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*

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)

RT 542 *Temperature Control Trainer*

RT 552 *pH Value Control Trainer*

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.

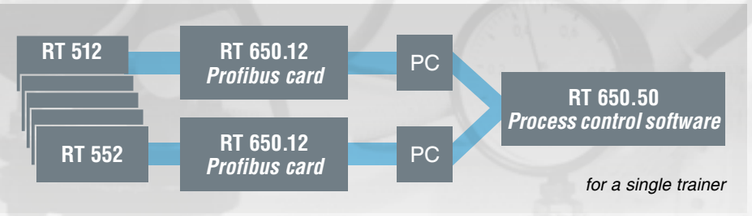
Process Control Software

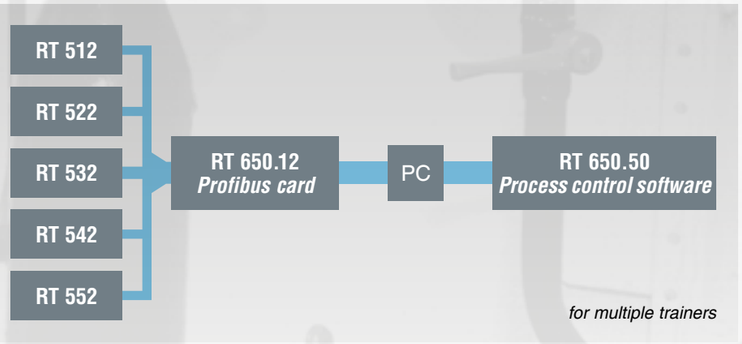
State-of-the-art LabVIEW-based process control software for Windows, featuring extensive monitoring and visualisation functionality:

- 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

*** 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**

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)

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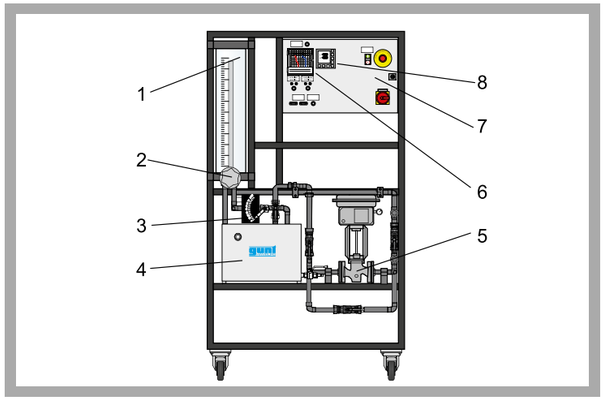
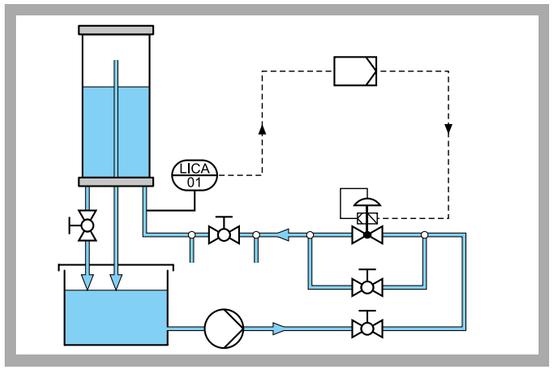
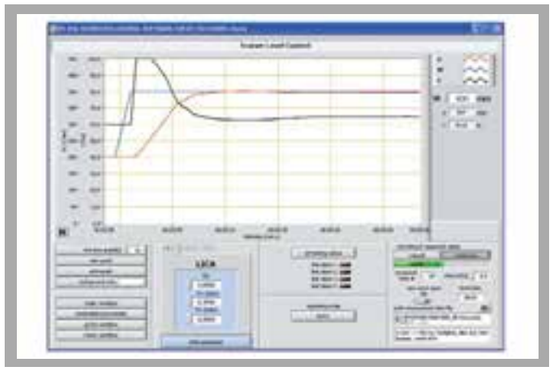
RT 512 Level Control Trainer



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

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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**

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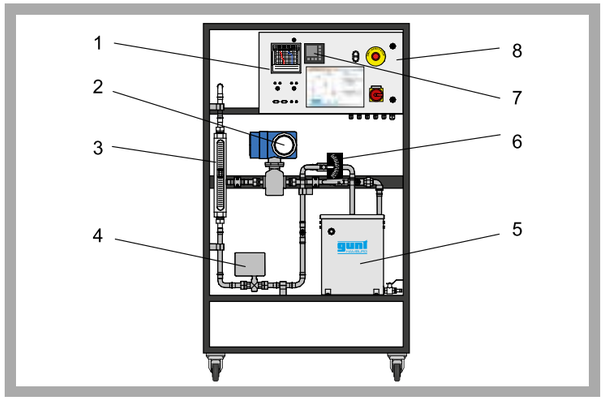
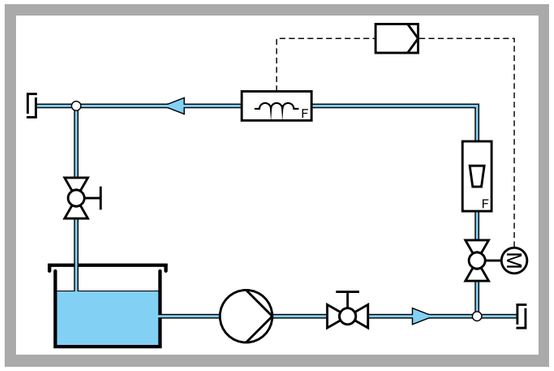
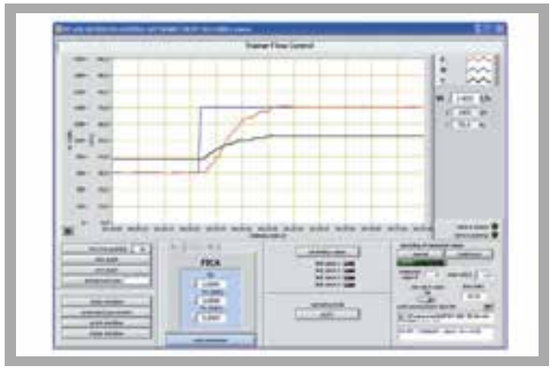
RT 522 Flow Control Trainer



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

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RT 532 *Pressure Control Trainer*

*** 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**

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)

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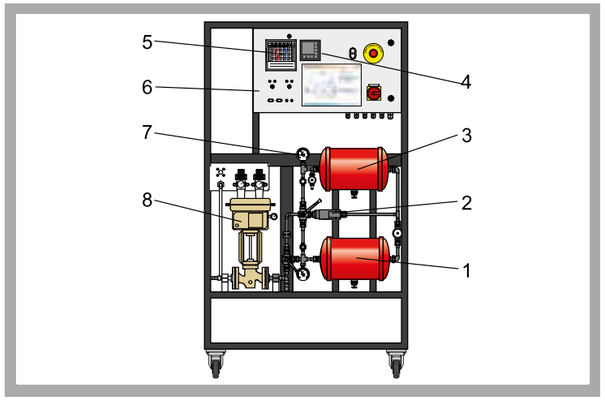
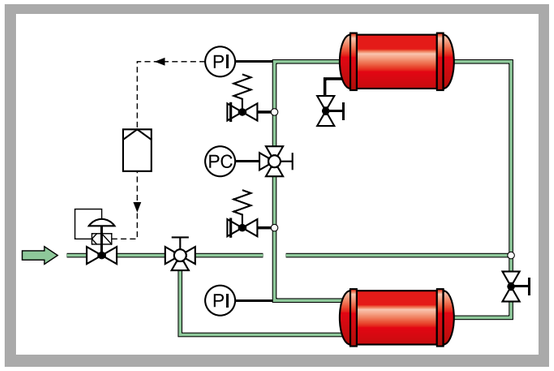
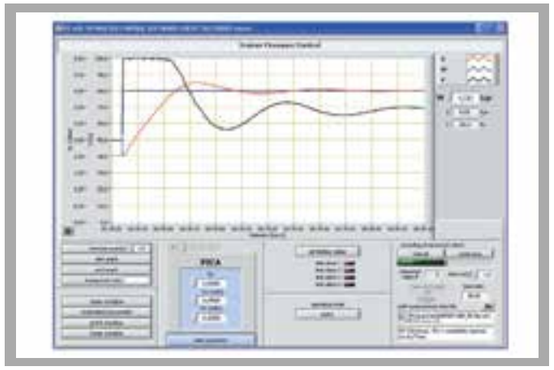
RT 532 *Pressure Control Trainer*



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

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RT 542 Temperature Control Trainer

*** 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**

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)

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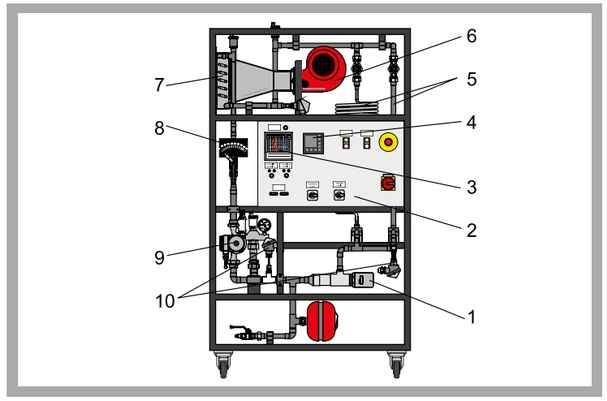
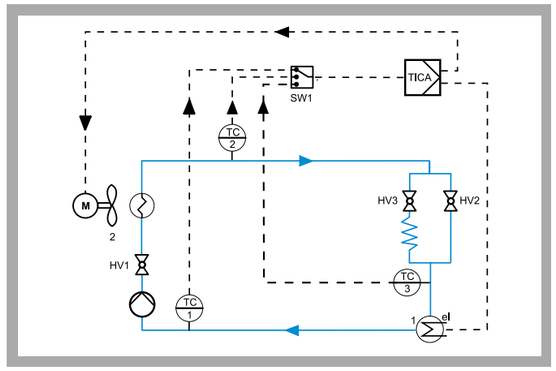
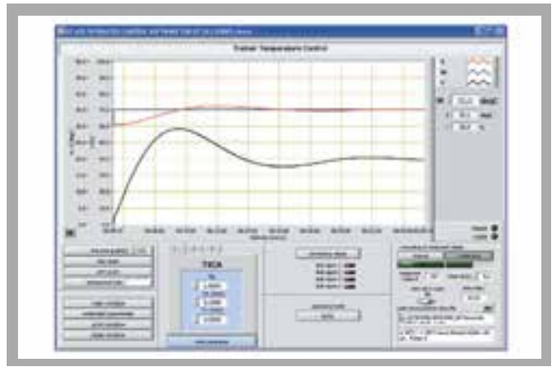
RT 542 Temperature Control Trainer



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

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RT 552 pH Value Control Trainer

The illustration shows a similar unit.

*** 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**

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)

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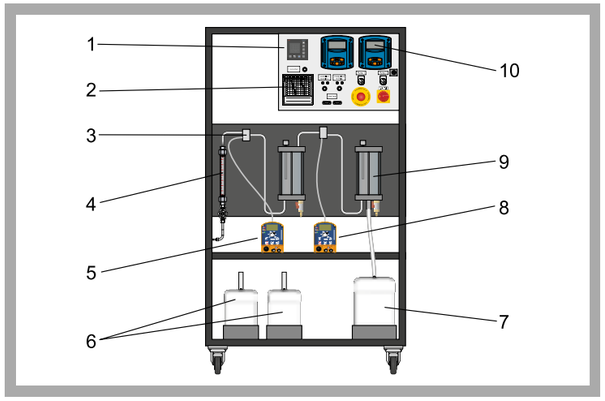
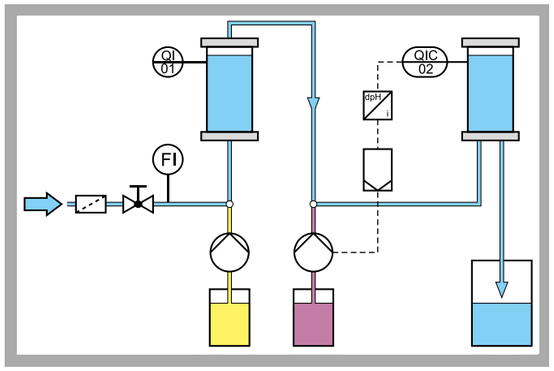
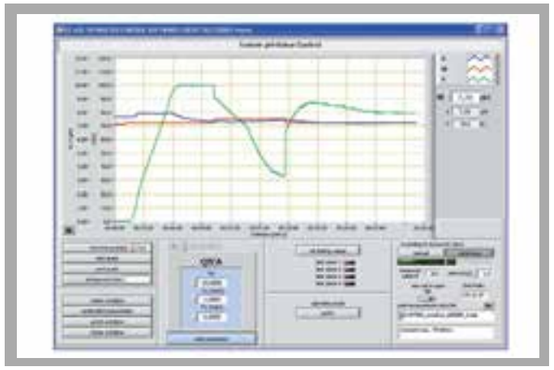
RT 552 pH Value Control Trainer



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

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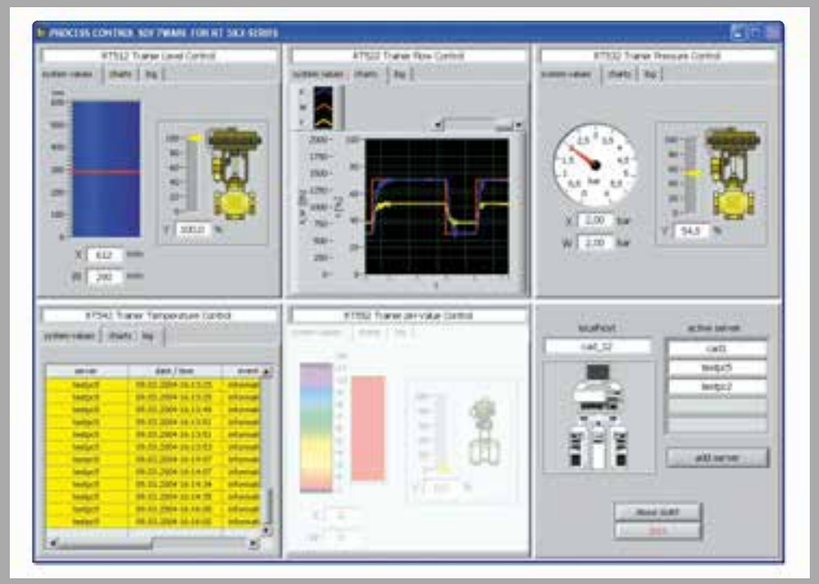
RT 650.50 *Process Control Software for RT 512 - RT 552 Series*



- *** 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

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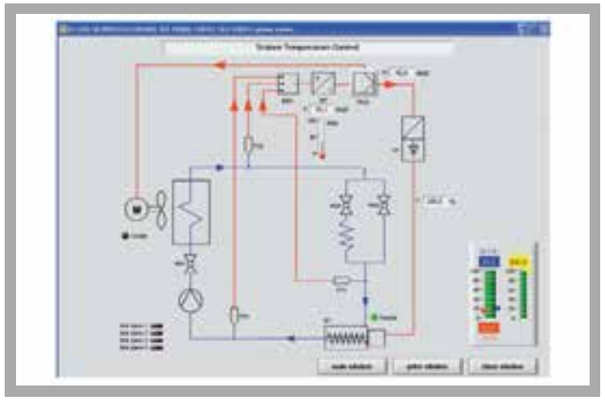
RT 650.50 *Process Control Software for RT 512 - RT 552 Series*



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

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 590 590 PROCESS CONTROL ENGINEERING EXPERI MENTATION 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

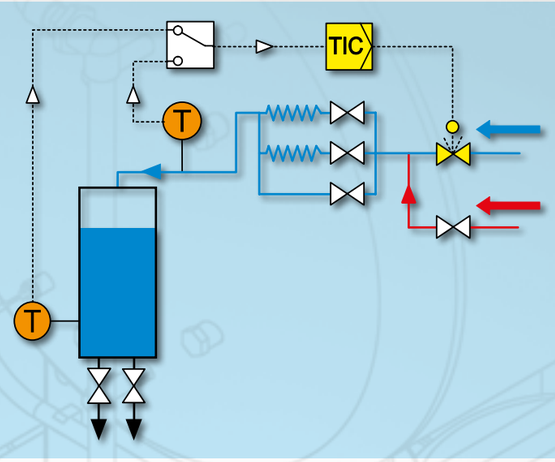
THE SUPPLY UNIT

- 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

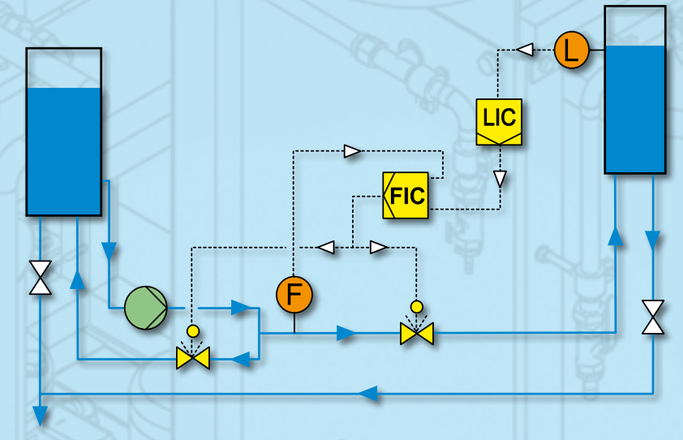
Temperature control

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.



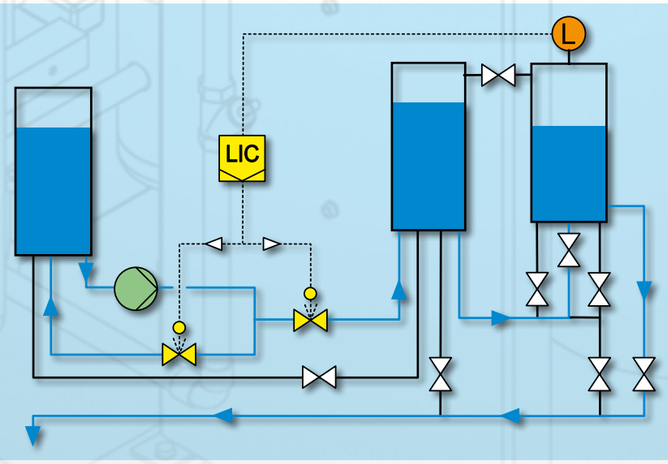
Cascade control level / flow rate

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

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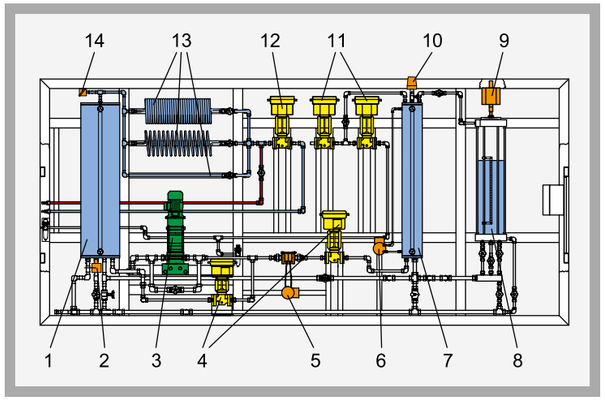
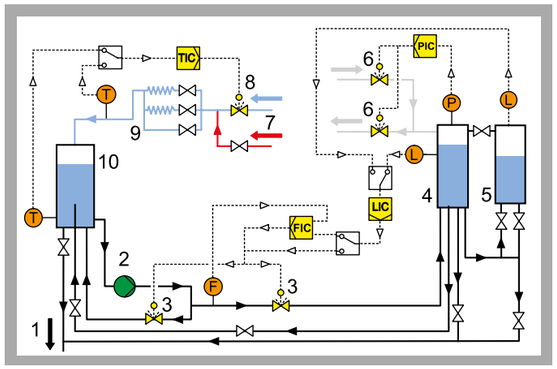
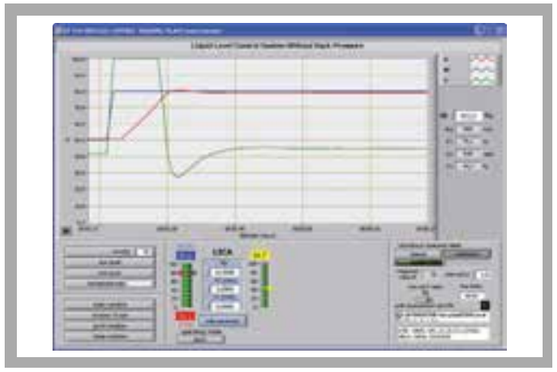
RT 590 Process Control Engineering Experimentation Plant



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

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*

*** 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

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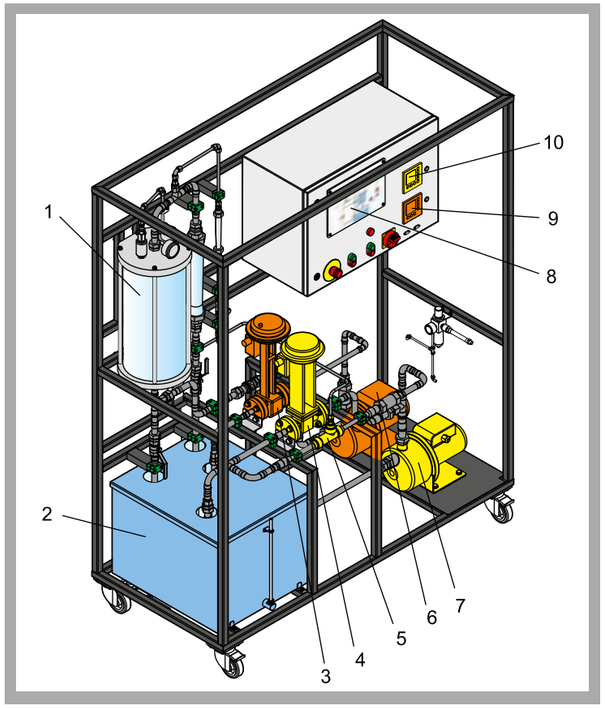
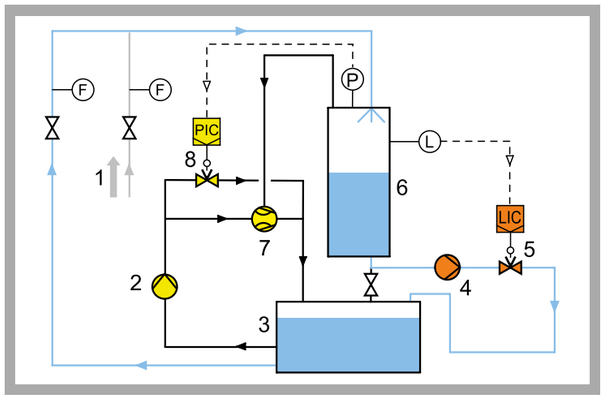
RT 681 *Multivariable Control: Vacuum Degassing*



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

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RT 682 Multivariable Control: Stirred Tank

* **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**

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.

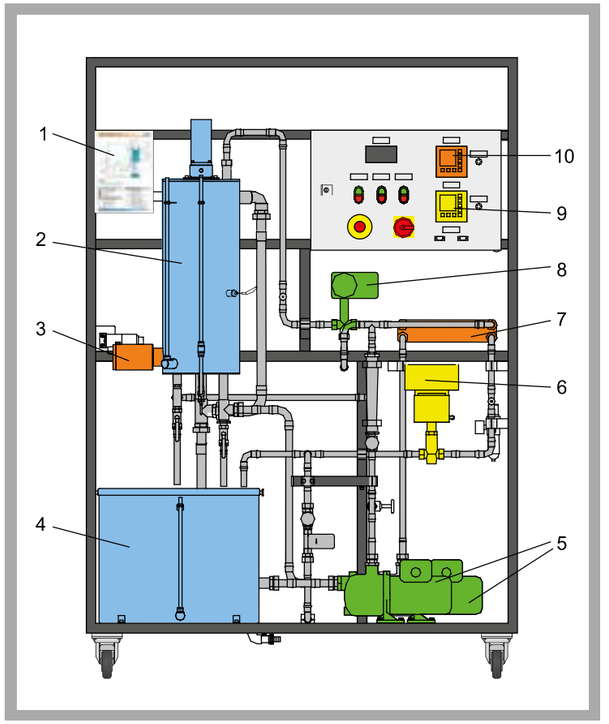
Two industrial controllers are provided as temperature and level controllers. They can be configured and parameterised using a supplied software. The controllers have a Profibus DP interface. The interface permits monitoring of the trainer via an optionally available software RT 650.60. The RT 650.60 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.

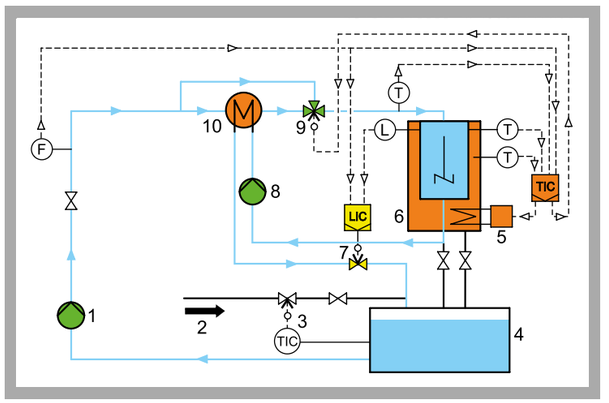
Learning Objectives / Experiments

- 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

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

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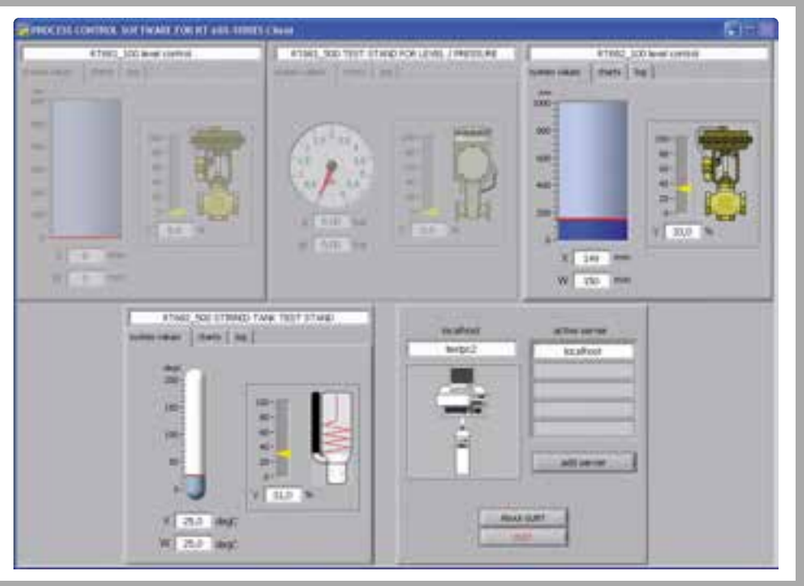
RT 650.60 Process Control Software for RT 681 and RT 682



*** 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

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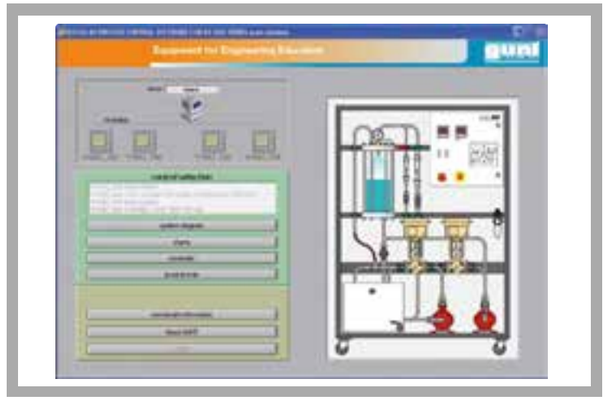
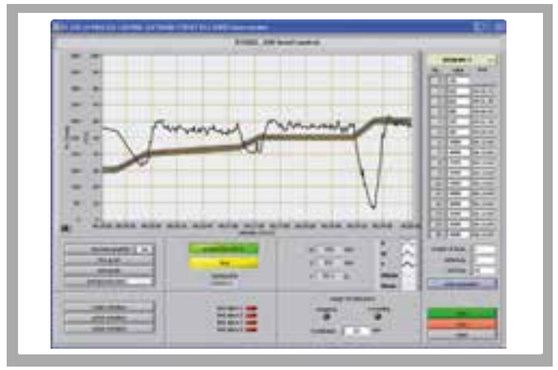
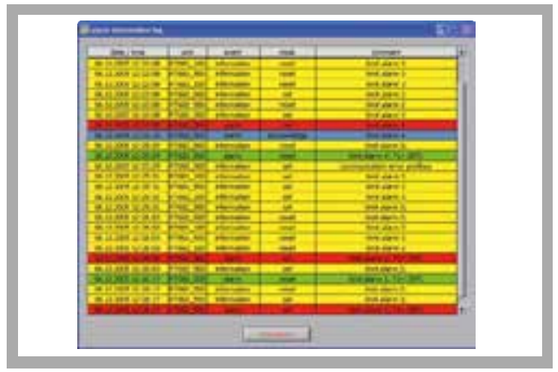
RT 650.60 Process Control Software for RT 681 and RT 682



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

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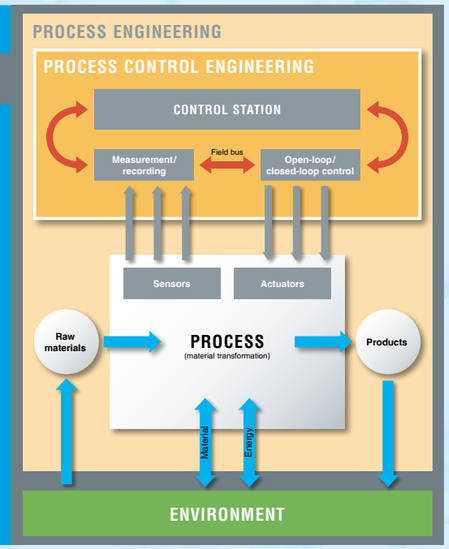
5 PROCESS CONTROL ENGINEERING LEARNING CONTENT

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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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.

* 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

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

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