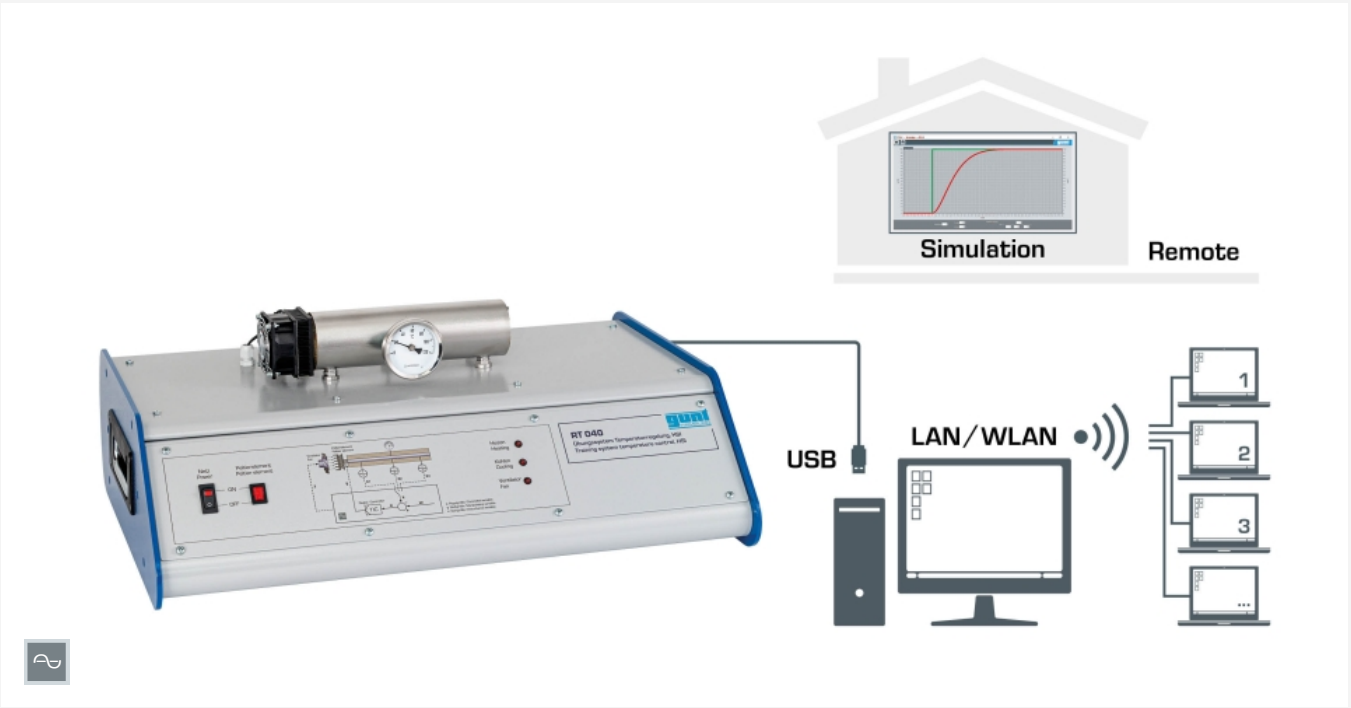
RT 040

Training system temperature control, HSI



Description

- **basic control engineering relationships on a temperature controlled system**
- **configurable and parametrisable software controller with extensive functions**
- **experiment preparation and software simulation for remote learning**
- **experiments can be followed and analysed on the local network**

The RT 040 device offers basic experiments on a temperature controlled system. A metal rod is used as the controlled system. The temperature of the metal rod represents the controlled variable. The temperature is measured at three different positions using thermistors (PTC). One measured value is fed to the software controller at a time. The other two values are recorded. This makes it possible to replicate different controlled system responses. The output signal from the controller is used to control the Peltier element actuator. The Peltier element has a hot and a cold side. This allows either heating or cooling power to be supplied to the metal rod. The software can be used to control a fan that dissipates heat energy in order to study the effects of disturbance variables. The control response is displayed in the form of a time dependency. There is a dial-gauge thermometer located on the metal rod, allowing the temperature to be read directly at any time.

The powerful GUNT software for the entire device series – in the form of Hardware/Software Integration (HSI) – is a major component for the entire series. The experimental unit and the PC are connected via a USB interface (external PC required).

The impact that modifications to the system behaviour have can be studied quickly and easily with the help of the software. An integrated programmer allows you to set reference values and time intervals to carry out reference value progressions. Further aspects of control engineering are studied using software simulations for controlled systems up to the 2nd order.

The combination of the clear, real-world controlled system and simulations of other controlled systems in the RT 010 – RT 060 device series aids understanding. Preparations for the experiments, as well as software simulations can be carried out in Remote Learning environments. The experiments can be observed at any number of workstations on the local network.

Learning objectives/experiments

- fundamentals of control engineering using the example of a temperature controlled system
- open control loop response
- controlled system without feedback
- effects of different controller parameters and methods on the closed loop system response
- controller optimisation by changing the controller parameters: K_p, T_n, T_v
- recording of step responses: manipulating variable step, reference value step and disturbance variable step
- manipulating variable limitation and effect on the control system
- effect of disturbance variables
- software simulation of different controlled systems (P, I, PT_1, PT_2)
- comparison of different controlled system parameters

- specific GUNT software for the entire device series
- controller: manual, uncontrolled manual operation, continuous controller, two or three-point controller
- programmer for your own reference value progressions
- design of disturbance variable controllers
- recording of time dependencies
- remote learning: software simulation at any number of workstations

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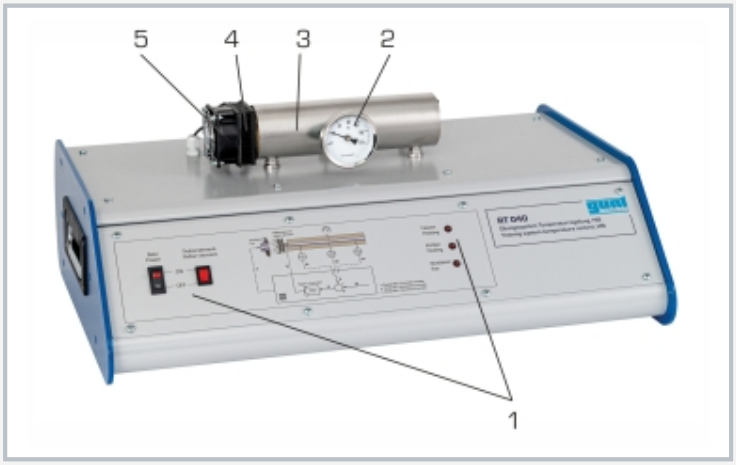
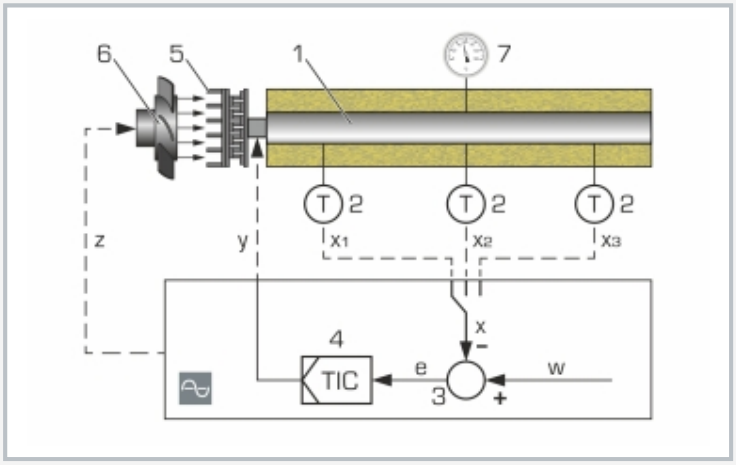
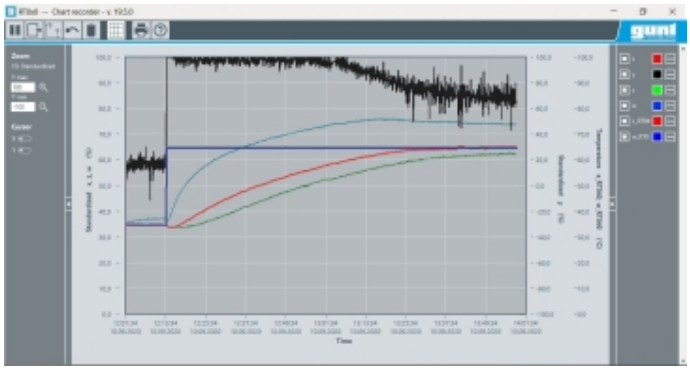


1 displays and controls, 2 dial-gauge thermometer, 3 metal rod with thermal insulation and three temperature measuring points, 4 Peltier element as heater/chiller, 5 fan



1 controlled system: metal rod, 2 measuring element: three temperature sensors at different positions, 3 comparator: part of the GUNT software, 4 software controller, 5 actuator: Peltier element for heating and cooling, 6 disturbance variable generated via a fan, 7 dial-gauge thermometer
x controlled variable: temperature, y manipulating variable: control voltage of the Peltier element, z disturbance variable: dissipation of thermal energy via fan, w reference value: input values, e control deviation, T temperature



Software screenshot: temperature control with PID controller, controlled variable is the temperature T_2 (approximate position in the centre of the metal rod), reference value step, no disturbance variable

Specification

[1] temperature control: typical controlled system
[2] controlled system: metal rod in a heat-insulated sheath
[3] controlled variable: temperature
[4] measuring element: 3x temperature sensors at different positions along the metal rod to display lag time, PT_1, PT_2, PT_3 system response
[5] software controller can be configured and parametrised as P, PI, PID and switching controller
[6] actuator: Peltier element as heater and chiller
[7] disturbance variable generated via a fan that dissipates heat energy
[8] observing temperature via dial-gauge thermometer
[9] software simulation: various controlled systems
[10] GUNT software: option to connect any number of external workstations on the local network to follow and analyse the experiment
[11] experiment preparation and software simulation at any number of workstations for remote learning
[12] GUNT software with control functions and data acquisition via USB under Windows 10
[13] multimedia instructional materials online in GUNT Media Center

Technical data

Heated metal rod with thermal insulation
- dxl: 20x200mm, material: aluminium

Peltier element
- temperature-dependent power consumption
  - output at 27°C: 38,2W
  - output at 50°C: 44,3W
- control via DC voltage

Temperature control range: 0...100°C

Fan
- power consumption: 2W
- max. flow rate: 40m³/h

Software controller can be configured and parametrised as P, PI, PID and switching controller

Measuring ranges
- temperature: 0...100°C (temperature sensor)
- temperature: 0...120°C (dial-gauge thermometer)

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 600x450x260mm
Weight: approx. 16kg

Required for operation

PC with Windows

Scope of delivery

1 experimental unit
1 GUNT software + USB cable
1 set of accessories
1 set of instructional material

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Optional accessories

020.30009	WP 300.09	Laboratory trolley