank. A sensor provides for the measurement of the pH value. The desired pH value is preset as the reference variable on the controller. The water is neutralized by adding diluted sulphuric acid with a metering pump. Another sensor in this tank is used to measure the oxygen concentration of the water. It is displayed on a meter and transmitted as an electrical signal to the controller. The controller influences the injection of compressed air, and thus the oxygen concentration of the water, by way of a control valve. The water flows into a collecting tank.

The redox potential is controlled in a separate section of the collecting tank. In this section the redox potential is measured using a sensor. The controller influences the redox potential of the water by the addition of iodine solution with a metering pump.

As a further check of performance, a sensor is employed to measure the pH value of the water in the collecting tank. It is displayed digitally on the switch cabinet. A six-channel line recorder is provided to record the control processes.

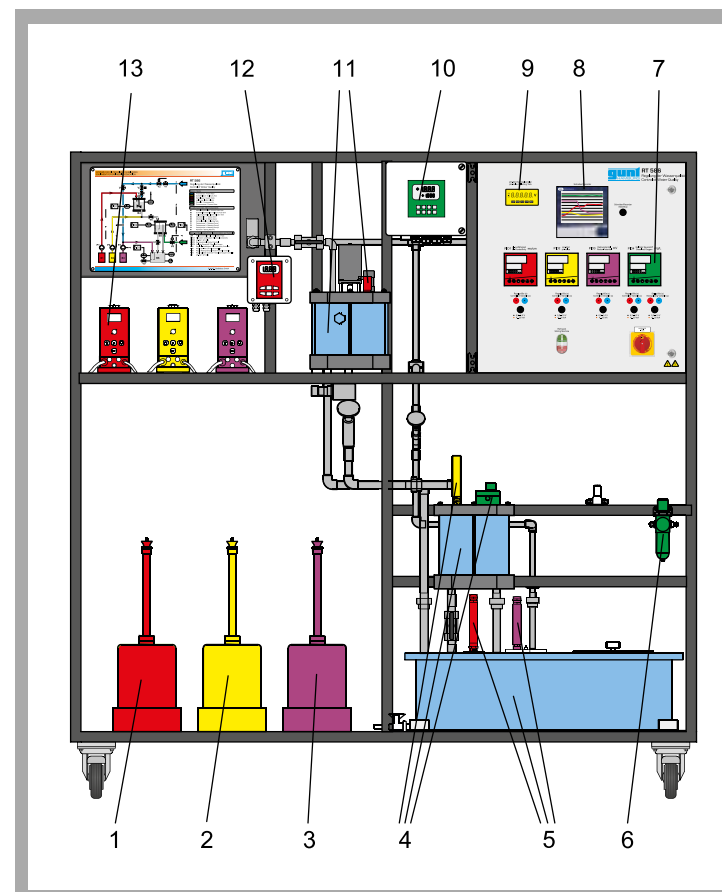
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

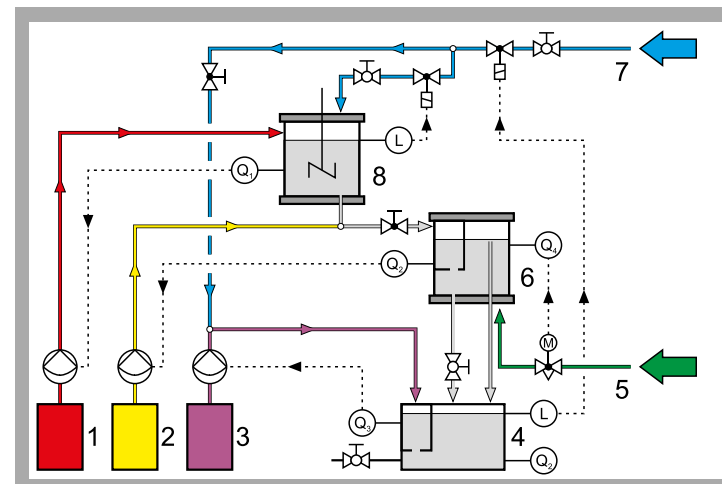
- comparison of various controller types
- * P, PD, PI and PID controllers
- * two-point controller
- influence of caustic soda on electrical conductivity and pH value
- influence of sulphuric acid on pH value
- influence of air injection on oxygen concentration
- influence of iodine on redox potential

RT 586

Control of Water Quality



1 caustic soda, 2 sulphuric acid, 3 iodine solution, 4 tank with sensors for pH value and oxygen concentration, 5 collecting tank with sensors for redox potential and pH value, 6 compressed air maintenance unit, 7 controller, 8 line recorder, 9 collecting tank pH value display, 10 oxygen meter, 11 tank with stirrer and conductivity sensor, 12 conductivity meter, 13 metering pump



1 caustic soda, 2 sulphuric acid, 3 iodine solution, 4 collecting tank for control of redox potential, 5 compressed air, 6 tank for control of pH value and oxygen concentration, 7 water inlet, 8 tank for control of conductivity; Q₁ conductivity, Q₂ pH value, Q₃ redox potential, Q₄ oxygen concentration

Specification

- [1] control of water parameters; pH value, redox potential, oxygen concentration and electrical conductivity
- [2] control of conductivity in transparent tank with stirrer
- [3] control of pH value and oxygen concentration in transparent tank
- [4] control of redox potential in collecting tank
- [5] change in conductivity, pH value and redox potential by addition of caustic soda, sulphuric acid and iodine solution
- [6] 3 industrial metering pumps
- [7] change in oxygen concentration by injection of compressed air
- [8] 4 parameterisable industrial controllers
- [9] 6-channel line recorder
- [10] 3 plastic tanks for caustic soda, sulphuric acid and iodine solution
- [11] recording of pH value in collecting tank

Technical Data

Tanks

- transparent tanks: 2x 5L
- collecting tank: 80L
- plastic tanks: 3x each

Metering pumps

- max. flow rate: each 2,1L/h
- max. head: each 160m

4 controllers parameterisable as

- P, PI or PID controller
- 2-point controller

Measuring ranges

- conductivity: 0...100mS/cm
- pH value: 1...12
- oxygen concentration: 0...60mg/L
- redox potential: 0...1000mV

Dimensions and Weight

LxWxH: 1800x700x1830mm

Weight: approx. 182kg

Required for Operation

230V, 50Hz, 1 phase
Compressed air: 3...8bar, water connection, drainage, iodine solution, caustic soda, sulphuric acid

Scope of Delivery

- 1 trainer
- 1 hose
- 1 set of instructional material

Order Details

080.58600 RT 586 Control of Water Quality

RT 578 Control of 4 Variables from Process Engineering


- * **Practical control of level, flow rate, pressure and temperature**
- * **Cascade control**
- * **Process control software**

Technical Description

The RT 578 facilitates practical learning in the control of four controlled variables which are commonplace in process engineering.

A circuit with a graduated transparent tank is provided for the control of flow rate, level and pressure. Two actuator possibilities are included for use, namely, a variable-speed pump and a pneumatic control valve. A disturbance variable can be generated by a valve in the tank outlet for level and pressure control. A valve at the tank head also permits investigation of level control with and without counter pressure.

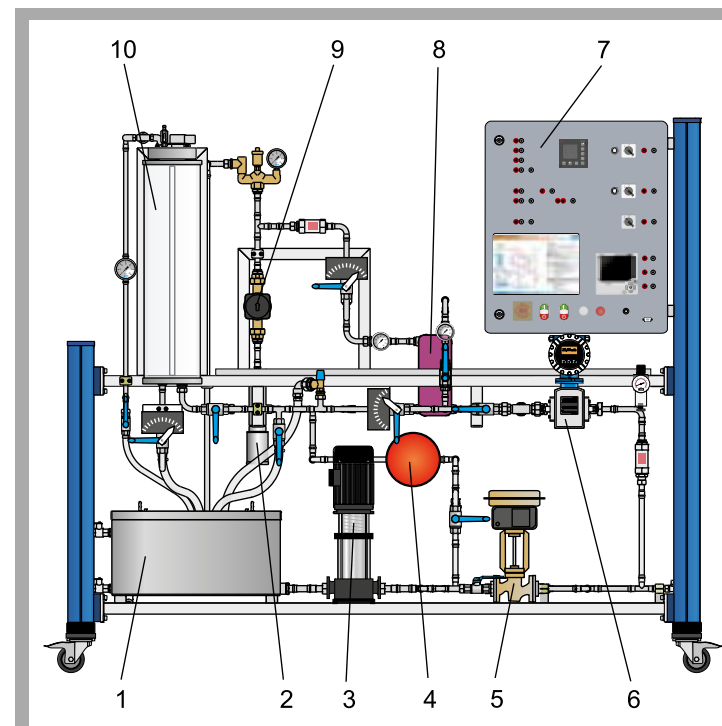
A heating circuit with a heater, heat exchanger and pump is provided for temperature control. The temperature can be controlled using the heater as the actuator, or by way of the flow of cooling water through the heat exchanger.

Two forms of cascade control are possible. The level in the tank can be controlled by way of the flow rate. The temperature in the heating circuit can be controlled by way of the flow rate through the heat exchanger. For these two cascade controls, either the pump or the control valve can be used as the actuator.

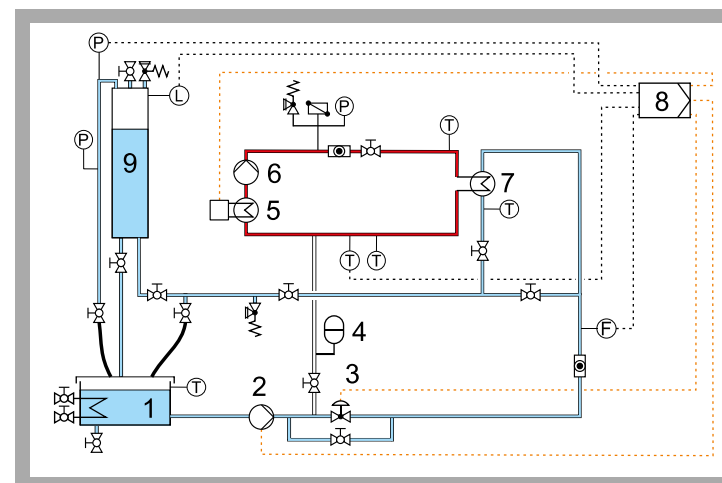
Sensors provide for measurement of the controlled variables. The variables can also be read-off directly from analogue meters. A line recorder is provided to record the control processes. The industrial controller has four selectable control loops. It has a Profibus DP interface. This enables the trainer to be controlled by way of a process control software. The software also permits recording of the process variables and parameterisation of the controller on the PC.

Learning Objectives / Experiments

- familiarisation with industrial control loop components
- setup, parameterisation and configuration on the controller
- optimisation of controller settings
- flow rate control
- level control in closed tank with or without counter pressure
- pressure control
- temperature control
- cascade control, level - flow rate
- cascade control, temperature - flow rate
- two-point control, temperature
- plotting step responses

RT 578 Control of 4 Variables from Process Engineering


1 collecting tank, 2 heater, 3 pump, 4 expansion vessel, 5 control valve, 6 flow rate sensor, 7 switch cabinet, 8 heat exchanger, 9 heating circuit pump, 10 graduated tank



1 collecting tank, 2 pump, 3 control valve, 4 expansion vessel, 5 heater, 6 heating circuit pump, 7 heat exchanger, 8 controller, 9 graduated tank;
Sensors: F flow rate, P pressure, L level, T temperature

Specification

- [1] control of level, flow rate, pressure, temperature and cascade control
- [2] circuit with collecting tank, graduated tank, pneumatic control valve and 6-stage variable-speed centrifugal pump
- [3] heating circuit with heater, pump, expansion vessel and heat exchanger
- [4] heater, pneumatic control valve and 6-stage variable-speed centrifugal pump as actuators
- [5] sensors for measurement of the controlled variables; level, flow rate, pressure and temperature
- [6] 2 flow indicators, 1 manometer and 3 thermometers for direct display
- [7] parameterisable controller with 4 selectable control loops
- [8] 3-channel line recorder
- [9] GUNT process control software via Profibus DP interface under Windows 7

Technical Data
Tanks

- graduated tank: approx. 6L
- collecting tank: approx. 90L

6-stage centrifugal pump

- max. flow rate: approx. 55L/min
- max. head: approx. 60m

Heating circuit pump

- max. flow rate: approx. 50L/min
- max. head: approx. 3,5m

Heater power output: approx. 2kW
Controller parameterisable as

- P, PI or PID controller
- switching controller

Sensor measuring ranges

- level: 0...700mm
- flow rate: 0...4000L/h
- pressure: 0...6bar
- temperature: 0...200°C

Dimensions and Weight

LxWxH: 2260x800x1990mm

Weight: approx. 250kg

Required for Operation

230V, 50/60Hz, 1 phase or 230V, 60Hz/CSA, 3 phase compressed air: 3...8bar; 25...50L/min

Scope of Delivery

- 1 trainer
- 1 set of cables
- 1 set of hoses
- 1 Profibus card
- 1 GUNT software CD
- 1 set of instructional material

Order Details

080.57800 RT 578 Control of 4 Variables from Process Engineering

RT 580

Fault Finding in Control Systems



- * **Practical control of level, flow rate and temperature**
- * **Simulation of typical faults**
- * **PLC to monitor safety devices**
- * **Refrigeration system for independent cold supply**

Technical Description

The RT 580 facilitates practical learning in the control of three controlled variables which are commonplace in process engineering.

A circuit with a collecting tank, pump and graduated tank is provided for control of level and flow rate. A pneumatic control valve is used as the actuator. There is a valve in the tank outlet to generate a disturbance variable in level control. Cascade control is possible whereby the level in the tank is controlled by way of the flow rate.

Two circuits are used in the control of the temperature. A refrigeration system cools the water in the collecting tank. A pump circulates the water via a heat exchanger (cooling circuit). A heater heats the water in the graduated tank. Another pump also circulates the warm water via the heat exchanger. In the heat exchanger the water in the cooling circuit is heated. The controlled variable is the temperature of the water in the cooling circuit after heating in the heat exchanger. The actuator is the pneumatic control valve which adjusts the flow rate of the warm water. Cascade control is also possible to control the temperature.

Two industrial controllers are supplied which can be employed as the master and slave in the implementation of cascade control. They have a Profibus DP interface. This enables the trainer to be controlled by way of a software. The software also permits recording of the process variables and parameterisation of the controllers on the PC.

The trainer is equipped with a PLC for monitoring of safety devices, such as a low water cut-off which protects the heater. On the switch cabinet there are also pushbuttons for the simulation of typical faults

such as failure of sensors or cable breaks.

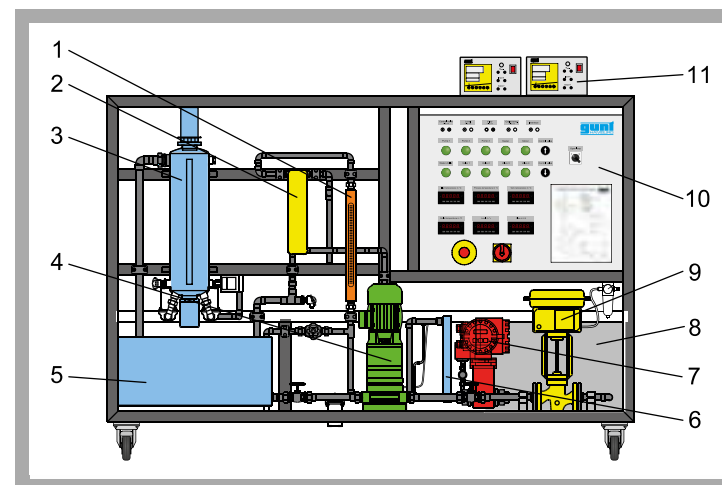
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

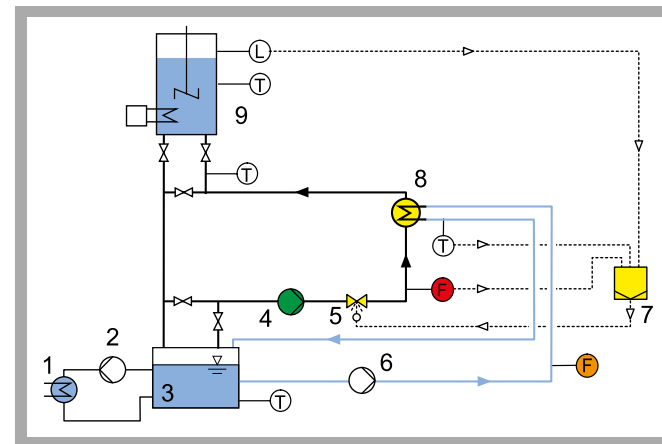
- familiarisation with industrial control loop components
- setup, parameterisation and configuration on the controller
- optimisation of controller settings
- level control
- flow rate control
- temperature control
- cascade control, level - flow rate
- cascade control, temperature - flow rate
- plotting step responses
- fault finding

RT 580

Fault Finding in Control Systems



1 flow meter, 2 heat exchanger, 3 stirred tank with heater, 4 main circuit pump, 5 collecting tank, 6 refrigeration system evaporator, 7 flow rate sensor, 8 refrigeration system, 9 control valve, 10 switch cabinet, 11 controller



1 refrigeration system evaporator, 2 refrigeration system pump, 3 collecting tank, 4 main circuit pump, 5 control valve, 6 cooling circuit pump, 7 controller, 8 heat exchanger, 9 stirred tank with heater; F flow rate, L level, T temperature



Process control software screenshot

Specification

- [1] control of level, flow rate, temperature and cascade control
- [2] main circuit with collecting tank, graduated stirred tank with heater, pneumatic control valve and centrifugal pump
- [3] cooling circuit with pump, heat exchanger and rotameter
- [4] refrigeration system and pump to cool the water in the collecting tank
- [5] pneumatic control valve in main circuit as actuator for all controls
- [6] sensors for the measurement of the controlled variables; level, flow rate and temperature
- [7] 2 parameterisable industrial controllers
- [8] 6 pushbuttons for fault simulation
- [9] PLC to monitor safety devices
- [10] GUNT process control software via Profibus DP interface under Windows Vista or Windows 7

Technical Data

- Tanks
 - stirred tank with scale: approx. 7L
 - collecting tank: approx. 90L
- Main circuit centrifugal pump
 - max. flow rate: approx. 75L/min
 - max. head: approx. 20m
- 2 pumps, cooling circuit and refrigeration system
 - max. flow rate: approx. 60L/min
 - max. head: approx. 4m
- Heater power output: approx. 2kW
- Controller parameterisable as
 - P, PI or PID controller

Measuring ranges

- level: 0...350mm
- flow rate: 0...1999L/h
- temperature: 0...100°C

Dimensions and Weight

- LxWxH: 1920x800x1530mm
- Weight: approx. 245kg

Required for Operation

- 230V, 50/60Hz, 1 phase or 230V, 60Hz, 3 phases
- compressed air: 3...8bar; 25...50L/min

Scope of Delivery

- 1 trainer
- 2 controllers
- 1 set of cables
- 1 Profibus card
- 1 CD with PLC programming software
- 1 GUNT software CD
- 1 set of instructional material

Order Details

- 080.58000 RT 580 Fault Finding in Control Systems

RT 590 590 PROCESS CONTROL ENGINEERING EXPERIMENTATION PLANT

Complex process engineering systems are often operated and controlled from a central control station, where system status information is collated. This makes it easy to make decisions and initiate appropriate measures on-site. The consolidated, centralised supply of multiple processes with media such as cooling water, steam, compressed air and electric power is also typical of industrial process

engineering plants. Such consolidated supply delivers the advantage of cost and energy savings. RT 590 enables students to familiarise themselves with the required supplies to various processes as well as the centralised monitoring and control of these processes. The operating environment is very similar to those they will encounter in practice.

THE TRAINER

Learning of many control tasks in process engineering can be facilitated with the trainer:

- Flow rate control
- Level control with and without counter pressure
- Level control with a second-order controlled system
- Cascade control of level and flow rate
- Pressure control with time-varying response of the controlled system
- Temperature control with time-varying response of the controlled system



THE CONTROL STATION



- 4 parameterisable controllers with Profibus interface for connection to a PC
- 4 3-channel line recorders
- Process control software
 - ▶ trainer monitoring
 - ▶ selection of controlled system with display of process schematic
 - ▶ plotting of time charts
- Fault simulation, e.g. sensor failure or cable break

THE SUPPLY UNIT

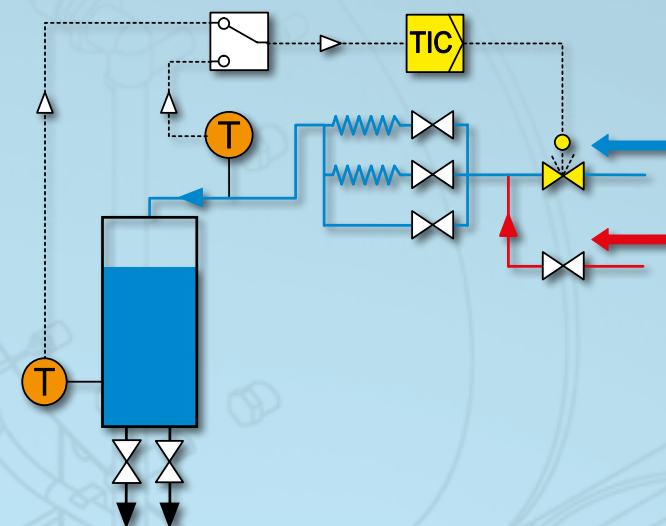
- Industrial compressor with pressure accumulator for supply of
 - ▶ compressed air for experiments
 - ▶ compressed air as auxiliary power for control valves
- Pump for water supply
- Heater for warm water supply for temperature control



EXAMPLES OF SELECTABLE CONTROLLED SYSTEMS

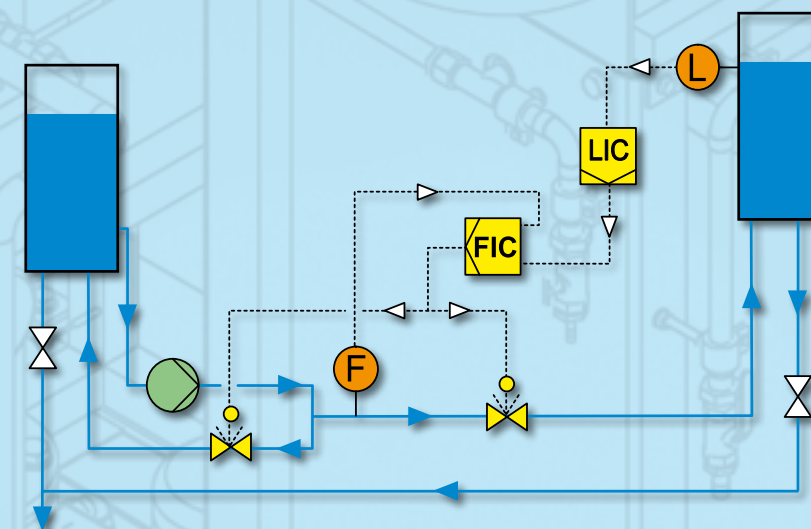
Temperature control

Warm water flows from the supply unit into the collecting tank. The temperature is altered by adding cold water by way of a control valve. Two different sensors are available for selection for the measurement of the controlled variable. This enables the temperature to be controlled either in the collecting tank inlet or directly in the collecting tank. Three delay sections are included of differing lengths, these permit the setting of differing dead times.



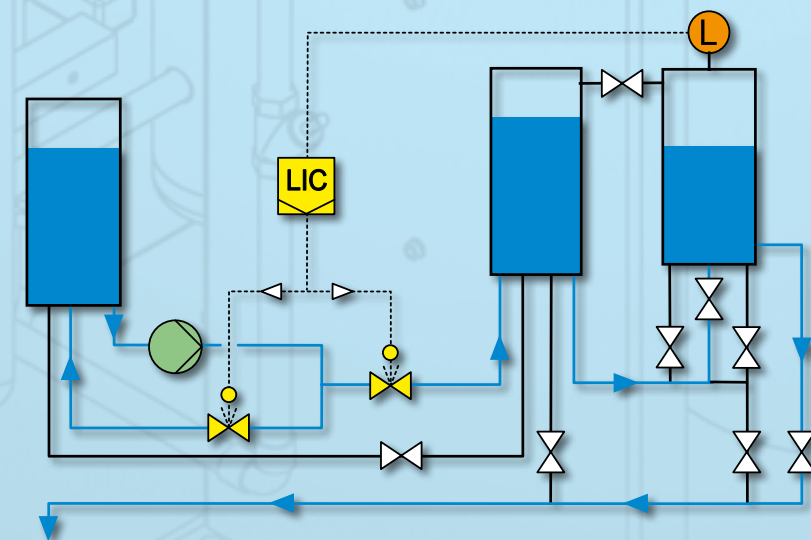
Cascade control level / flow rate

The level in the tank is controlled by way of the flow rate. The master controller (LIC) receives the actual level signal and the reference variable signal as inputs. The output signal from this controller and the actual flow rate signal are the input signals to the slave controller (FIC). This controller varies the flow rate by way of two opposite-acting control valves.



Level control with a second-order controlled system

Two series-configured tanks form the second-order controlled system. The level in the rear tank is measured and controlled by two opposite-acting control valves which vary the flow rate. The response over time of the controlled system is varied by way of valves.



RT 590

Process Control Engineering Experimentation Plant



From left: supply unit, trainer and control station

- * **Complete industrial-scale process engineering experimentation plant**
- * **Control of level, flow rate, pressure, temperature and cascade control**
- * **Simulation of typical faults**

Technical Description

The supply of processes with media such as water and compressed air in industry is usually provided from a separate, centralised supply unit. Control and monitoring of the processes are also centralised from a control station. RT 590 enables familiarisation with a practical scenario of this nature.

The trainer includes a water circuit with a pump, collecting tank and graduated tank. In this circuit, the flow rate and level are controlled by way of pneumatic control valves. The level control can also be executed under counter pressure or as cascade control. An additional tank can be connected to facilitate learning with a second-order level controlled system.

Compressed air is used in the control of pressure. The level of liquid in the tank can be varied to give time-varying response of the controlled system.

The temperature control takes place in the collecting tank. Warm water flows into the tank. Cold water is mixed in using a control valve, thereby regulating the temperature in the tank. Three delay sections are used to set different dead times.

The separate control station includes the controllers and line recorders for monitoring and control of the control processes. The controllers have a Profibus DP interface. This enables the trainer to be controlled by using a process control software. The software also permits recording of the

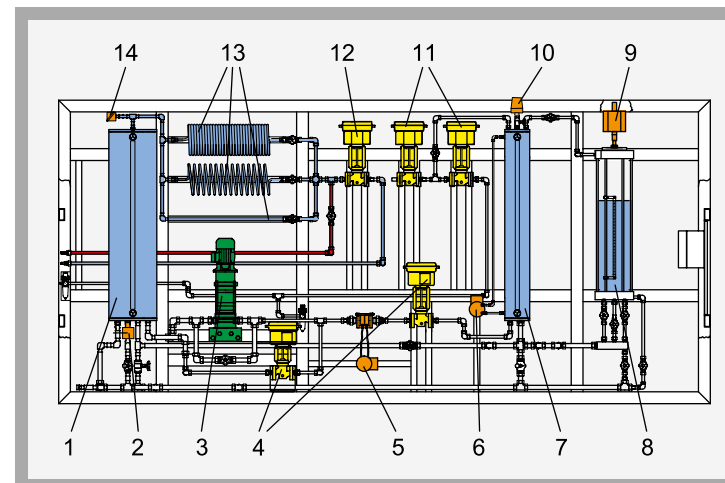
process variables and parameterisation of the controllers using the PC. Pushbuttons on the control station are used to simulate typical faults such as failure of sensors or cable breaks. The separate supply unit supplies compressed air and warm and cold water.

Learning Objectives / Experiments

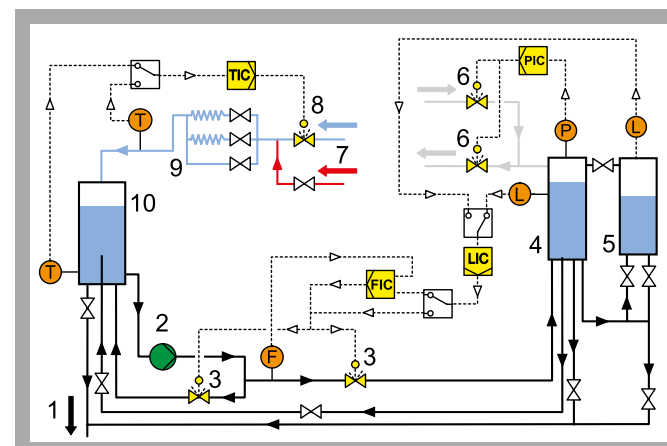
- familiarisation with industrial process engineering plant
- flow rate control
- level control with and without counter pressure
- level control with second-order controlled system
- cascade control of level and flow rate
- pressure control with time-varying response of the controlled system
- temperature control with time-varying response of the controlled system
- fault finding

RT 590

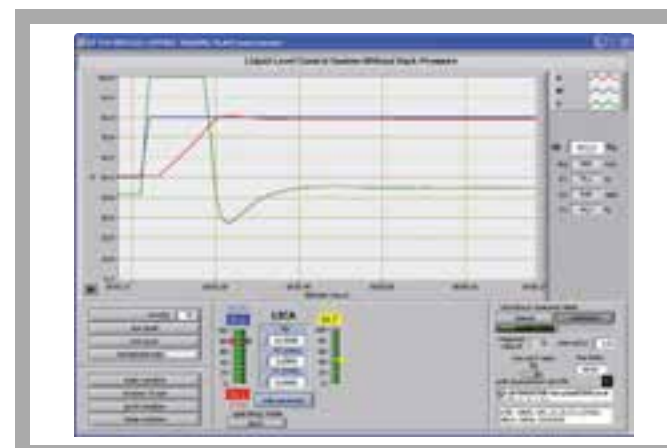
Process Control Engineering Experimentation Plant



1 collecting tank, 2 temperature sensor in collecting tank, 3 pump, 4 flow control valves, 5 flow rate sensor, 6 level sensor, 7 tank for level and pressure control, 8 tank for second-order system, 9 level sensor, 10 pressure sensor, 11 compressed air control valve, 12 cold water control valve, 13 delay section, 14 temperature sensor in inlet



1 outlet, 2 pump, 3 flow control valve, 4 tank for level and pressure control, 5 tank for second-order system, 6 compressed air control valve, 7 warm water inlet, 8 cold water control valve, 9 delay sections, 10 collecting tank



Software screenshot

Specification

- [1] control of level, flow rate, pressure, temperature and cascade control
- [2] trainer with pump, collecting tank and two tanks for level and pressure control
- [3] supply unit with compressor, pressure vessel, pump and heater
- [4] control station with four industrial controllers, 4 3-channel line recorders and fault simulation
- [5] level control with or without counter pressure, or second order system analysis
- [6] temperature control with three delay sections
- [7] pressure control via compressed air
- [8] control of level, flow rate and temperature with water
- [9] 5 pneumatic control valves as actuators
- [10] GUNT process control software via Profibus DP interface under Windows Vista or Windows 7

Technical Data

- Tanks
 - collecting tank: 100L
 - level / pressure: 25L
 - level, 2nd order: 25L
- Pump
 - max. flow rate: approx. 55L/min
 - max. head: approx. 60m
- Compressor
 - max. pressure: 10bar
 - pressure vessel: 270L
- Heater power output: 18kW
- Controller parameterisable: P, PI or PID controller

Measuring ranges

- flow rate: 0...40L/min
- level: 1x 0...1.2m; 1x 0...0.5m
- temperature: 1x 0...200°C; 1x 0...100°C
- pressure: 0...6bar

Dimensions and Weight

- Trainer: LxWxH: 4400x600x2100mm
- Supply unit: LxWxH: 2400x730x1620mm
- Control station: LxWxH: 1350x750x1350mm
- Weight: approx. 1500kg (complete system)

Required for Operation

- 400V, 50/60Hz, 3 phase or 230V, 60Hz, 3 phase
- Cold water connection: 30L/min

Scope of Delivery

- 1 trainer
- 1 supply unit
- 1 control station
- 1 set of cables
- 1 set of hoses
- 1 Profibus card
- 1 GUNT software CD
- 1 set of instructional material

Order Details

- 080.59000 RT 590 Process Control Engineering Experimentation Plant

RT 681 **Multivariable Control: Vacuum Degassing**


- * **Practical multivariable control of level and pressure in a vacuum tank**
- * **Model of "degassing of fluids" application from process engineering**
- * **2 configurable industrial controllers**
- * **Optional process control software RT 650.60 available**

Technical Description

With RT 681 the complexities of a multivariable control system can be learned in a practical manner. The model for the controlled process is a typical application from process engineering: separation of gas dissolved in liquid. The pressure falls below the vapour pressure of the dissolved gas in a vacuum tank, so that it passes into the gas phase and can be removed (desorption).

The liquid used in RT 681 is water, and the gas is ambient air. A water jet pump generates the negative pressure in the vacuum tank. The negative pressure firstly draws water from a collecting tank into the vacuum tank. Secondly, ambient air is drawn in and mixed with the water before entering the vacuum tank. The water/air mixing ratio can be adjusted by way of rotameters and valves. The negative pressure in the vacuum tank degasses the water again. A pump transports the water out of the vacuum tank back into the collecting tank. A control valve is used to influence the flow rate and thus the level in the vacuum tank. Another pump circulates water from the collecting tank to operate the water jet pump. A control valve adjusts the flow rate in this circuit. In this way the negative pressure in the vacuum tank is adjusted. The negative pressure and level are mutually dependent variables. It is this dependence that makes this multivariable control system so complex.

Two industrial controllers are provided as level and pressure

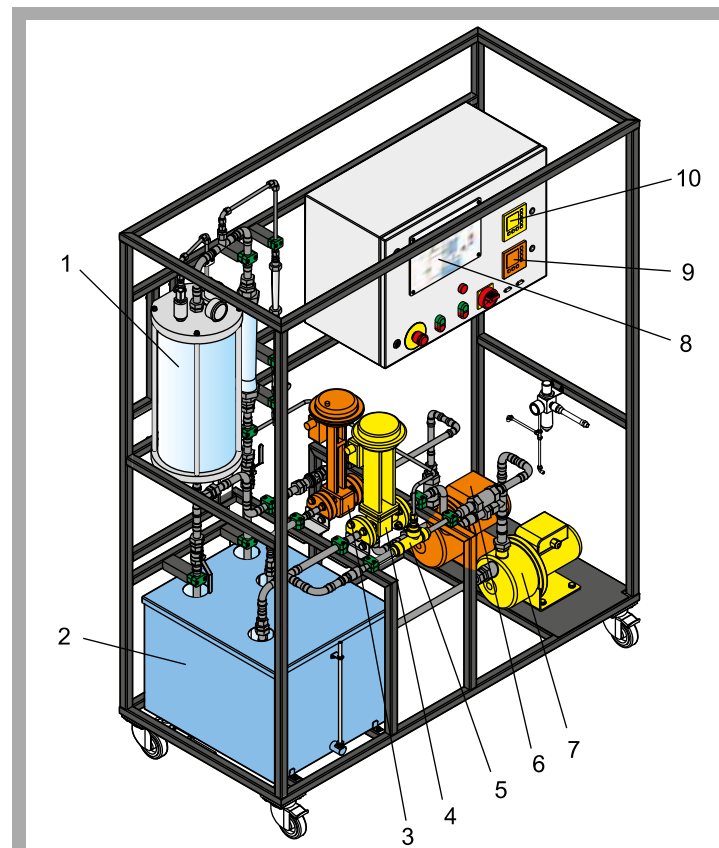
controllers. They can be configured and parameterised using a supplied software. The controllers have a Profibus DP interface. The interface permits monitoring of the trainer via an optionally available software RT 650.60. The RT 650.60 software also permits recording of the process variables and parameterisation of the controllers using the PC. It is also possible to interconnect multiple trainers from this series through the Profibus DP interface.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

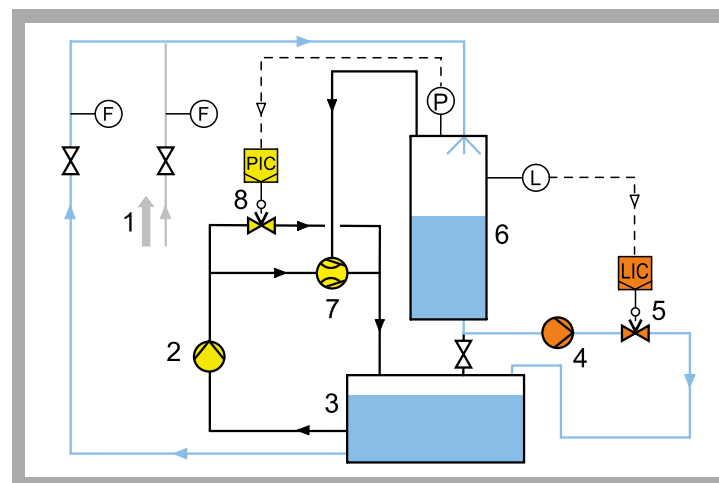
Learning Objectives / Experiments

- coupled level and pressure control
- level control with various controller types
- pressure control with various controller types
- plotting step responses

G.U.N.T. Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web <http://www.gunt.de>
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RT 681 **Multivariable Control: Vacuum Degassing**


1 vacuum tank, 2 collecting tank, 3 level control valve, 4 pressure control valve, 5 water jet pump, 6 pump (vacuum tank), 7 pump for operation of water jet pump, 8 process schematic, 9 level controller, 10 pressure controller



1 ambient air, 2 pump for operation of water jet pump, 3 collecting tank, 4 pump (vacuum tank), 5 level control valve, 6 vacuum tank, 7 water jet pump, 8 pressure control valve;
F flow rate, P pressure, L level, PIC controller (pressure), LIC controller (level)

Specification

- [1] coupled level and pressure control in one vacuum tank
- [2] water circuit with vacuum tank, collecting tank, pump and ambient air input device
- [3] water jet pump to generate a negative pressure in the vacuum tank
- [4] circuit with pump for operation of the water jet pump
- [5] level control with pneumatic control valve as actuator
- [6] pressure control with pneumatic control valve in the circuit for operation of the water jet pump
- [7] level controller and pressure controller configurable and parameterisable with software
- [8] optional process control software RT 650.60 via Profibus DP interface

Technical Data
Tanks

- vacuum tank: 19L
- collecting tank: 100L

2 centrifugal pumps

- max. flow rate: approx. 50L/min
- max. head: approx. 30m

Water jet pump: final vacuum: approx. 0,3bar

- Pressure and level controller parameterisable as
- P, PI or PID controller
- switching controller

Measuring ranges

- pressure: -1...0,6bar
- level: 30...480mm
- flow rate: 1x 200...2500L/h, 1x 0...360L/h

Dimensions and Weight

LxWxH: 1150x700x1970mm

Weight: approx. 115kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz, 1 phase
Compressed air connection for control valve: 2...10bar

Scope of Delivery

- 1 trainer
- 1 cable
- 1 hose
- 1 CD with software for parameterisation and configuration of the controllers
- 1 set of instructional material

Order Details

080.68100 RT 681 Multivariable Control:
Vacuum Degassing

G.U.N.T. Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web <http://www.gunt.de>
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RT 682

Multivariable Control: Stirred Tank



Technical Description

With RT 682 the complexities of a multivariable control system can be learned in a practical manner. The model for the controlled process is a typical application from process engineering: A chemical reaction taking place in a heated stirred tank. The reactants entering the stirred tank are pre-heated by the outflowing products in order to enhance energy efficiency.

Water is used as the product and reactant for RT 682. A pump transports the reactant out of a collecting tank via a heat exchanger into the stirred tank. The reactant is pre-heated by the heat exchanger. A heater in the double jacket permits control of the temperature in the stirred tank. Another pump transports the heated product out of the stirred tank via the heat exchanger back into the collecting tank. A bypass in the inlet routes the flow past the heat exchanger. A three-way motorised valve adjusts the ratio between the flow heated in the heat exchanger and the flow in the bypass. This is a further method of controlling the temperature in the stirred tank. A control valve changes the flow rate in the outlet and thus the level in the stirred tank. The temperature and level are mutually dependent variables. It is this dependence that makes this multivariable control system so complex.

Two industrial controllers are provided as temperature and level controllers. They can be configured and parameterised using a supplied software. The controllers have a Profibus DP interface. The interface permits monitoring of the trainer via an optionally available software RT 650.60. The RT 650.60 software also permits recording of the process variables and parameterisation of the controllers using the PC. It is also possible to interconnect multiple trainers from this series through the Profibus DP interface.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

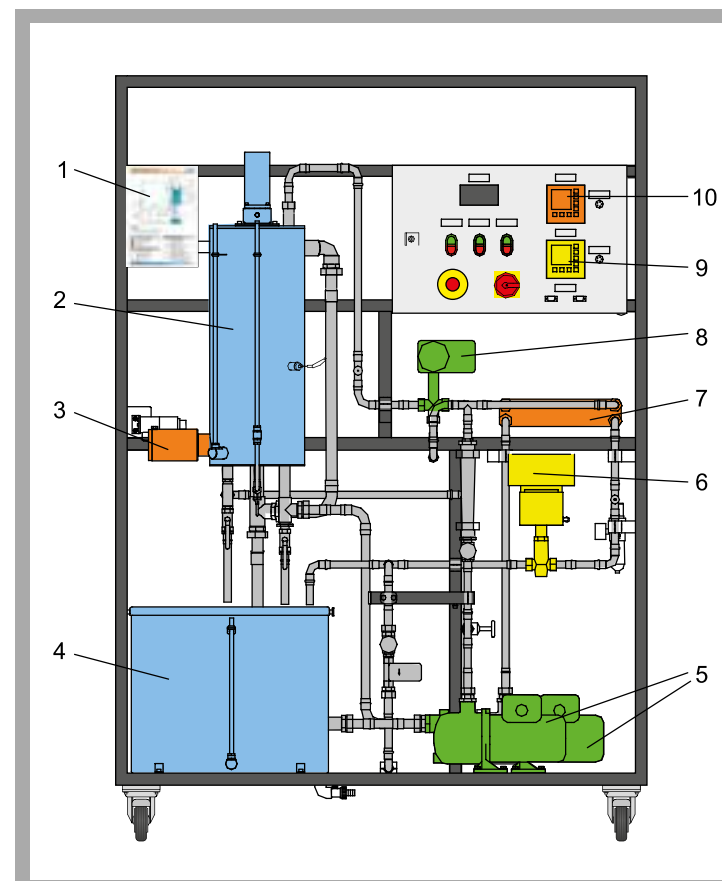
Learning Objectives / Experiments

- coupled level and temperature control
- level control with
 - * PI controller
 - * disturbance feedforward control
- temperature control
 - * with two-point controller
 - * with three-point controller (split range)
 - * with override control
 - * via motorised valve with position feedback
- plotting step responses

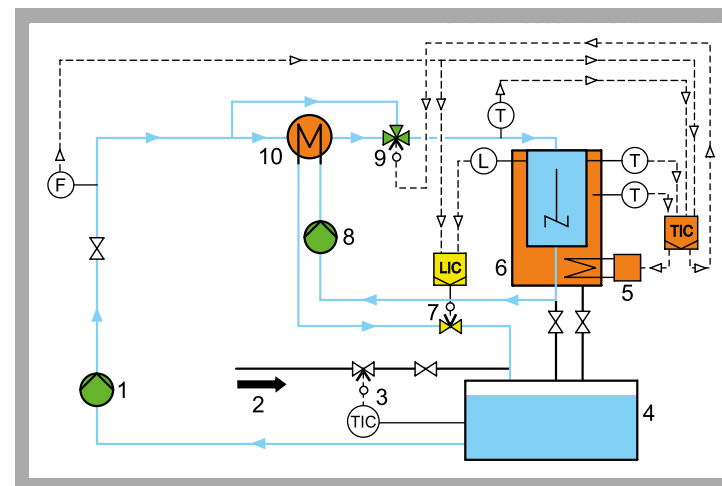
- * Practical multivariable control of temperature and level in a stirred tank
- * Typical application from process engineering with heat recovery
- * 2 configurable industrial controllers
- * Optional process control software RT 650.60 available

RT 682

Multivariable Control: Stirred Tank



1 process schematic, 2 stirred tank, 3 heater, 4 collecting tank, 5 pumps, 6 level control valve, 7 heat exchanger, 8 3-way motorised valve, 9 level controller, 10 temperature controller



1 main circuit pump, 2 external cooling water, 3 collecting tank temperature control, 4 collecting tank, 5 heater, 6 stirred tank, 7 level control valve, 8 pre-heating pump, 9 3-way motorised valve, 10 heat exchanger; F flow rate, T temperature, L level, LIC controller (level), TIC controller (temperature)

Specification

- [1] coupled level and temperature control in one stirred tank
- [2] circuit with stirred tank, collecting tank and pump
- [3] heat recovery with heat exchanger
- [4] stirred tank with double jacket and heater; level display for tank and jacket
- [5] temperature control with heater and 3-way motorised valve as actuators
- [6] level control with pneumatic control valve as actuator
- [7] temperature controller and level controller configurable and parameterisable with software
- [8] 2-point controller for constant temperature in collecting tank via external cooling water
- [9] optional process control software RT 650.60 via Profibus DP interface

Technical Data

- Tanks
 - stirred tank: 15L
 - collecting tank: 70L
- 2 pumps
 - max. flow rate: approx. 60L/min
 - max. head: approx. 20m
- Heat exchanger transfer surface: approx. 0.8m²
- Heater power output: approx. 2kW
- Temperature and level controller parameterisable as
 - P, PI or PID controller
 - switching controller

Measuring ranges

- flow rate: 60...640L/h
- temperature: 0...100°C
- level: 0...1000mm
- 3-way motorised valve opening: 0...100%

Dimensions and Weight

- LxWxH: 1360x610x1940mm
- Weight: approx. 162kg

Required for Operation

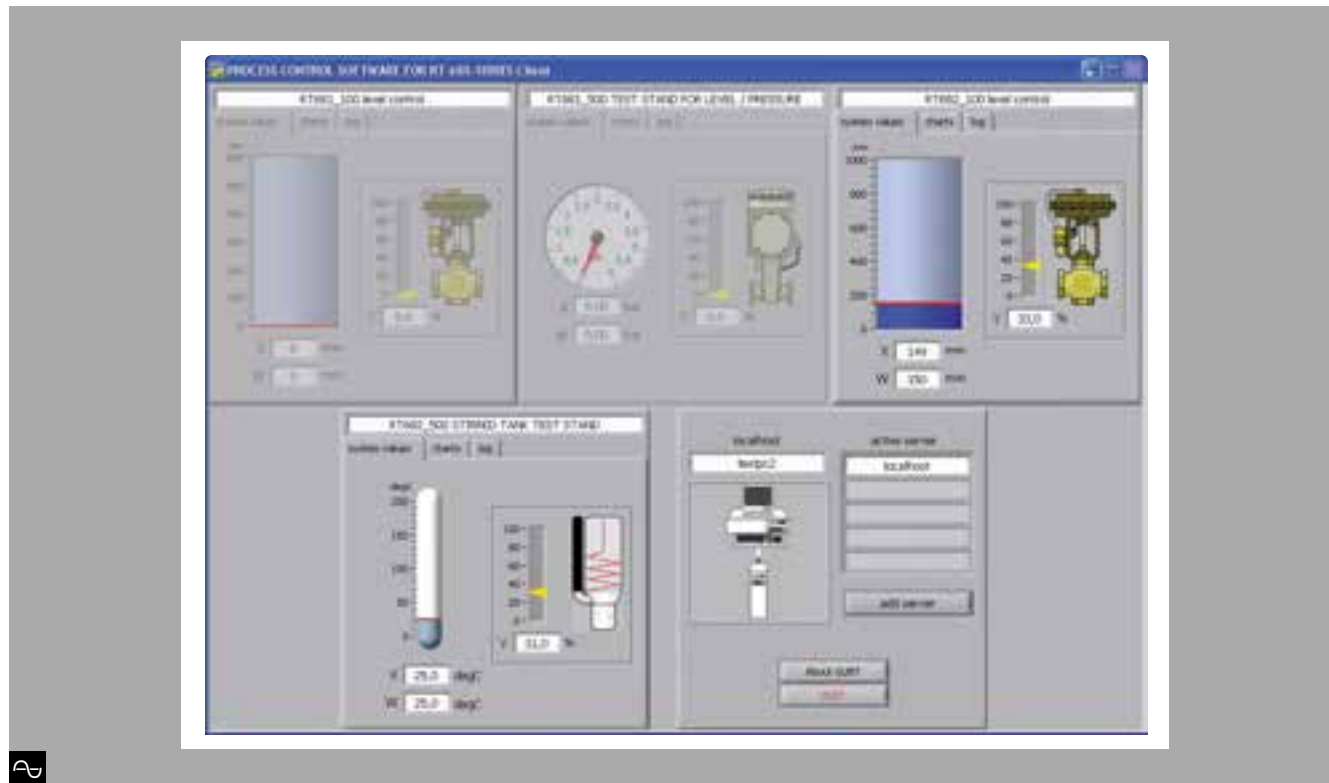
- 230V, 50Hz, 1 phase
- Water connection: min. 60L/h
- Compressed air connection for control valve: 2...10bar

Scope of Delivery

- 1 trainer
- 1 set of cables
- 1 set of hoses
- 1 CD with software for parameterisation and configuration of the controllers
- 1 set of instructional material

Order Details

- 080.68200 RT 682 Multivariable Control: Stirred Tank

RT 650.60 Process Control Software for RT 681 and RT 682


- * **Process control software for Profibus DP connection**
- * **Control station function provides for simultaneous operation of both trainers**
- * **Automatic operation with programmer possible**
- * **Alarm function with four limit values for triggering an alarm or message**

Technical Description

The RT 650.60 process control software (SCADA) was developed specifically for the RT 681 and the RT 682. It is possible to connect both trainers simultaneously. The software and the trainers communicate via Profibus DP modules. Changes to the software are transmitted to the controller of the relevant trainer.

The process is represented in the "Process schematic" window. The reference variable, controlled variable and manipulating variable are displayed in real time. Status displays for the alarms are also included.

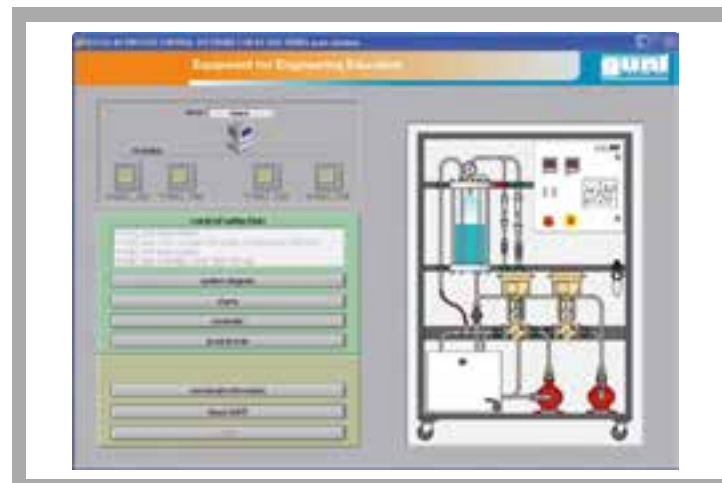
The "Charts" menu item offers features including controller mode selection, parameterisation, setting of the reference variable and limit values for the alarm function, as well as display of the controlled and manipulating variables. The reference variable characteristic is specified in the programmer. A total of three programs are available, each with 15 segments, which are saved together with custom controller parameters. The messages are divided into alarms (status indicators, over/under limit) and information (status monitoring, approaching the limit). The message status is colour-coded. The control station function permits simultaneous monitoring and (if required) access to both connected trainers.

Learning Objectives / Experiments

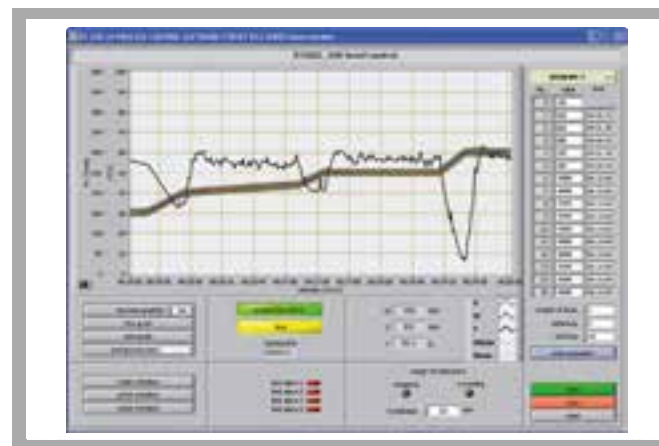
- familiarisation with and use of a process control system

- stand-alone with a single trainer
 - process schematics with online display of all process variables
 - alarm function with logging
 - parameterisation of the single controllers
 - manual or automatic controller mode
 - mode of operation of a programmer
 - network mode with Server/Client

- additionally with combination of both trainers on a PC
 - control station function

RT 650.60 Process Control Software for RT 681 and RT 682


Menu for selection of trainer, controller and user interface



Programmer for input of a reference variable characteristic



Alarm log

Specification

- [1] interactive, menu-driven process control software (SCADA) for operation and monitoring of control processes
- [2] control station function for simultaneous operation of both trainers
- [3] process schematic with real-time data display
- [4] recorder function with data saving
- [5] operation and parameterisation of hardware controllers
- [6] automatic operation with programmer (input of reference variable characteristics)
- [7] alarm function with logging
- [8] data communication via Profibus DP
- [9] use together with Profibus card RT 650.12; one Profibus DP card RT 650.12 per PC workstation required

Technical Data

Recorder function with data saving

- plotting and saving of time charts
- evaluation of step responses

Programmer

- up to 3 programs with 15 values in each
- custom controller parameters for each program
- setting of a tolerance band

Alarm function with 4 programmable values

- upper and lower alarm limit
- upper and lower message limit
- comments about alarms/messages can be entered

Language selection

- 4 pre-selectable languages
- 1 user-defined language possible

Software basis: LabVIEW

System requirements

- Windows Vista or Windows 7
- PCI slot

Scope of Delivery

- 1 GUNT software CD
- 1 set of instructional material

Order Details

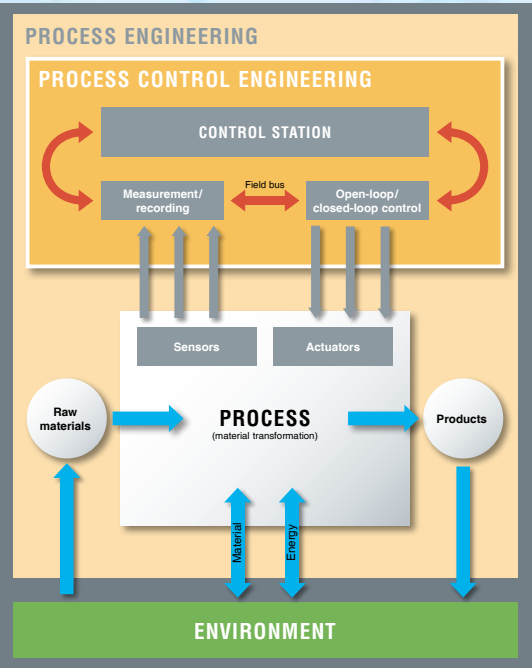
080.65060 RT 650.60 Process Control Software for RT 681 and RT 682

5 PROCESS CONTROL ENGINEERING LEARNING CONTENT

CATALOGUE 5c PROCESS CONTROL ENGINEERING
A KEY ELEMENT OF PROCESS ENGINEERING

The diagram on the right clearly shows how process control engineering is integrated into the wider field of process engineering. Process control engineering is a key aspect of all process engineering teaching and vocational training.

This catalogue number 5c forms part of our **PROCESS ENGINEERING** series, and as such is a key element within our overall concept.



DETAILED PRESENTATION
OF LEARNING OBJECTIVES

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09-2012

RT 682 Multivariable Control: Stirred Tank

Technical Description

With RT 682 the complexities of a multivariable control system can be learned in a practical manner. The model for the controlled process is a typical application from process engineering: A chemical reaction taking place in a heated stirred tank. The reactants entering the stirred tank are pre-heated by the outflowing products in order to enhance energy efficiency.

Water is used as the product and reactant for RT 682. A pump transports the reactant out of a collecting tank via a heat exchanger into the stirred tank. The reactant is pre-heated by the heat exchanger. A heater in the double jacket permits control of the temperature in the stirred tank. Another pump transports the heated product out of the stirred tank via the heat exchanger back into the collecting tank. A bypass in the inlet routes the flow past the heat exchanger. A three-way monitored valve adjusts the ratio between the flow heated in the heat exchanger and the flow in the bypass. This is a further overhead of controlling the temperature in the stirred tank. A control valve changes the flow rate in the outlet and thus the level in the stirred tank. The temperature and level are mutually dependent variables. It is this dependence that makes this multivariable control system so complex.

Two industrial controllers are provided as temperature and level controllers. They can be configured and parameterised using a supplied software. The controllers have a Profibus DP interface. The interface permits monitoring of the trainer via an optionally available software RT 650.60. The RT 650.60 software also permits recording of the process variables and parameterisation of the controllers using the PC. It is also possible to interconnect multiple trainers from this series through the Profibus DP interface.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

- coupled level and temperature control
- level control with
- PI controller
- disturbance feedforward control
- temperature control
- with two-point controller
- with three-point controller (split range)
- with override control
- via monitored valve with position feedback
- plotting step responses

*** Practical multivariable control of temperature and level in a stirred tank**

*** Typical application from process engineering with heat recovery**

*** 2 configurable industrial controllers**

*** Optional process control software RT 650.60 available**

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On each product data sheet you will find a section headed **Learning Objectives / Experiments**. It provides detailed information on the laboratory experiments you can perform with a given experimental unit and the specific learning content you can teach.

GUNT EXPERIMENTAL UNITS FOR PROCESS
CONTROL ENGINEERING TRAINING

The experimental units – ideal
teaching aids

All the experimental units contained in this sub-catalogue together provide complete teaching support for a standard process control engineering curriculum.

Adjacent you will find specimen extracts from the curriculum for a technician's course in "Process control engineering / Instrumentation and control technology".

All our fundamentals teaching systems are equally suitable for:

- Mechanical engineering
- Electrical engineering / automation
- Mechatronics
- Supply engineering
- Environmental engineering

TYPICAL PROCESS CONTROL ENGINEERING CURRICULUM

PROCESS CONTROL ENGINEERING	CONTROL ENGINEERING
Process Control and Visualisation	Automation of Technical Processes with Continuous Controllers
■ Structures of process control systems ■ Man-machine communication	■ Time response ■ Controller parameters ■ Key components of digital controller structures ■ Control and disturbance response
Planning a Process Control System	Automation of Technical Processes with Switching Controllers
■ Basic types of technical processes ▶ continuous-flow, batch or single-item process ■ Process description ▶ flow diagram ▶ measurement and control system diagram ▶ function diagram ■ Function blocks	■ Two-point controller ■ Three-point controller ■ Actuators for switching controllers
Communication in Automation Systems	Process Automation with Advanced Structures
■ Network topologies ■ Bus protocols ■ Interfaces ■ Transfer standards	■ Assessment of multivariable control loops in control and process terms ■ Cascade control ■ Disturbance feedforward control
OPEN-LOOP CONTROL AND ACTUATION SYSTEMS	METROLOGY
Structure-Oriented Design Methods and Implementation of Controls	Measurement and Processing of Process Variables
■ PLC ■ Circuit diagram, wiring diagram	■ Description of the underlying physical principles of the measurement methods used for typical process variables ■ Measurement circuits ■ Smart transducers
Open-Loop and Closed-Loop Control of Electric Drives	Transfer and Processing of Measured Values
■ Single and multi-quadrant mode ■ Frequency control ■ Actuators	■ AD/DA converter ■ Field bus system

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