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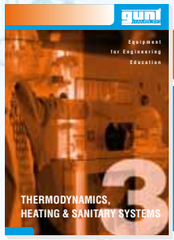

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G.U.N.T. Gerätebau GmbH
Fahrenberg 14
D-22885 Barsbüttel · GERMANY
phone: +49 40 67 08 54 - 0
fax: +49 40 67 08 54 - 42
web: www.gunt.de
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EQUIPMENT FOR ENGINEERING EDUCATION

RT 450 MODULAR PROCESS AUTOMATION TRAINING SYSTEM

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

RT 450 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	3
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	4
Familiarisation with Setup 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	5
Specific Control Applications	⁝· Pressure, level, flow, temperature ⁝· Cascade control	6
Planning and Displaying	Reading, editing and creating ⁝· Circuit diagrams ⁝· Wiring diagrams and plans of terminal connections ⁝· Work and process schematics ⁝· Plant installation diagrams	10
Practical Exercises	⁝· Making pipe connections ⁝· Making electrical connections, particularly signal links ⁝· Preparing plant for operation ⁝· Troubleshooting	11
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	12

Learning Topics: Industrial Automation Components

Digital industrial controller

Programmable logic control (PLC)

Pneumatic control valve with electro-pneumatic positioner

3-channel line recorder

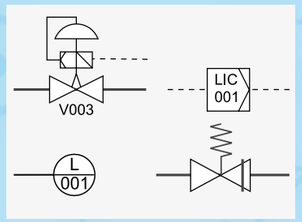
Typical questions:

- 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

Temperature sensor, Pt100



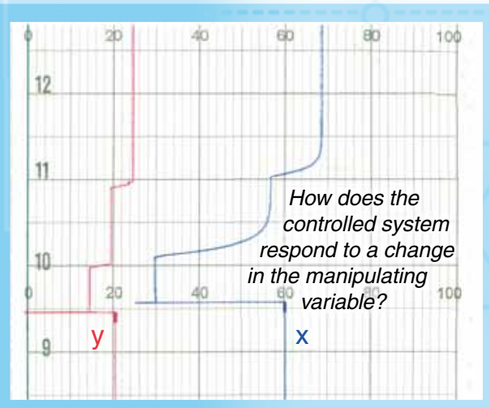
Process engineering symbols

Flow rate sensor, electromagnetic

Level sensor, capacitive

Learning Topics: Learning the Fundamentals of Control Engineering by Experimentation

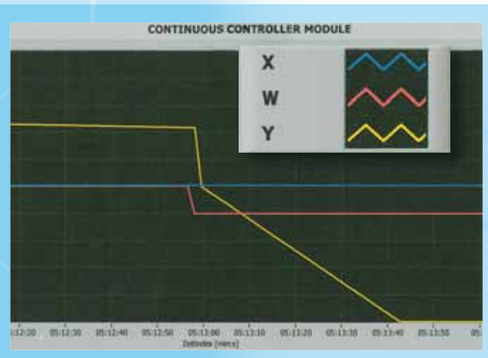
Operation and parameterisation of a digital controller via keypad



Paper feed rate 600 mm/h

1. y: 15% → 20%
2. y: 20% → 25%

Pressure control: We have a controlled system with compensation



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 RT010, RT030 and RT350 training systems.

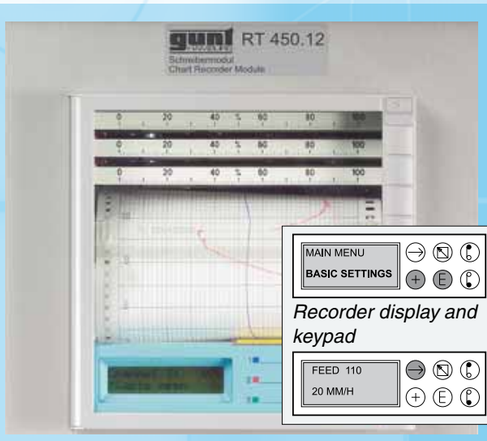
Learning Topics: Familiarisation with Setup Procedures

Digital process engineering instruments such as controllers, recorders and transducers offer wide-ranging options for customisation to specific tasks. The necessary setup 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 setup by way of a keypad. Later they can learn about the more user-friendly method of setup and configuration by software.

Examples of learning content
(all taught by practical exercise)

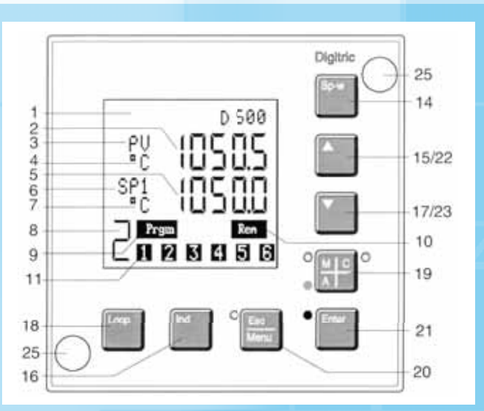
- Basic concepts of setup
  - Operating level
  - Parameter level
  - Configuration level
- Setting an industrial digital controller
  - Operation
    manual/automatic, setpoint changes
  - Parameterisation
    e. g. select P, I and D components of the controller
  - Configuration
    e. g. set controller 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

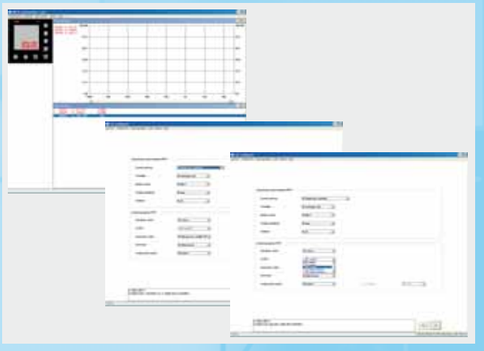


Recorder display and keypad

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.

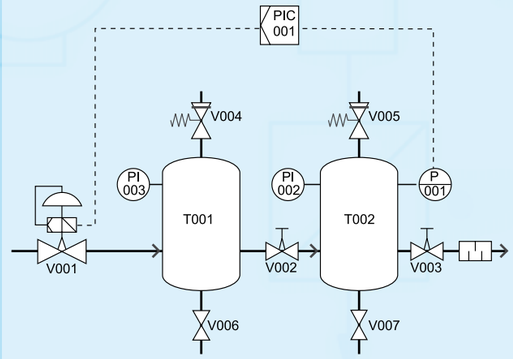
…and of course you can analyse your own ideas and issues by way of experiment.

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

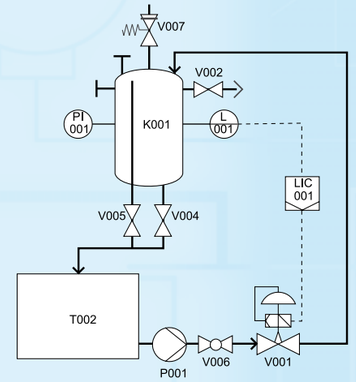
Examples of learning content

(all taught by experimentation)

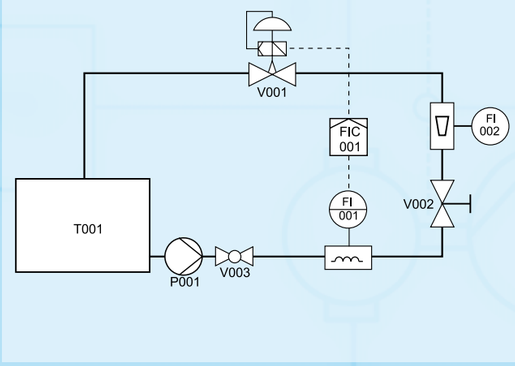
- Pressure control with two pressure tanks connected in series
- Level control with an open or closed tank
  also: program control with an industrial digital controller or with a PLC
  - With a capacitive level sensor or with a pressure sensor
  - With a motorised valve or electro-pneumatic control valve
- 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



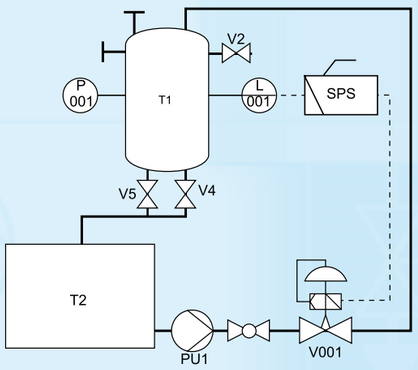
Pressure control



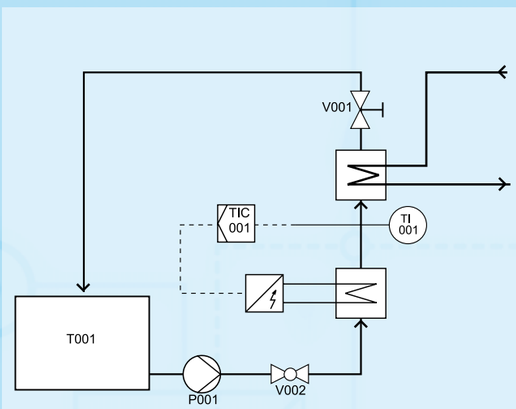
Level control with a continuous controller



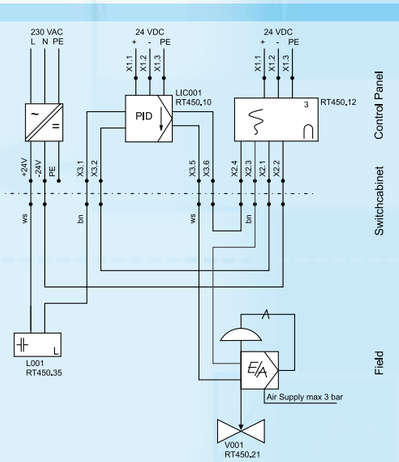
Flow control



Level control with a PLC



Temperature control with a switching controller



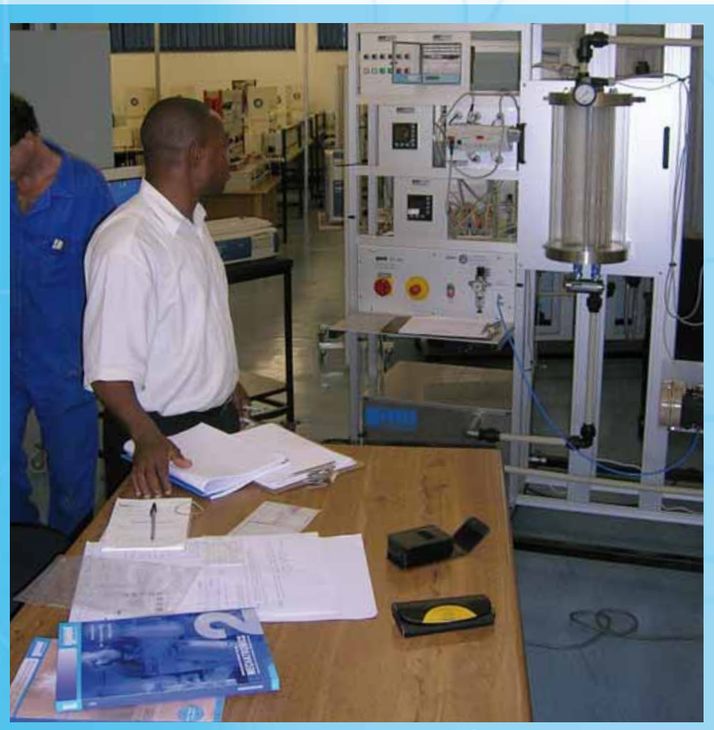
Electrical circuit diagram of a level control system

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

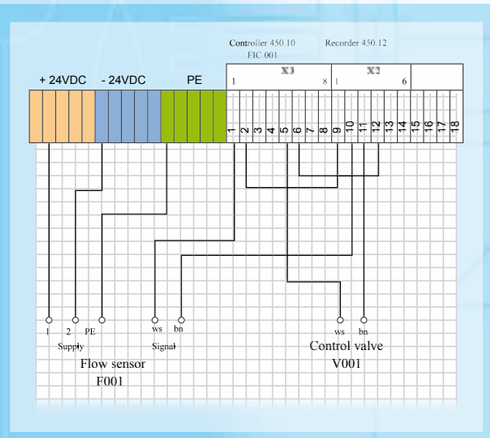
The Polytechnic of Namibia provides courses in core areas of automation based on experimentation using the GUNT RT 450 system.

Its laboratory houses six complete experimental setups. 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.

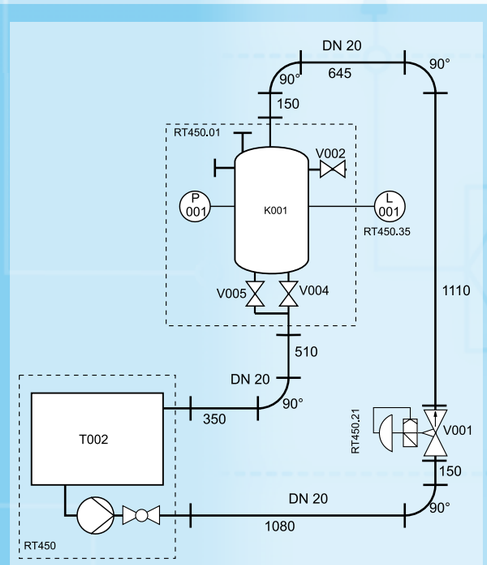
All systems have a Profibus computer communications interface.

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

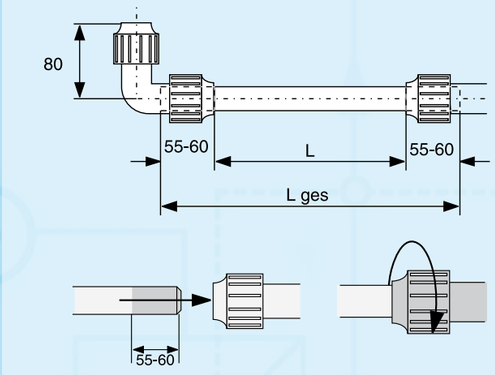
Example of a component list

Learning Topics: Practical Exercises

The basic idea underlying the RT 450 training system is not to create a permanent setup 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 setup 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)

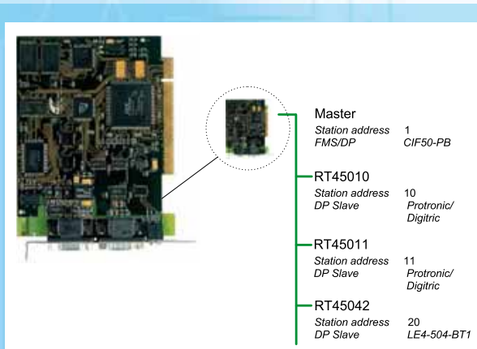
- Mounting the module panels on the mounting profiles of the RT 450 frame
- Making the pipework connection for the water circuit
  - Cutting to length and preparing the pipes
  - Fixing together using clamp fittings
- Cutting to length, laying and connecting compressed air hoses
- Cutting to length and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



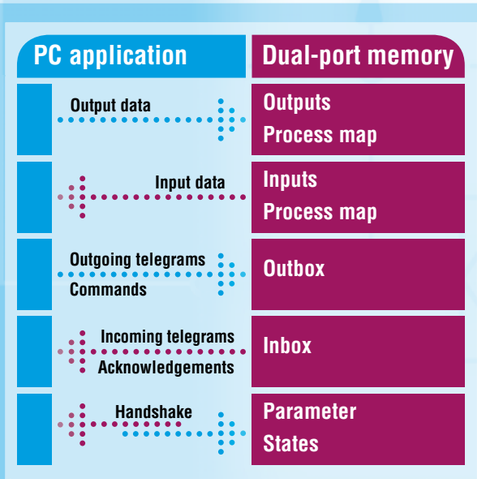
Making connections by plastic pipes

Electrical wiring and connections

Learning Topics: Familiarisation with Communication and Visualisation Systems



RT 450.40 is pre-set for two controllers and the PLC over Profibus. Changes can be made at any time.



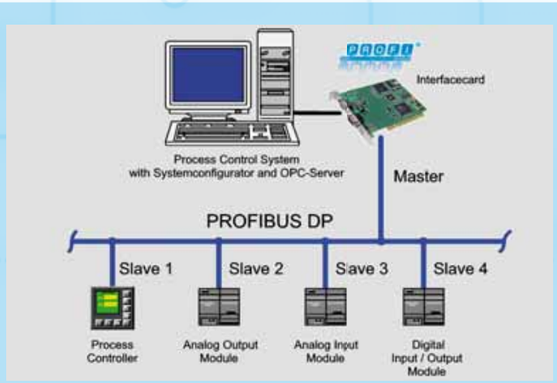
Data interchange between the application and the communications interface is run via a dual-port memory.

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 setup 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.



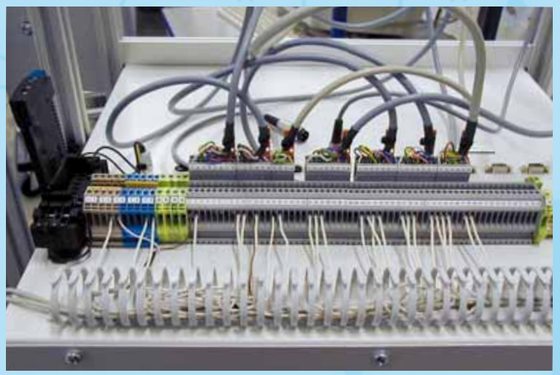
Topology of the field bus used, with master and slaves

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 Setup 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

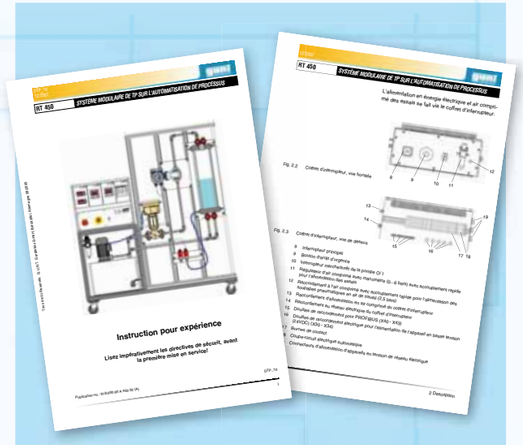
- Manual: RT 450 system description, approx. 130 pages
- Manual: fundamentals of control engineering, approx. 20 pages
- All electrical diagrams for the overall system and for all components
- Completed reference experiments and sample exercises, approx. 25 worksheets and relevant answers
- Materials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

Updates

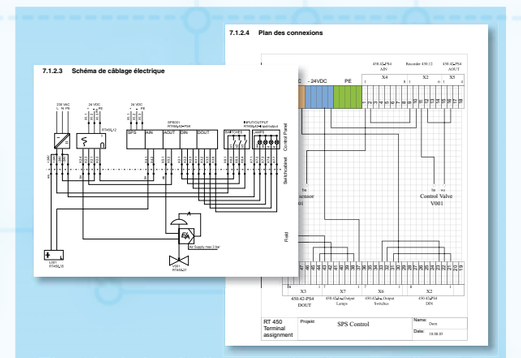
When any updates or additions to the RT 450 system are made – in particular with regard to the instructional material and the software – you, as a GUNT customer, will be notified accordingly.

Training

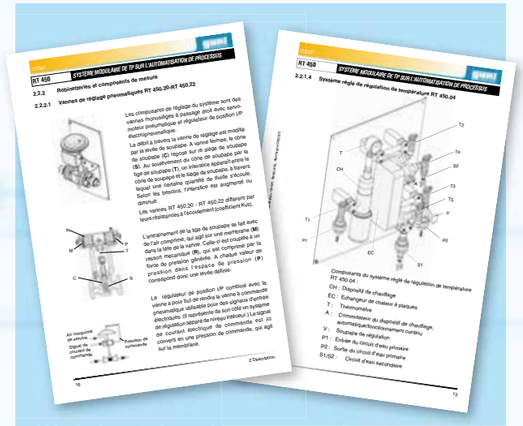
If you require installation or training services for the training system, we will be glad to help.



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
- Cutaway Models
- Dimensional Metrology
- Fasteners and Machine Parts
- Manufacturing Engineering

More detailed learning content

- Assembly Projects
- Maintenance
- Machinery Diagnosis
- Automation

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.