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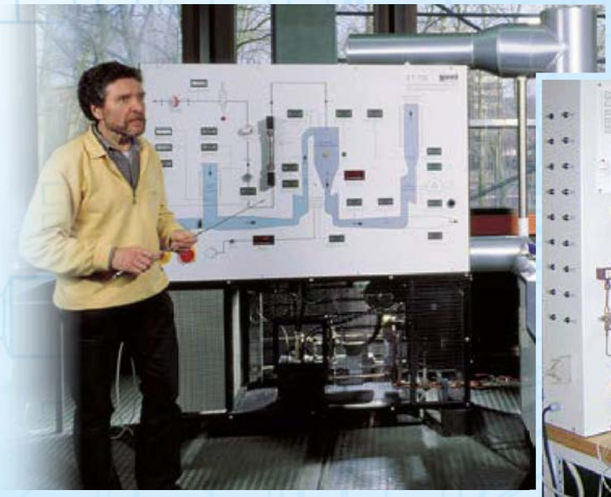
Equipment
for Engineering
Education

Interdisciplinary Technical Training

MECHATRONICS

Metalworking Trades · Electrical Trades · Mechatronics Engineers

WELCOME TO GUNT



Your reliable and experienced partner for

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

GUNT demonstration and experimentation equipment for

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

CONTENTS

MECHATRONICS

IMPRINT

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Technical revision: Mark McGrath M.Eng, Dublin Institute of Technology
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The complete GUNT programme – systems for technical training

1 Engineering mechanics and engineering design

- Engineering mechanics – statics
- Engineering mechanics – strength of materials
- Engineering mechanics – dynamics
- Machine dynamics
- Engineering design
- Testing of materials

2 Mechatronics

- Engineering drawing
- Cutaway models
- Dimensional metrology
- Fasteners and machine parts
- Manufacturing engineering
- Assembly projects
- Maintenance
- Machmachinery diagnosis
- Automation and process control engineering

3 Thermal engineering and HVAC

- Fundamentals of thermodynamics
- Applied thermodynamics
- Renewable energies
- Driving and driven machines
- Internal combustion engines
- Refrigeration and air conditioning technology
- Heating and ventilation in buildings
- Sanitary systems

4 Fluid mechanics

- Steady flow
- Transient flow
- Flow around bodies
- Fluid machinery
- Components in piping systems and plant design
- Hydraulic engineering

5 Process engineering

- Mechanical process engineering
- Thermal process engineering
- Chemical process engineering
- Biological process engineering
- Water treatment

6 2E Energy & Environment

Energy

- Solar energy
- Hydropower and ocean energy
- Wind power
- Biomass
- Geothermal energy
- Energy systems
- Energy efficiency in building service engineering

Environment

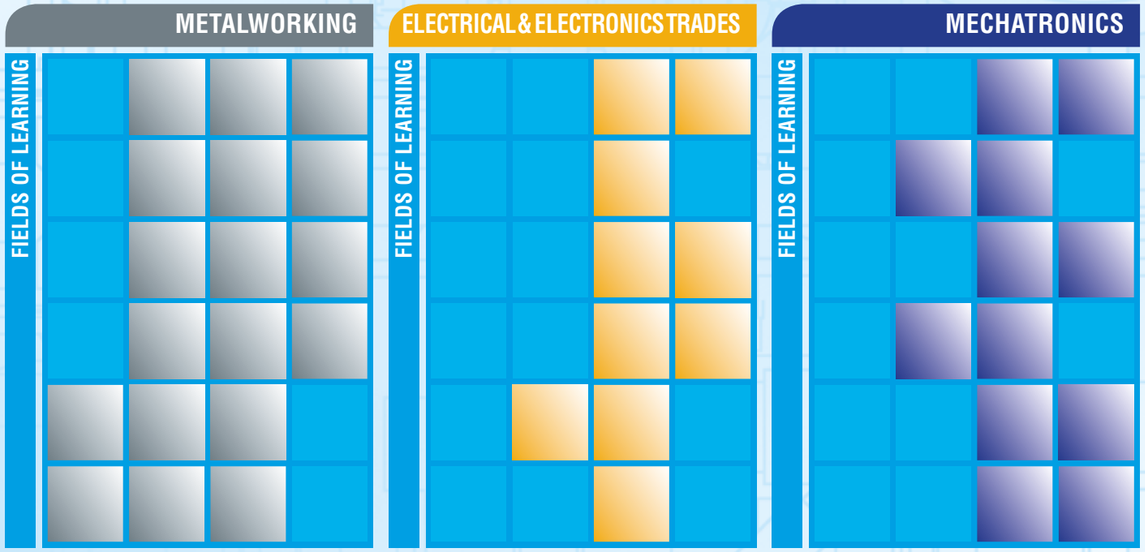
- Water
- Air
- Soil
- Waste

Planning & Consulting · Technical service
Commissioning & Training

TEACHING AND LEARNING SYSTEMS FOR TRAINING IN THE METALWORKING, ELECTRICAL AND ELECTRONICS TRADES

Depending on teaching/learning requirements: suitable for teaching apprentice tradesmen, industrial training and vocational qualification, and of course for training technicians and engineers.

Which fields of learning and which trades does this catalogue cover?



Although the GUNT training systems presented in this catalogue mainly cover fields of learning for the **metalworking trades**, it also provides good coverage for learning topics in electrical and electronic engineering as well as in mechatronics.

How can a short title be found for such a wide-ranging catalogue?

We chose MECHATRONICS!

"The integration of electronics, electrical engineering, computer technology and process control engineering into machinery manufacture is becoming more and more important in terms of the planning, manufacture and maintenance of a wide range of technical products and processes. Consequently, engineers, technicians and skilled tradesmen need to adopt an integrated, interdisciplinary approach to project planning. The term 'mechatronics' embodies this integrated approach. One consequence of this approach is that engineers, technicians and skilled tradesmen must possess skills and knowledge which are not restricted to a single specialist field. They must be capable of working and communicating across a number of different technical fields." (William Bolton)

…and that is just how we see the teaching and learning systems in this catalogue in terms of their didactic differentiation and combination.

What learning content can you cover by using the GUNT training systems in this catalogue?

LEARNING CONTENT – FOUNDATION	THE GUNT PROGRAMME GROUPS
Comprehensive coverage of the fundamentals: an introduction to technical drawing and technical communication assisted by GUNT's models and assembly kits. Cutaway models will help you to understand machine elements, components and mechanisms. A thorough insight into testing methods, processes, dimensional metrology, and familiarity with manufacturing methods are essential prerequisites for addressing complex and specialised topics. Our teaching and learning systems will help you to build these foundations in a way that is both effective and practice-oriented.	Engineering Drawing Cutaway Models Dimensional Metrology Fasteners and Machine Parts Manufacturing Engineering

LEARNING CONTENT – SPECIFIC	THE GUNT PROGRAMME GROUPS
Having acquired a thorough grounding in the fundamentals, you can then advance into specific fields of mechatronics. The training systems in the Assembly Projects and Maintenance groups offer totally practical applications that will allow you to design your tuition in an entirely hands-on and interdisciplinary way. Our Machinery Diagnosis group offers a range of the latest new subject areas. The Automation group focuses on process automation and – as an entirely new feature – Fuzzy Control training systems.	Assembly Projects Maintenance Machinery Diagnosis Automation

The teaching and training systems contained in GUNT Catalogue Number 2 cover an extensive range of key fields providing essential learning content for training in the metalworking and electrical and electronics trades and for mechatronics engineers. Programme group content is staged, and all groups are interlinked. For example, students should be familiar with the fundamentals of Engineering Drawing and Dimensional Metrology before progressing to the Assembly Projects or Maintenance groups.

ENGINEERING DRAWING

GEOMETRIC MODELS

TRAINING PANELS AND ASSEMBLY SETS

PRACTICE MODELS

Engineering drawing ... the language of engineering ... as important as ever in training

In this programme segment we offer you a comprehensive range of teaching and training systems on the subject of technical drawing:

- Geometric models to develop three-dimensional perception
- Small-scale practice models covering a wide-range of learning content which goes beyond the scope of just technical drawing: Dimensioning, tolerances, standard parts, surface finishes, materials, production engineering, etc.
- More complex technical systems supporting an introduction to the understanding of assembly and operation.

All models and parts are made from materials which are used in actual practice; they are precision-manufactured, enabling gauging and measurement exercises to be conducted at any stage.

Instructional material:
Always a complete set of to-standard drawings: Documentation as encountered in industrial practice, in many cases also in electronic form and in 3D.

Visit our website www.gunt.de

TZ 100 Three-Dimensional Display with Geometric Models

*** Model set to develop three-dimensional perception**

*** Fundamentals of three-dimensional views**

Technical Description

The TZ 100 three-dimensional display is an educational concept for beginners in technical drawing. A three-dimensional stand which consists of three Plexiglas planes has a receptacle for the precision-manufactured models. The associated view can be inserted on each plane of the stand, enabling a direct comparison between the workpiece and the drawing. The student must cut out and fold a template drawing to construct a model.

The model set includes ten shapes, involving differing degrees of difficulty. One shape is made from Plexiglas in order to develop an understanding of invisible edges. The other shapes are made from aluminium. All parts are clearly laid out in a case.

The model shapes are precision-manufactured, so measuring exercises can also be carried out.

For optimal learning, it is recommended that students work independently from each other on these exercises. Two students can easily work with one model set. Comprehensive and well structured instructional material makes the training system immediately usable in lessons.

Learning Objectives / Experiments

- familiarisation with three-dimensional views as the basis of technical drawing
- step-by-step development of three-dimensional visualisation
- measurement exercises

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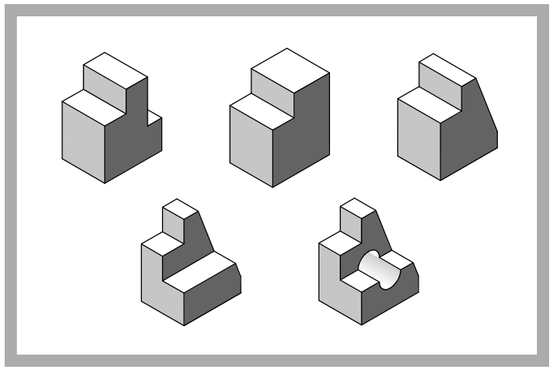
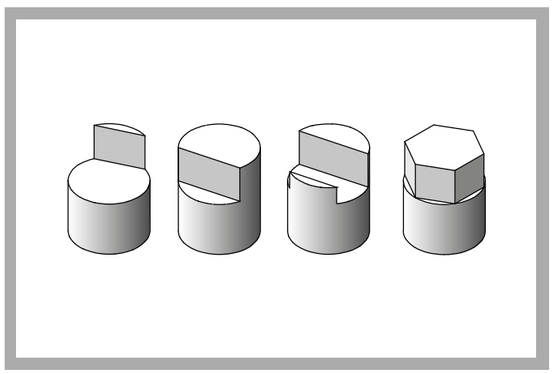
TZ 100 Three-Dimensional Display with Geometric Models

Three-dimensional display with inserted drawing



5 prismatic models



5 cylindrical models

Specification

[1] model set providing an introduction to technical drawing
[2] three-dimensional Plexiglas display
[3] 9 geometric models made from aluminium; cylindrical and prismatic shapes
[4] 1 Plexiglas model
[5] all parts clearly laid out in a practical case

Technical Data

Rectangular shapes LxWxH: 40x30x50mm

Rounded shapes: DxH: 40x50mm

Three-dimensional display
- LxWxH: 100x100x100mm

Dimensions and Weight

LxWxH: 350x300x100mm (case)
Weight: approx. 3kg

Scope of Delivery

1 case with foam inlay
10 geometric models
3 Plexiglas surfaces to construct a stand
1 rod to hold the models
1 paper punch
1 set of instructional material

Order Details

050.10000 TZ 100 Three-Dimensional Display with Geometric Models

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TZ 110 Cylindrical Work Samples with Cut-Outs Parallel to Axis

*** Collection of geometric models providing an introduction to technical drawing**

*** Systematically graduated degrees of difficulty**

Technical Description

The geometric models support the learning process by providing an introduction to technical drawings: from the solid model to the more abstract representation of the three views in a technical drawing.

The TZ 110 set contains 18 aluminium drawing models. The cylindrical models have cut-outs parallel to the main axis of the model. The models are precision-manufactured and are suitable for measurement exercises as well as drawing exercises.

For optimal learning, it is recommended that students work independently from each other on these exercises. Two students can easily work with one model set.

The models are clearly laid out on a tray. Multiple trays are stackable, providing for space-saving storage.

The instructional material includes a complete set of drawings. It includes each model in three views, as well as its 3D view and production drawing.

Learning Objectives / Experiments

- familiarisation with three-dimensional views as the basis of technical drawing
- step-by-step development of three-dimensional visualisation: from the solid model to the more abstract views in a technical drawing
- systematic familiarisation with a wide range of features on cylindrical base forms
- exercises in production-oriented and standard dimensioning
- measurement exercises: outer dimensions, inner dimensions, tolerances

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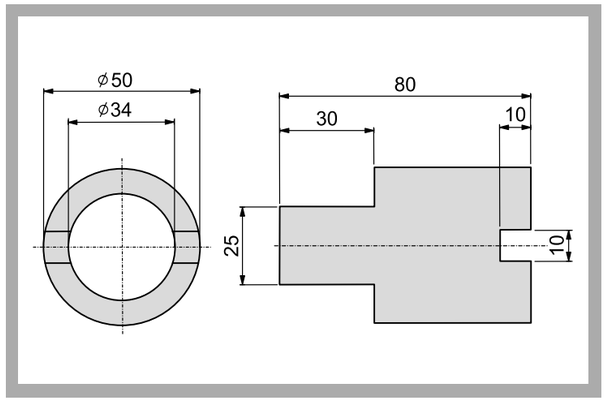
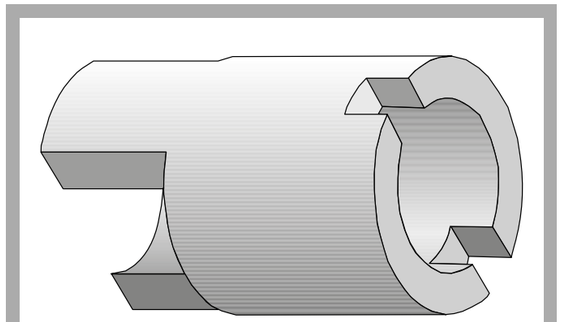
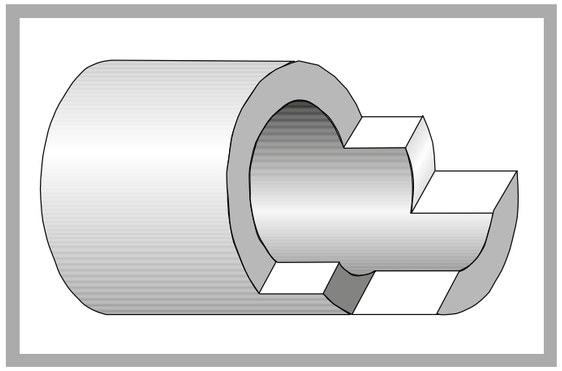
TZ 110 Cylindrical Work Samples with Cut-Outs Parallel to Axis



Dimensional drawing of model no. 3



3D view of model no. 3



3D view of model no. 6

Specification

[1] model set providing an introduction to technical drawing
[2] set of 18 cylindrical models, made from aluminium, with anodised finish
[3] models with cut-outs parallel to the major axes
[4] finely graduated degrees of difficulty within the model series
[5] all parts clearly laid out on a practical tray
[6] multiple trays stackable
[7] precision manufacture of the models enables measurement exercises
[8] lesson-supporting instructional material

Technical Data

Dimensions of each model
- approx. DxH: 50x80mm

Dimensions and Weight

LxWxH: 600x400x140mm (tray)
Weight: approx. 9kg

Scope of Delivery

1 tray with cut-out foam inlay
18 geometric models
1 set of instructional material

Order Details

050.11000 TZ 110 Cylindrical Work Samples with Cut-Outs Parallel to Axis

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TZ 120 Cylindrical Work Samples with Slanted Cut-Outs

*** Collection of geometric models providing an introduction to technical drawing**

*** Systematically graduated degrees of difficulty**

Technical Description

The geometric models support the learning process by providing an introduction to technical drawings: from the solid model to the more abstract representation of the three views in a technical drawing.

The TZ 120 set contains 18 aluminium drawing models. The cylindrical models have cut-outs parallel to, and at an angle to, the main axis. The models are precision-manufactured and are suitable for measurement exercises as well as drawing exercises.

For optimal learning, it is recommended that students work independently from each other on these exercises. Two students can easily work with one model set.

The models are clearly laid out on a tray. Multiple trays are stackable, providing for space-saving storage.

The instructional material includes a complete set of drawings. It presents each model in three views, as well as its 3D view and production drawing.

Learning Objectives / Experiments

- familiarisation with three-dimensional views as the basis of technical drawing
- step-by-step development of three-dimensional visualisation: from the solid model to the more abstract views in a technical drawing
- systematic familiarisation with a wide range of features on cylindrical base forms
- exercises in production-oriented and standard dimensioning
- measurement exercises: outer dimensions, inner dimensions, angles, tolerances

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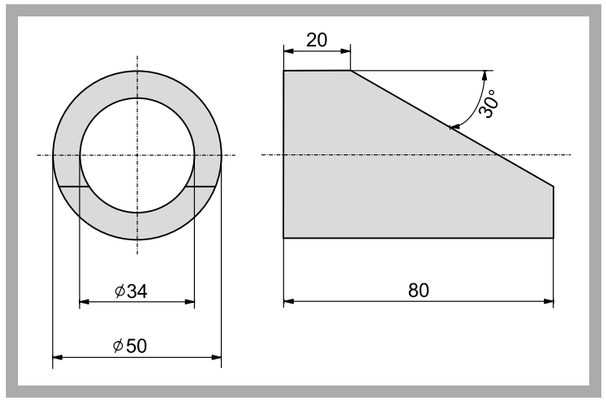
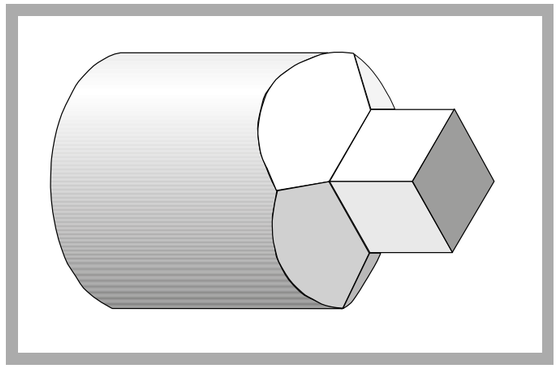
TZ 120 Cylindrical Work Samples with Slanted Cut-Outs



Dimensional drawing of model no. 6

Left: model no. 6; centre: model no. 10; right: model no. 16



3D view of model no. 13

Specification

[1] model set providing an introduction to technical drawing
[2] set of 18 cylindrical models, made from aluminium, with anodised finish
[3] models with slanted cut-outs
[4] finely graduated degrees of difficulty within the model series
[5] all parts clearly laid out on a practical tray
[6] multiple trays stackable
[7] precision manufacture of the models enables measurement exercises
[8] lesson-supporting instructional material

Technical Data

Dimensions of each model
- approx. DxH: 50x80mm

Dimensions and Weight

LxWxH: 600x400x140mm (tray)
Weight: approx. 9kg

Scope of Delivery

1 tray with cut-out foam inlay
18 geometric models
1 set of instructional material

Order Details

050.12000 TZ 120 Cylindrical Work Samples with Slanted Cut-Outs

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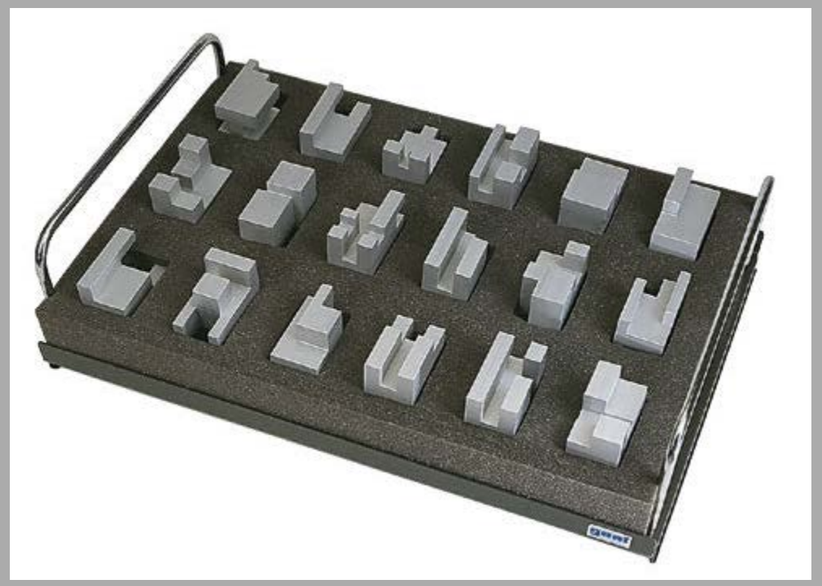
TZ 130 Prismatic Work Samples with Cut-Outs Parallel to Edges



*** Collection of geometric models providing an introduction to technical drawing**

*** Systematically graduated degrees of difficulty**

Technical Description

The geometric models support the learning process by providing an introduction to technical drawings: from the solid model to the more abstract representation of the three views in a technical drawing.

The TZ 130 set contains 18 aluminium drawing models. The prismatic models have cutouts parallel to the edges of the model. The models are precision-manufactured and are suitable for measurement exercises as well as drawing exercises.

For optimal learning, it is recommended that students work independently from each other on these exercises. Two students can easily work with one model set.

The models are clearly laid out on a tray. Multiple trays are stackable, providing for space-saving storage.

The instructional material includes a complete set of drawings. It presents each model in three views, as well as its 3D view and production drawing.

Learning Objectives / Experiments

- familiarisation with three-dimensional views as the basis of technical drawing
- step-by-step development of three-dimensional visualisation: from the solid model to the more abstract views in a technical drawing
- systematic familiarisation with a wide range of features on prismatic base forms
- exercises in production-oriented and standard dimensioning
- measurement exercises: outer dimensions, inner dimensions, tolerances

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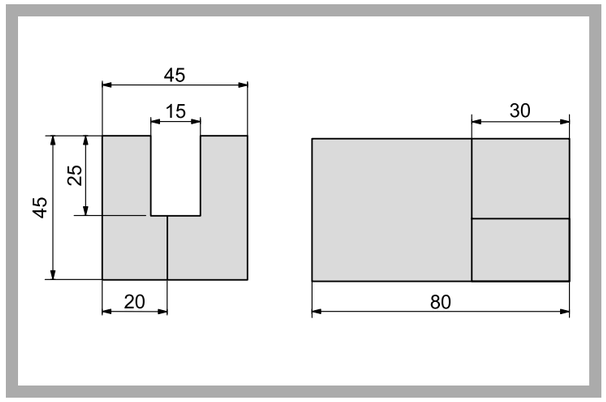
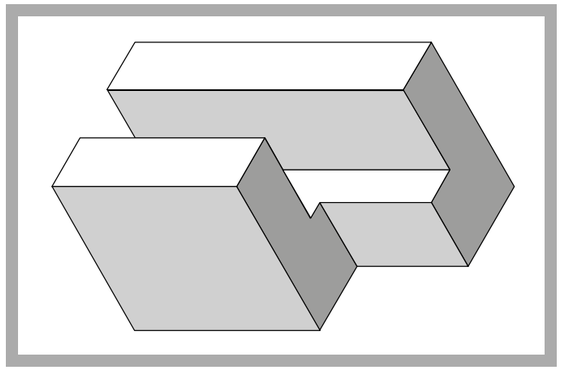
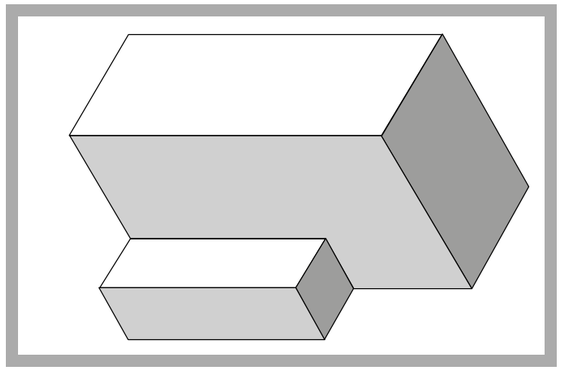
TZ 130 Prismatic Work Samples with Cut-Outs Parallel to Edges



Dimensional drawing of model no. 3



3D view of model no. 3



3D view of model no. 2

Specification

[1] model set providing an introduction to technical drawing
[2] set of 18 prismatic models, made from aluminium, with anodised finish
[3] models with cut-outs parallel to the spatial axes
[4] finely graduated degrees of difficulty within the model series
[5] all parts clearly laid out on a practical tray
[6] multiple trays stackable
[7] precision manufacture of the models enables measurement exercises
[8] lesson-supporting instructional material

Technical Data

Dimensions of each model
- approx. LxWxH: 45x45x80mm

Dimensions and Weight

LxWxH: 600x400x140mm (tray)
Weight: approx. 9kg

Scope of Delivery

1 tray with cut-out foam inlay
18 geometric models
1 set of instructional material

Order Details

050.13000 TZ 130 Prismatic Work Samples with Cut-Outs Parallel to Edges

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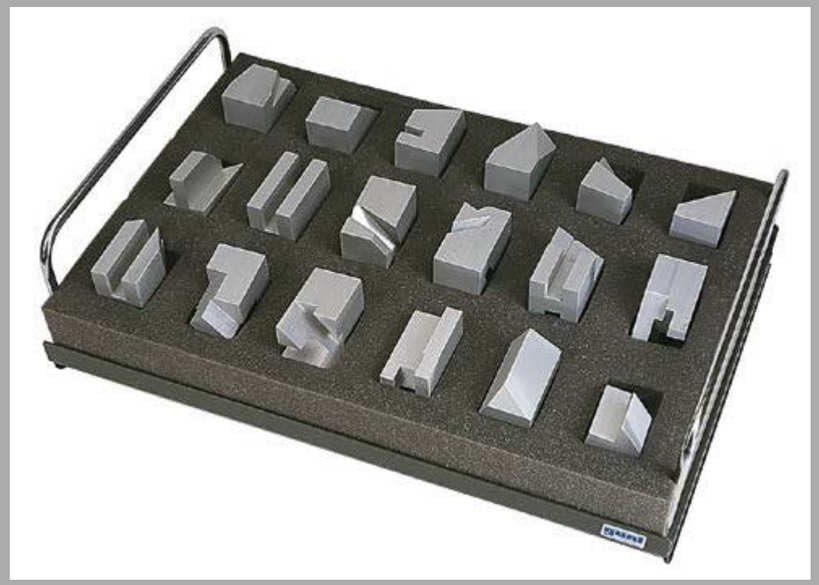
TZ 140 Prismatic Work Samples with Slanted Cut-Outs



*** Collection of geometric models providing an introduction to technical drawing**

*** Systematically graduated degrees of difficulty**

Technical Description

The geometric models support the learning process by providing an introduction to technical drawings: from the solid model to the more abstract representation of the three views in a technical drawing.

The TZ 140 set contains 18 aluminium drawing models. The prismatic models have cut-outs parallel to, and at an angle to, the edges of the prisms. The models are precision-manufactured and are suitable for measurement exercises as well as drawing exercises.

For optimal learning, it is recommended that students work independently from each other on these exercises. Two students can easily work with one model set.

The models are clearly laid out on a tray. Multiple trays are stackable, providing for space-saving storage.

The instructional material includes a complete set of drawings. It presents each model in three views, as well as its 3D view and production drawing.

Learning Objectives / Experiments

- familiarisation with three-dimensional views as the basis of technical drawing
- step-by-step development of three-dimensional visualisation: from the solid model to the more abstract views in a technical drawing
- systematic familiarisation with a wide range of features on prismatic base forms
- exercises in production-oriented and standard dimensioning
- measurement exercises: outer dimensions, inner dimensions, angles, tolerances

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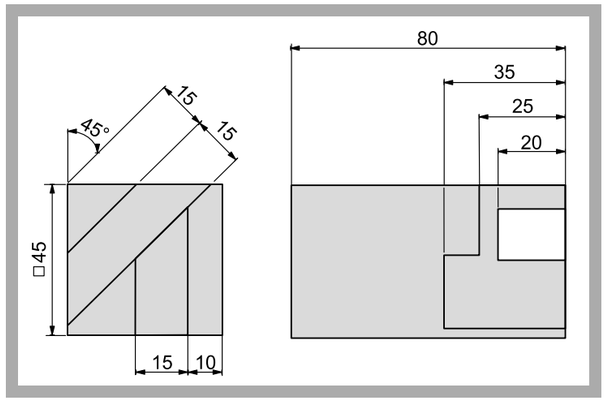
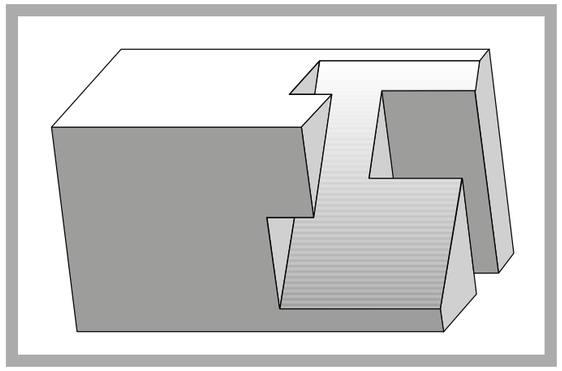
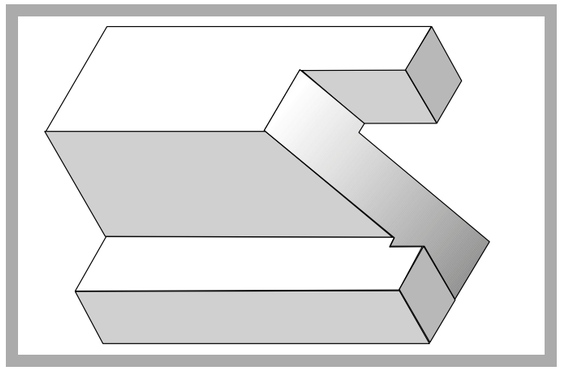
TZ 140 Prismatic Work Samples with Slanted Cut-Outs



Dimensional drawing of model no. 15



3D view of model no. 15



3D view of model no. 12

Specification

[1] model set providing an introduction to technical drawing
[2] set of 18 prismatic models, made from aluminium, with anodised finish
[3] models with slanted cut-outs
[4] finely graduated degrees of difficulty within the model series
[5] all parts clearly laid out on a practical tray
[6] multiple trays stackable
[7] precision manufacture of the models enables measurement exercises
[8] lesson-supporting instructional material

Technical Data

Dimensions of each model
- approx. LxWxH: 45x45x80mm

Dimensions and Weight

LxWxH: 600x400x140mm (tray)
Weight: approx. 9kg

Scope of Delivery

1 tray with cut-out foam inlay
18 geometric models
1 set of instructional material

Order Details

050.14000 TZ 140 Prismatic Work Samples with Slanted Cut-Outs

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TZ 200.11 Bending Device Assembly Kit

*** Course in technical drawing**
*** Bending device assembly kit**
*** Interdisciplinary teaching exercise**

Technical Description

The kit contains all the parts required to assemble a functional bending device. The parts are clearly laid out on a base plate. They are grouped into individual assembly sequences. The base plate is covered with a transparent cover panel on which a graphical representation of the assembly structure is printed. The graphic symbolises standard and production parts, and also represents fixed and moving connections differently.

All parts are precision-manufactured on CNC machines and feature standard engineering tolerances and surface finishes. The surfaces of the finished parts have a gunmetal finish to prevent corrosion.

Multiple trays are stackable, providing for space-saving storage.

The kit is ideally deployed for student exercises during teaching, with two/three students able to work with each kit.

The comprehensive and clearly structured instructional material is laid-out in line with modern principles and is of great help with lesson preparation.

Learning Objectives / Experiments

- introduction to technical drawing:
  * reading and understanding technical drawings
  * three-plane views
  * sectional views
  * drawing types
  * 3D views
  * parts lists
  * dimensioning
  * surface finish and tolerance specifications
  * differentiation between standard and production parts
  * material specifications

- planning and execution of simple assembly operations:
  * planning and describing work sequences
  * assessing results

- measurement exercises:
  * length measurements
  * angle measurements

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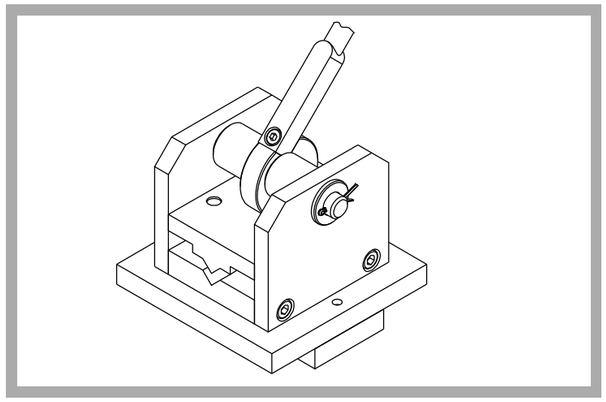
TZ 200.11 Bending Device Assembly Kit



3D view of assembled bending device

Specification

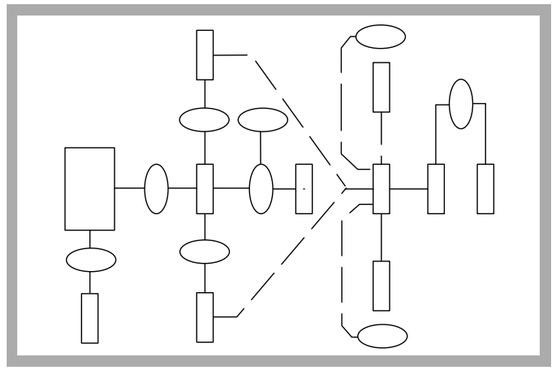
[1] part of the GUNT technical drawing course
[2] assembly set with components of a functional bending device (eccentric operation)
[3] all components made from steel, precision-manufactured, with gunmetal surface finish
[4] assembly schematic on transparent cover panel
[5] multiple trays stackable
[6] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

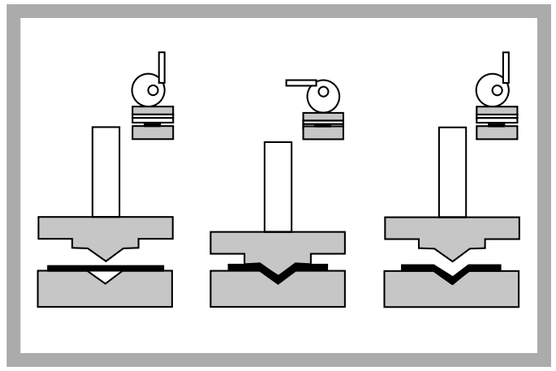
LxWxH: 540x350x75mm (tray)
Weight: approx. 6kg

Scope of Delivery

1 tray with bending device components
1 cover panel with assembly schematic
1 set of assembly/disassembly tools
1 set of instructional material



Graphical representation of assembly structure



Bending process

Order Details

050.20011 TZ 200.11 Bending Device Assembly Kit

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TZ 200.61 Drawing Demonstration: Drilling Jig

*** Course in technical drawing: presentation of rotationally symmetrical parts**

*** Introduction to sectional views**

*** Comprehensive instructional material**

Technical Description

The basis for the course is a drilling jig which can be used to drill holes in a bearing cover. All drilling jig components are clearly laid out on a base plate. It can facilitate the drilling of the workpiece and other small parts. An exploded-view of the jig is printed on the cover to illustrate the construction of the jig.

A quarter segment has been cut out of the main body of the drilling jig. This enables demonstration of the terms 'section' and 'half section' as used in technical drawing. The cut-away quarter segment is also present on the base plate, enabling the difficult topic of sectional views to be illustrated.

All parts are precision-manufactured on CNC machines and are therefore also suitable for measurement exercises.

Optimal learning is established when groups of two or three students work on one model.

The comprehensive instructional material is laid-out in line with modern principles and provides effective assistance with lesson preparation.

Learning Objectives / Experiments

- introduction to graphical representation of rotationally symmetrical parts (turned parts)
- familiarisation with sectional views: full section and half section
- dimensioning of turned parts and threads
- production engineering aspects:
  * jigs as aids to drilling and reaming
  * complete machining with state-of-the-art machine tools
  * tolerances, fits, surface finish specifications
- placement of the workpiece (bearing cover) in a wider technological context

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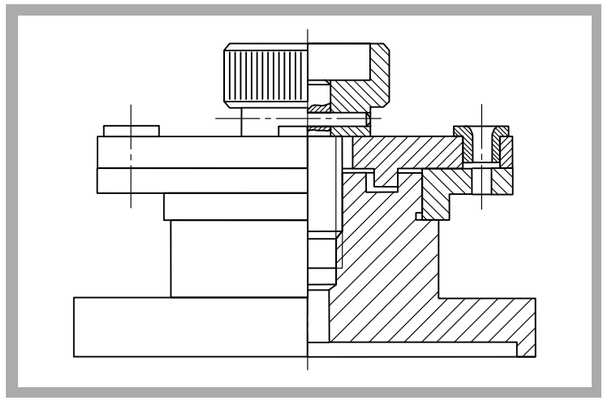
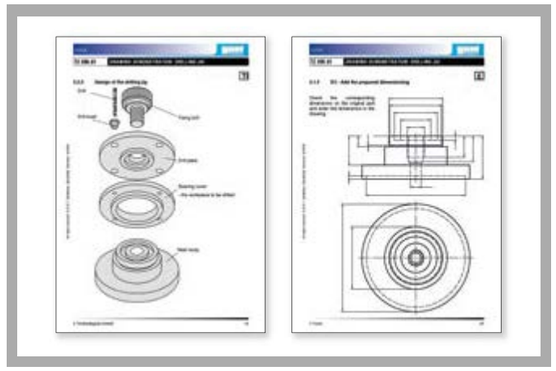
TZ 200.61 Drawing Demonstration: Drilling Jig



Sectional view of drilling jig with the workpiece to be drilled (bearing cover)

Assembled drilling jig with workpiece: 1 fastening screw, 2 drilling plate, 3 drill bush, 4 workpiece (bearing cover), 5 main drilling jig body



Instructional material

Specification

[1] part of the GUNT technical drawing course
[2] practical drilling jig for the machining of a bearing cover
[3] main drilling jig body fashioned as a half section
[4] all drilling jig components made from aluminium, precision-manufactured
[5] clearly identifiable workpiece: red PVC bearing cover
[6] base plate with screen-printed exploded-view drawing
[7] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 420x300x65mm (tray)
Weight: approx. 3kg

Scope of Delivery

1 base plate with drilling jig components
1 workpiece
1 set of standard parts (drill bush, straight pin, O-ring)
1 set of instructional material

Order Details

050.20061 TZ 200.61 Drawing Demonstration: Drilling Jig

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TZ 200.71 Lever Shears Assembly Kit

*** Course in technical drawing**
*** Lever shears assembly kit**
*** Interdisciplinary teaching exercise**

Technical Description

The kit contains all the parts required to assemble a functional lever shears. The parts are clearly laid out on a base plate. They are grouped into individual assembly sequences. The base plate is covered with a transparent cover panel on which a graphical representation of the assembly structure is printed. The graphic symbolises standard and production parts, and represents fixed and moving connections differently.

All parts are precision-manufactured on CNC machines and feature standard engineering tolerances and surface finishes. The surfaces of the finished parts have a gunmetal finish to prevent corrosion.

Multiple trays are stackable, providing for space-saving storage.

The kit is ideally deployed for student exercises during teaching, with two/three students able to work with each kit.

The comprehensive and clearly structured instructional material is laid-out in line with modern principles and is of great help with lesson preparation.

Learning Objectives / Experiments

- introduction to technical drawing
  * reading and understanding technical drawings
  * three-plane views
  * sectional views
  * drawing types
  * 3D views
  * parts lists
  * dimensioning
  * surface finish and tolerance specifications
  * differentiation between standard and production parts
  * material specifications

- planning and execution of simple assembly operations
  * planning and describing work sequences
  * assessing results

- measurement exercises
  * length measurements
  * angle measurements

- manufacturing methods
  * operational examples of handmade production and production on machine tools

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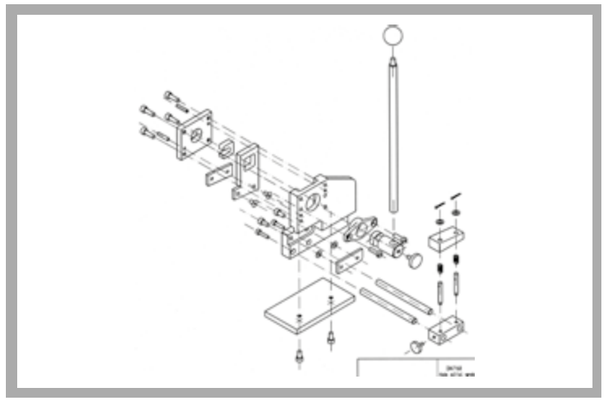
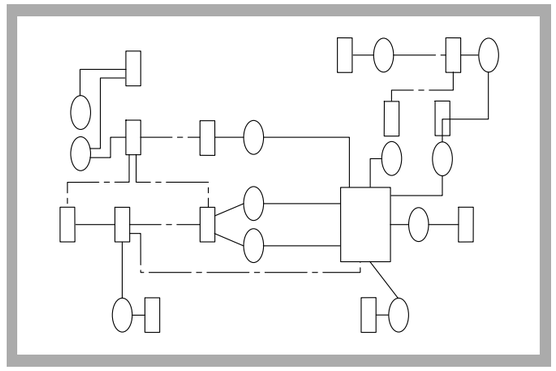
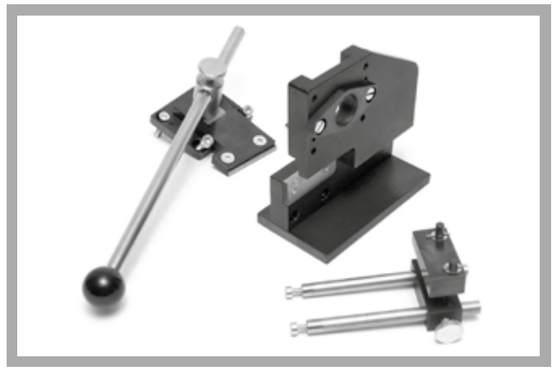
TZ 200.71 Lever Shears Assembly Kit



Exploded-view drawing of the lever shears



Graphical representation of assembly structure



Function groups of a lever shears: shear body, main body, stop

Specification

[1] part of the GUNT technical drawing course
[2] assembly kit with components of a functional lever shears
[3] all lever shears components made from steel, precision-manufactured, gunmetal surface finish
[4] assembly schematic on transparent cover panel
[5] multiple trays stackable
[6] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 540x350x70mm (tray)
Weight: approx. 7kg

Scope of Delivery

1 tray with lever shears components
1 cover panel with assembly schematic
1 set of assembly/disassembly tools
1 set of small parts
1 set of instructional material

Order Details

050.20071 TZ 200.71 Lever Shears Assembly Kit

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TZ 300 *Lever Press Assembly Kit*

*** Course in technical drawing**
*** Lever press assembly kit**
*** Interdisciplinary teaching exercise**

Technical Description

The kit contains all the parts required to assemble a functional lever press. The parts are clearly laid out on a base plate.

All parts are precision-manufactured on CNC machines and feature standard engineering tolerances and surface finishes. The surfaces of the parts have a gunmetal finish to prevent corrosion.

Multiple trays are stackable, providing for space-saving storage.

The kit is ideally deployed for student exercises during teaching, with two/three students able to work with each kit.

The lever press model can be considered as a project enabling interdisciplinary, action-oriented teaching. As well as the primary technical drawing focus of the teaching, other topics that can be covered include machine elements, assembly processes, and manufacturing technology.

The comprehensive and clearly structured instructional material is laid-out in line with modern principles, and is of great help with lesson preparation.

Learning Objectives / Experiments

- introduction to technical drawing
  * reading and understanding technical drawings
  * three-plane views
  * sectional views
  * drawing types
  * 3D views
  * parts lists
  * dimensioning
  * surface finish and tolerance specifications
  * differentiation between standard and production parts
  * material specifications

- planning and execution of simple assembly operations
  * planning and describing work sequences
  * assessing results

- measurement exercises
  * length measurements
  * angle measurements

- manufacturing methods
  * operational examples of handmade production and production on machine tools

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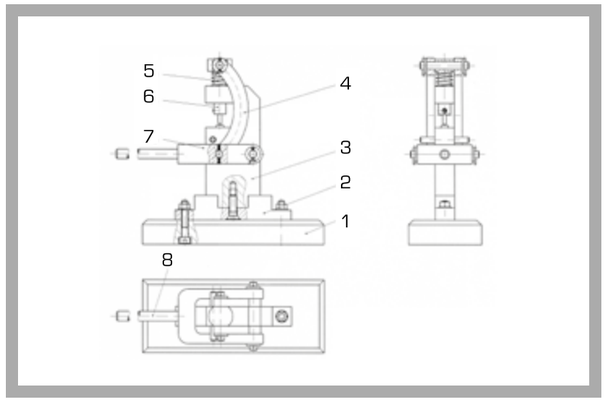
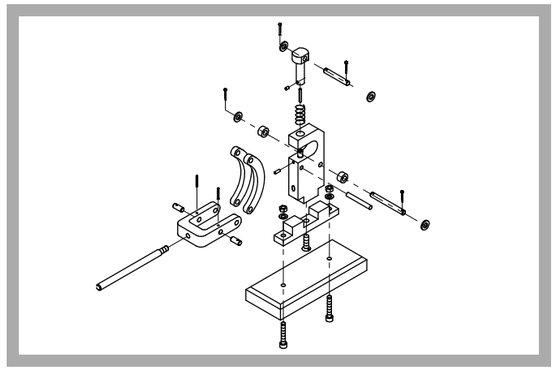
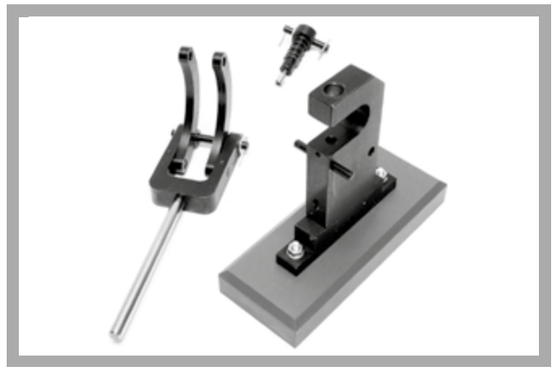
TZ 300 *Lever Press Assembly Kit*



1 base plate, 2 foot, 3 stand, 4 arch, 5 pressure spring, 6 pressure pin, 7 fork, 8 handle



Exploded-view drawing of the lever press



Function groups of a lever press: fork, pressure pin, main body

Specification

[1] part of the GUNT technical drawing course
[2] assembly kit with components of a functional lever press
[3] all lever press components made from steel, precision-manufactured, with gunmetal surface finish
[4] multiple trays stackable
[5] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 420x300x75mm (tray)
Weight: approx. 3kg

Scope of Delivery

1 base plate with lever press components
1 set of assembly/disassembly tools
1 set of small parts
1 set of instructional material

Order Details

050.30000 TZ 300 Lever Press Assembly Kit

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TZ 200.01 Bending Device

Technical Description

The bending device model forms part of the extensive GUNT course providing an introduction to technical drawing. The didactic approach involves teaching the systematic and transferable learning matter based on an operational mechanism.

TZ 200.01 presents an eccentrically-operated bending device which can be used to press a clamp profile out of a sheet-metal strip. All parts are precision-manufactured on CNC machines. The surfaces of the steel parts have a gunmetal finish to prevent corrosion.

Comprehensive and well-structured instructional material supports wide-ranging use of the model in technical training.

Optimal learning is established when one model is used with two/three students.

Learning Objectives / Experiments

Technical drawing
- familiarisation with three-dimensional views
- production-oriented and standardised representation of parts
- surface finish and tolerance specifications
- overview drawing
- parts list
- standard parts
- 3D views
- material specifications

Technology
- assembly and disassembly
- planning an assembly sequence
- functions
- material selection
- manufacturing methods
- measurement exercises
  * length measurements
  * angle measurements

*** Functional bending device as a practice model providing an introduction to technical drawing**

*** Introduction to simple assembly sequences**

*** Suitable for a broad range of learning matter**

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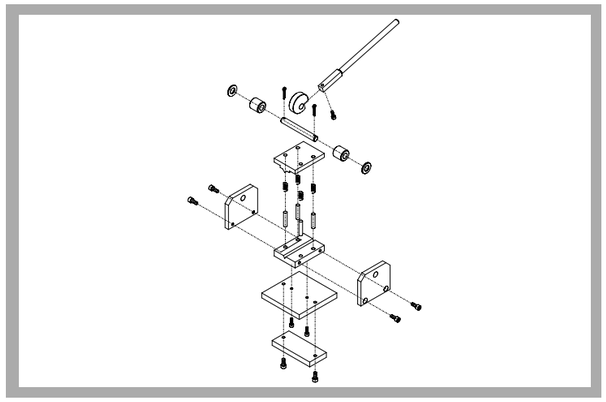
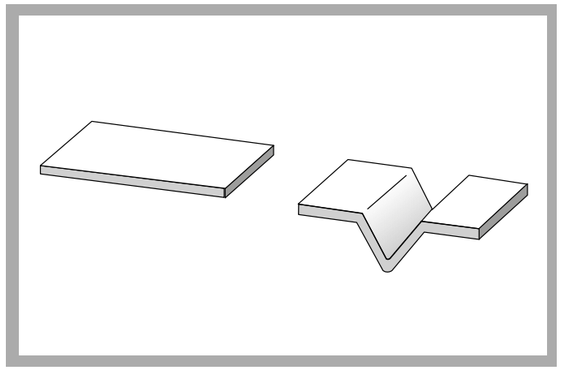
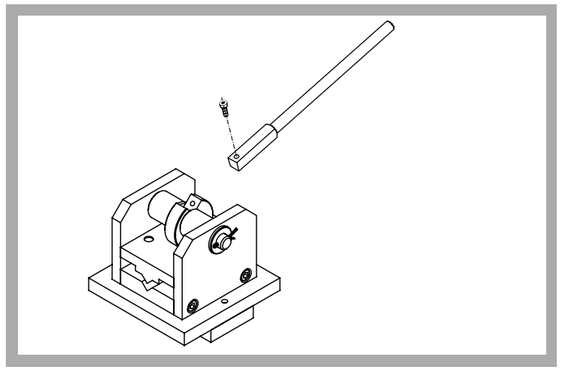
TZ 200.01 Bending Device



Exploded-view drawing of the bending device



From sheet-metal strip to clamp profile, the product of the bending device



Assembly of the lever

Specification

[1] part of the GUNT technical drawing course
[2] functional bending device with eccentric operation
[3] all components made from steel, precision-manufactured, with gunmetal surface finish
[4] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 90x90x60mm (excluding lever)
Weight: approx. 3kg

Scope of Delivery

1 bending device, assembled
1 set of assembly/disassembly tools
1 set of instructional material

Order Details

050.20001 TZ 200.01 Bending Device

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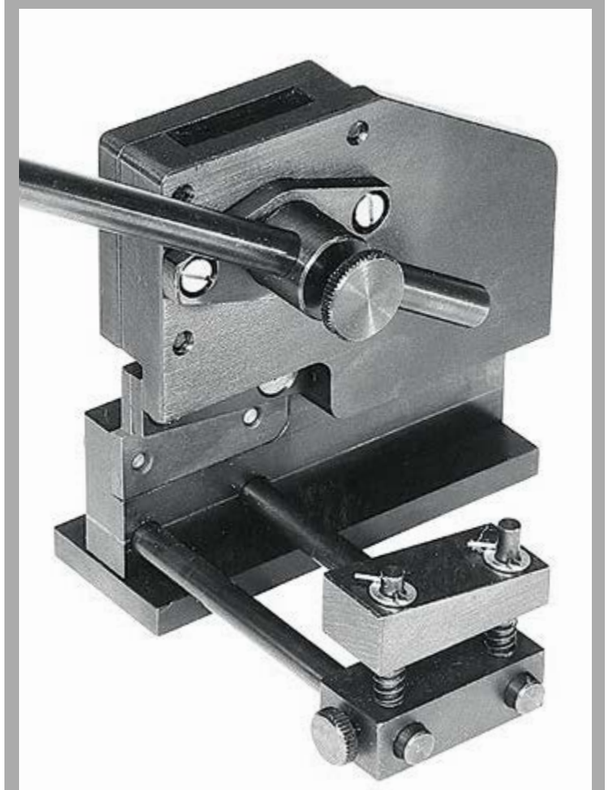
TZ 200.07 *Lever Shears*



Technical Description

The lever shears model forms part of the extensive GUNT course providing an introduction to technical drawing. The didactic approach involves teaching the systematic and transferable learning matter based on an operational mechanism.

The lever shears model can be considered to be a project enabling interdisciplinary, action-oriented teaching. As well as the primary technical drawing focus of teaching, other topics that can be covered include machine elements, assembly processes, and manufacturing technology.

TZ 200.07 presents a hand-operated lever shears which can be used to cut thin metal sheets.

All parts are precision-manufactured on CNC machines. The surfaces of the steel parts have a gunmetal finish to prevent corrosion.

Comprehensive and well-structured instructional material supports wide-ranging use of the model in technical training.

Optimal learning is established when one model is used with two/three students.

Learning Objectives / Experiments

Technical drawing
- familiarisation with three-dimensional views
- production-oriented and standardised representation of parts
- surface finish and tolerance specifications
- overview drawing
- parts list
- standard parts
- 3D views
- material specifications

Technology
- assembly and disassembly
- planning an assembly sequence
- functions
- material selection
- manufacturing methods
- length measurement exercises

*** Functional lever shears as a practice model providing an introduction to technical drawing**

*** Introduction to simple assembly sequences**

*** Suitable for a broad range of learning matter**

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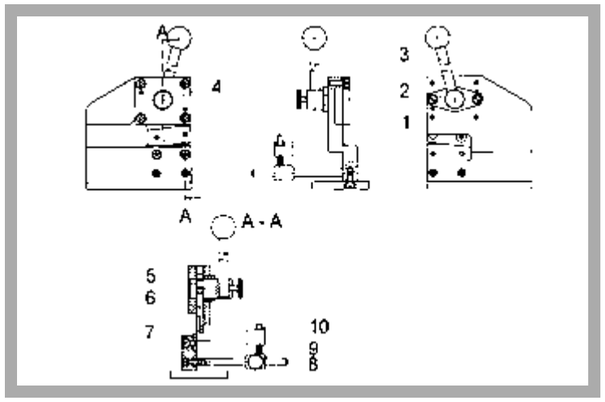
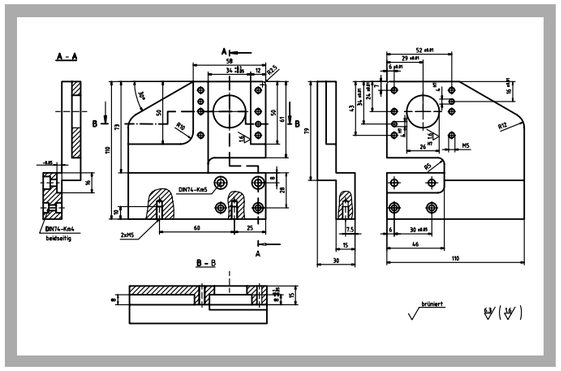
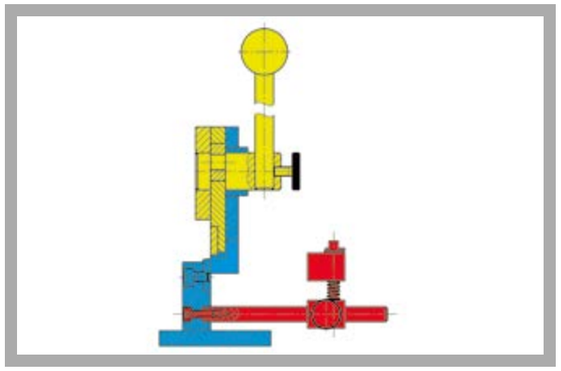
TZ 200.07 Lever Shears



1 main body, 2 bearing flange, 3 lever rod with ball head, 4 bearing cover, 5 eccentric shaft, 6 shear body with top blade, 7 bottom blade, 8 guide rod, 9 guide, 10 stop



Production drawing of main body



Function groups of a lever shears: blue: main body, yellow: shear body, red: stop

Specification

[1] part of the GUNT technical drawing course
[2] complex function model of a lever shears
[3] all lever shears components made from steel, precision-manufactured, with gunmetal surface finish
[4] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 120x120x120mm (excluding lever)
Weight: approx. 3kg

Scope of Delivery

1 lever shears, assembled
1 set of assembly/disassembly tools
1 set of instructional material

Order Details

050.20007 TZ 200.07 Lever Shears

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TZ 200.04 Drilling Jig for a Casting

*** Practice model for technical drawing of jigs**

*** Suitable for a broad range of learning matter**

Technical Description

The model comprises two elements: the actual drilling jig and a cast part representing the workpiece. The cast part is to be drilled with four through-holes using a standard drill. It is clamped in the jig and the drill is fed to it by way of bushes.

Core didactic aspects are reading and understanding technical drawings, standardised and production-oriented dimensioning of parts, sketching of suggested improvements or required parts. In addition, many other aspects can be covered with the aid of this interdisciplinary teaching model, including: jig geometry, cast parts, clamping techniques, and manufacturing technology.

Learning Objectives / Experiments

Technical drawing
- familiarisation with three-dimensional views
- production-oriented and standardised representation of components
- surface finish and tolerance specifications
- overview drawing, parts list
- standard parts
- 3D views
- material specifications

Technology
- jig and clamping techniques
- manufacturing methods
- work planning

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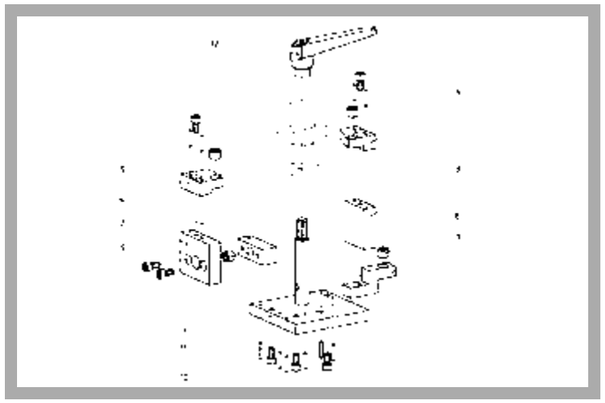
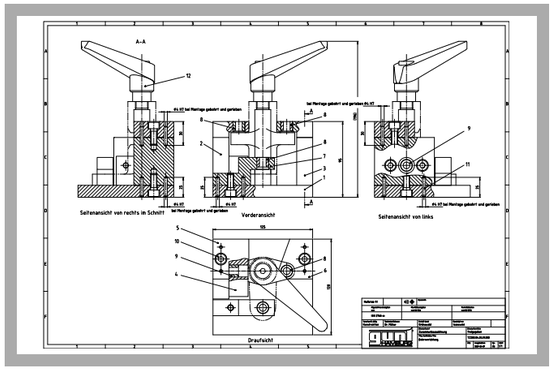
TZ 200.04 Drilling Jig for a Casting



Exploded-view drawing of the drilling jig



Assembly drawing of the drilling jig

Drilling jig in use

Specification

[1] part of the GUNT technical drawing course
[2] practical drilling jig for machining of a cast part
[3] all drilling jig components made from steel, precision-manufactured, surfaces in gunmetal finish
[4] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 125x125x150mm (drilling jig)
LxWxH: 60x80x105mm (cast part)
Weight: approx. 5kg

Scope of Delivery

1 drilling jig
1 cast part
1 set of instructional material

Order Details

050.20004 TZ 200.04 Drilling Jig for a Casting

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TZ 200.06 Drilling Jig for an Annular Disc

*** Functional drilling jig as a practice model providing an introduction to technical drawing**

*** Complete set of production-oriented drawings**

Technical Description

The drilling jig model forms part of the extensive GUNT course providing an introduction to technical drawing. The didactic approach involves teaching the systematic and transferable learning matter based on an operational mechanism.

All parts, made from steel, are precision-manufactured on CNC machines. The surfaces of the steel parts have a gunmetal finish to prevent corrosion.

Comprehensive and well-structured instructional material supports wide-ranging use of the model in technical training.

Optimal learning is established when one model is used with two/three students.

Learning Objectives / Experiments

- reading and understanding engineering drawings and parts lists
- production-oriented and standardised representation of turned parts: dimensioning, surface finish and tolerance specifications
- technological aspects: material selection, functions, manufacturing methods, work planning, manufacturing aids, jigs and fixtures, and much more.

Scope of Delivery

1 drilling jig, 1 bearing cover as workpiece, 1 set of instructional material

Specification

[1] part of the GUNT technical drawing course
[2] practical drilling jig for machining of a bearing cover
[3] all drilling jig components made from steel, precision-manufactured, with gunmetal surface finish
[4] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

DxH: 120x70mm (drilling jig)
DxH: 90x10mm (ring)
Weight: approx. 3kg

Order Details

050.20006 TZ 200.06 Drilling Jig for an Annular Disc

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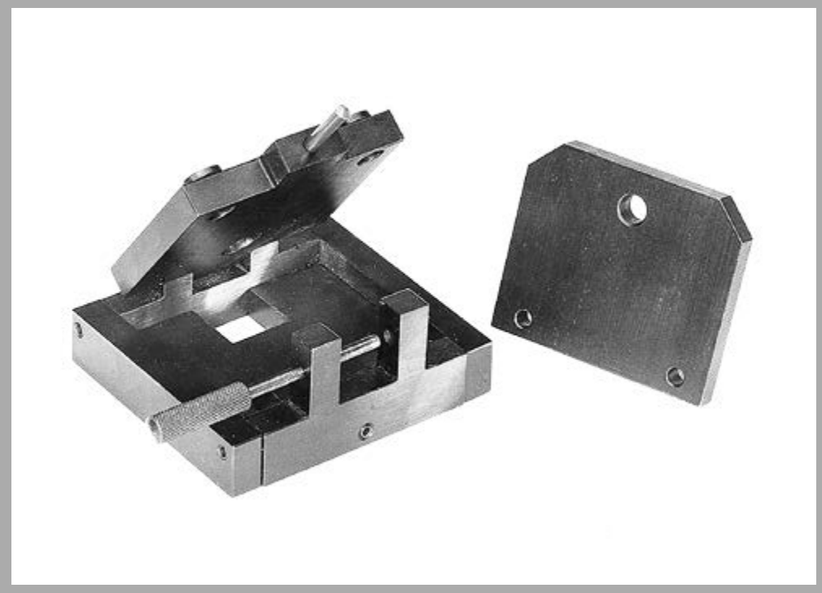
TZ 200.09 Drilling Jig for Flat Part



*** Functional drilling jig as a practice model providing an introduction to technical drawing**

*** Complete set of production-oriented drawings**

Technical Description

The drilling jig model forms part of the extensive GUNT course providing an introduction to technical drawing. The didactic approach involves teaching the systematic and transferable learning matter based on an operational mechanism.

All parts are precision-manufactured on CNC machines. The surfaces of the steel parts have a gunmetal finish to prevent corrosion.

Comprehensive and well-structured instructional material supports wide-ranging use of the model in technical training.

Optimal learning is established when one model is used with two/three students.

Learning Objectives / Experiments

- reading and understanding technical drawings and parts lists
- production-oriented and standardised representation of parts: dimensioning, surface finish and tolerance specifications
- technological aspects: including; material selection, functions, manufacturing methods, work planning, manufacturing aids, and jigs and fixtures

Scope of Delivery

1 drilling jig, 1 planar part, 1 set of instructional material

Specification

[1] part of the GUNT technical drawing course
[2] practical drilling jig for machining of a planar part
[3] all drilling jig components made from steel, precision-manufactured, with gunmetal surface finish
[4] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 90x90x40mm (drilling jig)
LxWxH: 70x60x8mm (plane part)
Weight: approx. 2kg

Order Details

050.20009 TZ 200.09 Drilling Jig for Flat Part

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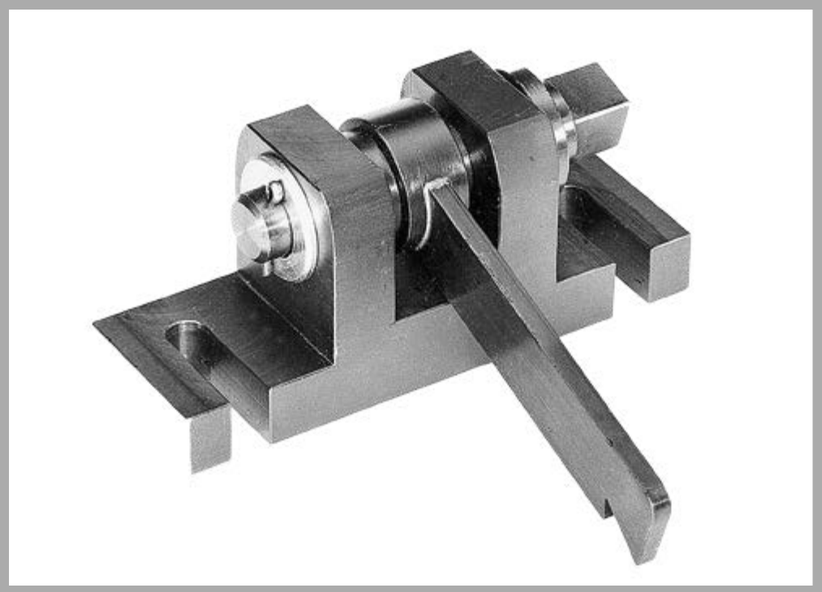
TZ 200.08 Safety Catch



*** Practice model providing an introduction to technical drawing**

*** Complete set of production-oriented drawings**

Technical Description

The safety catch model forms part of the extensive GUNT course providing an introduction to technical drawing. The didactic approach involves teaching the systematic and transferable learning matter based on an operational mechanism.

All parts, made from steel, are precision-manufactured on CNC machines. The surfaces of the steel parts have a gunmetal finish to prevent corrosion.

Comprehensive and well-structured instructional material supports wide-ranging use of the model in technical training.

Optimal learning is established when one model is used with two/three students.

Learning Objectives / Experiments

- reading and understanding technical drawings and parts lists
- production-oriented and standardised representation of parts: dimensioning, surface finish and tolerance specifications
- technological aspects: including; material selection, functions, manufacturing methods, and work planning.

Scope of Delivery

1 safety catch, 1 set of instructional material

Specification

[1] part of the GUNT technical drawing course
[2] practical working model of a pawl
[3] all safety catch components made from steel, precision-manufactured, with gunmetal surface finish
[4] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

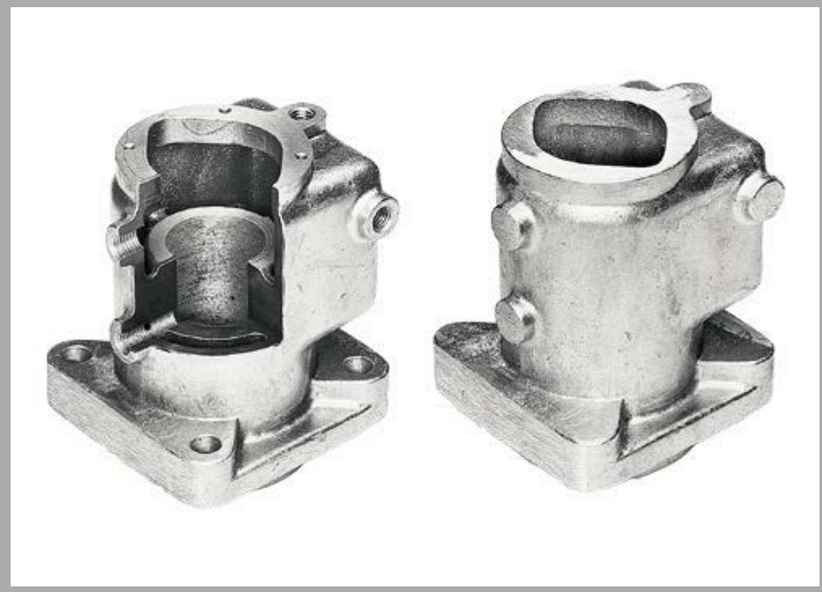
LxWxH: 125x100x60mm
Weight: approx. 2kg

Order Details

050.20008 TZ 200.08 Safety Catch

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

TZ 200.02 Bearing Housing, Casting



Machined (left) and unmachined (right) cast parts

*** Two practice models for technical drawing of cast parts**

*** From cast part to finished machine part**

Technical Description

A bearing housing made from sand-cast aluminium is used in teaching as an example to illustrate the subject of cast parts in technical drawing in a detailed and practical way. TZ 200.02 comprises two elements: an unmachined cast part, professionally 'polished', as it is delivered from the foundry; and a post-machined cast part additionally presented in the form of a cutaway model. This enables the entire process, from the shaping to the cutting, to be covered in the lesson. Optimal learning is established when one model is used with two/three students.

Learning Objectives / Experiments

Technical drawing
- drawings of cast parts and their special features: machining allowances, mould drafts, shrinkage, sectional views
- from the cast part to the finished part: production-oriented and standard dimensioning for subsequent machining

Technology
- manufacture of cast parts by the sand-casting method; manufacturing methods
- machine and tool selection, length measurement exercises
- machine elements and their function

Scope of Delivery

2 models, 1 set of instructional material

Specification

[1] part of the GUNT technical drawing course
[2] graphical views: from cast part to finished machine part
[3] 2 models illustrating progress in the manufacturing process: 1 unmachined cast part, 1 cutaway model
[4] instructional material incorporates action-oriented and interdisciplinary forms of teaching

Dimensions and Weight

LxWxH: 100x100x125mm (each model)
Weight: approx. 3kg

Order Details

050.20002 TZ 200.02 Bearing Housing, Casting

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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CUTAWAY MODELS

GEAR AND DRIVE ELEMENTS

COMPONENTS IN PIPING SYSTEMS

REFRIGERATION COMPONENTS

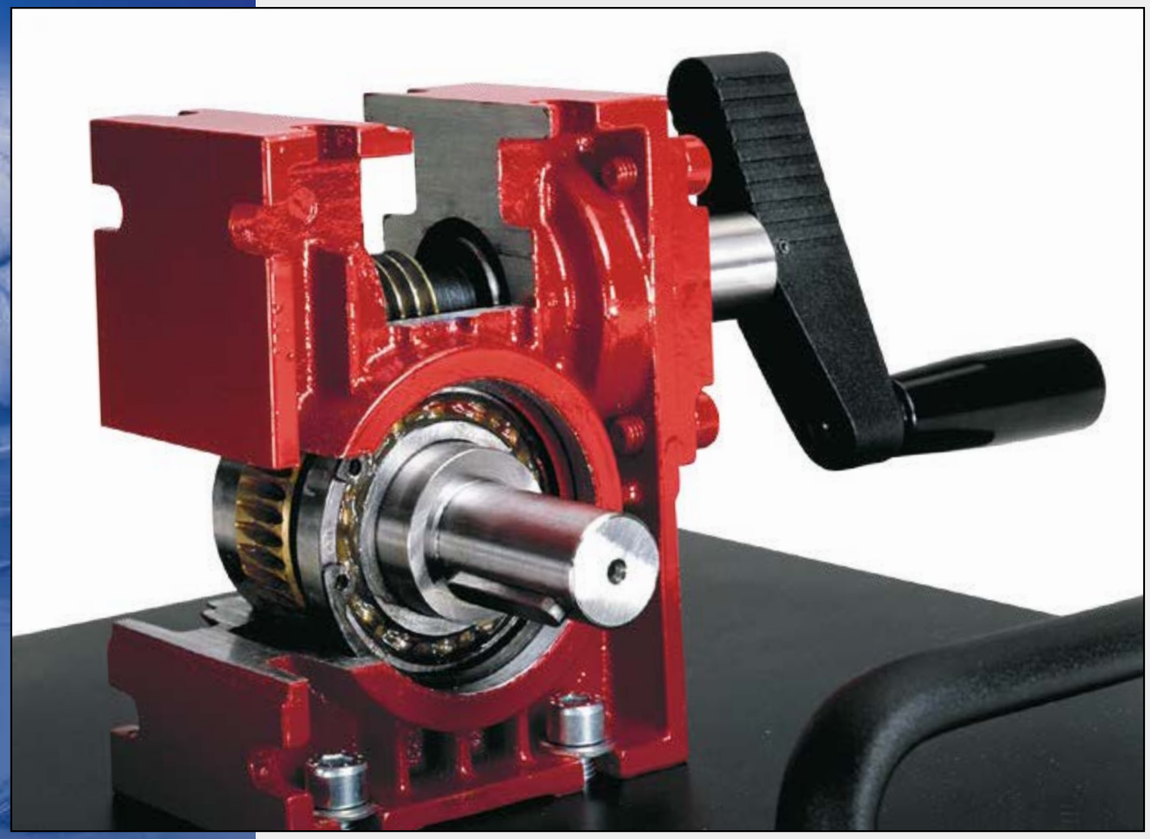
Cutaway models

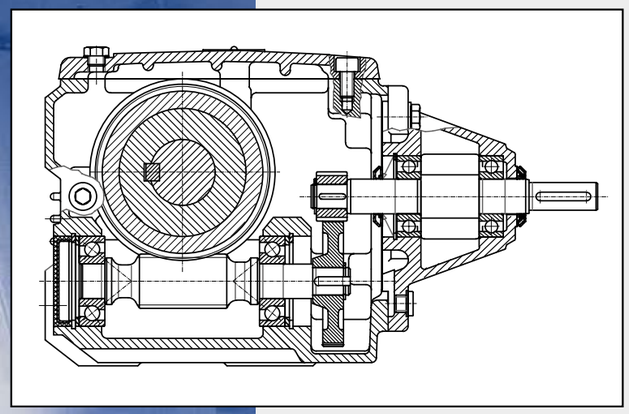
Explain technical correlations, functions and components simply and convincingly.

We always use the latest original components for our cutaway models. Movements and switching functions are retained.

Drawings and a technical description accompany the cutaway models to allow their use across a broad spread of technical teaching. Problems and tasks encountered in technical drawing, manufacturing engineering and testing and our chapter "fasteners and machine parts" can be demonstrated graphically in a very practical way.

GL 300.01 *Cutaway Model: Worm Gear*





The technical drawings are part of the instructional material.

Manually Operated Open Samples of Various Drive Components and Elements

- View of the details and function of the components
- Despite the cut outs the movement functions are completely retained
- Operation using a hand crank

These models are fitted to sturdy metal base plates. Lifting handles make the models easier to carry. Technical descriptions and sectional drawings are included so that calculations and design aspects can be used as an educational topic.

LxWxH: 350 x 300 x 140 mm
Weight: approx. 2,5 kg
Item No. 030.30001

left:
GL 300.02 ***Mitre Gear***
Cutaway model
Item No. 030.30002

right:
GL 300.03 ***Spur Gear***
Cutaway model
Item No. 030.30003

left:
GL 300.04
Two-Stage Spur Gear
Cutaway model
Item No. 030.30004

right:
GL 300.05 ***Planetary Gear***
Cutaway model
Item No. 030.30005

left:
GL 300.06
Variable Speed Belt Drive
Cutaway model
Item No. 030.30006

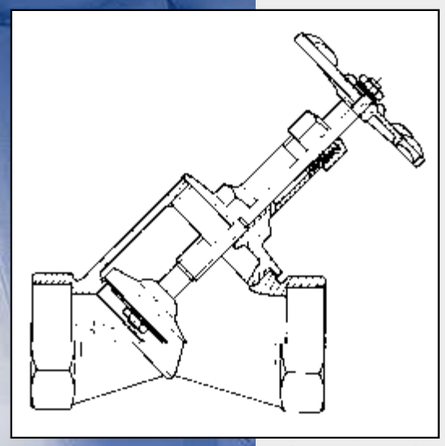
right:
GL 300.07 ***Control Gear***
Cutaway model
Item No. 030.30007

left:
GL 300.08 ***Multiple-Disc Clutch***
Cutaway model
Item No. 030.30008

right:
GL 300.12 ***Pedestal Bearing***
Cutaway model
Item No. 030.30012

HM 700 *Cutaway Models of Original Piping Components*

HM 700.01 Cutaway Model: Standard Orifice Plate



Sectional view of the HM 700.06 Angle Seat Valve

Commercial Fittings as Cutaway Models

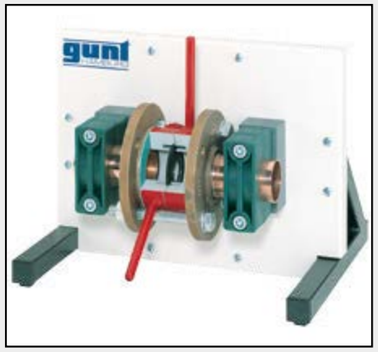
- Familiarisation with real components and their functions
- Detailed view and principle of operation of the components
- All fittings operate normally, the cuts do not hinder moving parts

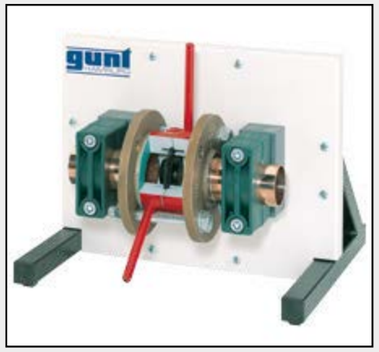
The cutaway models are actual fittings and components as used in real pipework installations, e.g. valves, an orifice plate, a measuring nozzle, shut-off fittings, a safety valve and pumps.

The models are clearly laid out on display panels or base plates.

A short description and a sectional view are included, so the models can also be used for technical drawing exercises.

The HM 700 series includes 19 different models that are shown on the following pages.



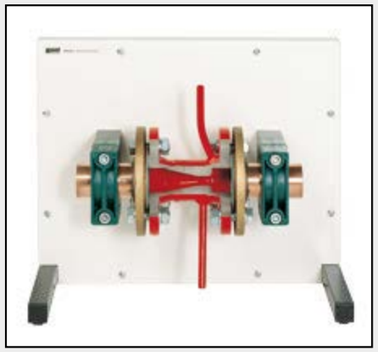


left:
HM 700.01 ***Standard Orifice Plate***

LxWxH: 400 x 370 x 300 mm
Weight: approx. 15 kg
Item No. 070.70001

right:
HM 700.02 ***Flow Nozzle***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 070.70002



left:
HM 700.03 ***Standard Venturi Meter***

LxWxH: 500 x 370 x 400 mm
Weigt: approx. 18 kg
Item No. 070.70003

right:
HM 700.04 ***Straight-Way Valve***

LxWxH: 400 x 370 x 300 mm
Weight: approx. 8 kg
Item No. 070.70004

left:
HM 700.05 ***Corner Valve***

LxWxH: 400 x 370 x 300 mm
Weight: approx. 8 kg
Item No. 070.70005

right:
HM 700.06 ***Angle Seat Valve***

LxWxH: 400 x 370 x 300 mm
Weight: approx. 10 kg
Item No. 070.70006

left:
HM 700.07 ***Non-Return Valve***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 070.70007

right:
HM 700.08
Pressure Reducing Valve

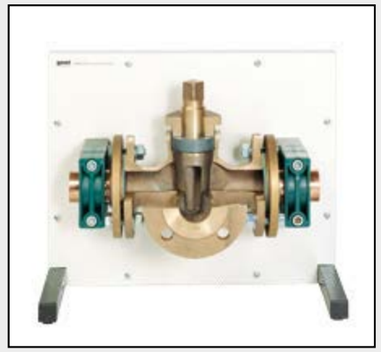
LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 070.70008

left:
HM 700.09 ***Strainer***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 10 kg
Item No. 070.70009

right:
HM 700.10 ***Gate Valve***

LxWxH: 400 x 370 x 300 mm
Weight: approx. 10 kg
Item No. 070.70010



left:
HM 700.11 ***Straight-Way Plug Valve***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 10 kg
Item No. 070.70011

right:
HM 700.12 ***3-Way Plug Valve***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 20 kg
Item No. 070.70012

left:
HM 700.13 ***Ball Valve***

LxWxH: 400 x 370 x 300 mm
Weight: approx. 10 kg
Item No. 070.70013

right:
HM 700.14 ***Safety Valve***

LxWxH: 400 x 370 x 300 mm
Weight: approx. 10 kg
Item No. 070.70014

left:
HM 700.15
Various Screwed Pipe Connections

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 070.70015

right:
HM 700.16 ***Pressure Gauges***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 12 kg
Item No. 070.70016

HM 700.17 *Cutaway Model: Centrifugal Pump*

Clearly Laid Out Benchtop Model

- Familiarisation with components and function

The model shows a standard centrifugal pump that has been prepared as a cutaway model and fitted to a base plate.

The impeller and shaft can be rotated.

LxWxH: 500 x 400 x 300 mm
Weight: approx. 29 kg
Item No. 070.70017

HM 700.20 *Cutaway Model: Piston Pump*

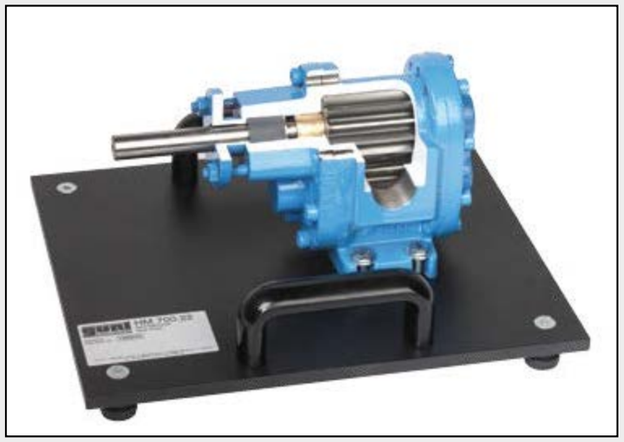
Clearly Laid Out Benchtop Model

- Familiarisation with components and function

A double-acting piston pump with disc piston is shown in cutaway, revealing all moving parts. The model is mounted on a base plate with carrying handles.

LxWxH: 650 x 350 x 450 mm
Weight: approx. 25 kg
Item No. 070.70020

HM 700.22 *Cutaway Model: Gear Pump*



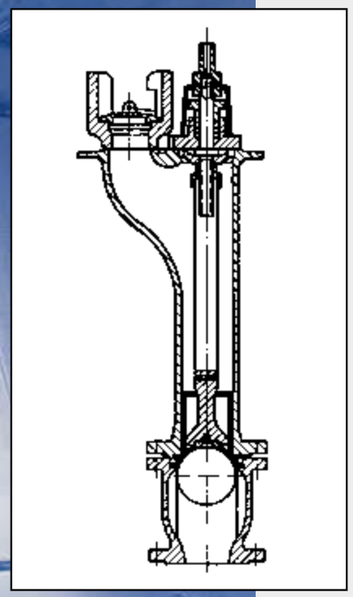
Clearly Laid Out Benchtop Model

- Familiarisation with components and function

A simple gear pump that has been prepared as a cutaway model and fitted to a base plate. By rotating the drive shaft it is possible to clearly demonstrate the function.

LxWxH: 350 x 300 x 300 mm
Weight: approx. 18 kg
Item No. 070.70022

VS 101 *Cutaway Model: Underground Hydrant*



Sectional view of the underground hydrant

Cutaway Models from Water and Gas Mains

- Familiarisation with components and their functions
- View of the details and understanding the principle of operation
- Movable parts retain functionality

The cutaway models shown on the following page illustrate commercial components used for drinking water and gas plumbing, such as shut-off fittings, backflow prevention valves and volumetric totalisers. These are similar in concept and design to the VS 101 model, but are mounted on vertical display panels.

A short description and a sectional view are included. In this way the models can also be used for technical drawing exercises.

The VS 101 is a normal underground hydrant made of cast iron. Hydrants are points for drawing water from the public water supply for emergency services or street cleaning.
The location of the cuts allow the design details to be clearly seen.

The cutaway model is mounted on a robust base plate. Two handles make it easier to carry.

LxWxH: 400 x 400 x 810 mm
Weight: approx. 35 kg
Item No. 076.10100

left:
VS 102 ***Resilient Seated Gate Valve***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 076.10200

right:
VS 103 ***Screw-Down Valve***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 076.10300

left:
VS 104 ***Changeover Valve***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 20 kg
Item No. 076.10400

right:
VS 105 ***Gas Meter***

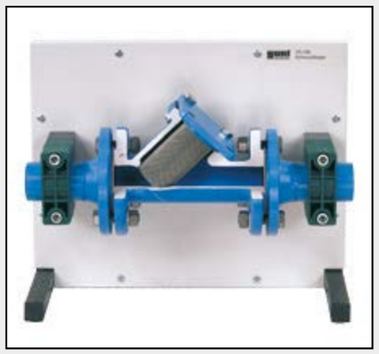
LxWxH: 500 x 370 x 400 mm
Weight: approx. 10 kg
Item No. 076.10500

left:
VS 106 ***Backflow Preventer***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 076.10600

right:
VS 107 ***Non-Return Butterfly Valve***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 076.10700



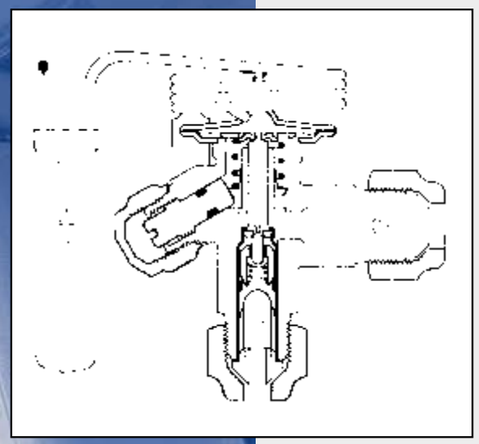
left:
VS 108 ***Water Meter***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 12 kg
Item No. 076.10800

right:
VS 109 ***Strainer***

LxWxH: 500 x 370 x 400 mm
Weight: approx. 15 kg
Item No. 076.10900

ET 499.30 *Cutaway Model: Ceiling Air Cooler*



Sectional drawing of a thermostatic expansion valve

Cutaway models from refrigeration engineering

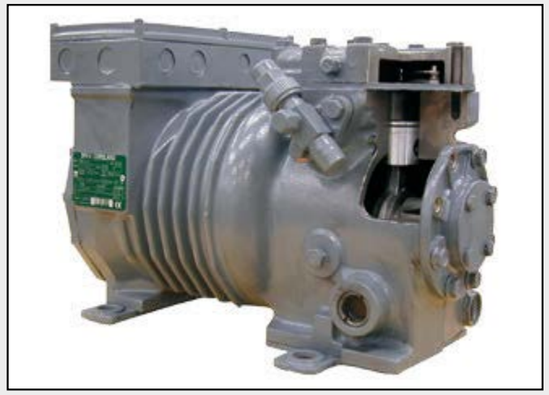
- Become familiar with components and their function
- Gain an insight into component details and understand functional principles
- All movements are fully reproduced

The cutaway models on the following pages show standard commercially available items from the field of refrigeration engineering, such as compressors, valves, driers and liquid separators. Each of the cutaway models come with a short description and a sectional drawing. This enables the didactic application of the models to be extended to exercises in technical drawing. The larger cutaway models are mounted on a solid base. Two handles aid transportation.
For ET 499.30, a commonly used ceiling air cooler, a thermostatic expansion valve and a filter drier are used. The cutaways are arranged to allow design details to be clearly identified.

LxWxH: 750 x 500 x 190 mm
Weight: approx. 20 kg
Item No. 061.49930

ET 499.01 ***Hermetic Refrigerant Compressor***

LxWxH: 300 x 300 x 240 mm, Weight: approx. 12 kg
Item No. 061.49901



ET 499.02 ***Semi-Hermetic Refrigerant Compressor***

LxWxH: 365 x 235 x 280 mm, Weight: approx. 41 kg
Item No. 061.49902

ET 499.03 ***Open Refrigerant Compressor, 2-Cyl.***

LxWxH: 300 x 300 x 200 mm, Weight: approx. 14 kg
Item No. 061.49903

ET 499.12 ***Block Drier***

LxWxH: 250 x 155 x 175 mm, Weight: approx. 5 kg
Item No. 061.49912

ET 499.13 ***Oil Separator***

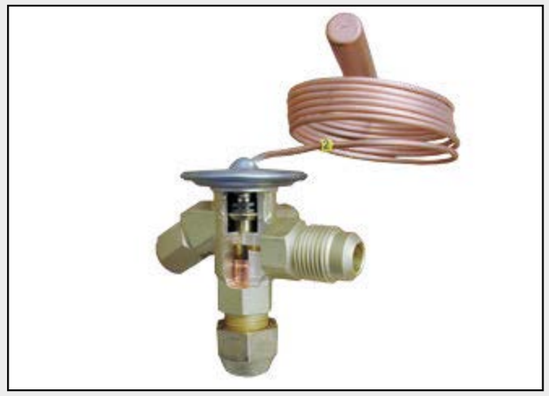
LxWxH: 360 x 110 x 130 mm, Weight: approx. 5 kg
Item No. 061.49913

ET 499.14 ***Liquid Separator***

LxWxH: 130 x 65 x 110 mm, Weight: approx. 1 kg
Item No. 061.49914

ET 499.16 ***Ball Valve***

LxWxH: 155 x 30 x 70 mm
Weight: approx. 1 kg
Item No. 061.49916



ET 499.18 ***Thermostatic Expansion Valve***

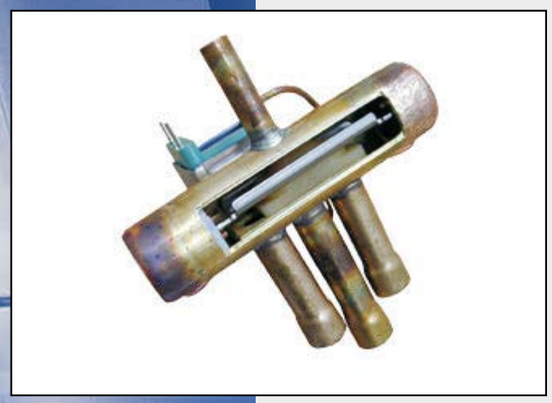
LxWxH: 120 x 70 x 120 mm, Weight: approx. 1 kg
Item No. 061.49918

ET 499.19 ***Automatic Expansion Valve***

LxWxH: 110 x 35 x 55 mm
Weight: approx. 1 kg
Item No. 061.49919

ET 499.21 ***Sight Glass with Humidity Indicator***

LxWxH: 75 x 35 x 35 mm, Weight: approx. 1 kg
Item No. 061.49921



ET 499.25
4/2-Way Reversing Valve

LxWxH: 110 x 70 x 120 mm
Weight: approx. 1 kg
Item No. 061.49925

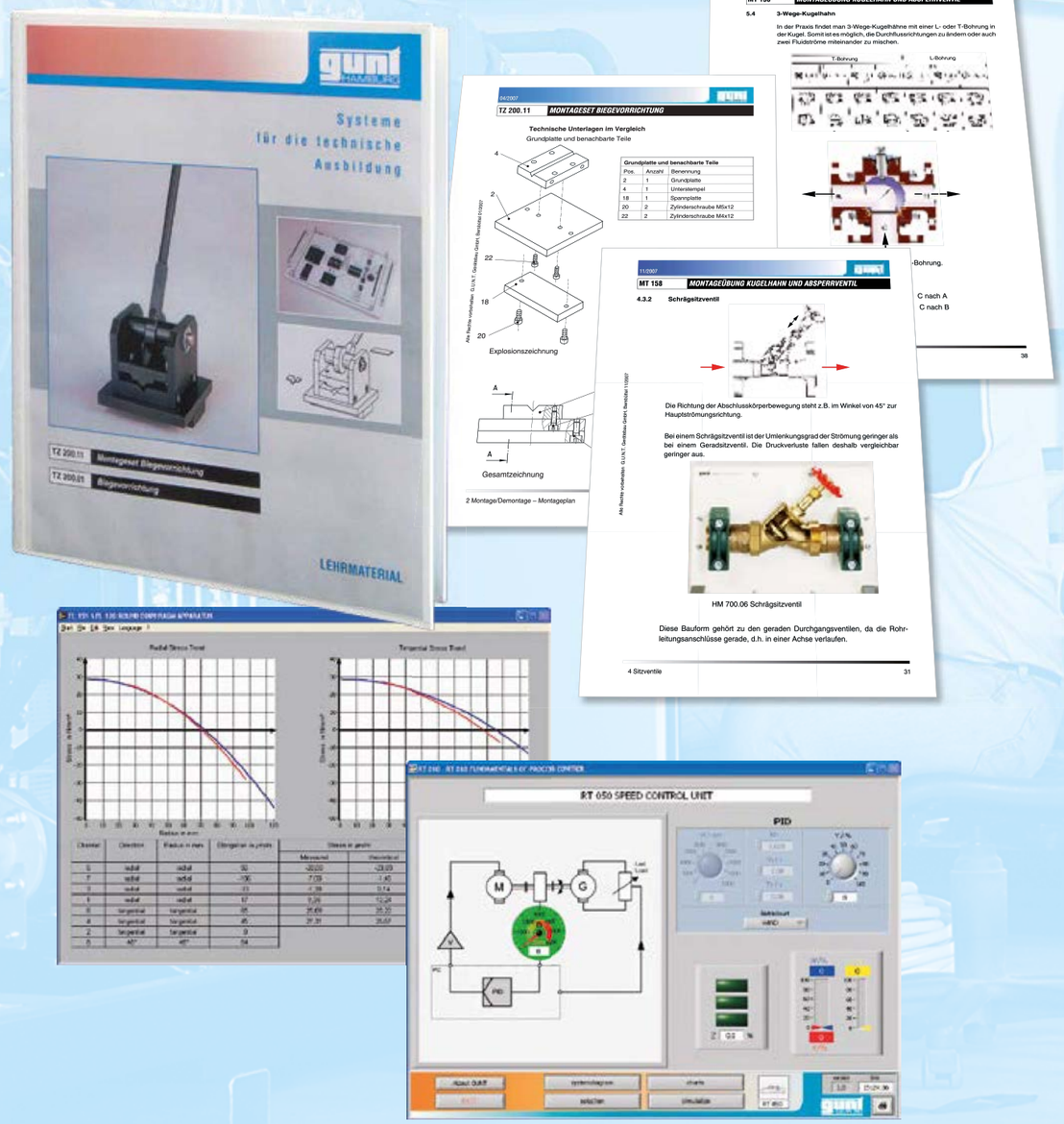
ET 499.26 ***Condensation Pressure Control Valve***

LxWxH: 180 x 30 x 105 mm, Weight: approx. 1 kg
Item No. 061.49926

INSTRUCTIONAL MATERIAL AND SOFTWARE

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

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



DIMENSIONAL METROLOGY

CODE	PRODUCT	PAGE
PT 105	Dimensional Metrology I: Training Kit 5	54
PT 101	Dimensional Metrology I: Training Kit 1	56
PT 102	Dimensional Metrology I: Training Kit 2	57

CODE	PRODUCT	PAGE
PT 103	Dimensional Metrology I: Training Kit 3	58
PT 104	Dimensional Metrology I: Training Kit 4	59
PT 106	Dimensional Metrology I: Training Kit 6	60

CODE	PRODUCT	PAGE
PT 201	Dimensional Metrology II: Training Kit 1	61
PT 202	Dimensional Metrology II: Training Kit 2	62

The testing and measuring of lengths, angles, radii etc. are tasks confronting all prospective skilled workers throughout their training. As well as becoming familiar with a wide range of equipment and methods, they also need to develop general skills such as:

- selecting a test or measurement method
- detecting systematic faults
- assessing measurement non-conformance
- keeping a measurement log
- reporting on results, etc.

We offer you eight different training kits aimed at achieving these learning goals. These kits are based on the assumption that you want your students to start work on the exercises immediately and without any further preparation. A kit contains everything required to begin the exercises immediately following a brief introduction. Optimal learning is achieved when students work in groups of 2/3 with each kit.

Our training kits follow the tried and proven concept for training courses in dimensional metrology developed by the Bundesinstitut für Berufsbildung (BIBB; Federal Institute for Vocational Training). And if you want to use your own measuring and testing equipment for the exercises, we will gladly supply you with just the test pieces.

PT 105 *Dimensional Metrology I: Training Kit 5*

*** Tried and tested dimensional metrology exercises**

*** Several test aids and 10 test pieces**

*** Comprehensive and well-structured instructional material**

Technical Description

This dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are stainless steel shafts with various protrusions. They were manufactured with the accuracy of CNC parts. The kit includes ten shafts, all of which differ to a minor degree in dimensions and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- familiarisation with the various measuring devices
- measurement of pre-determined lengths
- measurement of pre-determined diameters
- measurement of pre-determined radii
- dimensional checking with block gauges
- keeping a measurement log
- estimating measurement variations
- identifying typical errors

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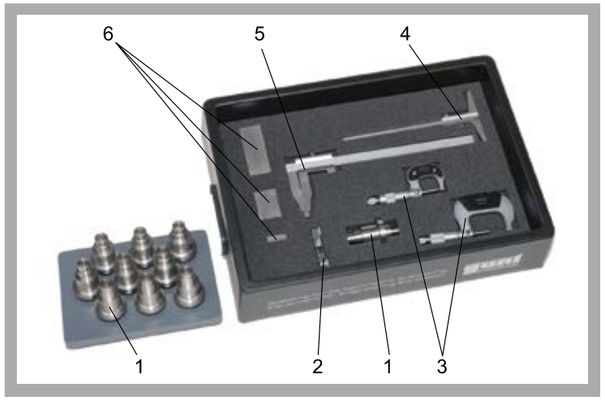
PT 105 *Dimensional Metrology I: Training Kit 5*



1 test piece, 2 radius gauges, 3 external micrometer, 4 depth caliper gauge, 5 caliper gauge, 6 block gauge

Measurement of length using a caliper gauge

Measurement of radius using a convex radius gauge

Specification

[1] practice kit for dimensional metrology in the metalworking trades
[2] measurement exercises on a stainless steel shaft
[3] instructional kit complete with test pieces and measuring aids
[4] 10 test pieces, each of different dimensions
[5] plastic storage system to house all parts
[6] detailed instructional material

Technical Data

Test pieces
- 6 lengths
- 7 diameters and radii measurable

Vernier caliper gauge: 0...200mm
Depth caliper gauge: 0...150mm
External micrometer
- 0...25mm
- 25...50mm

Radius gauges: 1...7mm concave and convex
Block gauges
- 10mm
- 50mm
- 90mm
- accuracy to DIN 861/2

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 7kg

Scope of Delivery

1 storage system with foam inlay
2 caliper gauges
2 external micrometers
1 set of radius gauges
3 block gauges
10 test pieces (shafts)
1 set of instructional material

Order Details

052.10500 PT 105 Dimensional Metrology I: Training Kit 5

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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PT 101 Dimensional Metrology I: Training Kit 1

*** Tried and tested dimensional metrology exercises**
*** Several test aids and 10 test pieces**
*** Comprehensive and well-structured instructional material**

Technical Description

The dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are flat stainless steel spacer plates. They were manufactured with the accuracy of CNC parts. The kit includes ten spacer plates, all of which differ to a minor degree in length and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- familiarisation with steel ruler and vernier caliper gauge
- measurement of pre-determined lengths:
  * with the steel ruler and an auxiliary stop
  * with the vernier caliper gauge
- keeping a measurement log
- estimating measurement variations
- identifying typical errors

Scope of Delivery

1 storage system with foam inlay, 1 vernier caliper gauge, 1 steel ruler, 10 test pieces (spacer plates), 1 set square, 1 auxiliary stop, 1 set of instructional material

Specification

[1] practice kit for dimensional metrology in the metalworking trades
[2] measurement exercises on a stainless steel spacer plate
[3] instructional kit complete with test pieces and measuring aids
[4] 10 test pieces, each of different dimensions
[5] plastic storage system to house all parts
[6] detailed instructional material

Technical Data

Test pieces: 13 lengths measurable
Vernier caliper gauge: 200mm
Steel ruler: 300mm
Set square: 90°, LxW: 100x70mm

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 5kg

Order Details

052.10100 PT 101 Dimensional Metrology I: Training Kit 1

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

PT 102 Dimensional Metrology I: Training Kit 2

*** Tried and tested dimensional metrology exercises**
*** Several test aids and 10 test pieces**
*** Comprehensive and well-structured instructional material**

Technical Description

This dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are stainless steel bearing plates. They were manufactured with the accuracy of CNC parts. The kit includes ten bearing plates, all of which differ to a minor degree in dimensions and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- familiarisation with vernier caliper gauge, depth caliper gauge, external micrometer and depth micrometer
- measurement of pre-determined lengths, depths and diameters
- keeping a measurement log
- estimating measurement variations
- identifying typical errors

Scope of Delivery

1 storage system with foam inlay, 1 vernier caliper gauge, 1 pocket caliper gauge, 1 depth caliper gauge, 1 external micrometer, 1 depth micrometer, 10 test pieces (bearing plates), 1 set of instructional material

Specification

[1] training kit for dimensional metrology in the metalworking trades
[2] measurement exercises on a stainless steel bearing plate
[3] instructional kit complete with test pieces and measuring aids
[4] 10 test pieces, each of different dimensions
[5] plastic storage system to house all parts
[6] detailed instructional material

Technical Data

Test pieces
- 9 lengths, 4 depths, 4 diameters measurable
Vernier caliper gauge: 0...200mm
Pocket caliper gauge: 0...150mm
Depth caliper gauge: 0...150mm
External micrometer: 0...25mm, resolution: 0,01mm
Depth micrometer: 0...25mm

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 7kg

Order Details

052.10200 PT 102 Dimensional Metrology I: Training Kit 2

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

PT 103 Dimensional Metrology I: Training Kit 3

*** Tried and tested dimensional metrology exercises**
*** Several test aids and 10 test pieces**
*** Comprehensive and well structured instructional material**

Technical Description

This dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are stainless steel bushes with various inner and outer diameters. They were manufactured with the accuracy of CNC parts. The kit includes ten bushes, all of which differ to a minor degree in dimensions and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- familiarisation with the various measuring devices
- measurement of pre-determined lengths and diameters
- using an inside spring caliper as gauge
- keeping a measurement log
- estimating measurement variations
- identifying typical errors

Scope of Delivery

1 storage system with foam inlay, 3 caliper gauges, 2 internal micrometers, 1 inside quick caliper, 1 internal caliper, 10 test pieces (bushes), 1 set of instructional material

Specification

[1] practice kit for dimensional metrology in the metalworking trades
[2] measurement exercises on a stainless steel bush
[3] instructional kit complete with test pieces and measuring aids
[4] 10 test pieces, each of different dimensions
[5] plastic storage system to house all parts
[6] detailed instructional material

Technical Data

Test pieces: 6 lengths, 9 diameters measurable
Vernier caliper gauge: 0...200mm
Pocket caliper gauge: 0...150mm
Depth caliper gauge: 0...150mm
Three-point internal micrometer: d12...d16mm
Internal micrometer: 25...50mm
Inside quick caliper: 10...30mm
Inside spring caliper: 125mm long

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 7kg

Order Details

052.10300 PT 103 Dimensional Metrology I: Training Kit 3

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

PT 104 Dimensional Metrology I: Training Kit 4

*** Tried and tested dimensional metrology exercises**
*** Several test aids and 10 test pieces**
*** Comprehensive and well-structured instructional material**

Technical Description

This dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are stainless steel angle plates that have been manufactured with the accuracy of CNC parts. The kit includes ten angle pieces, all of which differ to a minor degree in dimensions and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- familiarisation with a universal goniometer and its function
- measurement of pre-determined angles
- calculation of angles
- keeping a measurement log
- estimating measurement variations
- identifying typical errors

Scope of Delivery

1 storage system with foam inlay, 1 universal goniometer, 10 test pieces (angle pieces), 1 set of instructional material

Specification

[1] practice kit for dimensional metrology in the metalworking trades
[2] measurement exercises on a stainless steel angle piece
[3] instructional kit complete with test pieces and measuring aids
[4] 10 test pieces, each of different dimensions
[5] plastic storage system to house all parts
[6] detailed instructional material

Technical Data

Test pieces: 6 angles measurable
Universal goniometer
- track length: 150mm
- adjustable to any angle

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 5kg

Order Details

052.10400 PT 104 Dimensional Metrology I: Training Kit 4

G.U.N.T Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web http://www.gunt.de

PT 106 Dimensional Metrology I: Training Kit 6

*** Tried and tested dimensional metrology exercises**
*** Several test aids and 10 test pieces**
*** Comprehensive and well-structured instructional material**

Technical Description

This dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are stainless steel shafts with various protrusions including one square section. They were manufactured with the accuracy of CNC parts. The kit includes ten shafts, all of which differ to a minor degree in dimensions and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- familiarisation with the various measuring and testing devices
- measurement of pre-determined dimensions
- keeping a measurement log
- estimating measurement variations
- identifying typical errors

Scope of Delivery

1 storage system with foam inlay, 2 caliper gauges, 1 set of radius gauges, 1 universal goniometer, 10 test pieces (shafts), 1 set of instructional material

Specification

[1] practice kit for dimensional metrology in the metalworking trades
[2] measurement exercises on a stainless steel shaft
[3] instructional kit complete with test pieces and measuring aids
[4] 10 test pieces, each of different dimensions
[5] plastic storage system to house all parts
[6] detailed instructional material

Technical Data

Test pieces
- 9 lengths and angles, 7 diameters and radii measurable

Vernier caliper gauge: 0...200mm
Depth caliper gauge: 0...150mm
Radius gauges: 1...7mm concave and convex
Universal goniometer
- track length: 150mm
- adjustable to any angle

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 6kg

Order Details

052.10600 PT 106 Dimensional Metrology I: Training Kit 6

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

PT 201 Dimensional Metrology II: Training Kit 1

*** Tried and tested dimensional metrology exercises**
*** Several test aids and 6 test pieces**
*** Comprehensive and well-structured instructional material**

Technical Description

This dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are stainless steel slotted shafts. They were manufactured with the accuracy of CNC parts. The kit includes six shafts, all of which differ to a minor degree in dimensions and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- checking shaft slots
  * width and depth
  * parallelism
- keeping a measurement log
- estimating measurement variations

Scope of Delivery

1 storage system with foam inlay, 2 caliper gauges, 1 micrometer, 1 dial gauge, 1 V-block with fixture, 1 block gauge box, 1 magnetic stand, 6 test pieces (shafts), 1 set of instructional material

Specification

[1] practice kit for dimensional metrology in the metalworking trades
[2] measurement exercises on a stainless steel shaft
[3] instructional kit complete with test pieces and measuring aids
[4] 6 test pieces, each of different dimensions
[5] box of 32 block gauges, DIN EN ISO 3650
[6] plastic storage system to house all parts
[7] detailed instructional material

Technical Data

Test pieces: 4 dimensions measurable
Pocket caliper gauge: 0...150mm
Depth micrometer: 0...75mm
Dial gauge: 0...1mm, graduations: 0,001mm
Key-way vernier caliper: D=5...80mm
V-Block: indent 90°

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 12kg

Order Details

052.20100 PT 201 Dimensional Metrology II: Training Kit 1

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

PT 202 Dimensional Metrology II: Training Kit 2

*** Tried and tested dimensional metrology exercises**

*** Several test aids and 8 test pieces**

*** Comprehensive and well-structured instructional material**

Technical Description

This dimensional metrology practice kit is designed for practical training in the metalworking trades.

The kit offers the advantage of being ready for use immediately; it contains everything required for the exercises. The test pieces used are stainless steel internal and external tapers. They were manufactured with the accuracy of CNC parts. The kit includes eight tapers, all of which differ to a minor degree in dimensions and each of which is individually marked.

All parts are clearly laid out and well protected on a plastic storage system. The storage systems are stackable, providing for space-saving storage.

Learning Objectives / Experiments

- checking tapers:
  * checking an external taper with the taper ring gauge
  * checking an internal taper with the taper plug gauge
- keeping a measurement log
- estimating measurement variations

Scope of Delivery

1 storage system with foam inlay, 1 depth caliper gauge, 1 taper ring gauge, 1 taper plug gauge, 8 test pieces (4 internal tapers, 4 external tapers), 1 set of instructional material

Specification

[1] practice kit for dimensional metrology in the metalworking trades
[2] measurement exercises on an external and internal taper
[3] instructional kit complete with test pieces and measuring aids
[4] 8 stainless steel test pieces, each of different dimensions
[5] plastic storage system to house all parts
[6] detailed instructional material

Technical Data

Test pieces: 3 dimensions measurable
Taper ring gauge MK 3
Taper plug gauge MK 3
Depth caliper gauge: 0...150mm

Dimensions and Weight

LxWxH: 500x350x110mm (storage system)
Weight: approx. 4kg

Order Details

052.20200	PT 202	Dimensional Metrology II: Training Kit 2

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

FASTENERS AND MACHINE PARTS

WORKSHOP EXERCISES

DEMONSTRATION KITS

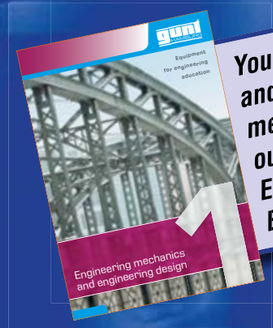
TECHNOLOGICAL EXPERIMENTS

Knowledge of fasteners and machine parts is key to gaining an understanding of mechatronic systems.

Our **workshop exercises** cover a range of joining techniques. They are less suitable for use in the classroom or for demonstration purposes.

The **demonstration kits** provide an overview of standard parts such as bolts, bolt locking devices, nuts and roller bearings. Their purpose is purely demonstrative; they do not contain experiments or exercises.

A third area is represented by our **technological experiments**. Here, students are able to learn about basic aspects of technical mechanics in a simple, clearly illustrated manner.



You will find more training and practice units relating to mechanical engineering in our catalogue number 1: ENGINEERING MECHANICS & ENGINEERING DESIGN

Visit our website www.gunt.de

MG 100 Instructional Kit: Assembly with Dowel Pins

*** Practical workshop exercise relating to pin joints**

*** Familiarisation with various pin types, their special features and applications**

Technical Description

The practice kit provides the material necessary for students to systematically learn how components can be joined together in a professional way using pins. Both flat and cylindrical parts are pinned together. We recommend that the exercises are carried out in a workshop, as all preparations such as scribing, drilling, clamping, reaming and joining must be carried out in a correct and proper manner by the student.

The material is clearly laid out on a plastic tray. The well-structured instructional material outlines all the necessary technical information and provides a step-by-step guide through the exercises.

Learning Objectives / Experiments

- familiarisation with different types of pin and their specific applications: grooved pins, dowel pins, straight pins, tapered pins
- familiarisation with the relevant standard designations and terms, including graphical representation
- planning and execution of all steps in the workshop environment
- familiarisation with types of pinned joint
- working with fits and tolerances

Scope of Delivery

1 complete set of material, laid out on a tray
1 set of instructional material

Specification

[1] set of material for workshop exercises relating to pin joints
[2] joining flat items
[3] joining cylindrical items
[4] pin puller
[5] all parts clearly laid out on a tray
[6] multiple trays stackable

Technical Data

Straight pins: d=6, 8mm
Grooved pins: d=3, 5, 8mm
Dowel pins: d=5mm
Tapered pins: d=6, 8mm
Studs: d=8mm
Shaft with set collar: shaft diameter: d=40mm
All parts made from steel, some with gunmetal finish

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 14kg

Order Details

053.10000 MG 100 Instructional Kit: Assembly with Dowel Pins

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

MG 110 Instructional Kit: Assembly with Keys

*** Practical workshop training relating to feather key joints**

*** Familiarisation with various feather keys, their production, special features and applications**

Technical Description

This instructional kit provides the necessary material for students to learn systematically how a hub and a shaft can be joined together in a professional way using feather keys. We recommend that the exercises are carried out in a workshop, as all preparations such as filing, drilling, countersinking and tapping must be carried out in a correct and proper manner by the student.

The material is clearly laid out on a plastic tray. The well-structured instructional material outlines all the necessary technical information and provides a step-by-step guide through the exercises.

Learning Objectives / Experiments

- production of different feather keys: round ended and straight ended
- assembly of feather key joints: light fit/sliding fit
- familiarisation with the relevant standard designations and terms, including graphical representation
- planning and execution of all steps in the workshop environment
- familiarisation with types of keyed joint
- working with fits and tolerances

Scope of Delivery

1 complete set of material, laid out on a tray
1 set of instructional material

Specification

[1] set of material for workshop exercises in feather key joints
[2] shaft with slots
[3] hub with 1 slot
[4] hub with 2 slots
[5] driver sleeve
[6] 1 set of semi-finished items for the production of feather keys to DIN 6885
[7] all parts clearly laid out on a tray
[8] multiple trays stackable

Technical Data

Semi-finished items
- feather key shape AS (round ended): 14x9x65mm
- feather key shape E (round ended): 14x9x142mm
- feather key shape E (straight ended): 14x9x142mm

All parts made from steel, some with gunmetal finish

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 18kg

Order Details

053.11000 MG 110 Instructional Kit: Assembly with Keys

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

MG 120 Instructional Kit: Assembly with Taper Keys

*** Practical workshop exercise relating to taper key joints**

*** Familiarisation with various taper keys, their production, special features and areas of application**

Technical Description

This instructional kit provides the necessary material for students to learn systematically how a shaft is joined to a hub or a coupler in a professional way using taper keys. We recommend that the exercises are carried out in a workshop, as all preparations such as filing, drilling, countersinking and tapping must be carried out in a correct and proper manner by the student.

The material is clearly laid out on a plastic tray. The well-structured instructional material outlines all the necessary technical information and provides a step-by-step guide through the exercises.

Learning Objectives / Experiments

- production of different taper keys: round ended, straight ended, nose key, tangential key pair, cotter
- assembling taper key joints:
- familiarisation with the relevant standard designations and terms, including graphical representation
- planning and execution of all steps in the workshop environment
- familiarisation with types of taper-keyed joint
- working with fits and tolerances

Scope of Delivery

1 complete set of material, laid out on a tray
1 set of instructional material

Specification

[1] set of material for workshop exercises in taper key joints
[2] shaft with slots
[3] 2 hubs with slots
[4] coupler
[5] key driver, key extractor, driver sleeve
[6] 1 set of semi-finished items for the production of taper keys to DIN 6886 and DIN 6887
[7] all parts clearly laid out on a tray
[8] multiple trays stackable

Technical Data

Semi-finished items
- taper key shape A (round ended): 14x9x75mm
- taper key shape B (straight ended): 14x9x82mm
- nose key: 14x9x90mm
- tangential key: 10x6x165mm
- cotter key: 25x6x62mm

All parts made from steel, some with gunmetal finish

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 18kg

Order Details

053.12000 MG 120 Instructional Kit: Assembly with Taper Keys

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

MG 200 Instructional Kit: Threaded Fasteners and Lock Washers

*** Practical workshop training relating to threaded joints**

*** Familiarisation with the key influencing factors**

Technical Description

This training kit provides the necessary material for joining workpieces with threaded joints. In the process, specific influencing factors (e.g. type of bolt locking, bolt length) can be analysed independently of each other. Bolt tightening and breakaway torques are measured using a torque wrench. The workpieces are held securely in a vice during the experiments.

The material, including the torque wrench, is clearly laid out on a plastic tray. The well-structured instructional material outlines all the necessary technical information and provides a step-by-step guide through the exercises.

Learning Objectives / Experiments

- tightening a threaded joint to a preset torque
- measuring the breakaway torque as a function of the bolt length, property class, bolt locking type and tightening torque
- familiarisation with the relevant standard designations and terms, including graphical representation

Scope of Delivery

1 complete set of material, laid out on a tray
1 set of instructional material

Specification

[1] set of material for workshop exercises relating to threaded joints
[2] brace with drill holes, 5 flat bars
[3] bolts to ISO 4014 and ISO 4017
[4] nuts to ISO 4032 and ISO 7040
[5] measurement of the tightening torque using a torque wrench with dial indicator
[6] all parts clearly laid out on a tray
[7] multiple trays stackable

Technical Data

Bolts M10
- property classes 5.6 and 8.8
- lengths: 35, 55, 75mm

Nuts M10, some self-locking
Various bolt locks, spring ring, toothed washer, strain washer
Torque wrench: 0...50Nm
Joined workpieces (flat bar and brace) made from steel, some with gunmetal finish

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 9kg

Order Details

053.20000 MG 200 Instructional Kit: Threaded Fasteners and Lock Washers

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

MG 901 Nuts and Bolts Kit

*** Comprehensive instructional kit of the main nuts and bolts used in engineering**

*** Familiarisation with standard designations and terms**

Technical Description

This instructional kit is used for demonstration and information purposes. No provision is made for conducting exercises or experiments. The industrially-standard items are clearly laid out, screw-fitted into an aluminium panel. The symbols on the panel show the correct graphical representation as well as the DIN and standard designations of the items concerned.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with the main nuts and bolts used in engineering and their specific applications
- familiarisation with the relevant standard designations and terms, including graphical representation

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] nuts and bolts demonstration kit
[2] 42 standard parts, clearly laid out on an aluminium panel
[3] screen-printed panel
[4] screen-printing shows graphical representation and DIN designation
[5] all parts clearly laid out on a plastic tray
[6] multiple trays stackable

Technical Data

Aluminium panel, LxW: 350x255mm
Bolts: C4.8, K4.8, M6, M8, M10
Nuts: M6, M8, M10

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 5kg

Order Details

053.90100 MG 901 Nuts and Bolts Kit

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

MG 903 Screw-Locking Devices Kit

*** Comprehensive instructional kit of the main screw-locking devices used in engineering**

*** Familiarisation with standard designations and terms**

Technical Description

This instructional kit is used for demonstration and information purposes. No provision is made for conducting exercises or experiments. Screw-locking devices are presented in the as-fitted position on an aluminium panel. A transparent multi-compartment storage tray holds large numbers of screw-locking devices.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with the main screw-locking devices used in engineering and their specific applications
- familiarisation with the relevant standard designations and terms, including graphical representation

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] screw-locking devices demonstration kit
[2] 18 fitted screw-locking devices, clearly laid out on an aluminium panel
[3] transparent storage tray with 18 compartments each holding 10 of the different screw-locking devices
[4] all parts clearly laid out on a plastic tray
[5] multiple trays stackable

Technical Data

Aluminium panel, LxW: 238x100mm
Locking devices for M6

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 5kg

Order Details

053.90300 MG 903 Screw-Locking Devices Kit

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

MG 905 *Thread Types Kit*

*** Comprehensive instructional kit of the main thread types used in engineering**

*** Familiarisation with standard designations and terms**

Technical Description

This instructional kit is used for demonstration and information purposes. No provision is made for conducting exercises or experiments.

Various bolt and nut threads are included. The thread flanks are made visible by cut-outs. A thread gauge enables the thread type and size to be determined.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with the main thread types used in engineering and their specific applications
- determining the thread type with the thread gauge

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] thread type demonstration kit
[2] 8 thread types, clearly laid out
[3] thread flanks visible with cut-outs
[4] galvanized parts
[5] thread gauge for determining thread type
[6] all parts clearly laid out on a plastic tray
[7] multiple trays stackable

Technical Data

Thread size: 24mm diameter
Thread gauge for male and female threads
- metric ISO thread
- Whitworth thread
- Whitworth pipe thread

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 5kg

Order Details

053.90500 MG 905 Thread Types Kit

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

MG 911 *Roller Bearings Kit*

*** Comprehensive instructional kit of the main roller bearings used in engineering**

*** Familiarisation with standard designations and terms**

Technical Description

This instructional kit is used for demonstration and information purposes. No provision is made for conducting exercises or experiments.

The kit presents various roller bearings. The bearings are selected for one size of shaft.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with the main roller bearings used in engineering and their specific applications
- familiarisation with the relevant standard designations and terms
- discussion of specific applications

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] roller bearings demonstration kit
[2] 13 roller bearings, clearly laid out: 5 roller bearings and 8 ball bearings
[3] 2 axial bearings / 11 radial bearings
[4] all parts clearly laid out on a plastic tray
[5] multiple trays stackable

Technical Data

Bearing dimensions
- inside diameter: d=20mm
- outside diameter: d=35, 40, 42, 47, 52mm
- bearing width: h=8, 10, 12, 14, 15, 18, 47mm

Dimensions and Weight

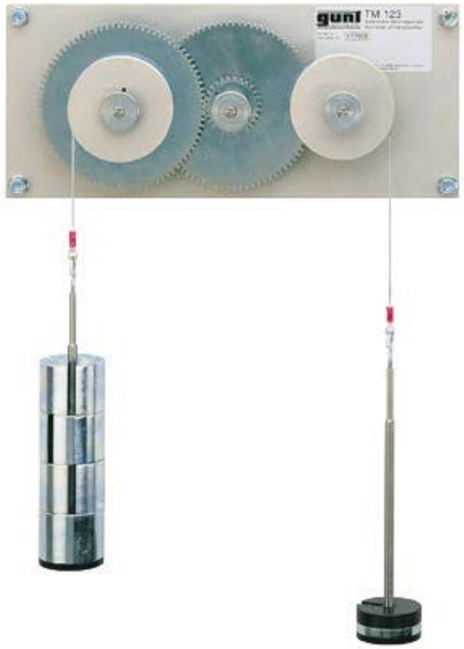
LxWxH: 500x350x110mm (tray)
Weight: approx. 6kg

Order Details

053.91100 MG 911 Roller Bearings Kit

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

TM 123 Spur Gear Lifting Apparatus



Specification

[1] demonstration and student experimental unit on setup and principle of toothed gearing mechanisms
[2] 4 galvanised steel gear wheels
[3] 2 anodised aluminium cable pulleys
[4] 2 sets of weights
[5] ball bearing-mounted gear wheels and pulleys
[6] anodised aluminium base plate

Technical Data

4 gear wheels
- 2x D=126mm, 84 teeth
- 2x D=42mm, 28 teeth
- modulus: m=2mm

Driving pulley radius: 35mm

Set of weights
- 2x 1N suspended
- 2x 0,25N
- 1x 0,5N
- 2x 1N
- 2x 2N
- 2x 2,5N

Base plate
- LxWxH: 350x150x10mm

Dimensions and Weight

LxWxH: 350x70x150mm
Weight: approx. 5kg

Scope of Delivery

1 gear unit, mounted on base plate
2 sets of weights
1 set of instructional material

*** Setup and principle of toothed gearing mechanisms**

Technical Description

The mechanism demonstrates the relationship between the ratio of the number of teeth on spur gears and the transmission ratio of gears. With straightforward experiments, the torque conversion in gear wheel pairs and the efficiency of a gear unit are investigated.

The model is intended for wall mounting. The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

Learning the key variables and correlations of a spur gear
- velocity ratios of spur gears
- gear with intermediate wheel or two-stage gearing
- influence of friction on transmission
- determining efficiency

Order Details

040.12300 TM 123 Spur Gear Lifting Apparatus

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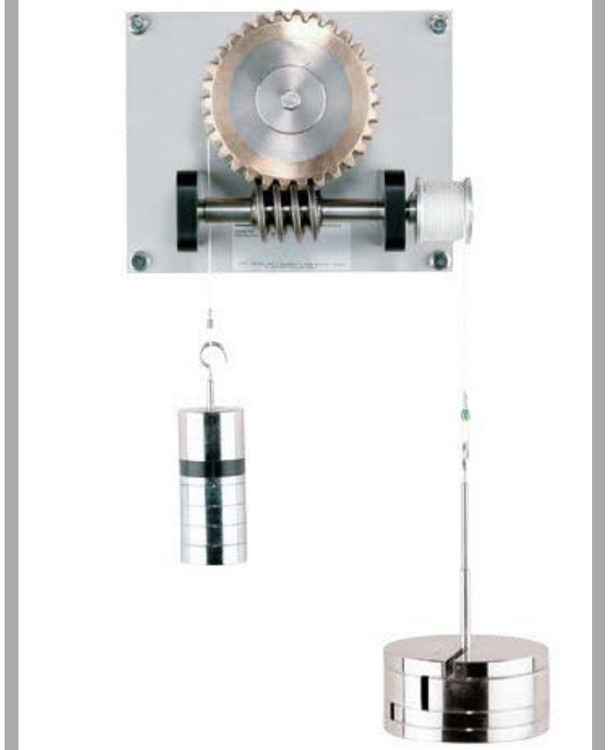
TM 124 Worm and Wheel Apparatus



Specification

[1] demonstration and student experimental unit on the setup and principle of a worm gear
[2] bronze worm gear wheel
[3] steel worm
[4] 2 Aluminium side drums
[5] 2 sets of weights
[6] worm, worm gear wheel and pulleys ball bearing-mounted
[7] anodised aluminium base plate

Technical Data

Side drum diameter
- on worm shaft: d=40mm
- on worm gear wheel shaft: d=120mm

Worm drive
- axle base: 80mm
- transmission ratio: 30:1
- modulus: m=4mm
- number of gears: 1
- power transmission: 10

Weights on worm side
- 1x 50N
- 1x 20N
- 2x 10N
- 1x 10N (suspended with balance mass)

Weights on worm gear wheel
- 1x 5N
- 4x 2N
- 1x 1N
- 1x 0,5N
- 1x 0,5N (suspended)

Base plate
- LxWxH: 250x200x12mm

Dimensions and Weight

LxWxH: 250x150x200mm
Weight: approx. 22kg

Scope of Delivery

1 gear unit, mounted on base plate
2 sets of weights
1 set of instructional material

*** Setup and principle of a worm gear**

Technical Description

TM 124 permits investigations of the torques and the efficiency of the gear unit. The transmission ratio of the gear can be determined. Students learn the basic terminology of gearing in a simple manner: numbers of teeth; modulus; reference circle and axle base.

The worm gear wheel and worm are ball bearing-mounted. The forces are generated by the sets of weights and can be quickly and easily varied.

The model is intended for wall mounting. The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

Learning the key variables and correlations of a worm gear
- investigating: transmission ratio, torque, friction and self-locking
- determining efficiency

Order Details

040.12400 TM 124 Worm and Wheel Apparatus

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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GL 110 *Cam Mechanism*

Specification

[1] action principle of cam mechanisms
[2] 4 different cams: arc/tangent/concave/asymmetric cam
[3] roller tappet, cup tappet and trailing lever
[4] angled scale 0...360°, D=100mm
[5] dial gauge D=58mm
[6] cams and tappets easy to change, without use of tools

Technical Data

Angle scale
- 0...360°
- graduations: 1°

Dial gauge for displacement
- 0...30mm
- graduations: 0,01mm

Dimensions and Weight

LxWxH: 160x160x260mm
Weight: approx. 7kg

Scope of Delivery

1 cam mechanism experimental unit
4 cams
2 cam tracers
1 dial gauge
1 set of instructional material

*** Demonstration and measurement of the displacement curves for cam mechanisms**

*** Rapid part changing without tool**

Technical Description

Cam mechanisms are used in many areas of technology, such as for valve control in combustion engines. The simple experimental setup permits quick demonstration of the action principle, and can be used to demonstrate the influence of different cam shapes. The cam follower can work either as a roller tappet, cup tappet, or trailing lever. The stroke is measured using a mechanical position measurement gauge. A scaled disk indicates the associated angle of rotation.

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

Learning Objectives / Experiments

- displacement curves for cam mechanisms
  * arc/tangent/concave/asymmetric cam
  * choice of roller tappet, cup tappet or trailing lever

Order Details

030.11000 GL 110 Cam Mechanism

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

TM 232 *Bearing Friction*

Technical Description

TM 232 provides experiments relating to friction on sliding and rolling bearings. Bearing shells in various materials serve as sliding bearings. Bearing forces are generated by the dead-weight of a heavy flywheel. A torque is applied by means of weights which correspond to the frictional torque when the motion begins. When the rolling bearings are used the bearing friction is very low. In this case the flywheel can be used for fundamental experiments in rotational dynamics.

The unit is intended for mounting on a laboratory wall.

Learning Objectives / Experiments

- determination of friction torque on sliding bearings: various material pairings by means of interchangeable bearing shells
- determination of the friction torque on a rolling bearing
- comparison between sliding and rolling bearing
- fundamental experiments in rotational dynamics

*** Sliding bearing friction with different bearing materials; comparison with rolling bearing friction**

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TM 282 Friction in Journal Bearings

*** Fundamentals of hydrodynamic lubrication**

*** Friction states for different operating states**

*** Electronic speed control and digital display of speed and lubricant temperature**

Technical Description

There a many factors of influence concerning the friction states in a hydrodynamic journal bearing. Speed, load, and viscosity are focused in particular.

TM 282 enables to study various factors of influence on friction.

The journal bearing consists of an electrically driven journal rotating in a freely movable bearing housing. The transparent bearing housing enables the observation of the displacement of the journal depending on the speed and the direction of rotation as well as the characteristic behaviour when starting.

A load device transfers the applied load to the bearing housing. The load can be varied with the supplied weights. The determination of the friction moment is realised by a sliding weight balancing the moment on a balance beam. The shaft is driven by an electric motor. The speed is variably adjustable by a frequency converter. A temperature sensor in the bearing bush records the temperature and therefore the viscosity of the lubricant. The temperature is indicated at the display and control unit. Lubricant is supplied by a drip-feed lubricator that feeds oil to the bearing bush via two lubrication channels. A drip tray collects the oil that leaks out.

Learning Objectives / Experiments

- developing technological correlations involved in hydrodynamic lubrication by experimentation
- moment of friction in a journal bearing dependent on
  * speed
  * bearing load
  * lubricant and lubricant temperature

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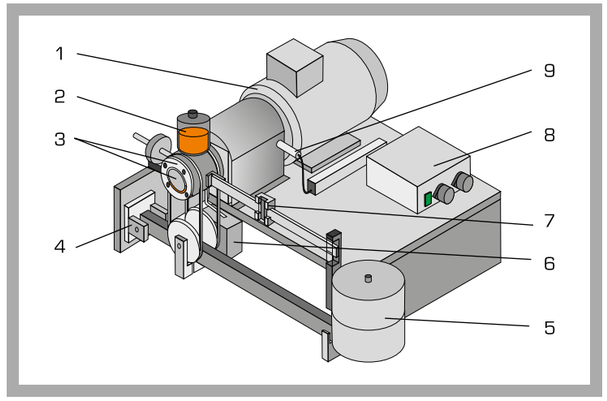
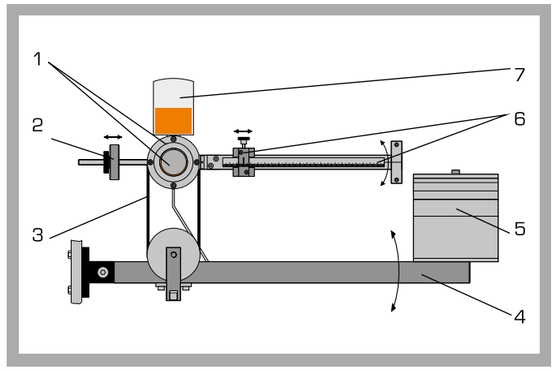
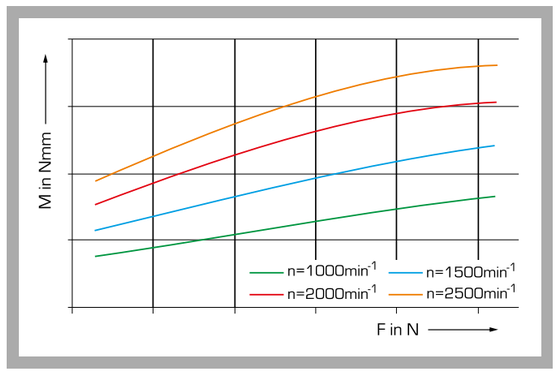
TM 282 Friction in Journal Bearings



1 motor, 2 drip-feed lubricator, 3 journal bearing housing with shaft, 4 fixed bearing for load lever, 5 load weights, 6 leakage oil tank, 7 sliding weight for measuring the friction moment, 8 switch box, 9 speed sensor



1 journal bearing housing with shaft, 2 balance weight, 3 belt for force transmission to bearing housing, 4 load lever, 5 weights, 6 measuring lever with scale and sliding weight, 7 drip-feed lubricator



Influence of load F and speed n on friction moment M

Specification

[1] investigation and visualisation of a hydrodynamic bearing
[2] radial journal bearing with stainless steel shaft journal and freely movable bronze bearing shells
[3] drip-feed lubrication for continuous lubricant supply (drip-feed lubricator)
[4] load applied to journal bearing using a mechanical lever
[5] variable speed via frequency converter
[6] measurement of friction moment using a lever with sliding weight
[7] inductive speed measurement
[8] thermocouple at the bearing housing for oil temperature measurement
[9] display and control unit with digital displays for oil temperature and speed

Technical Data

Journal bearing
- bearing journal diameter: D=30mm
- bearing width: 45mm
- friction pairing: steel / bronze

Motor: 0,37kW
Oil viscosity class: ISO VG 32
Set of weights
- 1x 50N, 1x 20N, 2x 10N, 2x 5N;
- lever transmission ratio: 5:1

Measuring ranges
- temperature: -50...200°C
- speed: 0...3.000min^{-1}
- bearing load: max. 525N
- friction moment: max. 295Nmm

Dimensions and Weight

LxWxH: 610x440x360mm (experimental unit)
LxWxH: 360x340x160mm (display and control unit)
Weight: approx. 40kg

Required for Operation

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

Scope of Delivery

1 experimental unit
1 display and control unit
1 set of weights
0,5L oil
1 set of instructional material

Order Details

040.28200 TM 282 Friction in Journal Bearings

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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TM 320 *Screw Tester*

*** Correlation between tightening torque and tension force on standardised bolts**

*** Breakaway torque of a bolt joint**

Technical Description

The main element of the unit is a slotted, elastically deformable steel block. By tightening the bolt joint, the slotted area is deformed, thereby generating an axial tension force in the bolt. The resulting deformation is recorded by a mechanical dial gauge, and is directly related to the bolt tension force generated. The bolt joint is tightened and slackened using a special torque wrench, which can be set sensitively with the aid of a threaded spindle. By using an axial bearing, the head friction of the bolt can be largely excluded, so that only the friction of the threaded joint is measured.

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

Learning Objectives / Experiments

- axial tension force in a bolt joint dependent on the tightening torque or the elastic deformation of a slotted block
- measurement of the breakaway torque, including for different fitting situations of the bolt joint
- measurement of thread friction and overall friction

Scope of Delivery

1 bolt tester complete with switchable ratchet, 1 set of bolts in transparent container, 1 set of instructional material

Specification

[1] experiment on the correlation between the tension force and tightening torque of bolts
[2] bolt size M8x100, wrench jaw size 13mm
[3] elastic deformation of a slotted block by the bolt
[4] determining the tightening and breakaway torque with a mechanical torque measuring device
[5] 2 position dial gauges
[6] sensitive torque setting by hand wheel

Technical Data

Tension force: max. 40kN
Force/travel constant: 20kN/mm (on slotted block)
Max. tightening torque: 40Nm
Torque/travel constant: 10Nm/mm (on torque measuring device)
Position dial gauge: 0...10mm, graduations: 0,01mm

Dimensions and Weight

LxWxH: 450x400x260mm
Weight: approx. 27kg

Order Details

040.32000 TM 320 Screw Tester

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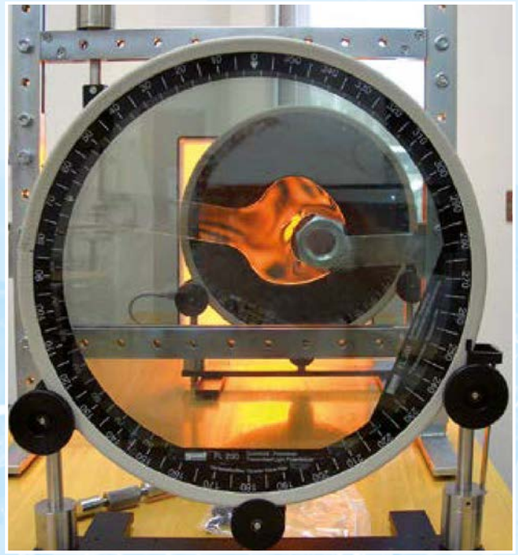
A LOOK INSIDE OUR CUSTOMERS' LABORATORIES



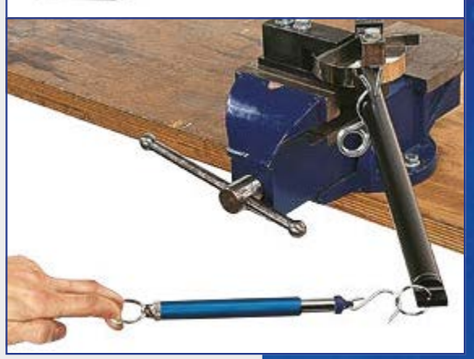
GUNT demonstration and experimentation units have been in use for many years at hundreds of technical education and training centres, and have always proved highly satisfactory to our customers

The very finest design and detailing: Working with GUNT demonstration and experimentation units teaches students in an engaging, illustrative manner.

MANUFACTURING ENGINEERING

The fundamentals of manufacturing engineering are an essential element within the broad training concept of 'mechatronics'. Our teaching and training systems support this field of activity by providing demonstration kits and a number of basic technological experiments.

You will find comprehensive, clearly structured instructional material accompanying all GUNT training systems, providing you with a major aid to lesson preparation.



DEMONSTRATION KITS

TECHNOLOGICAL EXPERIMENTS

Visit our website www.gunt.de

FT 901 *Drilling Kit*

*** Comprehensive instructional kit of the key drilling tools used in engineering**

Technical Description

The kit is used primarily for viewing and information purposes. Exercises or experiments can only be carried out to a limited extent.

It includes 19 different drills, including special types, e.g. a centre drill or a taper pin hole drill. In addition a taper shaft and the associated key, as well as a sliding gauge are included. The cutting geometry has been deliberately changed on some of the drills so that the influence of the cutting angle and clearance angle can be demonstrated.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the collection.

Learning Objectives / Experiments

- familiarisation with the key drilling tools used in engineering and their specific application
- investigation of cutting geometry
  * cutting angle
  * clearance angle
  * incorrect cutter profile

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] drilling tools demonstration collection
[2] content: 19 different drills, 7 workpieces with specimen cuts, 1 taper shaft MK1 with key and a twist drills grinding gauge for checking point angle
[3] all parts clearly laid out on a plastic tray
[4] multiple trays stackable

Technical Data

14 twist drills: D=10mm
1 subland twist drill: D=5mm
4 centre drills: D=2,5mm

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 6kg

Order Details

054.90100 FT 901 Drilling Kit

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

FT 903 *Countersinking Kit*

*** Comprehensive instructional kit of the countersinking tools used in engineering**

Technical Description

The kit is used primarily for viewing and information purposes. No provision is made for conducting exercises or experiments.

It includes 12 different countersinks including special types, e.g. a backward countersink tool. It also includes interchangeable guiding pins and a machining specimen with initial countersinking. The largest tool diameter is 16,75mm.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the collection.

Learning Objectives / Experiments

- familiarisation with the key countersinking tools used in engineering and their specific application
- applications of different countersink angles

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] countersinking tools demonstration collection
[2] content: 12 different countersink tools, 3 interchangeable guiding pins, 1 holder for a backward countersink tool and a specimen with initial countersinking
[3] all parts clearly laid out on a plastic tray
[4] multiple trays stackable

Technical Data

1 core drill: D=16,75mm
5 conical countersink tools (M8/90°, C20/60°, A20/60°, C15/90°, C16,5/90°)
4 flat countersink tools (3xM8, D=15mm)
1 counterbore: D=15mm
1 backward countersink tool: D=15mm

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 6kg

Order Details

054.90300 FT 903 Countersinking Kit

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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FT 905 Reaming Kit

*** Comprehensive instructional kit of the key reaming tools used in engineering**

Technical Description

The kit is used primarily for demonstration and information purposes. It allows only limited scope for conducting exercises or experiments.

It includes 10 different reaming tools and a limit plug gauge. The kit includes a sample plate with reamed bores with which a fit can be checked.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with the key reaming tools used in engineering and their specific application
- checking a fit with the limit plug gauge

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] reaming tools demonstration collection
[2] content: 10 different reamers, 1 limit plug gauge and a sample plate with reamed bores
[3] all parts clearly laid out on a plastic tray
[4] multiple trays stackable

Technical Data

2 hand reamers, 1 of which is adjustable, D=10mm
1 stub reamer: D=10mm
7 chucking reamers: D=10mm
2 machine reamers with Morse taper: D=5mm (taper 1:50) and MK1
Limit plug gauge: D=10mm, fit H7

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 6kg

Order Details

054.90500 FT 905 Reaming Kit

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

FT 907 Grinding Kit

*** Comprehensive instructional kit of typical abrasives and grinding tools used in engineering**

Technical Description

The kit is used primarily for viewing and information purposes. No provision is made for conducting exercises or experiments.

It includes 13 different grinding tools and abrasives. The largest tool diameter is 115mm.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with typical abrasives and grinding tools used in engineering and their specific application
- investigation of
  * grain / shape / material
  * construction of grinding wheels
- discussion of areas of application

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] abrasives and grinding tools demonstration kit
[2] content: 6 different grinding wheels, 5 sheets of abrasive paper with different grain sizes, 1 cylindrical abrasive pencil, 1 hand finishing stick
[3] all parts clearly laid out on a plastic tray
[4] multiple trays stackable

Technical Data

3 flat grinding wheels: 1x for structural steel (rough grinding), 1x for tool steel (medium standard), 1x for hard metal (fine grinding)
1 depressed centre wheel
1 cup grinding wheel
1 right angle grinder for surface grinding
1 abrasive pencil with shaft
1 hand finishing stick (fine grain)
Abrasive paper: P=40, 100, 180, 320, 400

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 6kg

Order Details

054.90700 FT 907 Grinding Kit

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

FT 909 *Turning Kit*

*** Comprehensive instructional kit of typical lathe tools used in engineering**

Technical Description

The kit is used primarily for viewing and information purposes. No provision is made for conducting exercises or experiments.

It includes 13 different lathe tools, including a reversible carbide tip holder. Four reversible carbide tips and a turned part are also included. The turned part features examples of machining with the different tools.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with typical lathe tools used in engineering and their specific application
- familiarisation with
  * different lathe tools: shape, application
  * reversible carbide tips (cutting geometry)
- discussion of specific examples of application

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] lathe tools demonstration kit
[2] content: 13 different lathe tools, 4 reversible carbide tips, 1 turned part
[3] turned part: aluminium shaft 262mm long, diameter 70mm
[4] all parts clearly laid out on a plastic tray
[5] multiple trays stackable

Technical Data

1 reversible carbide tip holder
4 reversible carbide tips of different materials
12 lathe tools with soldered-in carbide tips (including inside tool, parting-off tool, side tool, face tool)

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 10kg

Order Details

054.90900 FT 909 Turning Kit

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

FT 913 *Milling Kit*

*** Comprehensive instructional kit of typical milling cutters used in engineering**

Technical Description

The kit is used primarily for viewing and information purposes. No provision is made for conducting exercises or experiments.

It includes 12 different milling cutters. A shell end mill arbor and 2 cutter arbor rings are also included. A small steel plate with examples of machining is provided to help identify the possible applications for the different types of milling cutter.

The kit is clearly laid out on a plastic tray. The well-structured instructional material enhances the informational value of the kit.

Learning Objectives / Experiments

- familiarisation with typical milling cutter types used in engineering and their specific application
- investigation of a milling cutter fixture
- discussion of specific applications for the various milling cutters

Scope of Delivery

1 complete kit, laid out on a tray
1 set of instructional material

Specification

[1] milling cutter demonstration kit
[2] content: 12 different milling cutters, 1 shell end mill arbor with 2 cutter arbor rings and 1 steel plate with examples of machining
[3] all parts clearly laid out on a plastic tray
[4] multiple trays stackable

Technical Data

2 keyway milling cutters: D=12mm, 2 and 3 blades
8 shell end mills: D=12mm (type N, NR, NF, W, HR)
1 shell end mill: D=40mm
1 side and face milling cutter: D=50mm
Milling cutter arbor: SK 30, MK 1 and d=12mm

Dimensions and Weight

LxWxH: 500x350x110mm (tray)
Weight: approx. 10kg

Order Details

054.91300 FT 913 Milling Kit

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

FT 100 Cutting Forces during Drilling

*** Measurement of feed force and torque**

Technical Description

Investigation of cutting forces during drilling is fundamental to the teaching of cutting techniques. The setup comprises a transducer, which also holds the specimen being machined, and an amplifier unit with digital displays. The axial force (feed force) and torque occurring during cutting are measured using strain gauge transducers and digitally displayed on the amplifier unit.

The experiments must be conducted in a workshop environment, as a suitable drilling machine is required.

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

Learning Objectives / Experiments

- measuring feed force and torque at the cutting surface
  * influence of rotational speed, rate of feed, lubrication and cooling conditions
- influence of the cutting geometry of the drill
- influence of the material being machined

Scope of Delivery

1 measurement kit for drilling experiments, comprising transducer and strain gauge amplifier
1 GUNT software CD + USB cable
1 set of instructional material

Specification

[1] drilling measurement device
[2] measurement of feed force and torque
[3] strain gauge type measuring transducer
[4] strain gauge amplifier with digital displays for axial force and torque
[5] splash-proof stainless steel housing for transducer
[6] GUNT software for data acquisition via USB under Windows Vista or Windows 7

Technical Data

Drilling diameter: max. 16mm
Specimens
- square LxW: 25x10...25x20mm
- possible materials: steel, brass, aluminium, copper, plastic

Measuring ranges
- axial force: 0...10kN
- torque 0...50Nm

Strain gauge in half-bridge configuration

Dimensions and Weight

LxWxH: 220x150x230mm (transducer housing)
LxWxH: 230x210x120mm (amplifier)
Weight: approx. 20kg

Required for Operation

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

Order Details

054.10000 FT 100 Cutting Forces during Drilling

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FT 102 Cutting Forces during Turning

*** Measurement of the forces acting on the lathe tool**

Technical Description

Investigation of cutting forces during turning is fundamental to the teaching of cutting techniques.The setup comprises a transducer, which also holds the lathe tool, and an amplifier unit with digital displays. The forces that act on the lathe tool during machining are measured in three directions: cutting force, feed force and passive force. The 3-component force measurement device uses a strain gauge system. The amplifier unit supplies the strain gauge bridges and displays the measured values on three digital displays.

The experiments must be conducted in a workshop environment, as a suitable lathe is required.

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

Learning Objectives / Experiments

- measurement of forces in turning
  * influence of rotational speed, rate of feed, feed motion, lubrication and cooling conditions
- influence of the cutting geometry of the lathe tool
- influence of the material being machined

Scope of Delivery

1 measuring device for turning experiments, comprising strain gauge amplifier and transducer
1 GUNT software CD + USB cable
1 set of instructional material

Specification

[1] 3-component force measuring device for cutting experiments during turning
[2] lathe tool holder implemented as transducer with strain gauge system
[3] strain gauge amplifier unit with 3 digital displays for forces
[4] transducer with splash-proof housing
[5] GUNT software for data acquisition via USB under Windows Vista or Windows 7

Technical Data

Force sensor
- number of force axes: 3 (x, y, z)
- measuring range: +/-5kN
- overload capacity up to: +/- 6,5kN
- breaking load: +/-8kN
- non-linearity: <1%
- supply: 10VDC

Strain gauge in full-bridge configuration

Dimensions and Weight

LxWxH: 365x315x150mm (measuring amplifier)
Weight: approx. 7kg

Required for Operation

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

Order Details

054.10200 FT 102 Cutting Forces during Turning

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

FT 200 Forming by Bending

*** Permanent deformation of flat bars**

*** Measurement of deformation forces**

Technical Description

The experimental setup enables fundamental experimentation in the mechanics of deformation. Flat rods can be permanently deformed by means of a simple bending device. The necessary deformation work, e.g. to produce a 90° angle, is recorded in the experiment using a force measurement system. A range of different materials and bend radii can be investigated using this experiment. The experiments should be conducted in a workshop environment, as the bending device has to be clamped into a vice. A suitable force measuring device and a wide range of specimens are supplied.

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

Learning Objectives / Experiments

- deformation experiments on flat sections
- measurement of the deformation force
  * influence of bend radius, bend angle, material

Scope of Delivery

1 bending device with lever and moulding
1 force measuring device
1 set of specimens
1 set of instructional material

Specification

[1] experimental setup for deformation experiments on flat sections
[2] bending device for insertion in a vice
[3] device to measure the deformation forces
[4] rotatable moulding to allow for 4 different bend radii
[5] deformation forces on the lever up to 200N

Technical Data

Bending device
- lever length: 500mm

Bend specimens
- cross-section: 10x6mm
- material: steel, copper, brass, aluminium

Force measuring device: 200N
Bend radii: R1, R2, R4, R8

Dimensions and Weight

LxWxH: 640x120x100mm
Weight: approx. 10kg

Order Details

054.20000	FT 200 Forming by Bending

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ASSEMBLY PROJECTS

DRIVE ELEMENTS AND GEARS

FITTINGS

PIPING ASSEMBLY

COMPRESSORS

Accompanying instructional material – our policy

We believe that a rounded teaching and training system has to combine hardware (a trainer unit or assembly kit for example) with the accompanying instructional material (technical description, set of drawings, tuition plan, exercises). If the hardware changes, then we update the accompanying documentation as well.

We are not a publishing company so we do not offer the documentation relating to GUNT units as items for separate purchase.

Visit our website www.gunt.de

THE GUNT LEARNING CONCEPTS FOR ASSEMBLY PROJECTS – HOW SPECIALISTS LEARN

How is the concept structured?

THE ASSEMBLY EXERCISES ARE DERIVED FROM FOUR MAIN AREAS

- Drive elements and gears
- Fittings
- Piping systems, pumps
- Compressors

We are dealing with a narrower field of engineering in this section.

Then in the following chapter entitled ‘MAINTENANCE’, we offer more complex, interdisciplinary assembly and maintenance projects that incorporate electrical and electronic features as well as instrumentation and control engineering.

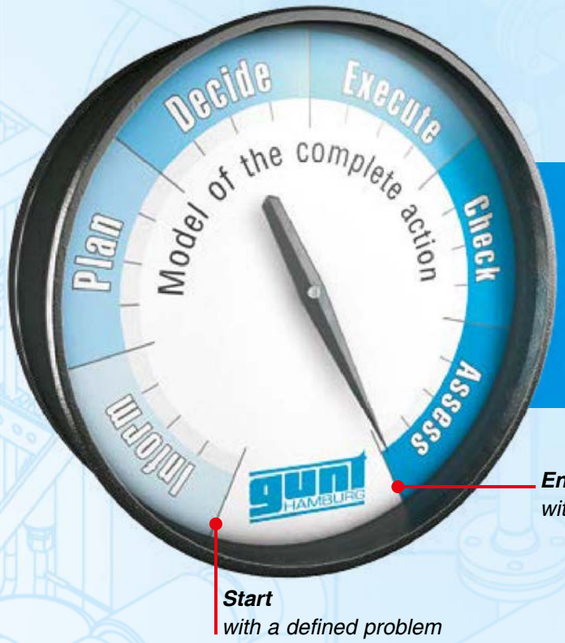
In all areas you will find relatively simply structured exercises as an introduction, as well as more complex and demanding projects.

Inside the assembly shop at GUNT Gerätebau GmbH, where skilled tradesmen and engineers get to grips with tasks that are varied and demanding.
So we know what we’re talking about: apprentices and trainees should develop their skills and abilities with the help of GUNT teaching and training systems.

Didactic criteria

All exercises and projects are ideal for students working together in a team.

Here, a group can work on a project while at the same time pursuing different exercises in parallel, ultimately enabling them to bring together a range of findings.



All the training systems in this series offer an excellent basis for organising hands-on teaching.
The sequence of a complete action – from information, through execution, to assessment – can always be carried out and explained.

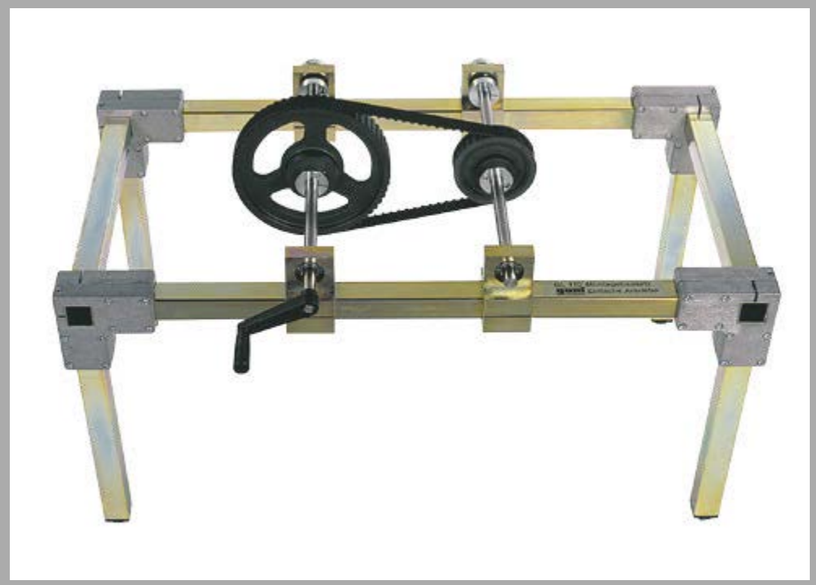
End
with a measurable result for assessment

Start
with a defined problem

Learning goals

To develop a broad knowledge of assembly techniques as a basis for maintenance	To retrieve and apply information from manufacturer’s documentation
To become familiar with machine elements and standard parts	To plan assembly steps and sequences
To identify subassemblies, understand functions, and describe systems	To check and assess work results
Introduction to technical terminology and language	To become familiar with typical tools and jigs
To read and understand engineering drawings	To become familiar with characteristic features of maintenance and repair work

GL 410 Gear Assembly Unit: Simple Drives



*** Flexible and robust assembly system for mechanical drive systems**

*** Practical orientation based on use of standard components**

*** Quick and easy assembly with no jigs and fixtures, just simple tools**

*** Safe drive with hand crank**

*** Comprehensive well-structured instructional material**

Technical Description

This laboratory system is used to introduce the basics of gearing and the correct method of assembling drive elements. The programme of exercises enables familiarisation with six different drive implementation and analysis methods: understanding the brief and the drawing, assembly, setting, adjusting, testing, and making calculations.

The flexibility of the setup and the modularity of the components simplifies experimentation and implementation of the students' own ideas.

A robust tubular steel frame with a square profile and bearing elements provide the accuracy for the setting of precise gearing. All the system components are kept ready to hand and well protected in a storage system.

GUNT offers three assembly kits in this product series, each focussing on different aspects: GL 410, GL 420 and GL 430. Each kit is used entirely independently of the other kits within the series.

Learning Objectives / Experiments

- familiarisation with key components of mechanical drive systems
- basic types of drive
  * simple belt drive
  * simple chain drive
  * simple spur gear drive
  * bevel gear drive
  * worm gear drive
  * rack drive
- calculations on mechanical drives
- practical setup of various drives, linked to simple configuration and alignment exercises
- reading and understanding engineering drawings, familiarisation with technical terminology

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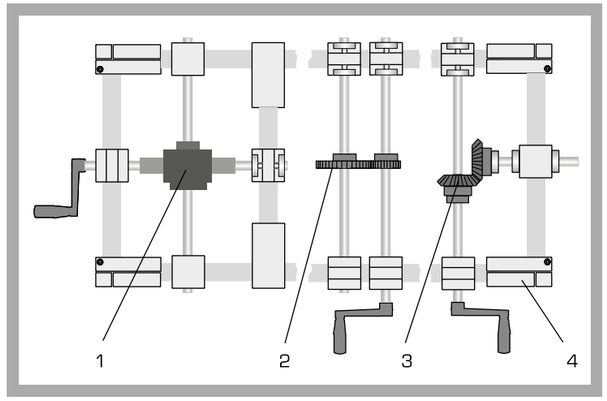
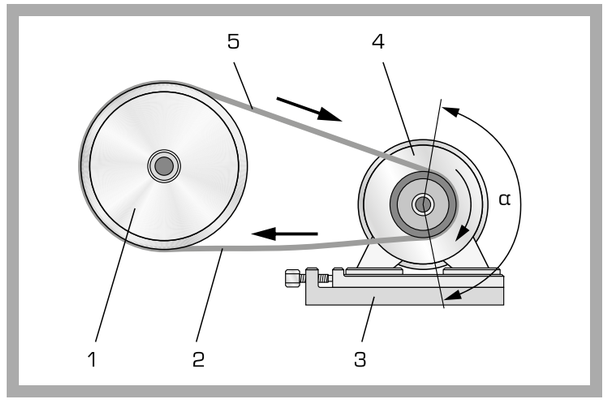
GL 410 Gear Assembly Unit: Simple Drives



1 worm gear, 2 spur gear, 3 bevel gear set, 4 square steel tube frame



Mode of operation of a belt drive: 1 driven, 2 loose side, 3 slide rail with bolts, 4 drive, 5 load side, α angle of contact

Specification

[1] demonstration and experimentation kit for assembling single drives
[2] simple belt drive
[3] simple chain drive
[4] simple spur gear drive
[5] bevel gear drive
[6] worm gear drive
[7] rack drive
[8] hand operation with crank
[9] usage of standard industrial parts
[10] solid universal frame manufactured from square steel tube

Technical Data

Toothed belt pulleys: z=30, 60
Chain sprockets: z=20, 30, DIN 8192 ISO 10B-1
Spur gears: z=30, 60, m=2mm
Bevel gear pair
- z=30, m=3mm, i=1, angle between axes 90°

Dimensions and Weight

LxWxH: 1000x500x500mm (assembled frame)
Weight: approx. 69kg
LxWxH: 600x400x220mm (storage system)
LxWxH: 600x400x170mm (storage system)

Scope of Delivery

1 base frame
1 crossbar
4x bearing block, single
1 bearing block, double
1 set of drive elements, consisting of
- 2 toothed belt pulleys
- toothed belt
- 2 chain sprockets
- roller chain
- 2 gear wheels
- bevel gear set
- worm gear
- bored worm
- rack
- 2x fixing block with guide bush
- shaft
- 2 shafts with square shaft end
- hand crank
- set of small items (bolts, spacer bushes, clamp rings, reducer bushes, shaft nuts, featherkeys)

1 set of assembly tools
2 storage systems with foam inlay
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, description of assembly processes, specimen calculations

Order Details

030.41000	GL 410	Gear Assembly Unit: Simple Drives

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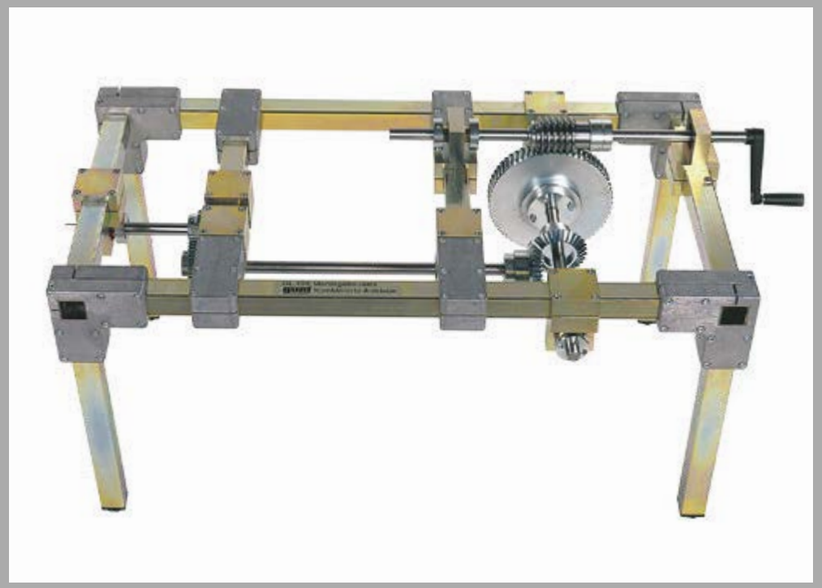
GL 420 Gear Assembly Unit: Combined Drives



*** Flexible and robust assembly system for mechanical drive systems**

*** Practical orientation based on use of standard components**

*** Quick and easy assembly with no jigs and fixtures, just simple tools**

*** Safe drive with hand crank**

*** Comprehensive well-structured instructional material**

Technical Description

This laboratory system is used to introduce combined drives and their correct assembly. The programme of exercises enables familiarisation with six different drive implementation and analysis methods: understanding the brief and the drawing, assembly, setting, adjusting, testing, and making calculations.

The flexibility of the setup and the modularity of the components simplifies experimentation and implementation of the students' own ideas.

A robust tubular steel frame with a square profile and bearing elements provide the accuracy for the setting of precise gearing. All the system components are kept ready to hand and well protected in a storage system.

GUNT offers three kits in this product series, each focussing on different aspects: GL 410, GL 420 and GL 430. Each kit is used entirely independently of the other kits within the series.

Learning Objectives / Experiments

- familiarisation with key components and types of mechanical drive systems
  * dual belt drive
  * chain drive with tensioning sprocket and spur gear transmission
  * dual spur gear drive
  * combined bevel gear and spur gear drive
  * combined worm and bevel gear drive
  * rack drive with spur gear drive
- calculations on mechanical drives
- practical setup of various drives, linked to simple configuration and alignment exercises
- reading and understanding engineering drawings, familiarisation with technical terminology

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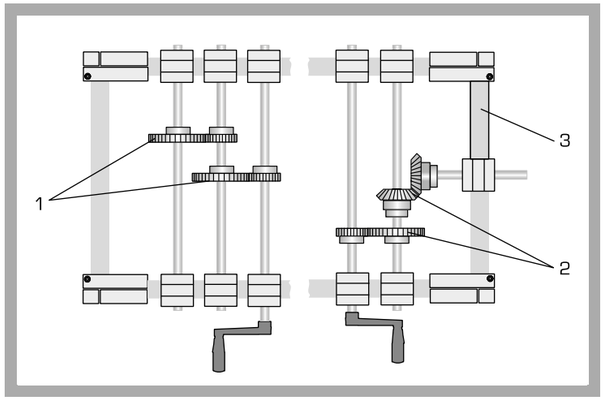
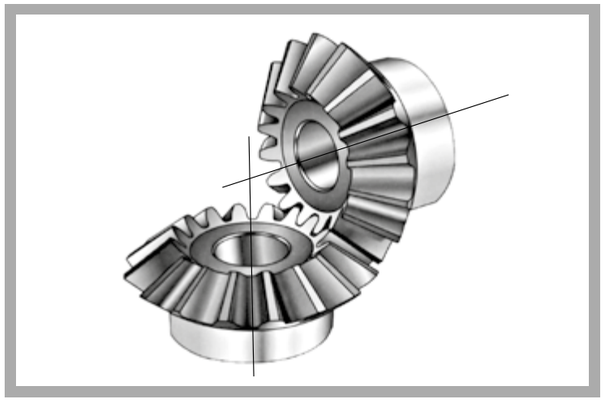
GL 420 Gear Assembly Unit: Combined Drives



1 two-stage spur gear drive, 2 combined spur gear - bevel gear drive, 3 base frame



Bevel gear stage

Specification

[1] demonstration and experimental kit for laying out and assembling multiple and combined drives
[2] dual belt drive
[3] chain drive with tensioning sprocket and spur gear transmission
[4] dual spur gear drive
[5] combined bevel gear and spur gear drive
[6] combined worm gear and bevel gear drive
[7] rack drive with spur gear drive
[8] hand operation with crank
[9] usage of standard industrial parts
[10] solid universal frame manufactured from square steel tube

Technical Data

Toothed belt pulleys: z=30, 32, 48, 60
Chain sprockets: z=20, 30, DIN 8192 ISO 10B-1
Gears: z=30, 36, 50, 60, m=2mm
Bevel gear pair: z=30, m=3mm, i=1, angle between axes 90°

Dimensions and Weight

LxWxH: 1000x500x500mm (assembled frame)
Weight: approx. 91kg
LxWxH: 600x400x120mm (storage system)
LxWxH: 600x400x170mm (storage system)

Scope of Delivery

1 base frame
2x crossbars
8x bearing block, single
1 bearing block, double
1 set of drive elements, consisting of
- 4 toothed belt pulleys
- 2 toothed belts
- 2 sprockets
- roller chain
- 4 gear wheels
- 2x mitre gear set
- worm gear
- bored worm
- rack
- 2x fixing block with guide bush
- shaft
-3 shafts with square shaft end
- hand crank
- set of small items (bolts, nuts, washers, spacer bushes, clamp rings, reducer bushes, featherkeys, etc.)

1 set of assembly tools
2 storage systems with foam inlay
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, description of assembly processes, specimen calculations

Order Details

030.42000	GL 420	Gear Assembly Unit: Combined Drives

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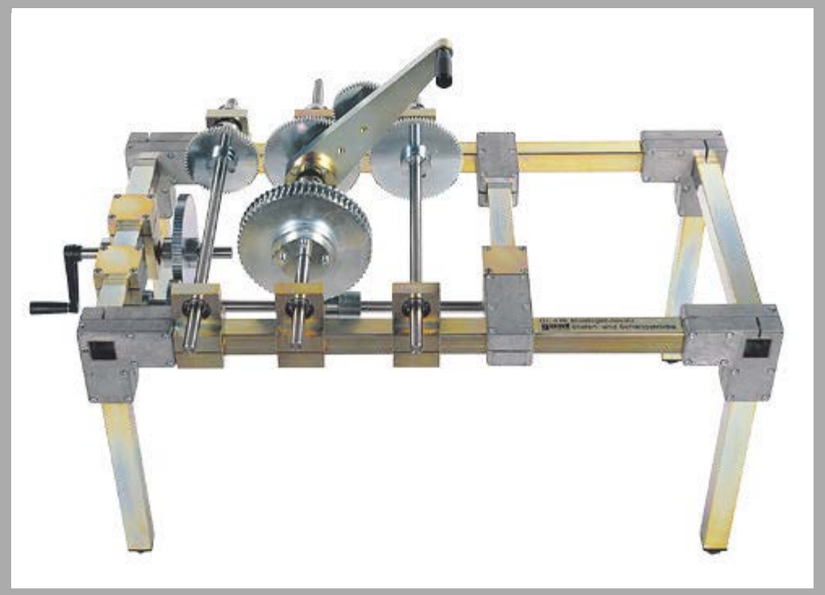
GL 430 Gear Assembly Unit: Step and Shift Gears



- *** Flexible and robust assembly system for mechanical drive systems**
- *** Practical orientation based on use of standard components**
- *** Quick and easy assembly with no jigs and fixtures, just simple tools**
- *** Safe drive with hand crank**
- *** Comprehensive well-structured instructional material**

Technical Description

This laboratory system is used to familiarise students with the design and correct assembly of step and shift gears. The programme of exercises enables familiarisation with six different drive implementation and analysis methods: understanding the brief and the drawing, assembly, setting, adjusting, testing, and making calculations.

The flexibility of the setup and the modularity of the components simplifies experimentation and implementation of the students' own ideas.

A robust tubular steel frame with a square profile and bearing elements provide the accuracy for the setting of precise gearing. All the system components are kept ready to hand and well protected in a storage system.

The multi-step and shift gears in GL 430 are based on those of a conventional lathe. The step gear unit is very similar to the primary drive on a pillar drill.

GUNT offers three kits in this product series, each focussing on different aspects: GL 410, GL 420 and GL 430. Each kit is used entirely independently of the other kits within the series.

Learning Objectives / Experiments

- familiarisation with key components and types of mechanical drive systems
  - * cone pulley drive
  - * sliding gear unit
  - * quick change gear unit
  - * tumbler gear unit
  - * change gear train
  - * cam box (drop worm)
- calculations on mechanical drives
- practical setup of various drives, linked to simple configuration and alignment exercises
- reading and understanding engineering drawings, familiarisation with technical terminology

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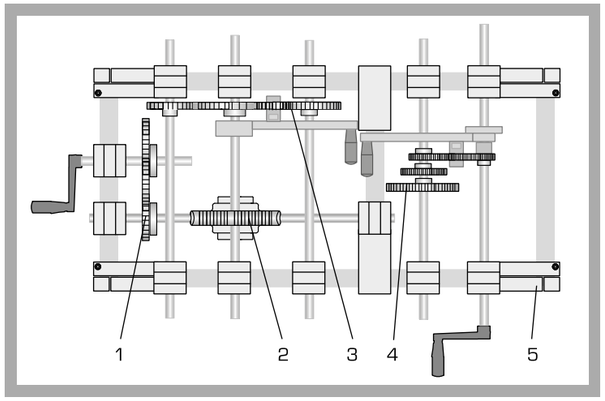
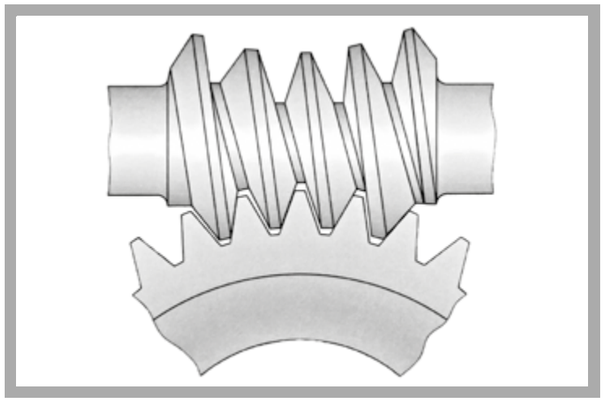
GL 430 Gear Assembly Unit: Step and Shift Gears



1 spur gear, 2 worm gear, 3 change gear train, 4 quick change gear, 5 base frame



Worm gear unit

Specification

[1] demonstration and experimental kit for laying out and assembling 6 different step and shift gear units
[2] cone pulley drive
[3] sliding gear drive
[4] quick change gear
[5] tumbler gear
[6] change gear train
[7] cam box (drop worm)
[8] hand operation with crank
[9] usage of standard industrial parts
[10] solid universal frame manufactured from square steel tube

Technical Data

Spur gears
- z=24, 30, 36, 40, 45, 50, 60, 76, 80, 95
- m=2mm

Worm drive
- worm: z=6
- worm gear wheel: z=62, m=3,15mm

Dimensions and Weight

LxWxH: 1000x500x500mm (assembled frame)
Weight: approx. 80kg
LxWxH: 600x400x120mm (storage system)
LxWxH: 600x400x170mm (storage system)

Scope of Delivery

1 base frame
1 crossbar
8x bearing block, single, 1x bearing block, double
1x pendulum ball bearing, 1x drop worm
1 set of drive elements, consisting of
- 6 V-belt pulleys, 1 V-belt
- worm gear, bored worm
- 10 gear wheels
- swing lever, reversing lever, gear change mechanism
- 3x bearing flange
- change gear axle
- 3x shaft
- 2 shafts with square shaft end
- hand crank, 4 handles
- set of small items (bolts, nuts, washers, spacer bushes, clamp rings, reducer bushes, featherkeys, pressure springs, ball bearings, pins etc.)

1 set of assembly tools
2 storage systems with foam inlay
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, description of assembly processes, specimen calculations

Order Details

030.43000	GL 430	Gear Assembly Unit: Step and Shift Gears

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MT 170 Assembly Exercise: Shaft with Journal Bearings

The illustration shows the tool box with parts set. A fully assembled journal bearing is shown in the foreground.

*** Practical exercise based on the assembly of a shaft / journal bearings arrangement**

*** Comprehensive and well-structured instructional material**

Technical Description

Journal bearings execute a sliding motion between a bearing journal and a bearing shell. This sliding motion is usually lubricated by an intermediate medium. The damping effect of the lubricant in the bearing gap means journal bearings run particularly smoothly and quietly. Vibration and shock impact from gear wheels or crank drives are also damped by journal bearings. They are widely used in piston engines, punches and presses as they are insensitive to high shock loads.

The journal bearings in MT 170 are grease-lubricated. Grease lubrication allows for a simple bearing construction. MT 170 consists of a ground steel shaft and two horizontally split pedestal bearings. The upper bearing shell includes a lubrication fitting with a female thread to which a Stauffer lubricator can be screw-fitted by way of an intermediate pipe to supply the bearing with lubricant. The face of the upper bearing shell, which is not subjected to load, contains a flat lubricating slot. This distributes the grease over the full width of the bearing. The grease serves not only as a lubricant but also seals the bearing against external dirt and foreign bodies.

The practice kit MT 170 forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content.

MT 170 enables a simple journal bearing to be assembled and disassembled. Students become familiar with all the components and their modes of operation. The parts are clearly laid out and well protected in a tool box. The accompanying material details the individual steps involved in assembly, and provides additional information on the areas of application, mode of operation and design of the journal bearings.

Learning Objectives / Experiments

- design and function of a simple journal bearing
- assembly and disassembly, including for the purposes of maintenance and repair
- measuring the bearing play
- checking the alignment
- reading and understanding engineering drawings and operating instructions
- investigating the running properties of the journal bearing (together with MT 172)

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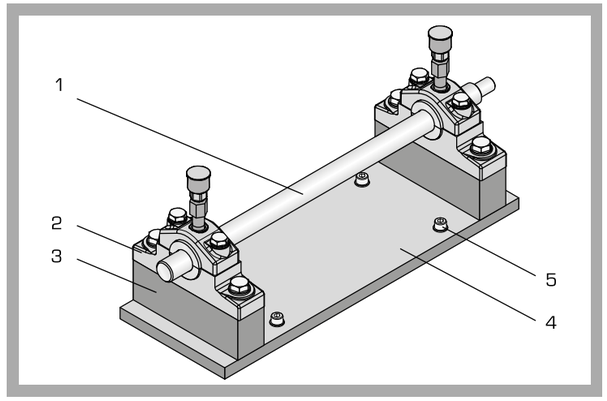
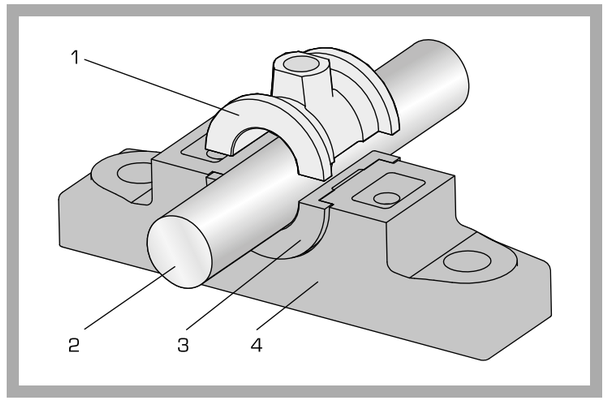
MT 170 Assembly Exercise: Shaft with Journal Bearings



1 steel shaft, 2 pedestal bearing, 3 spacer, 4 base plate, 5 bolt to fix MT 170 into MT 172



1 upper bearing shell, 2 shaft, 3 bearing block, 4 lower bearing shell

Specification

[1] learning concept for assembly exercises on a shaft with journal bearings
[2] horizontally split pedestal bearing according to DIN 505, grease lubricated
[3] steel shaft, hardened and ground
[4] 2 pedestal bearings with split shells
[5] set of plastic strips to measure bearing play
[6] checking bearing alignment using touch-up paste
[7] complete assembly tool kit
[8] journal bearing parts and tools housed in a sheet-steel tool box
[9] The kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Shaft
D=25mm, shaft journal for coupling: D=16mm
Materials
- pedestal bearings, bearing covers: grey cast iron
- bearing shells: gunmetal brass according to DIN 8.221
- shaft: hardened, ground steel
- stauffer lubricator: steel

Dimensions and Weight

LxWxH: 640x230x230mm (box)
Weight: approx. 45kg

Scope of Delivery

1 complete set of journal bearing parts
1 metal bellows coupling to join to MT 172
1 base plate
1 set of tools, consisting of
- 1 set of plastic strips to measure bearing play, 0,10...0,25mm
- 1 soft-faced hammer
- 2 open-end wrenches: size 17, 19
1 set of bolts and washers
1 tube of touch-up paste
1 tube of multi-purpose grease
1 rectangular box for small parts
1 sheet-steel tool box with foam inlay
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly processes, also in relation to repair operations

Order Details

051.17000 MT 170 Assembly Exercise: Shaft with Journal Bearings

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MT 171 Assembly Exercise: Hydrodynamic Journal Bearing

The illustration shows the tool box with parts set and tool compartment insert. A fully assembled journal bearing as is assembled from the parts is shown in the foreground.

*** Practical exercise based on the assembly of a hydrodynamic journal bearing**

*** Comprehensive and well-structured instructional material**

Technical Description

Journal bearings execute a sliding motion between a bearing journal and a bearing shell. This sliding motion is usually lubricated by an intermediate medium.

Hydrodynamic journal bearings give wear-free continuous duty for large diameters at high rotational speeds, and are suitable for high and shock-type loading. They are usually constructed as split bearings. Frictional heat occurring during operation must be dissipated by the lubricant.

MT 171 is a horizontally split hydrodynamic pedestal journal bearing. The bearing shells are supported from a face in the spherical bearing housing so as to ensure uniform transfer of any forces that arise to the bottom housing. The journal bearing is lubricated by a loose lubricating ring. Standard commercially available mineral oils can be used.

An auxiliary shaft is supplied together with the bearing as an aid to assembly and functional testing.

The practice kit MT 171 forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres.

A close link between theory and practice is key to the learning content. MT 171 enables a hydrodynamic journal bearing to be assembled and disassembled. Students become familiar with all the components and their modes of operation. The parts are clearly laid out and well protected in a tool box. The accompanying material details the individual steps involved in assembly, and provides additional information on the areas of application, mode of operation and design of the journal bearing.

Learning Objectives / Experiments

- design and function of a hydrodynamic journal bearing
- principles of lubrication and sealing elements
- assembly and disassembly, including for the purposes of maintenance and repair
- reading and understanding engineering drawings and operating instructions

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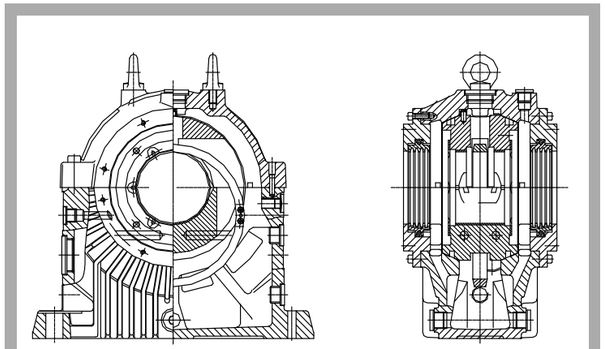
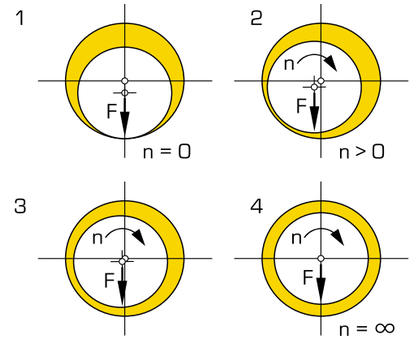
MT 171 Assembly Exercise: Hydrodynamic Journal Bearing



Sectional drawing of a hydrodynamic journal bearing



Operation of a hydrodynamic journal bearing: build-up of a load-bearing oil film at increasing speed

Specification

[1] learning concept for assembly exercises on an upright hydrodynamic journal bearing
[2] journal bearing according to DIN 31690
[3] stainless steel drive shaft
[4] oil lubrication
[5] floating edge seal to seal the face of the shaft
[6] sealing of contact faces of housing halves with non-setting sealing compound
[7] complete assembly tool kit
[8] journal bearing parts and tools housed in a sheet-steel tool box
[9] The kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Bearing bore: D=80mm
Drive shaft: nominal diameter: D=80mm

Materials
- bearing housing: grey cast iron
- bearing shells: steel supports, coated with white metal
- seal: ultra-heat-resistant, fibre-reinforced plastic
- shaft: stainless steel

Dimensions and Weight

LxWxH: 690x360x312mm (box)
Weight: approx. 60kg

Scope of Delivery

1 complete set of hydrodynamic journal bearing parts
1 drive shaft
1 set of tools, consisting of:
- 1 set of Allen keys, size 3, 5, 10, 22
- 1 hammer
- 1 punch, 4mm

1 tube of non-setting sealing compound
1 rectangular box for small parts
1 sheet-steel tool box with foam inlay
1 set of instructional material, consisting of:
technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly processes, also in relation to repair operations

Order Details

051.17100 MT 171 Assembly Exercise: Hydrodynamic Journal Bearing

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MT 152 Assembly Exercise: Spur Gear

*** Practical exercise based on the assembly of a spur gear unit**

*** Broad scope of learning with interdisciplinary problems**

*** Comprehensive and well-structured instructional material**

Technical Description

Gears transmit rotational movements. They adapt the torques and speeds of a consumer drive according to demand.

The MT 152 is a spur gear unit with helical gear wheels. The gear is single-stage, and has a fixed transmission ratio (fixed gear unit). It is a standalone gear unit, i.e. a self-contained transmission in its own gear case. Self-contained gear units are usually arranged between the motor and the machine, or are used as installation kits in machines. By contrast, open-running gear wheel pairs forming part of a machine are termed non-self-contained gears.

Helical gear wheels run more smoothly and quietly than spur toothed gears because the gear teeth intermesh gradually and multiple teeth are engaged. They are suitable for higher speeds, and can withstand greater loading than comparable spur toothed gears.

The MT 152 training unit serves as an introductory project to the field of assembly techniques. The assembly and disassembly processes can easily be completed within standard lesson times. Basic tools, all supplied with the kit, are required for assembly.

The unit is of most benefit in teaching if small groups of 2 to 3 students work independently. The group has a defined task to perform, with clear assignments to complete.

The comprehensive instructional material is oriented to practical needs. This includes a complete set of drawings with a general arrangement drawing, parts list and single part drawings.

Learning Objectives / Experiments

- design and function of a spur gear, with helical gear wheels
- planning and presentation of the assembly process
- assembly and disassembly, including for the purposes of maintenance and repair
- reading and understanding engineering drawings
- dimensioning exercises, gauging of parts
- familiarisation with various machine elements: ball bearings, shaft seals
- familiarisation with assembly aids and jigs
- material selection criteria

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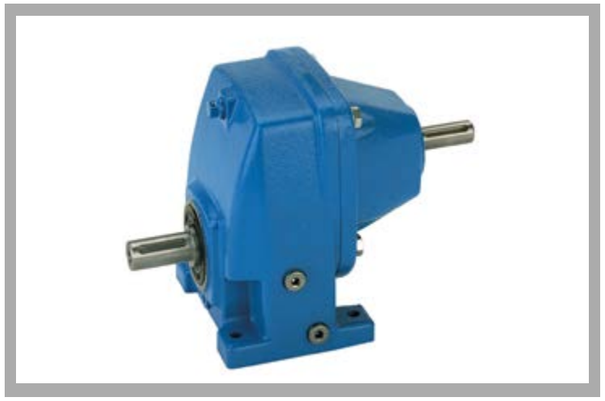
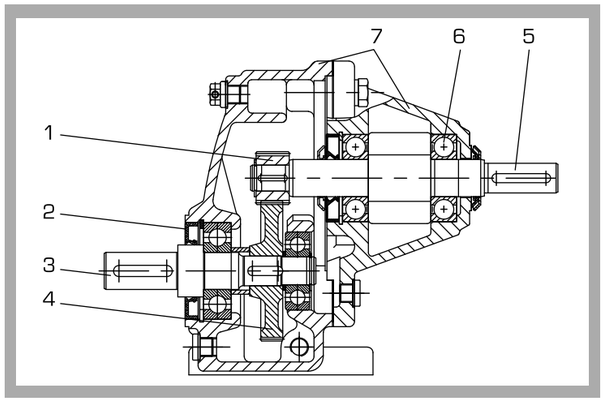
MT 152 Assembly Exercise: Spur Gear



The illustration shows the completely assembled spur gear unit.



1 drive shaft, 2 ball bearings, 3 housing parts, 4 pinion, 5 shaft seal, 6 power take-off shaft, 7 gear wheel

Specification

[1] assembly exercise for engineering training
[2] disassembled spur gear with set of small parts and 4 assembly jigs, housed in a sturdy metal case
[3] helical spur gear wheels
[4] gear unit consisting of input housing, pedestal housing, input and output shafts, input gear and output pinion, as well as bearings
[5] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Gear unit dimensions without shaft couplings
- LxWxH: 160x135x175mm

Transmission ratio
- pinion: number of teeth: z=24, real pitch module: m=1mm
- gear wheel: number of teeth: z=68, real pitch module: m=1mm
- transmission ratio: i=2,83

Max. output torque: 54Nm at 494min^{-1}
Materials
- housing: grey cast iron
- shafts: heat treated steel
- spur gears: case-hardened alloy steel

Shaft couplings
- drive: DxL: 16x40mm
- power take-off: DxL: 20x40mm

Dimensions and Weight

LxWxH: 600x450x180mm (case)
Weight: approx. 18kg

Scope of Delivery

1 complete set of spur gear parts
1 box for small parts (bolts, washers, gaskets, circlips, ball bearings, feather keys)
1 set of assembly tools, consisting of
- 4 assembly jigs
- 1 soft-faced hammer
- 2 sets of circlip pliers (DIN 471, DIN 472)
- Allen key, size 5
- 2 combination wrenches, size 10, 13
- screwdriver
- bearing puller

1 case with foam inlay
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly sequences, also in relation to repair operations

Order Details

051.15200 MT 152 Assembly Exercise: Spur Gear

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MT 110.02 Assembly Exercise: Spur Wheel / Worm Gear Mechanism

The illustration shows the tool box with parts set. The compartment insert for tools and small parts is shown in the foreground.

*** Practical exercise on the assembly of a modern industrial gear unit, using simple tools and jigs**

*** Broad scope of learning with interdisciplinary problems**

*** Comprehensive and well-structured instructional material**

Technical Description

The MT 110.02 two-stage gear unit kit contains all the parts required to construct the gear unit. It consists of a spur gear stage as its input, with a downstream worm gear stage (multistage gear combination). The fit seatings of the gear unit are designed to allow the complete assembly process to be carried out by hand. All parts are clearly laid out and well protected in a sheet-steel tool box. Small parts are supplied in a box with a transparent lid.

This assembly exercise permits wide-ranging and, above all, interdisciplinary work to be carried out by the students. The project unit is particularly well suited to action-based teaching. This, in conjunction with students working in an independent capacity, as well as developing teamworking skills, ensures that the unit serves as an excellent learning tool.

The modern style used in the instructional materials outlines comprehensive and in-depth technical information which forms the basis for the teaching process.

The teaching material includes a complete set of drawings with parts lists, single part drawings, an exploded view and assembly drawing. All drawings are to standard, and dimensioned in line with production requirements. Another very useful feature is the extensive set of transparencies for the overhead projector.

A tool kit is also included. The fully assembled gear unit can be function tested together with the optionally available MT 172 unit.

Learning Objectives / Experiments

- design and function of a multistage gear combination
- reading and understanding engineering drawings
- familiarisation with component and assemblies, their design features and functions
- dimensioning exercises, gauging of parts
- work planning, particularly planning and presentation of the assembly process
- familiarisation with assembly aids and jigs
- assembly exercises: component and complete unit assembly
- analysis of faults and damage, in conjunction with maintenance and repair steps
- material selection criteria

In conjunction with MT 172
- functional testing of the assembled gear unit

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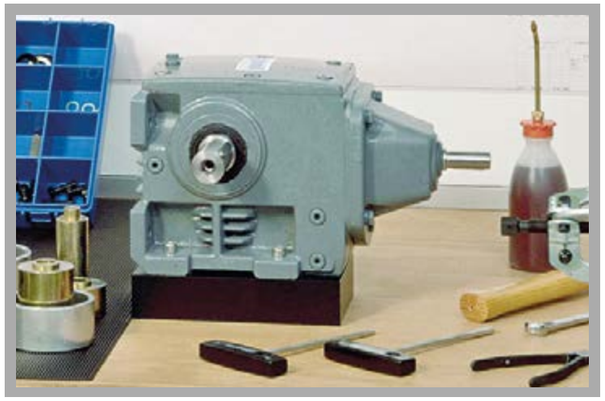
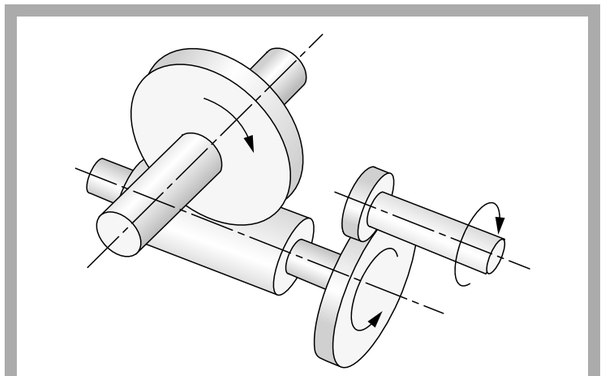
MT 110.02 Assembly Exercise: Spur Wheel / Worm Gear Mechanism



The illustration shows the fully assembled multistage gear combination.



Principle of operation of the two-stage spur wheel worm gear mechanism

Specification

[1] assembly exercise for engineering training
[2] complete, disassembled multistage gear combination with small parts set and 12 assembly jigs in a box
[3] spur gear stage with helical gear wheels
[4] worm gear stage with cylindrical worm and globoid wheel
[5] gear unit consisting of drive housing, worm pedestal housing, power take-off and drive shafts, spur gear stage and worm gear stage
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Gear unit dimensions without shaft couplings
- LxWxH: 282x138x188mm, approx. 22kg

Transmission ratios
- spur gear stage: i=2,83
- worm gear stage: i=12,33
- total transmission ratio: i=34,89

Spur gear stage
- pinion: number of teeth: z=24, real pitch module: m=1mm
- gear wheel: z=68, m=1mm

Worm gear stage
- worm: z=3
- worm gear wheel: z=37, m=2,578mm

Max. output torque: 212Nm

Materials
- housing: grey cast iron
- shafts: heat treated steel
- spur gear wheels, worm: case-hardened alloy steel

Shaft couplings
- drive: DxL: 16x40mm
- power take-off: DxL: 30x60mm

Dimensions and Weight

LxWxH: 700x380x320mm (box)
Weight: approx. 38kg

Scope of Delivery

1 complete set of multistage gear combination parts
1 box for small and loose parts (e.g. bolts, circlips, feather keys, washers)
1 set of gaskets
12 assembly jigs
1 set of assembly / disassembly tools
1 sheet-steel tool box with foam inlay
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly sequences, set of transparencies for overhead projector

Order Details

051.11002	MT 110.02	Assembly Exercise: Spur Wheel / Worm Gear Mechanism

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MT 172 Alignment of Drives, Shafts and Gears

The illustration shows MT 172 together with a combination gear unit assembled from parts set MT 110.02.

*** Assembling and aligning drive elements**

*** Understanding a wide range of mechanical drives**

*** Functional testing of completed GUNT assembly projects**

Technical Description

The units MT 170 (shaft with journal bearings), MT 110 and MT 110.02 (combination gear units) are tested with unit MT 172. The assembled element system - journal bearing or gear unit - is mounted on the MT 172 test bed. Here, the complete system is properly assembled, with particular regard to the alignment of the system components. A successfully completed assembly project can then be examined in operation with a formal final test. Parameters examined during test procedure are; running noise, heat generation, vibration or leakage.

MT 172 includes a single-phase asynchronous motor drive, a magnetic particle brake with adjustable braking torque, and a rigid machine bed with T-slots on which the motor and the drive element under test are mounted. The T-slots allow the installed length to be varied, and therefore can be easily adapted to the drive element. Two couplings connect the element system to the motor and the brake. The students must align the connections between the motor and the element system, and between the element system and the brake. The controls are on the switch box. The braking torque is set here using a potentiometer.

The exciter current of the magnetic particle brake serves as a measure of the braking torque, and is displayed in digital form. Removable guards protect the couplings.

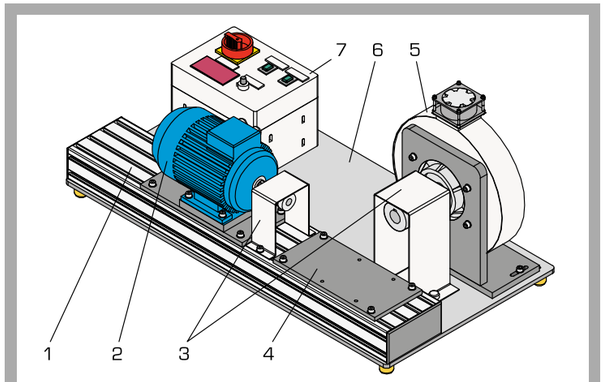
Learning Objectives / Experiments

In conjunction with MT 170 and MT 110.02
- assembling and aligning drive systems
- planning and execution of final testing
  * on a spur wheel/worm gear mechanism (MT 110.02)
  * on a journal bearing-supported shaft (MT 170)
- familiarisation with mechanical and electrical drive elements and their functions

In conjunction with combination gear unit MT 110.02
- checking gear functionality after assembly using a load test
- running of the gear under variable load
  * assessment of running noise
  * checking for heat build-up
  * checking for leaks

In conjunction with MT 170 - shaft with journal bearings
- running properties of a journal bearing

MT 172 Alignment of Drives, Shafts and Gears



1 machine bed, 2 drive motor, 3 coupling guard, 4 combination gear unit mounting plate, 5 magnetic particle brake, 6 base plate with flexible elements for vibration damping, 7 switch box with displays and controls

The illustration shows MT 172 together with the journal bearing-supported shaft MT 170.

Specification

[1] tester for functionality testing mechanical drive systems: journal bearing-supported shaft, combination gear unit
[2] single-phase asynchronous motor with metal bellows coupling
[3] externally vented magnetic particle brake with claw clutch, braking power adjustable by potentiometer
[4] T-slot aluminium profile for adjustable mounting of drive components
[5] switch box with controls and digital display of exciter current
[6] coupling guards
[7] the unit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Drive motor
- 4-pole asynchronous motor
- max. power output: 0,55kW
- speed: 1400min^{-1}

Magnetic particle brake with fan, and temperature sensor
- nominal braking torque at exciter current 0... 0,4A: 0...45Nm
- max. braking torque at 1A: 110Nm
- bi-metallic strip temperature protection: 70°C

Machine bed manufactured from aluminium with T-slots
- installation space: LxW: 640x160mm
- slot spacing: 40mm
- for M8 sliding blocks

Dimensions and Weight

LxWxH: 950x500x450mm
Weight: approx. 75kg

Required for Operation

230V, 50/60Hz, 1 phase

Scope of Delivery

1 drive motor with electrical control housing on base plate
1 magnetic particle brake on base plate
2 claw couplings
1 metal bellows clutch
1 gear base plate
1 set of bolts, slot nuts, washers
1 set of shims
1 instruction manual

Order Details

051.17200 MT 172 Alignment of Drives, Shafts and Gears

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MT 110 Assembly Station: Spur Wheel / Worm Gear Mechanism

*** Fully equipped mobile teaching station for demonstration purposes, providing an introduction to assembly techniques using an industrial gear unit as an example**

*** Comprehensive and well-structured instructional material**

*** Learning in a practical environment**

*** Highly suitable for developing interdisciplinary technical understanding**

Technical Description

Gears transmit rotational movements. They adapt the torques and speeds of a consumer drive according to demand. MT 110 deals with a fixed gear unit. The gear unit comprises a worm gear with an upstream spur gear stage. Combining the two types of gear in a single box enables high transmission ratios to be attained at high levels of efficiency in a compact space. Worm gears are normally deployed to gear down, and are mostly self-locking. Typical applications include motor vehicle wiper blades, escalators, and cable winches.

The mobile workstation MT 110 forms part of the GUNT assembly, maintenance and repair practice range designed for training at technical colleges and in company training centres. The station includes everything required to provide students with an introduction to a wide range of demanding assembly projects. The drawers in the trolley cabinet contain a disassembled combination gear unit and the tools, assembly aids, small parts and gaskets required for assembly. A second fully functional combination gear unit, permanently mounted to the workbench, can be used for demonstration purposes. This enables components to be compared directly with the complete system. Large-format drawings suitable for workshop practice can be attached to the display board at the rear of the trolley. All steps can be demonstrated to, and then performed by, the students themselves. The comprehensive and clearly structured instructional material, which includes a set of drawings, sets out the individual assembly steps in detail and provides additional information on the areas of application, mode of operation and design of the assemblies.

Learning Objectives / Experiments

- design and function of a combination gear unit
- reading and understanding engineering drawings
- familiarisation with components and assemblies, their design features and functions
- dimensioning exercises, gauging parts
- work planning, in particular planning and presentation of the assembly process
- familiarisation with assembly aids and jigs
- assembly exercises: assembly of modules and complete units
- analysis of faults and damage, in conjunction with maintenance and repair steps
- material selection criteria

In conjunction with MT 172
- function testing of the assembled gear unit

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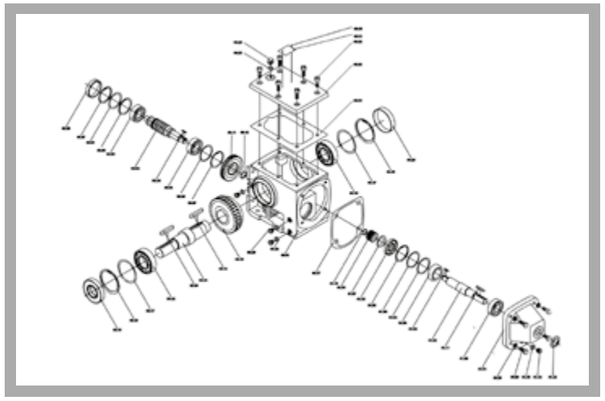
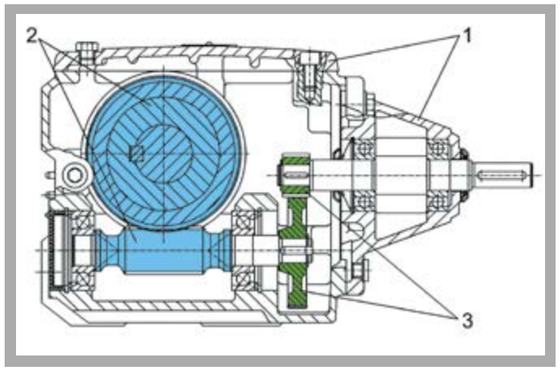
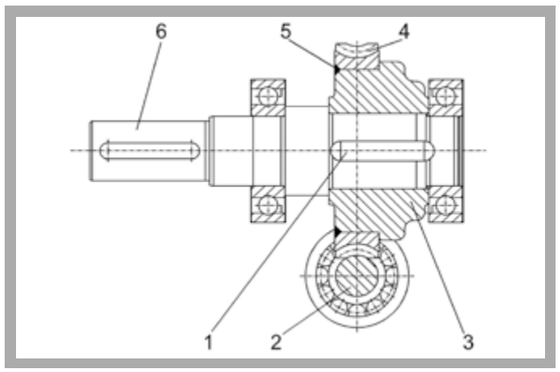
MT 110 Assembly Station: Spur Wheel / Worm Gear Mechanism



The illustration shows a clear exploded drawing which the students can use as an aid to assembling the gear unit. It is designed to be put up on the display board at the rear of the workshop trolley.



Sectional drawing of the combination gear unit: 1 housing function group, 2 worm gear stage function group, 3 spur gear stage function group



Worm gear stage: 1 feather key, 2 worm, 3 hub, 4 worm gear rim, 5 weld seam 6 power take-off shaft

Specification

[1] assembly project for engineering training
[2] 2 combination gear units: 1x set of components for assembly, 1x assembled, mounted on trolley as demonstrator
[3] spur gear stage with helical gear wheels
[4] worm gear stage with cylindrical worm and globoid wheel
[5] workshop trolley with drawing display board at rear, built-under cabinet with 3 lockable drawers and vice with 115mm jaw width
[6] assembly kit, tool kit, assembly aids, accessories and gaskets as well as instructional material contained in built-under cabinet
[7] the assembly station forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Gear unit dimensions without shaft couplings
- LxWxH: 282x138x188mm, approx. 22kg

Transmission ratios
- spur gear stage: i=2,83
- worm gear stage: i=12,33
- total transmission ratio: i=34,89

Spur gear stage
- pinion: number of teeth: z=24, real pitch module: m=1mm
- gear wheel: z=68, m=1mm

Worm gear stage
- worm: z=3; worm gear wheel: z=37, m=2,578mm

Max. output torque: 212Nm at 1.400min^{-1}

Materials
- housing: grey cast iron
- shafts: heat treated steel
- spur gear wheels, worm: case-hardened alloy steel

Shaft couplings
- drive: DxL: 16x40mm
- power take-off: DxL: 30x60mm

Dimensions and Weight

LxWxH: 1.520x750x1.850mm (trolley)
Weight: approx. 150kg

Scope of Delivery

1 workshop trolley with rear drawing display board and built-under cabinet
1 working combination gear unit
1 combination gear unit in parts
1 set of assembly tools and jigs
1 set of small parts and gaskets
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly sequences, set of tranparencies for overhead projector

Order Details

051.11000 MT 110 Assembly Station: Spur Wheel / Worm Gear Mechanism

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MT 154 Assembly Exercise: Shut-off Valve

*** Practical exercise based on the assembly of a shut-off valve**

*** Broad scope of learning with interdisciplinary problems**

*** Comprehensive and well-structured instructional material**

Technical Description

Shut-off valves of the type included in the MT 154 unit are used to shut-off and restrict the flow of media. They must be capable of total flow shut-off. The closing of the valve should be such that the volumetric flow does not suddenly drop to zero so as to prevent shock loads. The valve taper is moved by the spindle and ensures a metallic seal against the seating ring pressed into the housing. The spindle is sealed by a packing gland. The joint between the housing and the clamp cover is sealed by a flat seal.

The MT 154 project unit presents an introduction exercise to the area of assembly techniques. The assembly and disassembly processes can easily be completed within standard lesson times. Basic tools, all supplied with the kit, are required for assembly.

The unit is of most benefit in teaching if small groups of 2/3 students work independently. The group has a defined task to perform, with clear assignments to complete.

The comprehensive instructional material is oriented to practical needs. It includes a complete set of drawings with a general arrangement drawing, parts list and individual part drawings.

Together with the hydraulic valves and fittings test stand MT 162, the assembled valve can be subjected to a pressure test.

Learning Objectives / Experiments

- design and function of a shut-off valve
- assembly and disassembly, including for the purposes of maintenance and repair
- reading and understanding engineering drawings
- planning and presentation of the assembly process
- familiarisation with various machine elements: thread mechanism, seals, packing gland
- material selection criteria
- leak testing (together with the hydraulic valves and fittings test stand MT 162)

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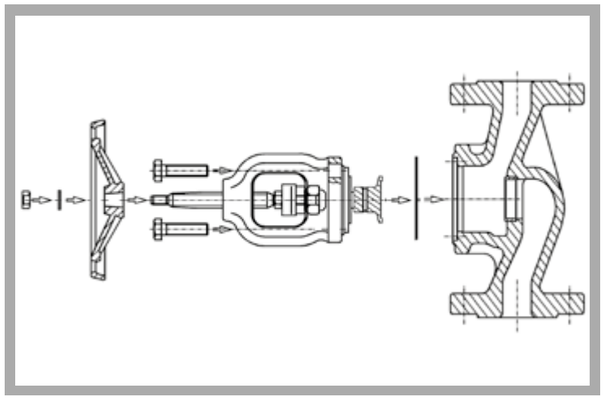
MT 154 Assembly Exercise: Shut-off Valve

The illustration shows the shut-off valve fully assembled.



Shut-off valve assembly drawing

Specification

[1] assembly exercise for engineering training
[2] shut-off valve PN 16 as parts set, with associated set of small parts, in a sturdy case
[3] shut-off valve consisting of housing, hand wheel, clamp cover, packing gland frame, taper and spindle
[4] spindle sealing based on the gland principle
[5] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Shut-off valve with flange connections:
- DN25
- PN16
- stroke: 13mm
- housing, hand wheel, clamp cover, packing gland frame: grey cast iron
- taper, seating ring, spindle, ring segment etc.: stainless steel

Dimensions and Weight

LxWxH: 600x450x180mm (case)
Weight: approx. 16kg

Scope of Delivery

1 complete set of shut-off valve parts
1 box for small parts (bolts, washers, nuts, gaskets)
1 set of assembly tools, consisting of:
- 3 open-end wrenches: size 13, 16, 22
- soft-faced hammer
- punch

1 case with foam inlay
1 set of instructional material, consisting of: technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly sequences, also in relation to repair operations

Order Details

051.15400 MT 154 Assembly Exercise: Shut-off Valve

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MT 156 Assembly Exercise: Wedge Gate Valve and Angle Seat Valve

The illustration shows the tool box with parts sets and tools. In the foreground the valves and fittings as they are assembled from the parts sets.

*** Practical exercise based on the assembly of a wedge gate valve and an angle seat valve**

*** Comprehensive and well-structured instructional material**

Technical Description

Wedge gate valves are used as fittings for water, water vapour, oil and other non-aggressive liquids. Operating temperatures of up to 200°C are possible. Wedge gate valves in this design are operated by a hand-wheel turned spindle. During closing, the slider is pushed by the spindle nut into the sealing rings in the housing.

Angle seat valves are the typical fittings used in drinking water pipes. Angle seat valves are also used in many areas of industry. They are designed for neutral fluids and gaseous media. Stainless steel versions are suitable for mildly and highly aggressive media. The valves can be used for high flow rates, and are non-sensitive to lightly contaminated and high-viscosity media. The valve spindle is usually arranged at a 45° angle to the direction of flow. Angle seat valves generate substantially lower pressure loss than screw down valves or corner valves owing to the less tortuous flow path of the fluid.

The MT 156 practice kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content.

MT 156 enables two typical industrially relevant valves and fittings to be assembled and disassembled. Students become familiar with all the components and their modes of operation. The parts are clearly laid out and well protected in a tool box. Systematic assembly and disassembly of the valves is practiced. The accompanying material details the individual steps involved in assembly, and provides additional information on the areas of application, mode of operation and design of the valves and fittings.

Learning Objectives / Experiments

- design and function of a wedge gate valve
- design and function of an angle seat valve
- assembly and disassembly, including for the purposes of maintenance and repair
- replacing components (e.g. seal)
- comparison of 2 different valves and fittings
- reading and understanding engineering drawings and operating instructions
- leak testing (together with hydraulic valves and fittings test stand MT 162)

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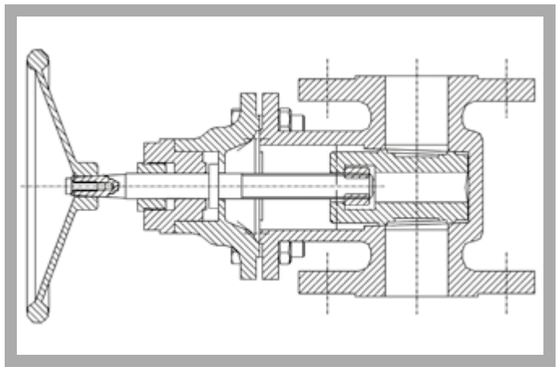
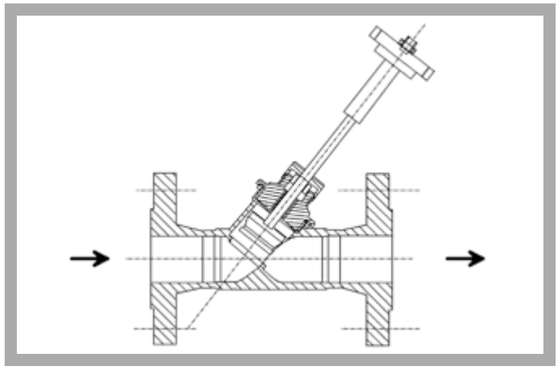
MT 156 Assembly Exercise: Wedge Gate Valve and Angle Seat Valve

Assembly of the slider



Sectional drawing of the wedge gate valve



Sectional drawing of the angle seat valve

Specification

[1] learning concept for assembly exercises on valves and fittings
[2] wedge gate valve with hand wheel, as set of parts
[3] angle seat valve with manual drive, as set of parts
[4] complete assembly tool kit
[5] valve parts and tools housed in a sheet-steel tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Wedge gate valve with flange connections
- DN40, PN10
- materials
  housing, cover, taper: grey cast iron
  spindle, sealing surfaces of housing and taper: stainless steel
  packing rings: graphite

Angle seat valve with flange connections
- DN25, PN16
- materials
  housing: stainless steel
  metallic inner parts: stainless steel
  seals: PTFE

Dimensions and Weight

LxWxH: 720x360x310mm (box)
Weight: approx. 35kg

Scope of Delivery

1 complete set of wedge gate valve parts
1 set of replacement parts, consisting of:
- 3x flat seal
- 3x packing gland seal
- 2x packing gland

1 complete set of angle seat valve parts
1 seat seal for angle seat valve
1 set of tools, consisting of:
- 1 combination wrench, size 10
- 4 single-end wrenches: size 24, 30, 2x 17
- 2 open-ended wrenches: size 27, 50
- 1 Allen key, size 2,5

1 set of bolts, nuts, washers
3 rectangular boxes for small parts
1 sheet-steel tool box with foam inlay
1 set of instructional material, consisting of:
technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly processes, also in relation to repair operations

Order Details

051.15600	MT 156	Assembly Exercise: Wedge Gate Valve and Angle Seat Valve

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MT 157 Assembly Exercise: Butterfly Valve and Non-Return Valve

The illustration shows the tool box with parts sets and tools. In the foreground the valves and fittings as they are assembled from the parts sets.

*** Practical exercise based on the assembly of a butterfly valve and a non-return valve**

*** Comprehensive and well-structured instructional material**

Technical Description

Non-return valves are used where flow reversal is not permitted. They must fully seal off the reverse direction while offering the lowest possible resistance in the forward flow direction. If the differential pressure of the medium falls below the value as dictated by the spring force, the valve closes. Non-return valves are installed in pipelines, and must close if the pressure drops or if a high back-pressure occurs. They are largely maintenance-free and low-wearing.

Butterfly valves are installed in the pipelines of water supply pumping stations and filter systems; in power plant cooling circuits; in the chemical industry for process water, including acidic and alkaline media; and in sewage treatment plants. They seal drip-tight like gate valves, and take up little space, as they are usually similar in size to the pipe cross-section.

Butterfly valves are constructed for ultra-large nominal widths (DN5300). Their operating pressure is normally in the range 4...16bar. Butterfly valves may be operated by hand, by electric motor via a spur gear segment or worm gear, or by a hydraulic piston. The valve is closed by rotating its shaft through 90°.

The MT 157 practice kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content.

MT 157 enables two typical industrially relevant valves and fittings to be assembled and disassembled. Students become familiar with all the components and their modes of operation. The parts are clearly laid out and well protected in a tool box. Systematic assembly and disassembly of the valves and fittings is practiced. The accompanying material details the individual steps involved in assembly, and provides additional information on the areas of application, mode of operation and design of the valves and fittings.

Learning Objectives / Experiments

- design and function of a butterfly valve
- design and function of an a non-return valve
- assembly and disassembly, including for the purposes of maintenance and repair
- replacing components (e.g. seal)
- comparison of 2 different valves and fittings
- reading and understanding engineering drawings and operating instructions
- leak testing (together with hydraulic valves and fittings test stand MT 162)

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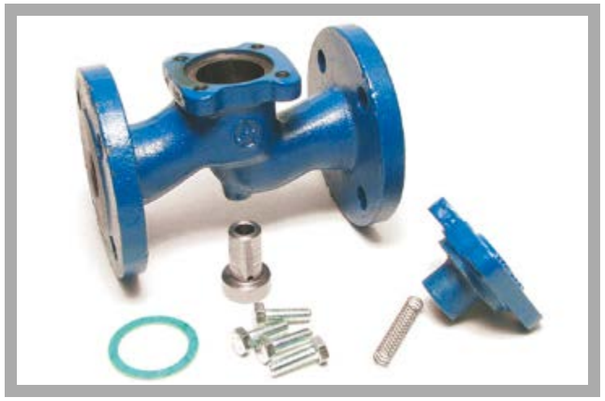
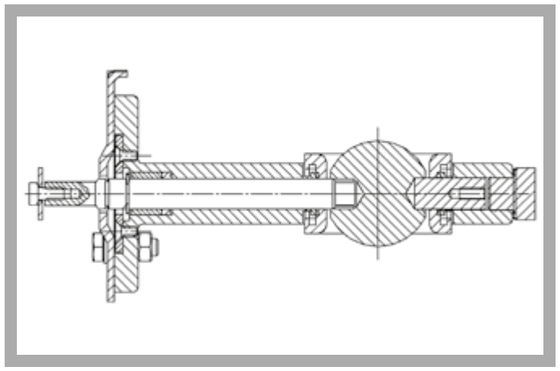
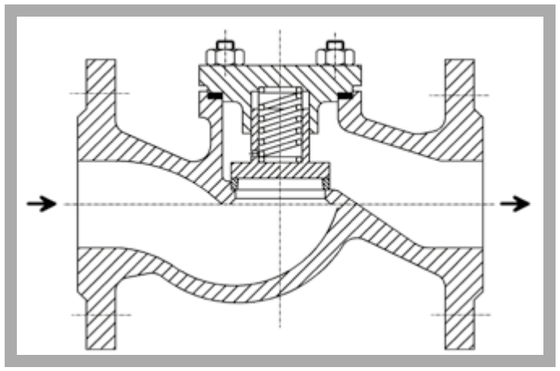
MT 157 Assembly Exercise: Butterfly Valve and Non-Return Valve



Non-return valve, disassembled



Sectional drawing of the butterfly valve



Sectional drawing of the non-return valve

Specification

[1] learning concept for assembly exercises on valves and fittings
[2] butterfly valve with manual adjuster, as set of parts
[3] typical non-return valve, as set of parts
[4] complete assembly tool kit
[5] valve parts and tools housed in a sheet-steel tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Butterfly valve with flange connections
- DN40, PN16
- materials
  housing: grey cast iron
  disk, shafts: stainless steel
  sleeve: rubber
  hand lever: aluminium
  bush: bronze

Non-return valve with flange connections:
- DN25, PN16
- materials
  housing: grey cast iron
  taper, spring: stainless steel
  flat seal: graphite

Dimensions and Weight

LxWxH: 720x360x310mm (box)
Weight: approx. 35kg

Scope of Delivery

1 complete set of butterfly valve parts
1 set of replacement parts, consisting of:
- 1 seal
- 1 sleeve
- 8 bolts M8x25

1 complete set of non-return valve parts
1 set of tools, consisting of:
- 3 single-end wrenches: size 10, 13, 22
- 1 Allen key, size 3
- 1 slotted screwdriver 5,5x1
- 1 set of circlip pliers
- 1 soft-faced hammer

2 rectangular boxes for small parts
1 sheet-steel tool box with foam inlay
1 set of instructional material, consisting of:
technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly processes, also in relation to repair operations

Order Details

051.15700 MT 157 Assembly Exercise: Butterfly Valve and Non-Return Valve

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MT 158 Assembly Exercise: Ball Valve and Shut-off Valve

The illustration shows the tool box with parts sets and tools. In the foreground the valves and fittings as they are assembled from the parts sets.

*** Practical exercise based on the assembly of a ball valve and a shut-off valve**

*** Comprehensive and well-structured instructional material**

Technical Description

Shut-off valves, of the design presented here, are used to shut off and restrict the flow of media. They must be capable of complete flow shut-off. Closure of the valve should be such that the volumetric flow does not suddenly drop to zero in order to prevent shock loads. The valve taper is moved by the spindle and makes a metallic seal against the seating ring pressed into the housing. The spindle is sealed by a packing gland. The joint between the housing and the clamp cover is sealed by a flat seal.

Ball valves are used where media flows or pressures in pipelines need to be stopped quickly and easily, e.g. when valves and fittings are to be removed from a pressurised pipeline. They have a very low flow resistance when open, require little space due to the compact design, and have a self-cleaning sealing face. The sealing body is a ball with a cylindrical bore allowing full flow when the valve is fully open. The ball is rotated through 90° by way of a lever with spindle, enabling it to open or close the valve fully.

The practice kit MT 158 forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content.

MT 158 enables two typical shut-off valves to be assembled and disassembled. Students become familiar with all the components and their modes of operation. The parts are clearly laid out and well protected in a tool box. Systematic assembly and disassembly of valves and fittings is practiced. The accompanying material details the individual steps involved, and provides additional information on the areas of application, mode of operation and design of the fittings.

Learning Objectives / Experiments

- design and function of a ball valve
- design and function of a shut-off valve
- assembly and disassembly, including for the purposes of maintenance and repair
- replacing components (e.g. seal)
- comparison of 2 different valves and fittings
- reading and understanding engineering drawings and operating instructions
- leak testing (together with hydraulic valves and fittings test stand MT 162)

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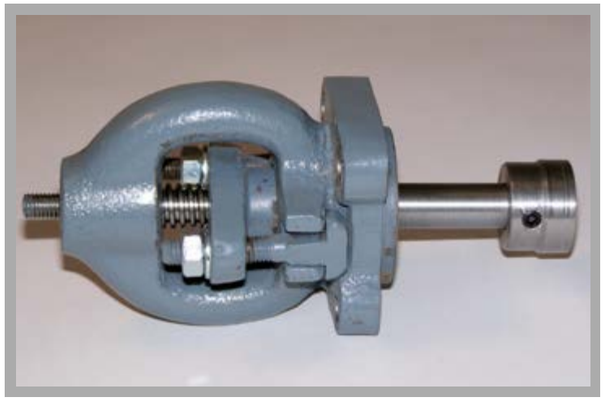
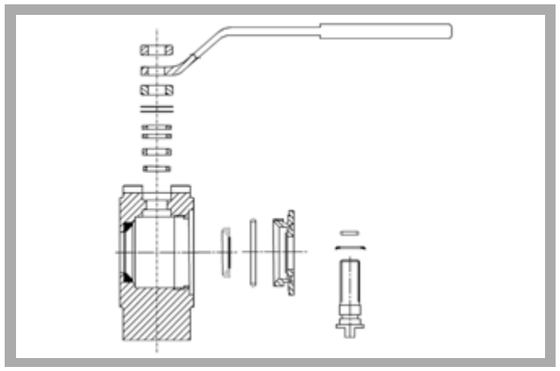
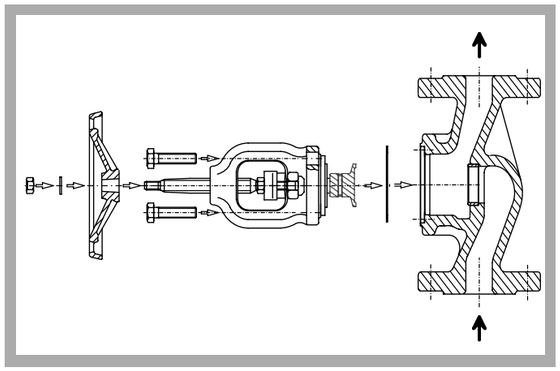
MT 158 Assembly Exercise: Ball Valve and Shut-off Valve



Assembly unit 2 of the shut-off valve, assembled



Assembly drawing of the ball valve



Assembly drawing of the shut-off valve

Specification

[1] learning concept for assembly exercises on valves and fittings
[2] shut-off valve, as set of parts
[3] 2-way ball valve, as set of parts
[4] complete assembly tool kit
[5] valve parts and tools housed in a sheet-steel tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Shut-off valve with flange connections
- DN25, PN16
- housing, hand wheel, clamp cover, packing gland frame: grey cast iron
- taper, seating ring, spindle, ring segment etc.: stainless steel

Ball valve with flange connections
- DN25, PN16
- housing: C22
- ball: brass
- spindle, lever, disks etc.: galvanized steel

Dimensions and Weight

LxWxH: 720x360x310mm (box)
Weight: approx. 35kg

Scope of Delivery

1 complete set of shut-off valve parts
1 set of replacement parts, consisting of:
- 2 packing glands for spindle sealing
- 16 steel balls for seating ring assembly
- 2 seals

1 complete set of ball valve parts
1 set of replacement parts, consisting of:
- 2 seal sets

1 set of tools, consisting of:
- 2 single-end wrenches: size 13, 17
- 1 Allen key, size 3
- 1 pin-type face wrench, adjustable
- 1 slotted screwdriver 5,5x1
- 1 punch
- 1 soft-faced hammer

1 set of nuts and bolts
2 rectangular boxes for small parts
1 sheet-steel tool box with foam inlay
1 set of instructional material, consisting of:
technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly processes, also in relation to repair operations

Order Details

051.15800 MT 158 Assembly Exercise: Ball Valve and Shut-off Valve

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MT 162 Hydraulic Valves and Fittings Test Stand

The illustration shows MT 162 together with the gate valve from MT 156.

*** Mobile test stand for pressure testing of valves and fittings**

*** Final testing for the GUNT MT 154, MT 156, MT 157 and MT 158 assembly projects**

Technical Description

MT 162 is used for pressure testing of various types of valves and fittings. The unit can be used to test if the valve opens and closes easily under pressure, and if the housing and seals can withstand the test pressure. A manually operated piston pump draws water from the storage tank, fills the valve interior, and generates the test pressure. A manometer indicates the test pressure. The welded-in collector tray is fitted with a ball valve to allow it to be drained. The valve under test is attached to a mounting flange and sealed by a blank flange. The piston pump and mounting flange are interconnected via a pressure hose. The test stand includes its own storage tank so it can be operated independently of a water pipe supply. The tank must be topped up occasionally.

The test stand is used in particular for the final testing of the valves assembled and disassembled in the GUNT MT 154, MT 156, MT 157 and MT 158 assembly projects series. This ensures that a successfully completed assembly project can be examined for operability with a formal test procedure.

Learning Objectives / Experiments

the following experiments can be conducted together with valves and fittings, such as a wedge gate valve or angle seat valve (MT 156), butterfly valve or non-return valve (MT 157), ball valve or shut-off valve (MT 158)

- correct connection of valves to a flange coupling
- familiarisation with the terms "nominal pressure" and "test pressure"
- performing the final test for the GUNT MT 154, MT 156, MT 157 and MT 158 assembly projects
- checking the free movement of the valves and fittings
- pressure testing
  * leak testing of housing and flange seals
  * leak testing of the valve seat
- drafting a test report

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MT 162 Hydraulic Valves and Fittings Test Stand

1 manometer, 2 mounting flanges with blank flange, 3 benchtop tray with drain, 4 pressure test pump with water tank, 5 hand lever, 6 hose

A	B
4bar	5.2bar
6bar	7.8bar
10bar	13.0bar
16bar	20.8bar
40bar	52.0bar

Column A: nominal pressure, column B: test pressure

Specification

[1] test stand on which to mount industrial valves and fittings
[2] pressure testing of valves and fittings
[3] hand-operated piston pump to generate the test pressure, a return valve to relieve the system pressure, and a manometer for pressure measurement
[4] 2 different sizes of mounting flange with blank flange and flange seal
[5] connection of pump and test flange via pressure hose
[6] test medium: water
[7] mobile frame with collector tray and ball valve to drain
[8] water storage tank
[9] the test stand forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Piston pump with tank
- test pressure: 0...60bar
- tank capacity: 12L
- manometer: 0...60bar

Mounting flanges for valves and fittings under test
- DN25
- DN40

Dimensions and Weight

LxWxH: 1000x750x1200mm
Weight: approx. 80kg

Scope of Delivery

1 test stand, complete with pump, tank, pressure hose
1 blank flange DN25 with flange seal
1 blank flange DN40 with flange seal
1 blank flange DN40 with spacer and flange seal for butterfly valve
1 set of bolts for flange connections
1 set of tools
1 instruction manual

Order Details

051.16200 MT 162 Hydraulic Valves and Fittings Test Stand

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HL 960 Assembly Station: Pipes and Valves and Fittings

*** Practically oriented assembly of real piping and system installations**

*** Detailed, practically-based familiarisation with system components**

Technical Description

HL 960 is a practical exercise and training system which provides an entirely authentic introduction to industrial pipes and valves and fittings. The assembly kit comprises a wide variety of valve and fittings, piping elements and one pressure tank, as well as sealing and fastening components. A sturdy U-shaped mounting frame permits assembly of a variety of piping systems, plant components and functional units. The piping elements are prepared ready for assembly, and matched to installation lengths and flange connections. The components permit multiple assembly and disassembly.

The training system is designed for students to work together in a learning group. The complete process of constructing a system may take several days if all the steps are followed: obtaining information, planning, deciding, executing, checking and assessing.

The detailed instructional material assists in creating an effective and ordered learning process. It contains technical descriptions of all the system components as well as various specimen systems and installations.

Finished setups can be subjected to real testing with water. The pump system HL 960.01 (closed circuit) is available for this purpose.

Learning Objectives / Experiments

- design and function of valves and fittings, piping elements and system components
- planning of piping and system installations according to specification, e.g. a process schematic
- selection of components and drafting of requirement lists
- technically correct preparation and execution of system assembly
- reading and understanding engineering drawings and technical documentation
- operational testing of the constructed systems (in conjunction with suitable water supply and disposal)

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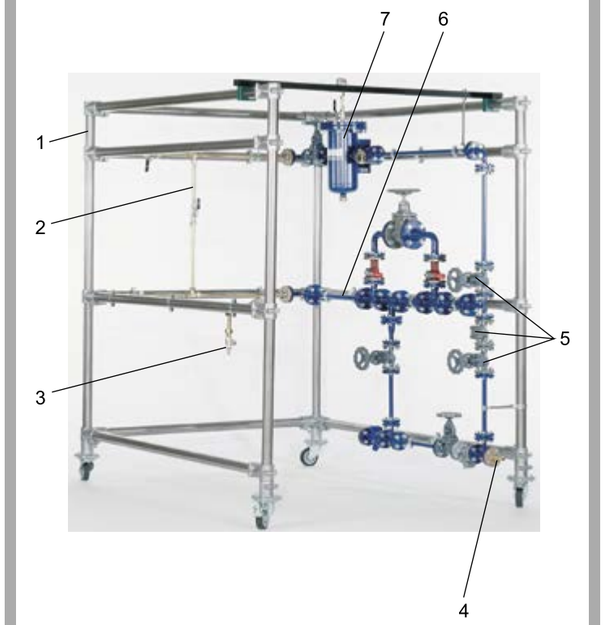
HL 960 Assembly Station: Pipes and Valves and Fittings



1 mobile frame, 2 DN15 pipe, 3 connection for HL 960.01 (outlet), 4 connection for HL 960.01 (inlet), 5 various valves and fittings, 6 DN25 pipe, 7 pressure vessel with manometer

The picture shows HL 960 with a completed specimen installation.
In the foreground: pump system HL 960.01.

Specification

[1] assembly exercise for engineering training
[2] piping network comprising pipe bends, elbows, T-pieces and transitions in nominal widths DN15, 25, 40
[3] pipe connections via flanges or cutting ring screw fittings
[4] standard commercially available flanged fittings: shut-off valve, non-return valve, strainer, condensation drain, inspection glass, ball valve, gate valve
[5] ball valve with cutting ring screw fitting
[6] pressure vessel with manometer, connection via DN15 flanges
[7] connection to water supply via hose with coupling
[8] mobile frame for mounting of pipe network
[9] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Flange fittings
- grey cast iron
- nominal pressure: PN16 for DN15, 25 / PN10 for DN40

Ball valve with cutting ring screw fitting
- brass, nickel-plated
- nominal pressure: PN25
- nominal size: G1/2"

Manometer: 0...4bar

Dimensions and Weight

LxWxH: 1540x1840x2020mm
Weight: approx. 300kg

Required for Operation

Water connection and drain via hoses with couplings

Scope of Delivery

1 frame
1 set of valves and fittings, pipes, piping elements with sealing and fastening material
1 set of tools
1 set of instructions, comprising drawing set and instructional material

Order Details

065.96000 HL 960 Assembly Station: Pipes and Valves and Fittings

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HL 960.01 Assembly and Alignment of Pumps and Drives

*** Installing a pump in a system**

*** Alignment of electric motor and pump by different methods**

Technical Description

A complete work process when repairing work machines such as pumps consists of the following steps: assembly – alignment – test. The trainer described here was designed with industrial conditions in mind and is primarily intended for the practical training of maintenance engineers. It also offers a variety of topics and starting points for training in vocational schools.

The HL 960.01 trainer enables students to practise the entire maintenance process. On its own, the trainer can be used for assembly exercises with the option of aligning the drive and the pump. Combined with HL 960 Assembly Station Pipes and Valves and Fittings, the HL 960.01 trainer can be used as a test system for the completely assembled piping system.

The trainer consists of an electric drive motor, a standard pump and a piping system with storage tank and can be operated independent of the water supply mains. Students can practise exchanging pumps for inspection or repair as part of the assembly exercise. The exercises cover the entire system and its individual subassemblies. A manometer displays the pressure at the outlet of the pump.

The position of the electric motor can be adjusted in three directions for alignment purposes. The alignment can either be checked in a conventional manner with a straight edge or with the reverse alignment method using two dial gauges. Non-contact, microprocessor-aided methods can also optionally be used (specific alignment systems are not included in the scope of delivery).

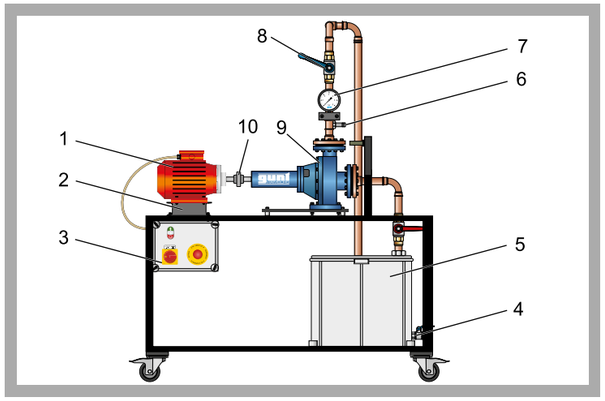
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

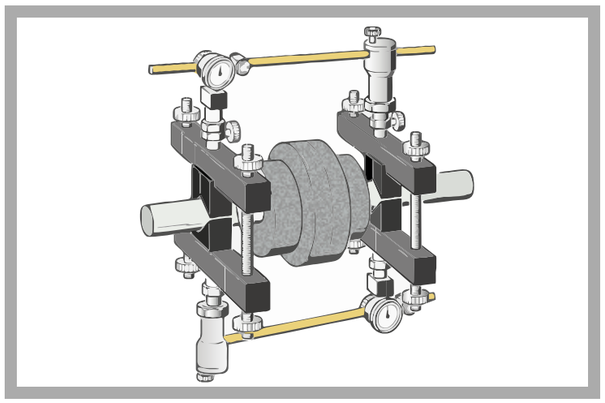
- installing a pump in a system
- connecting and aligning motor and pump
- familiarisation with various alignment methods: straight edge, dial gauges
- familiarisation with key system components
- electrical installation of motor and switching elements
- assembly of pipes and instrumentation
- detail installation on a standard centrifugal pump
- reading and understanding engineering drawings, product documentation and circuit diagrams
- familiarisation with maintenance procedures
- planning assembly and maintenance steps

in conjunction with HL 960
- operational testing in a pipe network

HL 960.01 Assembly and Alignment of Pumps and Drives



1 electric motor, 2 foundation for electric motor, 3 switch box, 4 HL 960 return connection, 5 storage tank, 6 HL 960 inlet connection, 7 manometer, 8 shut-off valve, 9 pump, 10 coupling



The illustration shows the principle of the dual radial dial gauge method of aligning shafts.

Specification

[1] mobile system for alignment of a standard pump and its drive motor
[2] asynchronous electric motor with constant speed
[3] electric motor with positioning frame and fit plates for alignment
[4] pump and motor connected via coupling
[5] checking of alignment using straight-edge or dial gauges
[6] manometer at pump outlet
[7] pump with ball valves at inlet and outlet
[8] closed water circuit
[9] the system forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Centrifugal pump
- max. flow rate: 300L/min
- max. head: 16,9m
- power consumption: 750W

Asynchronous motor, single phase
- power output: 1100W
- speed: 3000min^{-1}

Storage tank: 96L

Measuring ranges
- dial gauges: 0...3mm / 0...20mm, resolution: 0,01mm
- manometer: 0...1,6bar

Dimensions and Weight

LxWxH: 1250x830x1520mm
Weight: approx. 122kg

Required for Operation

230V, 50/60Hz, 1 phase

Scope of Delivery

1 trainer with centrifugal pump and drive
1 set of measuring aids, consisting of
- 2 dial gauges 0...3mm
- straight-edge
- test shaft for sag measurement
- dial gauge with magnetic holder, 0...20mm

1 set of tools
1 set of instructional material

Order Details

065.96001	HL 960.01	Assembly and Alignment of Pumps and Drives

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MT 140 Assembly Station: Piston Compressor

*** Fully equipped mobile teaching station for demonstration purposes. Provides an introduction to assembly techniques using a piston compressor as an example**

*** Comprehensive and well-structured instructional material**

*** Learning in a practical environment**

*** Highly suitable for developing interdisciplinary technical understanding**

Technical Description

Compressors are at the core of compressed air generator plants. These plants are used where compressed air is used as a source of energy. Compressed air is often used instead of electrical energy, particularly in workplaces where there is a risk of explosion of combustible gases. The heat generated by compression is dissipated by cooling fins. The compressor is driven by a V-belt.

The mobile workstation MT 140 forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. The station includes everything required to provide students with an introduction to a wide range of demanding assembly projects. A disassembled piston compressor is contained in the drawers of the trolley cabinet which also holds the tools and assembly aids, small parts and gaskets required for assembly. A second fully functional compressor, permanently mounted to the workbench, can be used for demonstration purposes. This enables references to be made between individual components and the complete assembled system at any time during teaching.

Large-format drawings suitable for workshop practice can be attached to the display board at the rear of the trolley. All steps involved can be demonstrated to, and then performed by, the students. The comprehensive and clearly structured instructional material, including a set of drawings, sets out the individual steps in detail. It also provides additional information on the areas of application, mode of operation and design of the assemblies.

The MT 140.01 test stand is required for functional testing after assembly is complete. Multimedia learning software MT 140.20 is also available.

Learning Objectives / Experiments

- design and function of a compressor
- reading and understanding engineering drawings
- familiarisation with components and assemblies, their design features and functions
- dimensioning exercises, gauging parts
- work planning, in particular planning and presentation of the assembly process
- familiarisation with assembly aids and jigs
- assembly exercises: assembly of modules and complete units
- analysis of faults and damage, in conjunction with maintenance and repair steps
- material selection criteria

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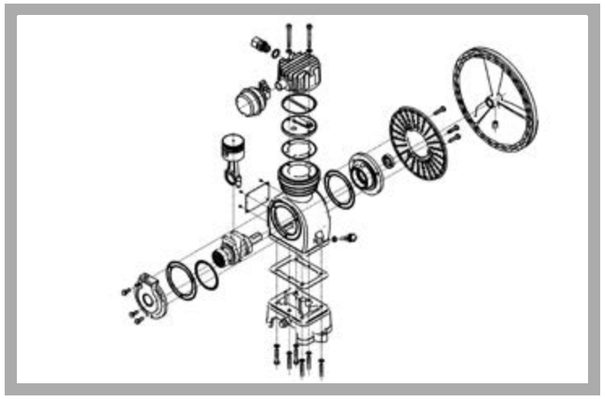
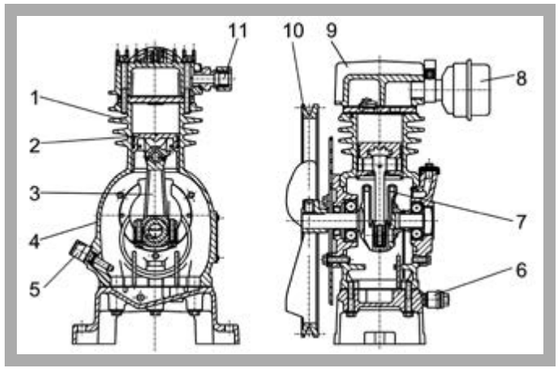
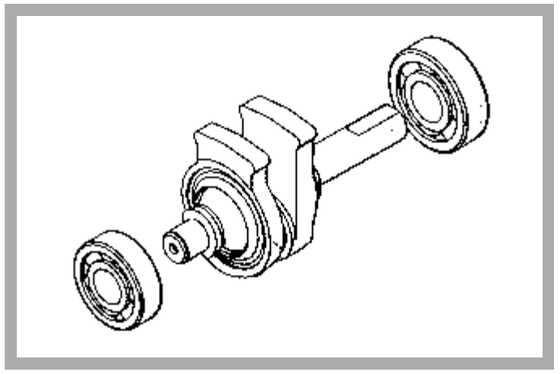
MT 140 Assembly Station: Piston Compressor



The illustration shows the graphic explosion drawing which serves as an aid to the students in the assembly of the compressor. It is designed to be put up on the display board at the rear of the workshop trolley.



1 cylinder, 2 piston, 3 connecting rod, 4 crankcase, 5 dipstick, 6 oil drain plug, 7 crankshaft, 8 air filter, 9 cylinder cover, 10 V-belt pulley, 11 pressure joint



Crank mechanism

Specification

[1] assembly project for engineering training
[2] 2 piston compressors: 1x set of components for assembly, 1x assembled, mounted on trolley as demonstrator
[3] single-stage compressor, air-cooled, with fan flywheel, intake filter and pipe unions
[4] compressor consisting of piston and cylinder, housing, driving gear, cylinder cover with valves
[5] workshop trolley with rear drawing display board, built-under cabinet with 3 lockable drawers and vice with 115mm jaw width
[6] assembly kit, tool kit, assembly aids, accessories and gaskets as well as instructional material contained in built-under cabinet
[7] the assembly station forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Air-cooled single-cylinder piston compressor
- cylinder bore: 50mm
- stroke: 32mm
- displacement volume: 63cm³
- speed: 1.850min^{-1}
- max. pressure: 10bar
- intake capacity: 115L/min
- drive power output: 700W
- dimensions, assembled: LxWxH: 223x256x314mm

Dimensions and Weight

LxWxH: 1.520x800x1.850mm (trolley)
Weight: approx. 150kg

Scope of Delivery

1 workshop trolley with rear drawing display board and built-under cabinet
1 working piston compressor
1 compressor in parts
1 set of assembly tools and jigs
1 set of small parts and gaskets
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly sequences, set of transparencies for overhead projector

Order Details

051.14000 MT 140 Assembly Station: Piston Compressor

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MT 140.01 Assembly Exercise Piston Compressor: Functional Test

The illustration shows MT 140.01 together with the compressor MT 140.02 under test.

*** Test device for the piston compressor assembly exercise from the parts sets MT 140.02 or MT 140**

*** Permits assessment of the assembly**

Technical Description

The MT 140.01 test device is used in conjunction with the piston compressor assembly exercises, MT 140.02 or MT 140. The fully assembled compressor is placed on the test device. Here the complete system is professionally assembled, including alignment of the motor and compressor. The electrical connection of the compressor can also be demostrated if required as part of the teaching process. A successfully completed assembly exercise can then be examined for operability using a formal test procedure. During the functionality test, the pressure rise in the tank and the current consumption of the drive motor are recorded over time.

The components of MT 140.01 are clearly laid out on a base plate. The unit contains an electric motor with belt pulley and protective screen. A switch box is included with displays and controls as well as a pressure vessel with display, safety valve and pressure switch. An ammeter on the switch box indicates the current consumption of the drive motor. The compressor being checked is installed on the test bed and connected to the drive motor via a belt drive.

Learning Objectives / Experiments

in conjunction with a piston compressor (MT 140 or MT 140.02)
- functional testing of a piston compressor
- pressure rise in tank over time
- current consumption of drive motor as function of pressure
- familiarisation with a compressed air generator and its components
- function and mode of operation of safety elements
  * safety valve
  * pressure switch
  * non-return valve
- professional installation of the compressor in the test device, including setting and alignment

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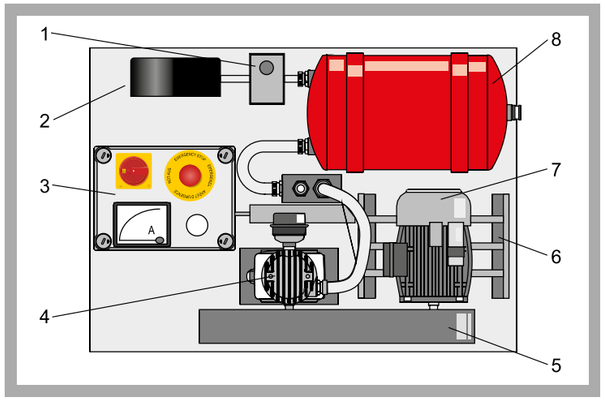
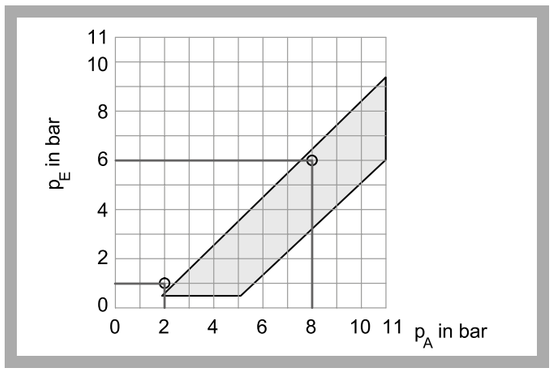
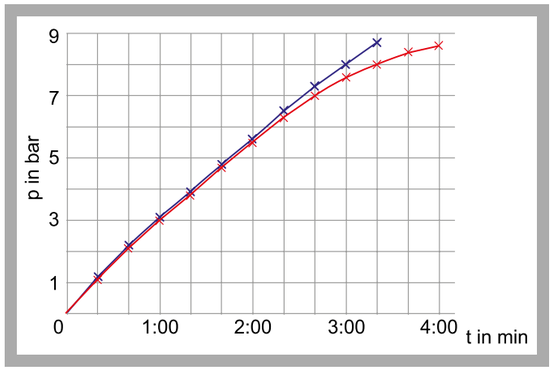
MT 140.01 Assembly Exercise Piston Compressor: Functional Test



1 pressure switch, 2 manometer, 3 switch box with ammeter, 4 compressor MT 140, 5 belt guard, 6 motor carriage, 7 electric motor, 8 pressure vessel



Pressure diagram of the pressure switch: p_E switch-on pressure, p_A switch-off pressure, grey area: permissible pressure switch values



Tank pressure p in bar over pumping time t in minutes; blue: good assembly, red: poor assembly

Specification

[1] unit for functionality testing of the piston compressor from assembly exercises MT 140.02 or MT 140
[2] driven by electric motor and belt drive
[3] single-phase electric motor on adjustable carriage
[4] pressure vessel with adjustable pressure switch and manometer
[5] switch box with controls and ammeter to indicate current consumption
[6] safety devices: pressure switch, safety valve, protective screen for belt drive, emergency-off switch
[7] the unit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Single-phase motor
- power output: 250W
- speed: 1405min^{-1}

Pressure vessel
- capacity: 10L
- max. pressure: 10bar

Measuring ranges
- manometer: 0...16bar
- ammeter: 0...4A, class 2,5

Dimensions and Weight

LxWxH: 820x550x500mm
Weight: approx. 45kg

Required for Operation

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

Scope of Delivery

1 experimental unit
1 stopwatch
1 set of assembly/disassembly tools
0,5L compressor oil
1 manual

Order Details

051.14001 MT 140.01 Assembly Exercise Piston Compressor: Functional Test

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MT 140.02 Assembly Exercise: Piston Compressor

The illustration shows the tool box with parts set. The compartment insert for tools and small parts is shown in the foreground.

*** Practical assembly of an industrial compressor, using simple tools and jigs**

*** Broad scope of learning with interdisciplinary problems**

*** Comprehensive and well-structured instructional material**

Technical Description

The MT 140.02 kit contains all the parts required to construct the compressor. The compressor fits are designed so as to allow the complete assembly process to be carried out by hand. All parts are clearly laid out and well protected in a sheet-steel tool box. Small parts and tools are contained in a box with a transparent plastic lid.

The nature of this assembly exercise permits wide-ranging, and in particular, interdisciplinary work to be carried out by the students. The exercise is particularly well suited to action-based teaching, in conjunction with students working both independently and in teams.

The well-structured instructional materials set out comprehensive and in-depth technical information which forms the basis for the teaching process. The teaching material included consists of a complete set of drawings with parts lists, individual part drawings, an exploded view and assembly drawing. All drawings are to standard, and dimensioned in line with production requirements. The comprehensive set of transparencies for the overhead projector is another very useful feature.

The fully assembled compressor can be tested for functionality using the optionally available MT 140.01 test bed unit. Interactive learning software (MT 140.20) supports effective learning by means of graphics, animations and vocal support.

Learning Objectives / Experiments

- design and function of a compressor
- reading and understanding engineering drawings
- familiarisation with components and assemblies, their design features and functions
- dimensioning exercises, gauging of parts
- work planning, particularly planning and presentation of the assembly process
- familiarisation with assembly aids and jigs
- assembly exercises: component and complete unit assembly
- analysis of faults and damage, in conjunction with maintenance and repair steps
- material selection criteria

in conjunction with MT 140.01
- functional testing of the assembled compressor

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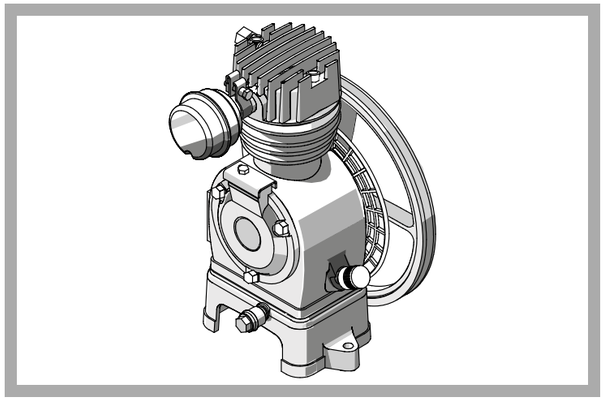
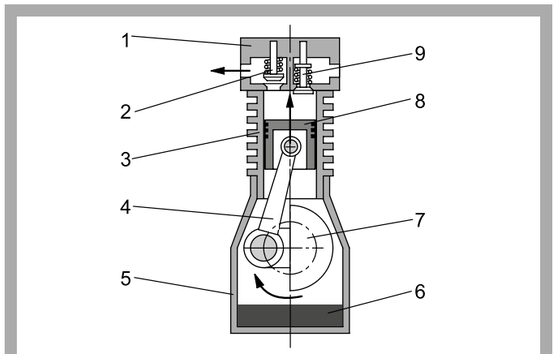
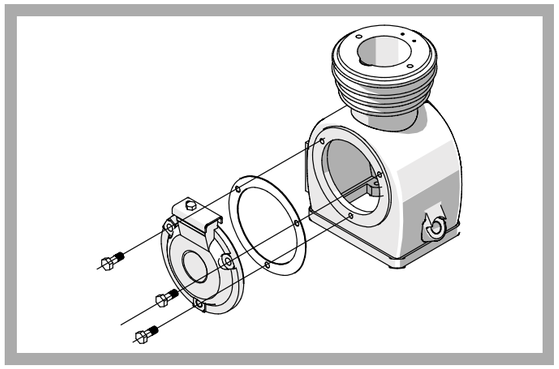
MT 140.02 Assembly Exercise: Piston Compressor



Three-dimensional view of the assembled compressor



1 cylinder cover, 2 pressure valve, 3 cylinder, 4 connecting rod, 5 crankcase, 6 oil sump, 7 crankshaft, 8 piston, 9 intake valve



Assembly of the side cover

Specification

[1] assembly exercise for engineering training
[2] complete, disassembled piston compressor with small parts set and 6 assembly jigs in a storage case
[3] single-stage compressor, air-cooled, with fan flywheel, intake filter and pipe unions
[4] compressor consisting of piston and cylinder, housing, driving gear, cylinder cover with valves
[5] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Air-cooled single-cylinder piston compressor
- cylinder bore: 50mm
- stroke: 32mm
- displacement volume: 63cm³
- speed: 1850min^{-1}
- max. pressure: 10bar
- intake capacity: 115L/min
- drive power output: 700W
- dimensions, assembled, LxWxH: 223x256x314mm

Dimensions and Weight

LxWxH: 720x360x310mm (box)
Weight: approx. 28kg

Scope of Delivery

1 complete set of compressor parts
1 box for small and loose parts (e.g. bolts, circlips, washers)
1 set of gaskets
6 assembly jigs
1 set of assembly / disassembly tools
1 sheet-steel tool box with foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of assembly and disassembly sequences, set of transparencies for overhead projector

Order Details

051.14002 MT 140.02 Assembly Exercise: Piston Compressor

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MT 140.20 Multimedia Learning Software: Piston Compressor

*** Learning software with calculations and AutoCAD drawings**

*** Computer animated demonstration of complex correlations: Functions and assembly steps**

*** Comprehensive package with clear menu structure**

Technical Description

The MT 140.20 learning software was developed specially for the piston compressor assembly trainers MT 140.02 and MT 140. It is designed for use in teaching at technical colleges, and is intended to motivate students using demonstration and illustration. The piston compressor assembly project is analysed under a number of headings: assembly/disassembly; functional descriptions; modules and components; calculations and technical data. The user is guided through the assembly process with clear, descriptive computer animations. Various functions are explained by computer-generated visualisation of the moving compressor. Students can also access the supplied AutoCAD or Excel files with drawings and parts lists. The calculation module is used to detemine screw sizes, determine forces, and design the connecting rod. Password-protected configuration files permit custom adaptation to the specific teaching situation by allowing or barring access to modules and files. The software also includes a quiz with a variable set of questions.

Note:
Only if the hardware is used together with this learning software, the didactic function of the software becomes completely apparent to the user. The software is therefore only available together with the assembly trainers.

Learning Objectives / Experiments

- understanding engineering drawings, exercises with AutoCAD files
- printout of parts lists
- planning the assembly sequence
- familiarisation with single parts and modules
- virtual assembly and disassembly
- explanation of functions
- computer-aided calculations
- dealing with design aspects
- use of Technical English on a real project

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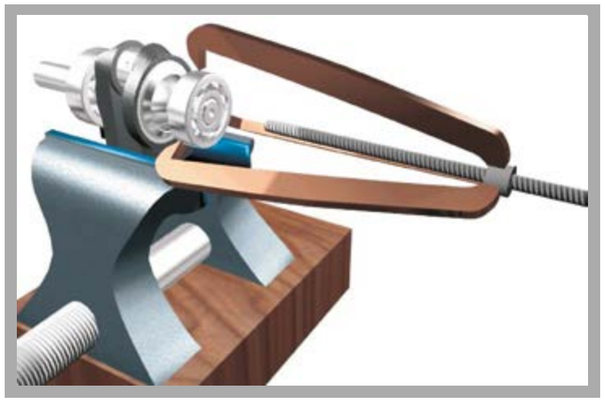
MT 140.20 Multimedia Learning Software: Piston Compressor

The illustration is a screenshot of an animation showing lubrication of the compressor.



The illustration is a screenshot of an animation showing a bearing being pulled.

Specification

[1] multimedia learning software as an accessory to assembly projects MT 140.02 and MT 140
[2] simple operation with user interfaces similar to MS Windows
[3] access to parts lists and drawings with AutoCAD or MS Excel
[4] editable drawings and parts lists
[5] password-protected configuration files
[6] language options: German and English
[7] integrated quiz with catalogue of questions (order of questions can be varied to suit lesson/test)

Technical Data

Language options
- German and English

Minimum hardware and software requirements
- PC with Windows XP or higher

Scope of Delivery

2 CDs
1 instruction manual

Order Details

051.14020	MT 140.20	Multimedia Learning Software: Piston Compressor

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MAINTENANCE

SYSTEM COMPONENTS: VALVES, PUMPS, PIPES

CODE	PRODUCT	PAGE
MT 180	Assembly & Maintenance Exercise: Centrifugal Pump	142
MT 181	Assembly & Maintenance Exercise: Multi-Stage Centrifugal Pump	144
MT 182	Assembly & Maintenance Exercise: Screw Pump	146
MT 183	Assembly & Maintenance Exercise: Diaphragm Pump	148
MT 184	Assembly & Maintenance Exercise: Piston Pump	150
MT 185	Assembly & Maintenance Exercise: In-Line Centrifugal Pump	152
MT 186	Assembly & Maintenance Exercise: Gear Pump	154
Overview	HL 962 Assembly and Maintenance Exercises: Pipes, Fittings, Pumps	156
HL 962	Assembly Stand for Pumps	158
HL 962.01	Standard Chemicals Pump	160
HL 962.02	Canned Motor Pump	161
HL 962.03	Side Channel Pump	162
HL 962.04	Standard Chemicals Pump with Magnetic Clutch	163
HL 962.30	Tank System	164

TEST STANDS

CODE	PRODUCT	PAGE
RT 395	Maintenance of Valves and Fittings and Actuators	166
RT 396	Pump and Valves and Fittings Test Stand	168

ASSEMBLY KITS

CODE	PRODUCT	PAGE
MT 210	Assembly & Maintenance Exercise: Refrigeration	170
MT 190	Assembly Project: Materials Tester	172
MT 190.01	Assembly Project: Data Acquisition for Materials Tester	174
Leaflet	Assembly Projects – Maintenance	177

The principle of complete systems from GUNT

It is our principle to provide you with complete teaching and training systems that are ready for immediate use. This means that GUNT always supplies comprehensive instructional material to accompany the actual product.

For our **maintenance** training systems we additionally include the necessary jigs, fixtures and assembly tool kits in almost every case. In many cases additional small and wearing parts are also included, ensuring long-term usability of the training system.

Visit our website www.gunt.de

LEARNING CONCEPTS RELATING TO INDUSTRIAL MAINTENANCE

The maintenance

of industrial plant and machinery is a key field of activity for technicians and skilled tradesmen working in mechanical and electrical engineering.

Key area in technical training

The level of attention devoted to the subject of maintenance by the curricula is therefore high.

TEACHING AND LEARNING SYSTEMS RELATING TO MAINTENANCE

GUNT-Gerätebau GmbH offers you a wide range of wholly practice-oriented teaching and training systems relating to technical maintenance with which you can cover essential learning content:

Use of specific manufacturer's documentation for maintenance, inspection and repair	Planning and assessing maintenance sequences and steps
Reading and understanding engineering drawings	Practical execution and documentation of maintenance operations
Familiarisation with machine and system components	Testing and commissioning of repaired systems
Understanding maintenance as the interaction between inspection, maintenance and repair	Assessment of malfunctions, detection of faults

The GUNT training systems are ideally suitable for students' group working, and of course for project-oriented working methods.

Things don't have to get this bad

It's possible to do something in time

What is maintenance?

'Maintenance' as defined by German industry standard DIN 31051 is a complex field, so the range of teaching and training systems we offer in this area is very diverse.

MAINTENANCE TO DIN 31051

Maintenance	Inspection	Repair
Maintaining the required condition	Recording and assessing the actual condition	Restoring the required condition
Cleaning, lubricating, adjusting	Measuring, testing, diagnosing	Replacing, correcting
With the plant shut down only, and in accordance with the maintenance instructions	With the plant running and shut down, in accordance with inspection instructions	With the plant shut down only, based on work order and after thorough preparation

This Maintenance chapter of the GUNT catalogue should be read in close conjunction with the other sections.

LEARNING THROUGH PRACTICE...

This chapter deals with the process of familiarisation with component and their functions, reading and understanding engineering drawings or operating instructions, and familiarisation with technical terminology and language. The assembly exercises can be conducted in relatively short periods of time (within lesson units) and do not as yet require any particular technical experience. Fault diagnosis and maintenance measures are not yet central to the training systems set out in this chapter.

CHAPTER ASSEMBLY PROJECTS

CHAPTER MAINTENANCE

The real, industrial nature of the exercises is higher than in the Assembly Projects. Typical maintenance methods and testing procedures are offered as learning content. Some of the exercises take a lot of time to complete and amount to substantial project work. Demands are made on technical skills.

CHAPTER MACHINERY DIAGNOSTICS

The teaching systems familiarise trainees with the specific methods of monitoring plant / machinery condition, such as the early detection of bearing or gear damage. We work primarily with vibration analysis methods which constitute diagnostic steps for preventive maintenance or targeted repair.

...SO THE THEORY IS EASY!

MT 180 Assembly & Maintenance Exercise: Centrifugal Pump

The illustration shows the tool box with kit and tool inlay, and in the foreground the fully assembled pump.

*** Practical exercise on the assembly and maintenance of a standard centrifugal pump**

*** Comprehensive and well-structured instructional material**

Technical Description

Centrifugal pumps are rotodynamic pumps and operate normally primed. They are in widespread use, and are deployed primarily in the pumping of water. Their applications include use in shipbuilding, the process industries and in water supply systems. They are compact and relatively simple in design. The water is conveyed by centrifugal force generated by the rotation of the pump impeller. Standard pumps are - as the term suggests - standard items. As a result they are relatively inexpensive to purchase and maintain. In the lifecycle of a pump, maintenance and repair work is usually required as in many cases pumps are not considered as pure replacement items.

The MT 180 kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content. The kit is ideally suited to project based learning with a particular emphasis on ‘hands-on’ work. Independent working by the students is assisted and encouraged. Learning in a small team offers a useful learning format.

MT 180 enables a typical standard centrifugal pump to be assembled and maintained. Students become familiar with all the pump components and their modes of operation. The parts are clearly laid out in a tool box. Systematic assembly and disassembly of a pump is practiced.

The instructional material details the individual steps involved in the exercise, and provides additional information on the areas of application, mode of operation and design of the pump.

Learning Objectives / Experiments

- design and function of a centrifugal pump and its components
- assembly and disassembly for maintenance and repair purposes
- replacing components (e.g. seals or bearings)
- troubleshooting, fault assessment
- planning and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

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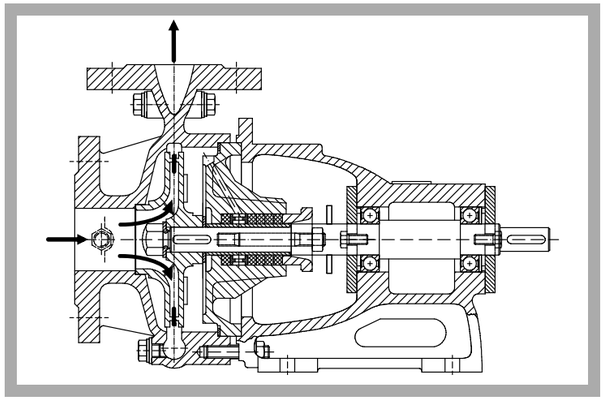
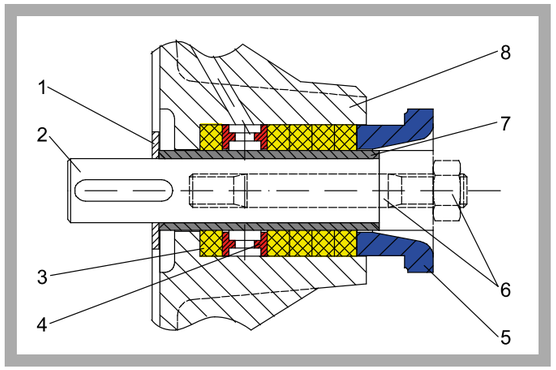
MT 180 Assembly & Maintenance Exercise: Centrifugal Pump



Sectional drawing of the centrifugal pump



Packing gland: 1 disk, 2 shaft, 3 gland packing, 4 locking ring, 5 packing gland frame, 6 stud bolt with hexagon nut, 7 shaft sheath, 8 housing cover

Assembly of the centrifugal pump: fixing of the bearing cover with screws

Specification

[1] learning concept for maintenance and repair exercises on a single-stage, normally primed centrifugal pump with a spiral housing
[2] pump according to DIN 24255
[3] enclosed pump impeller with 5 blades, designed for pure liquids
[4] pump shaft sealing, based on the gland principle
[5] 2 assembly aids and a complete tool set
[6] pump parts and tools housed in a tool box
[7] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Single-stage centrifugal pump
- power consumption: max. 1100W
- max. flow rate: 19m³/h
- max. head: 25m
- speed: 3000min^{-1}
- intake connection: DN50
- delivery connection: DN32
- housing and impeller: grey cast iron

Dimensions and Weight

LxWxH: 690x360x312mm (tool box)
Weight: approx. 35kg

Scope of Delivery

1 complete kit of a standard centrifugal pump
1 set of tools, consisting of
- 2 combination wrenches size 13, 17
- 1 double-ended box spanner size 24/26 with tommy bar
- 1 bearing puller, three-arm
- 1 slotted screwdriver, 5,5
- 1 soft-faced hammer
- 2 assembly aids for assembly / disassembly of bearings

1 set of replacement parts, consisting of
- 1 flat seal
- 1 gland packing

1 tool box with compartment insert and foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair processes, suggested exercises
- 1 operator's manual for the industrial pump

Order Details

051.18000 MT 180 Assembly & Maintenance Exercise: Centrifugal Pump

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MT 181 Assembly & Maintenance Exercise: Multistage Centrifugal Pump

The illustration shows the tool box with kit and tools. The fully assembled pump is shown in the foreground.

*** Practical exercise on the assembly and maintenance of a multistage centrifugal pump**

*** Comprehensive and well-structured instructional material**

Technical Description

Centrifugal pumps are rotodynamic pumps and operate normally primed.They are in widespread use, and are deployed primarily in the pumping of water. Their range of applications include use in shipbuilding, the process industries and in water supply systems. Very high delivery pressures can be generated by connecting multiple impellers in series. Centrifugal pumps are compact and relatively simple in design. The water is conveyed by centrifugal force generated by the rotation of the pump impeller. In the lifecycle of a pump, maintenance and repair work is usually required as in many cases pumps are not considered as pure replacement items.

The MT 181 kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content. The kit is ideally suited to project-based learning with a particular emphasis on ‘hands-on’ work. Independent working by the students is assisted and encouraged. Learning in a small team offers a useful learning format.

MT 181 enables a typical multistage centrifugal pump to be assembled and maintained. Students become familiar with all the pump components and their modes of operation. The parts are clearly laid out in a tool box. Systematic assembly and disassembly of a pump is practiced.

The instructional material details the individual steps involved in the exercise, and provides additional information on the areas of application, mode of operation and design of the pump.

Learning Objectives / Experiments

- design and function of a multistage pump and its components
- assembly and disassembly for maintenance and repair purposes
- replacing components (e.g. seals, bearings or impellers)
- troubleshooting, fault assessment
- planning and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

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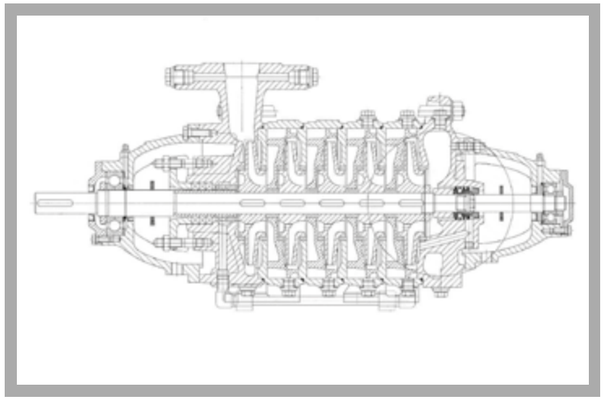
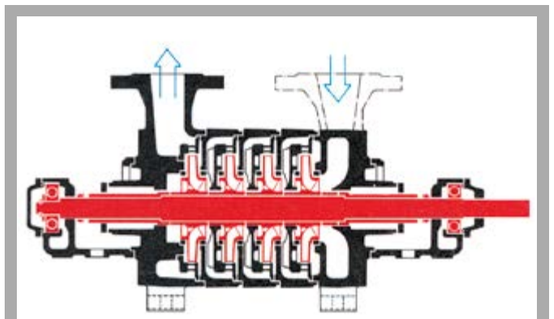
MT 181 Assembly & Maintenance Exercise: Multistage Centrifugal Pump



Sectional drawing of a similar multistage centrifugal pump (MT 181 has four stages; the intake and delivery connections are on the same side)



Schematic view of a four-stage centrifugal pump

Assembly of the four-stage centrifugal pump: assembling the packing gland rings

Specification

[1] learning concept for maintenance and repair exercises on a four-stage, normally primed centrifugal pump
[2] shaft sealing based on the gland principle (delivery side) and with floating ring seal (intake side)
[3] driven by motor (not included) and clutch via pump shaft
[4] 4 assembly aids and complete tool set
[5] pump parts and tools housed in a tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Four-stage centrifugal pump
- power consumption: max. 1400W
- max. flow rate: 18m³/h
- max. head: 28m
- speed: 1450min^{-1}
- intake connection: DN50
- delivery connection: DN40
- housing and impellers: grey cast iron

Dimensions and Weight

LxWxH: 690x360x312mm (tool box)
Weight: approx. 58kg

Scope of Delivery

1 complete kit of a 4-stage centrifugal pump
1 set of tools, consisting of
- 8 combination wrenches size 10, 13, 17, 24, 27, 36, 2x size 19
- 1 bearing puller, two-arm
- 2 screwdrivers
- 1 set of forcing pliers for shaft circlips
- 1 punch
- 1 soft-faced hammer
- 1 tool for slot nut
- 1 brace
- 2 striker sleeves for assembly / disassembly of bearings

1 set of replacement parts, consisting of
- 1 set of packing gland rings
- 1 seal
- 1 slot nut

1 tin of corrosion-proofing spray
1 box for small parts
1 tool box with foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair processes, suggested exercises
- 1 operator's manual for the industrial pump

Order Details

051.18100	MT 181	Assembly & Maintenance Exercise: Multistage Centrifugal Pump

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MT 182 Assembly & Maintenance Exercise: Screw Pump

The illustration shows the tool box with kit and tools. The fully assembled pump is shown in the foreground.

*** Practical exercise on the assembly and maintenance of a screw pump**

*** Comprehensive and well-structured instructional material**

Technical Description

Screw pumps are positive displacement pumps and operate in a rotary manner, normally primed. The pump presented here can be used for a number of different fluids. These include any non-aggressive fluids with lubricating properties, with viscosities between 2...1500mm²/s, such as lubricating oil, vegetable oil, hydraulic fluid, glycols, polymers and emulsions. Typical applications include: lubricating diesel motors; gears; gas, steam and water turbines; and cooling and filtration circuits in large-scale machines and hydraulic systems.

The MT 182 kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content. The kit is ideally suited to project-based learning with a particular empasis on ‘hands-on’ work. Independent working by the students is assisted and encouraged. Learning in a small team offers a useful learning format.

MT 182 enables a typical screw pump to be assembled and maintained. Students become familiar with all the pump components and their modes of operation. The parts are clearly laid out in a toolbox. Systematic assembly and disassembly of a pump is practiced.

The accompanying material details the individual steps involved in the exercise, and provides additional information on the areas of application, mode of operation and design of the pump.

Learning Objectives / Experiments

- design and function of a screw pump and its components
- assembly and disassembly for maintenance and repair purposes
- replacing components (e.g. seals)
- troubleshooting, fault assessment
- planning and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

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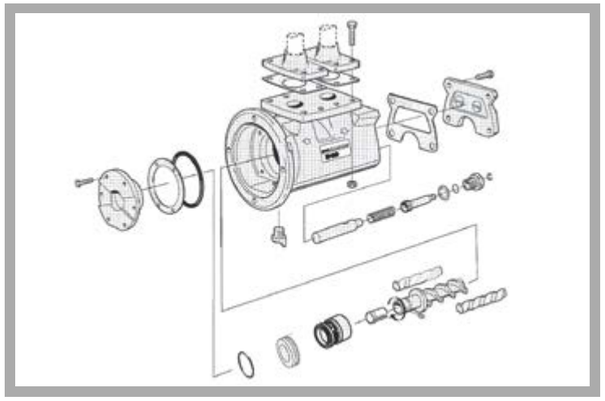
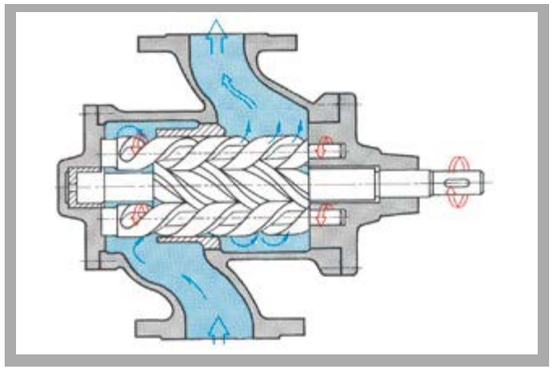
MT 182 Assembly & Maintenance Exercise: Screw Pump



Exploded-view drawing of the screw pump



Principle of operation of the screw pump

Assembly of the srew pump: assembling the valve piston with the valve spring

Specification

[1] learning concept for maintenance and repair exercises on a screw pump
[2] three-spindle screw pump with one driving spindle and two delivery spindles
[3] integrated pressure limiting valve; at overpressures a portion of the flow is returned to the intake side
[4] used for media with a kinematic viscosity in the range 2...1500mm²/s
[5] pump parts and tools housed contained in a tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Screw pump
- power consumption: max. 1350W
- max. head: 12bar
- displacement: 13,9cm³/spindle revolution
- max. speed: 3600min^{-1}
- intake connection: DN25
- delivery connection: DN25
- grey cast iron housing

Dimensions and Weight

LxWxH: 690x360x312mm (tool box)
Weight: approx. 50kg

Scope of Delivery

1 complete kit of a screw pump
1 set of tools, consisting of
- 2 combination wrenches size 13, 25
- 2 Allen keys size 2,5, 10
- 2 screwdrivers

1 set of replacement parts, consisting of
- 1 flange seal
- 1 O-ring
- 1 snap ring

1 tin of corrosion-proofing spray
1 box for small parts
1 tool box with foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair processes, suggested exercises
- 1 operator's manual for the industrial pump

Order Details

051.18200 MT 182 Assembly & Maintenance Exercise: Screw Pump

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MT 183 Assembly & Maintenance Exercise: Diaphragm Pump

The illustration shows the tool box with kit and tools. The fully assembled pump is shown in the foreground.

*** Practical exercise on the assembly and maintenance of a diaphragm pump**

*** Comprehensive and well-structured instructional material**

Technical Description

Diaphragm pumps are positive displacement pumps and operate in an oscillatory manner, normally primed. Since diaphragm pumps operate absolutely leakage-free, they are particularly suitable - provided the appropriate pump materials are used - for handling aggressive fluids such as acids and caustic solutions as well as radioactive, combustible, odorous and toxic liquids. Another advantage is that they can run dry. Diaphragm pumps are often used for volumetric metering (metering pumps).

The materials used in the construction of the diaphragm pump employed here make it particularly suitable for use in chemical engineering. It is equipped with a stroke length adjuster, and is deployed as a metering pump.

The MT 183 kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content. The kit is ideally suited to project-based learning with a particular emphasis on ‘hands-on’ work. Independent working by the students is assisted and encouraged. Learning in a small team offers a useful learning format.

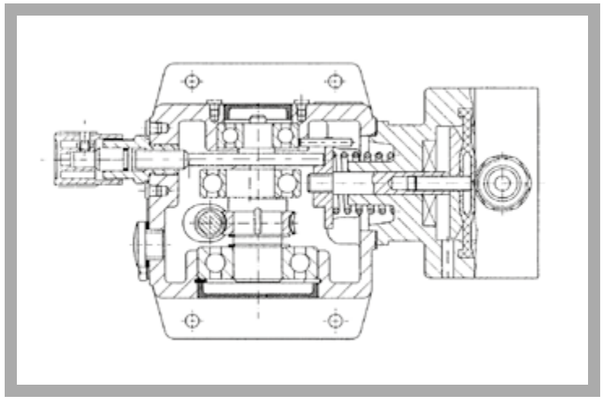
MT 183 enables a typical diaphragm pump to be assembled and maintained. Students become familiar with all the pump components and their modes of operation. The parts are clearly laid out in a toolbox. Systematic assembly and disassembly of a pump is practiced.

The instructional material details the individual steps involved in the exercise, and provides additional information on the areas of application, mode of operation and design of the pump.

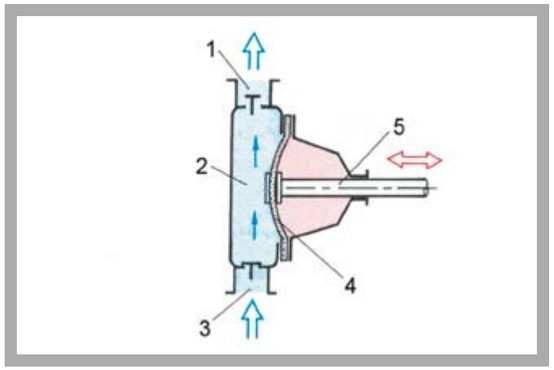
Learning Objectives / Experiments

- design and function of a diaphragm pump and its components
- assembly and disassembly for maintenance and repair purposes
- replacing components (e.g. seals or bearings)
- troubleshooting, fault assessment
- planning and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

MT 183 Assembly & Maintenance Exercise: Diaphragm Pump



Sectional drawing of the diaphragm pump



Operating principle of the single diaphragm pump: 1 outlet, 2 pumping chamber, 3 inlet, 4 diaphragm, 5 push rod

Assembly of the diaphragm pump: driving the eccentric into the housing (using a device)

Specification

[1] learning concept for maintenance and repair exercises on a single-diaphragm pump
[2] diaphragm and push rod directly linked
[3] flow setting by manual stroke length adjustment (including during operation)
[4] manual drive with crank instead of a drive motor
[5] pump parts and tools housed in a tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Diaphragm pump
- flow rate: 0...2,4L/h
- max. head: 100m
- nominal stroke rate at 50Hz: 156min^{-1}
- power consumption: max. 90W
- intake connection: DN5
- delivery connection: DN5
- pump materials
  pump body: Polypropylene (PP)
  double-ball valves: PP/glass fibre-reinforced plastic
  valve balls: glass
  valve seals: FPM
  drive diaphragm: PTFE-lined

Dimensions and Weight

LxWxH: 690x360x312mm (tool box)
Weight: approx. 15kg

Scope of Delivery

1 complete kit of a diaphragm pump
1 set of tools, consisting of
- 4 combination wrenches size 22, 27, 2x8
- 3 Allen keys size 2.5, 3, 4
- 1 screwdriver; 1 bearing puller, three-arm
- 1 set of forcing pliers for inner circlips
- 1 set of forcing pliers for outer circlips
- 1 soft-faced hammer
- 2 striker sleeves for assembly/disassembly of bearings

1 hand drive
1 flange seal
1 tin of corrosion-proofing spray
1 box for small parts
1 tool box with foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair processes, suggested exercises
- 1 operator's manual for the industrial pump

Order Details

051.18300 MT 183 Assembly & Maintenance Exercise: Diaphragm Pump

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MT 184 Assembly & Maintenance Exercise: Piston Pump

The illustration shows the tool box with kit and tools. The fully assembled pump is shown in the foreground.

*** Practical exercise based on the assembly and maintenance of a piston pump**

*** Comprehensive and well-structured instructional material**

Technical Description

Piston pumps are positive displacement pumps and operate in an oscillatory manner, normally primed. At constant speed, their characteristic is an almost vertical straight line; at different pressures the volumetric flow remains approximately constant.

The pump presented here is a dual-action piston pump. This means that each piston stroke is both an intake and delivery stroke. Typical applications of the pump dealt with here are the pumping of drinking and service water for domestic use, in agriculture, shipping, industry and gardening centres.

The MT 184 kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content. The kit is ideally suited to project-based learning with a particular emphasis on ‘hands-on’ work. Independent working by the students is assisted and encouraged. Performing in a small team offers a useful learning format.

MT 184 enables a typical piston pump to be assembled and maintained. Students become familiar with all the pump components and their modes of operation. The parts are clearly laid out in a tool box. Systematic assembly and disassembly of a pump is practiced. The instructional material details the individual steps involved in the exercise, and provides additional information on the areas of application, mode of operation and design of the pump.

Learning Objectives / Experiments

- design and function of a piston pump and its components
- assembly and disassembly for maintenance and repair purposes
- replacing components (e.g. seals or bearings)
- troubleshooting, fault assessment
- planning and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

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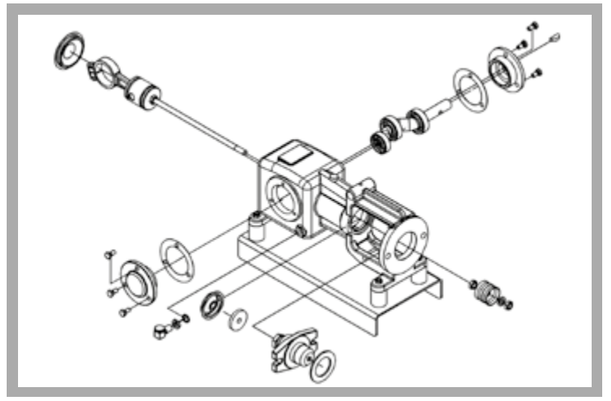
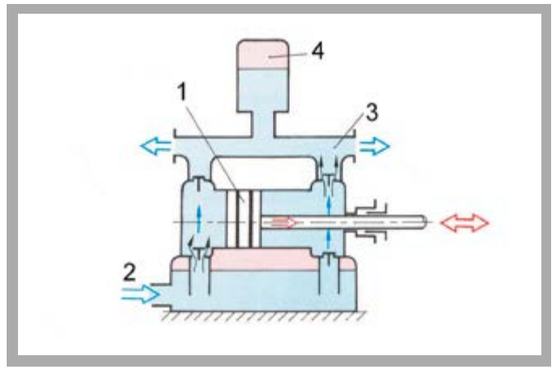
MT 184 Assembly & Maintenance Exercise: Piston Pump



Exploded-view drawing of the piston pump



Principle of a double-acting piston pump: 1 piston, 2 inlet, 3 outlet, 4 air vessel

Dissassembly of the piston pump: pulling off the ball bearing of the eccentric shaft (using a bearing puller)

Specification

[1] learning concept for maintenance and repair exercises on a double-acting piston pump
[2] air vessel to compensate for pressure surges
[3] integrated safety valve returns a portion of the flow back to the intake side in event of overpressure
[4] piston rod seal based on the gland principle
[5] pump drive via V-belt pulley
[6] pump parts and tools housed in a tool box
[7] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Piston pump
- max. flow rate: 1000L/h
- max. head: 60m
- max. power consumption: 370W
- drive via V-belt, motor speed: 1450min^{-1}
- intake connection: 1"
- delivery connection: 1"

Dimensions and Weight

LxWxH: 690x360x312mm (tool box)
Weight: approx. 33kg

Scope of Delivery

1 complete kit of a piston pump
1 set of tools, consisting of
- 6 open-end wrenches, size 13, 14, 19, 22, 2x size 10
- 1 soft-faced hammer
- 1 bearing puller, three-arm
- 1 punch
- 1 screwdriver
- 1 wrench for pressure relief valve
- 2 striker sleeves for assembly/disassembly of bearings
- 1 brace to disassemble connecting rod bearing

1 base plate
1 sleeve packing for piston
1 set of replacement parts, consisting of
- 1 sleeve packing for piston
- 4 packing gland rings
- 2 bearing cover seals

1 tin of corrosion-proofing spray
1 box for small parts
1 tool box with foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair operations, suggested exercises
- 1 operator's manual for the industrial pump

Order Details

051.18400	MT 184	Assembly & Maintenance Exercise: Piston Pump

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MT 185 Assembly & Maintenance Exercise: In-Line Centrifugal Pump

The illustration shows the tool box with kit and tools. The fully assembled pump is shown in the foreground.

*** Practical exercise on the assembly and maintenance of an in-line centrifugal pump**

*** Comprehensive and well-structured instructional material**

Learning Objectives / Experiments

- design and function of an in-line centrifugal pump and its components
- assembly and disassembly for maintenance and repair purposes
- replacing components (e.g. seals or bearings)
- troubleshooting, fault assessment
- planning and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

Technical Description

In-line centrifugal pumps are rotodynamic pumps and operate normally primed. In-line pumps are installed in the straight runs of pipelines. The difference between an in-line pump and a standard pump is that the intake and delivery connections of an in-line pump are aligned on a single axis.

The in-line centrifugal pump presented here is used to pump mechanically and chemically non-aggressive liquids. Its range of applications include use in water supply, irrigation and sprinkler systems, and heating engineering systems.

The MT 185 kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content. The kit is ideally suited to project-based learning with a particular emphasis on ‘hands-on’ work. Independent working by the students is assisted and encouraged. Performing exercises in a small team offers a useful learning format.

MT 185 enables a typical in-line centrifugal pump to be assembled and maintained. Students become familiar with all the pump components and their modes of operation. The parts are clearly laid out in a tool box. Systematic assembly and disassembly of a pump is practiced.

The instruction material details the individual steps involved in the exercise, and provides additional information on the areas of application, mode of operation and design of the pump.

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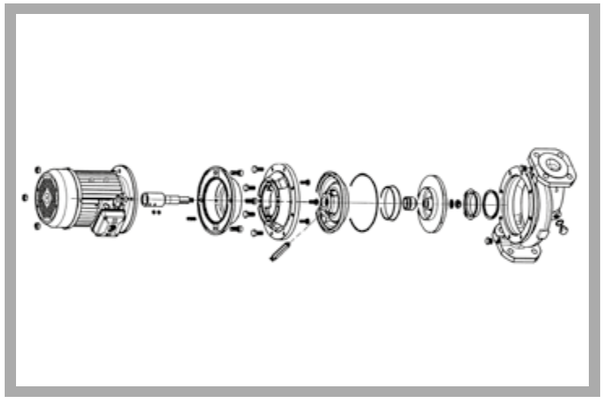
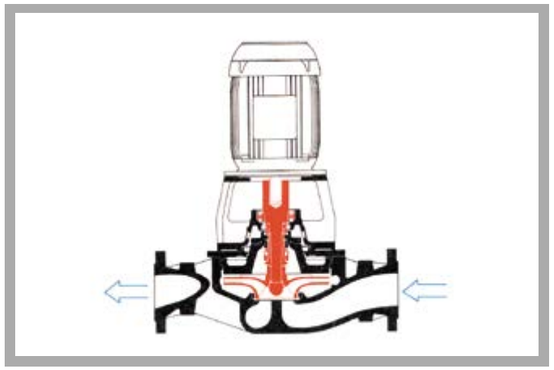
MT 185 Assembly & Maintenance Exercise: In-Line Centrifugal Pump



Exploded-view drawing of the in-line centrifugal pump



In-line centrifugal pump: intake and delivery connections on the same axis

Assembly of the in-line centrifugal pump: tightening the impeller nut

Specification

[1] learning concept for maintenance and repair exercises on an in-line centrifugal pump
[2] enclosed pump impeller with 5 blades, designed for pure liquids
[3] pump shaft sealing with floating ring seal
[4] pump drive by 3-phase AC motor
[5] pump parts and tools housed in a tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

In-line centrifugal pump
- power consumption: max. 750W
- max. flow rate: 19m³/h
- max. head: 16m
- speed: 2900min^{-1}
- intake connection: DN40
- delivery connection: DN40
- housing and impeller: grey cast iron

Drive motor
- 400V, 50Hz, 3 phases; or 230V, 60Hz, 3 phases

Dimensions and Weight

LxWxH: 690x360x312mm (tool box)
Weight: approx. 40kg

Scope of Delivery

1 complete kit of an in-line centrifugal pump
1 set of tools, consisting of
- 5 combination wrenches size 13, 14, 17, 20, 22
- 2 Allen keys size 3, 8
- 1 screwdriver

1 sealing ring
1 box for small parts
1 tool box with foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair processes, suggested exercises
- 1 operator's manual for the industrial pump

Order Details

051.18500	MT 185	Assembly & Maintenance Exercise: In-Line Centrifugal Pump

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MT 186 Assembly & Maintenance Exercise: Gear Pump

The illustration shows the tool box with kit and tools. The fully assembled pump is shown in the foreground.

*** Practical exercise on the assembly and maintenance of a gear pump**

*** Comprehensive and well-structured instructional material**

Technical Description

Gear pumps are piston-type rotary pumps which operate on the positive-displacement principle. They are simple in design, and easy to handle. Gear pumps can generate operating pressures of up to 40bar and flow rates of up to 60m³/h. Their pulse-free delivery increases linearly with speed. High-viscosity media (oils, paints, adhesives, etc.) can also be pumped. Gear pumps are sensitive to hard solid-matter particles in the flow.

The materials used in the construction of the pump presented here make it resistant to most corrosive and aggressive chemicals. The plastic / metal gear wheel pairing results in relatively quiet running.

The MT 186 kit forms part of the GUNT assembly, maintenance and repair practice line designed for training at technical colleges and in company training centres. A close link between theory and practice is key to the learning content. The kit is ideally suited to project-based learning with a particular emphasis on ‘hands-on’ work. Independent working by the students is assisted and encouraged. Performing exercises in a small team offers a useful learning format.

MT 186 enables a typical gear pump to be assembled and maintained. Students become familiar with all the pump components and their modes of operation. The parts are clearly laid out in a tool box. Systematic assembly and disassembly of a pump is practiced. The instructional material details the individual steps involved in the exercise, and provides additional information on the areas of application, mode of operation and design of the pump.

Learning Objectives / Experiments

- design and function of a gear pump and its components
- assembly and disassembly for maintenance and repair purposes
- replacing components (e.g. seals)
- troubleshooting, fault assessment
- planning and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

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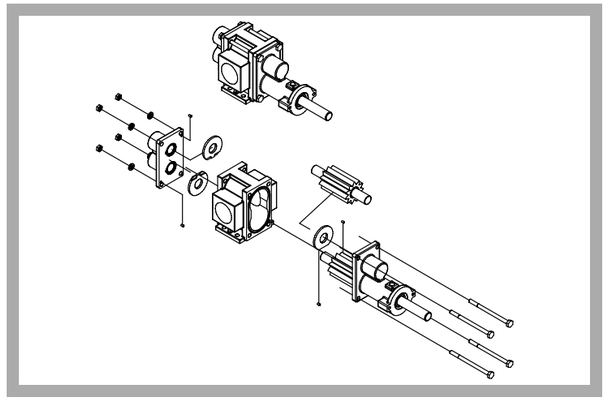
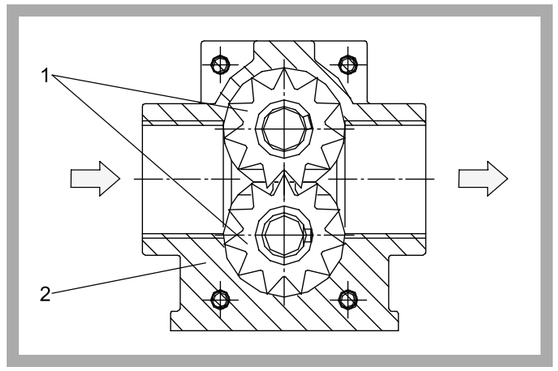
MT 186 Assembly & Maintenance Exercise: Gear Pump



Exploded-view drawing of the gear pump



Function of a gear pump: 1 gear pair, 2 housing

Assembly of the centrifugal pump: assembling the driving shaft

Specification

[1] learning concept for maintenance and repair exercises on a gear pump
[2] relatively quiet running owing to the plastic/metal gear wheel pairing
[3] pump shaft sealing with floating ringseal
[4] suitable for solids-free media with dynamic viscosity up to 0...10000mPas
[5] pump parts and tools housed in a tool box
[6] the kit forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Gear pump
- power consumption: max. 2kW
- max. flow rate: 80L/min
- max. head: 70m
- motor speed: 300...1750min^{-1}
- intake connection thread: R 1 1/4"
- delivery connection thread: R 1 1/4"
- pump materials
  housing: stainless steel 316 (1.4401)
  gear wheels: stainless steel 316 (1.4401)/PTFE
  wearing plates: PTFE
  bearings: PTFE
- speed-dependent viscosities
  n=300min^{-1}: 10000mPas,
  n=1750min^{-1}: 3000mPas

Dimensions and Weight

LxWxH: 690x360x312mm (tool box)
Weight: approx. 20kg

Scope of Delivery

1 complete kit of a gear pump
1 set of tools, consisting of
- 2 combination wrenches size 11
- 1 hexagonal screwdriver, size 3/32"
- 2 screwdrivers
- 1 round wire snap ring for shafts

1 roll of PTFE sealing tape
1 box for small parts
1 tool box with foam inlay
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair operations, suggested exercises
- 1 operator's manual for the industrial pump

Order Details

051.18600 MT 186 Assembly & Maintenance Exercise: Gear Pump

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HL 962 ASSEMBLY AND MAINTENANCE EXERCISES: PIPES, FITTINGS, PUMPS

HL 962 *Assembly Stand for Pumps*

HL 962.01 *Standard Chemicals Pump*

HL 962.02 *Canned Motor Pump*

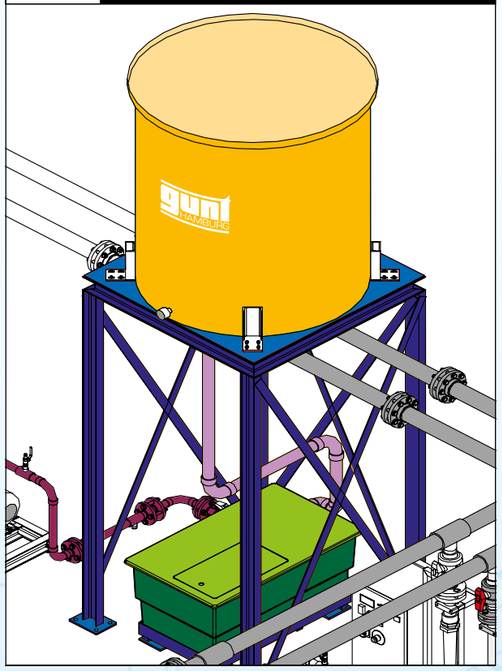
HL 962.03 *Side Channel Pump*

HL 962.04 *Standard Chemicals Pump with Magnetic Clutch*

HL 962.32 *Set of Connecting Lines*

Set of pipes, fittings and connecting elements, adapted to the ordered configuration.

HL 962.30 *Tank System*



The practice and training system is based entirely on industrial technologies. It presents a complex project task for the training of piping and plant fitters as well as for maintenance mechanics. The planning and practical procedures may take several days.

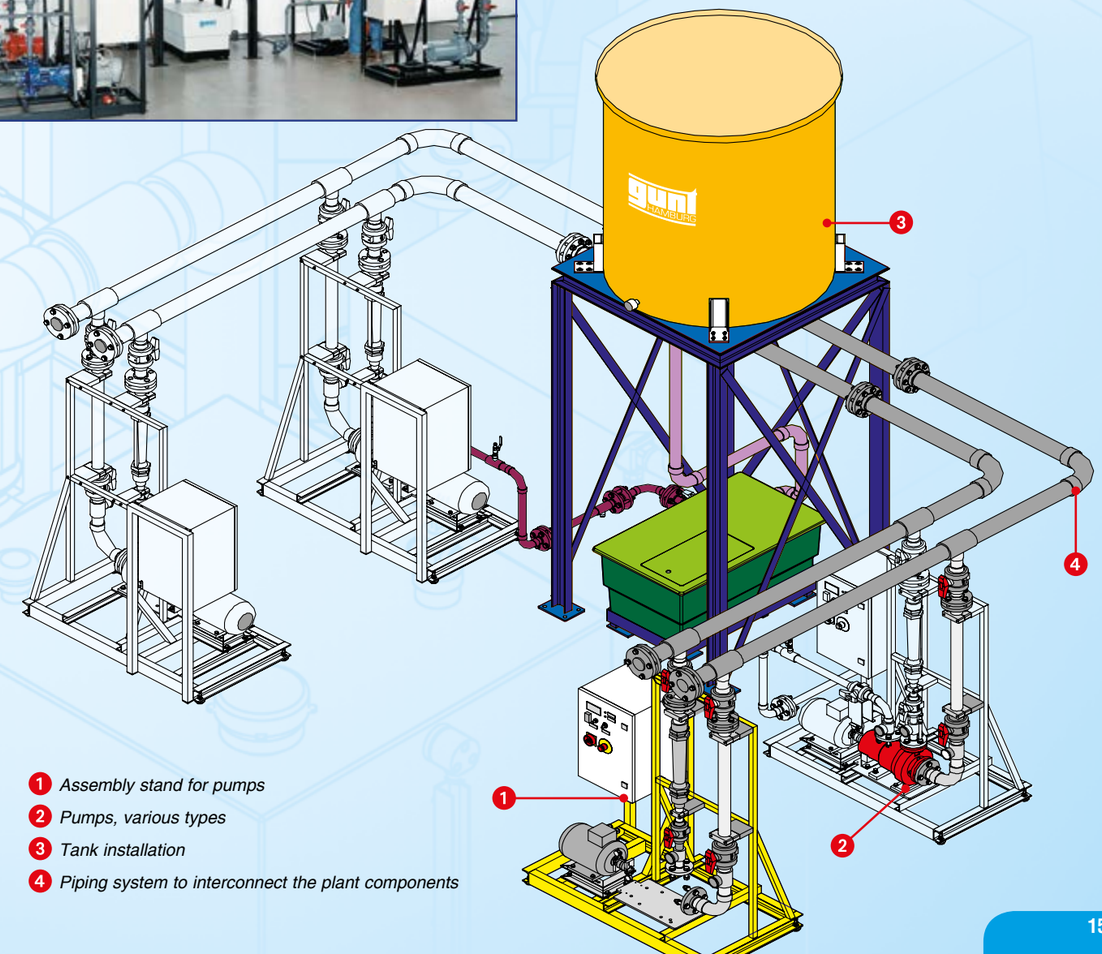
The training system is particularly suitable for action-oriented project work in small groups of students. Detailed technical documentation, allied to didactic instruction, forms the basis for a successful learning process.

The HL 962 assembly stand for pumps is the main element of the training system. It can facilitate the installation of different centrifugal pumps (HL 962.01 – HL 962.04) and also provides the drive. Other key subassemblies are the tank installation for water supply (HL 962.30) and the piping system, constructed with the set of pipework and connection elements (HL 962.32). This then creates a complete system with a closed water circuit.

Multiple assemblies with identical or different pumps can be integrated into the network.

LEARNING CONTENT

- Planning and construction of a complex piping and pump system to transport water
- Configuration and modification of the complete system
- Familiarisation with plant components:
  - Different pumps and their drive systems
  - Components of piping systems
  - Fittings, connecting and sealing elements, measuring devices
- Different connecting techniques in piping construction, assembly techniques, assembly aids
- Electrical connections of a pump drive and control, display and operating components
- Aligning the pump and drive motor
- Operational measurements in piping and pump systems
- Familiarisation with different materials utilised in the manufacture of plant equipment
- Maintenance tasks and operations
- Reading and understanding technical documents, such as drawings, schematic diagrams, or original operating instructions
- Familiarisation with commissioning procedures



1 *Assembly stand for pumps*
2 *Pumps, various types*
3 *Tank installation*
4 *Piping system to interconnect the plant components*

HL 962 Assembly Stand for Pumps

The illustration shows a similar unit.

*** Mounting of different pumps (available as accessories)**

*** Alignment of motor and pump by different methods**

*** Base unit when constructing a complex piping system**

Technical Description

The individual steps for repairing driven machines such as pumps are: removal and installation of pumps for inspection, repair or replacement; aligning the drive and commissioning and checking the pump, e.g. for leaks.

In conjunction with the HL 962.30 tank system, the HL 962.32 connecting pipes and one of the four HL 962.01 – HL 962.04 pumps, the HL 962 assembly stand forms a complete training system for complex piping and plant systems. The training system forms a closed water circuit.

The assembly stand HL 962 includes a three-phase asynchronous motor with frequency converter as the drive and pipes with valves to adjust the pressure. A pump from the accessory equipment is attached to the base plate of the assembly stand and connected to the drive and the pipes. The pumps that are available as accessories are typical centrifugal pumps used in process engineering.

The position of the asynchronous motor can be adjusted in three directions for alignment purposes. The alignment can either be checked in a conventional manner with a straight edge or with the reverse alignment method using two dial gauges. Non-contact, microprocessor-aided methods can also optionally be used (specific alignment systems are not included in the scope of delivery).

Manometers indicate the pressures upstream and downstream of the pump. The flow rate is measured with a rotameter. Speed and power output of the motor are indicated on digital displays.

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

Learning Objectives / Experiments

in conjunction with an accessory pump (standard chemicals pump HL 962.01, canned motor pump HL 962.02, side channel pump HL 962.03, standard chemicals pump with magnetic clutch HL 962.04) and a suitable water supply, e.g. HL 962.30 with HL 962.32

- mounting of the pump and alignment of the electric motor
- familiarisation with various methods of aligning the motor and pump
- commissioning and leak testing
- recording a pump characteristic
- comparison of various pump types (only if multiple pumps are available)

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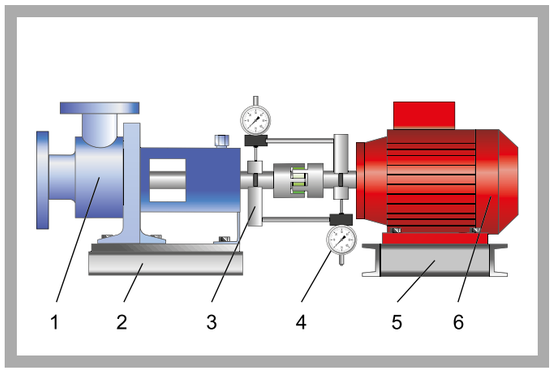
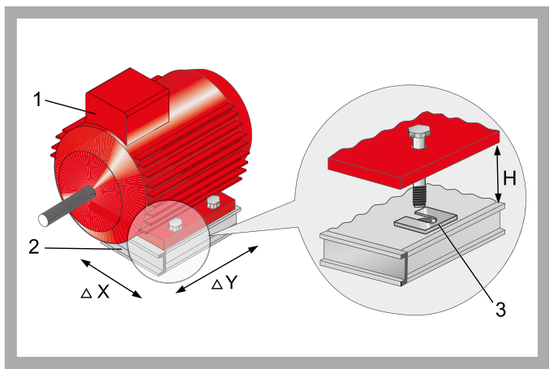
HL 962 Assembly Stand for Pumps

1 flange connections to connect HL 962 to HL 962.30, 2 switch box with displays and controls, 3 electric motor, 4 mounting plate for test pump, 5 flange connections for test pump, 6 manometer, 7 valve, 8 flow meter



1 HL 962.01 pump, 2 pump base plate, 3 bracket for dial gauge, 4 dial gauge, 5 motor base plate, 6 electric motor



Aligning the electric motor (height, x and y direction):
1 electric motor, 2 base plate, 3 fitting plates to adjust the height H

Specification

[1] stand for mounting of various pumps
[2] asynchronous motor with variable speed via frequency converter
[3] electric motor with positioning frame and fit plates for alignment
[4] base plate prepared for mounting of various pumps
[5] alignment of motor and pump with straight-edge or by dial gauges
[6] switch box with speed adjuster and digital display of speed and power output
[7] frame with adjustable feet for levelling
[8] PVC piping
[9] water supply from tank system HL 962.30
[10] the system forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Three-phase AC asynchronous motor
- power output: 4kW, speed range: 0...1450min^{-1}

Connecting flanges for water supply
- intake side: DN50
- delivery side: DN50
- intake side channel pump: DN32

Fit plates as motor chocks
- 43x43mm
- 4 different thicknesses: 0,1-0,2-0,5-1,0mm, 20 of each

Measuring ranges
- pressure (inlet): -1...1bar
- pressure (outlet): 0...16bar
- rotameter: 0...11m³/h
- speed: 0...3000min^{-1}
- power meter: 0...4kW
- dial gauge: 0...3mm, resolution: 0,01mm

Dimensions and Weight

LxWxH: 1300x750x1800mm
Weight: approx. 220kg

Required for Operation

400V, 50/60Hz, 3 phases or 230V, 60Hz, 1 phase

Scope of Delivery

1 assembly stand
1 set of tools
1 set of measuring aids: 2 dial gauges with attachment, 1 straight-edge
80 fit plates, differing thicknesses
1 set of instructional material

Order Details

065.96200 HL 962 Assembly Stand for Pumps

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HL 962.01 Standard Chemicals Pump

*** Centrifugal pump according to ISO 5199 as accessory for installation in assembly stand HL 962**

Technical Description

The standard pump used here is a centrifugal pump commonly used in the chemical and process engineering industries. The media being carried are often corrosive, toxic, explosive or volatile, or are carried at very high or very low temperatures. This places extreme stress on the pump.

The standard pump is a single-stage spiral casing pump in process configuration. The process configuration ensures quick and easy exchanging of wearing parts. The spiral housing is the most common design for single-stage pumps. Its design is precisely adapted to the flow of the pump. This enables the optimum efficiency levels to be attained. The hydraulic design and connecting dimensions of the pump conform to ISO 2858; the technical requirements are to ISO 5199.

Learning Objectives / Experiments

in conjunction with HL 962, HL 962.30 and HL 962.32
- operation of a standard pump
- recording the pump characteristic
- leak testing
- alignment of pump and drive motor

Scope of Delivery

1 pump, 1 instruction manual

Specification

[1] centrifugal pump as accessory for installation in HL 962
[2] drive and water supply provided by HL 962
[3] process configuration permits easy exchange of wearing parts
[4] pump hydraulic design according to ISO 2858
[5] pump technical requirements according to ISO 5199

Technical Data

Centrifugal pump (at nominal speed: 1450min^{-1})
- max. flow rate: 9,5m³/h
- max. head: 9,5m
- power consumption: 0,5kW

Connecting flange
- delivery side: DN32
- intake side: DN50

Materials
- housing, impeller: grey cast iron
- shaft: stainless steel

Dimensions and Weight

LxWxH: 570x240x300mm
Weight: approx. 43kg

Order Details

065.96201 HL 962.01 Standard Chemicals Pump

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HL 962.02 Canned Motor Pump

*** Hermetic centrifugal pump, particularly suitable for pumping liquid gases**

*** Accessory for installation in assembly stand HL 962**

Technical Description

Canned motor pumps are used primarily in process engineering to pump aggressive, toxic, fire-hazard, explosive, delicate or volatile liquids (such as liquid gases). They are also suitable for pumping extremely hot or cold products, and liquids under high system pressure or under vacuum.

The pump is a fully self-contained centrifugal pump with no shaft seal, the drive is provided electro-magnetically via the canned motor. Its design means it is completely leak-tight and largely maintenance-free. Part of the primary flow is branched off by way of a self-cleaning filter to cool the motor and lubricate the journal bearings, and to provide hydraulic compensation for the axial thrust. After passing through the hollow shaft and the rotor chamber, the cooling medium is returned to the primary flow on the delivery side.

Learning Objectives / Experiments

in conjunction with HL 962, HL 962.30 and HL 962.32
- operation of a canned motor pump
- recording the pump characteristic
- leak testing

Scope of Delivery

1 pump, 1 instruction manual

Specification

[1] hermetic pump for aggressive liquids
[2] accessory for installation in HL 962
[3] drive: three-phase squirrel-cage motor
[4] water supply provided by HL 962
[5] maintenance-free pump

Technical Data

Canned motor pump
- max. flow rate: 12m³/h
- max. head: 39m
- power consumption: 3kW
- nominal speed: 2900min^{-1}

Connecting flange
- delivery side (radial): DN32
- intake side (axial): DN50

Dimensions and Weight

LxWxH: 510x240x305mm
Weight: approx. 62kg

Required for Operation

400V, 50Hz, 3 phases

Order Details

065.96202 HL 962.02 Canned Motor Pump

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HL 962.03 Side Channel Pump

The illustration shows the pump with a fitting from HL 962.30 on the intake (grey elbow + manometer).

*** Self-priming three-stage centrifugal pump**

*** Accessory for installation in assembly stand HL 962**

Technical Description

Side channel pumps are self-priming centrifugal pumps, and are in widespread use. They can attain relatively high pressures at low flow rates. They are able to intake and deliver liquids containing gases. The pump can be started even when there is no head of liquid in the intake pipe. The side channel stage removes the air from the intake pipe and generates the necessary suction to intake the liquid.

The pump used here is three-stage. Drive and water supply are provided by the assembly stand HL 962.

Learning Objectives / Experiments

in conjunction with HL 962, HL 962.30 and HL 962.32
- operation of a side channel pump
- recording the pump characteristic
- leak testing
- alignment of pump and drive

Scope of Delivery

1 pump, 1 instruction manual

Specification

[1] three-stage self-priming pump for installation in HL 962
[2] drive and water supply provided by HL 962
[3] pump can intake and deliver air/water mixture
[4] relatively high head at low flow rate

Technical Data

Side channel pump
- 3 stages
- max. flow rate: 4,5m³/h
- max. head: 122m
- power consumption: 3kW
- nominal speed: 1450min^{-1}
- max. speed: 1800min^{-1}

Connecting flange
- delivery side: DN32
- intake side: DN50

Materials
- housing: grey cast iron
- shaft: stainless steel

Dimensions and Weight

LxWxH: 470x220x240mm
Weight: approx. 30kg

Order Details

065.96203 HL 962.03 Side Channel Pump

HL 962.04 Standard Chemicals Pump with Magnetic Clutch

*** Hermetic centrifugal pump according to ISO 5199**

*** Accessory for installation in assembly stand HL 962**

Technical Description

Magnetic drive pumps are used primarily in process engineering to pump aggressive, toxic and flammable liquids. Leakage of such liquids could result in major problems. Its design means it is completely leak-tight, even at continuous operation and under difficult usage conditions.

The viscosity of the delivered liquid is a key criterion in selecting a pump, as it determines the coupling torque to be transmitted. The torques transmitted by magnetic couplings are limited. As a result, magnetic drive pumps are not suitable for all operating conditions and media.

The pump is a fully self-contained centrifugal pump with no shaft seal. It is fitted with a permanent-magnetic synchronous drive complete with clutch. Drive and water supply are provided by the assembly stand HL 962.

Learning Objectives / Experiments

in conjunction with HL 962, HL 962.30 and HL 962.32
- operation of a standard chemicals pump with magnetic clutch
- recording the pump characteristic
- leak testing
- alignment of pump and drive

Scope of Delivery

1 pump, 1 instruction manual

Specification

[1] single-stage centrifugal pump with magnetic clutch as accessory for installation in HL 962
[2] drive and water supply provided by HL 962
[3] permanent-magnetic synchronous drive inside pump
[4] pump technical requirements according to ISO 5199

Technical Data

Pump (at nominal speed: 2900min^{-1})
- max. flow rate: 12m³/h
- max. head: 39m
- power consumption: 3,7kW

Connecting flange
- delivery side: DN32
- intake side: DN50

Dimensions and Weight

LxWxH: 625x240x300mm
Weight: approx. 60kg

Order Details

065.96204 HL 962.04 Standard Chemicals Pump with Magnetic Clutch

HL 962.30 Tank System

The illustration shows the complete layout of a pump system, comprising four HL 962 assembly stands, each with one pump (HL 962.01 - HL 962.04), the piping system HL 962.32 and the tank system HL 962.30.

*** Water supply for a complex piping and pump system**

*** Large high-level tank for normally primed pumps**

*** Low-level tank for self-priming pumps**

Technical Description

The HL 962 assembly stands are connected with piping elements from HL 962.32 to form a complex piping and pump system. The tank system HL 962.30 is required so that the system can operate as a closed process.

The tank system consists of a large high-level tank with a mounting frame, a low-level tank and connections with shut-off devices to the PVC piping system HL 962.32.

The high-level tank has a capacity of approximately 1,5m³ of water. A manometer close to the base of the tank measures the base pressure, thereby indicating the fill level. The high-level tank supplies the intake pipes of normally primed centrifugal pumps, and ensures an adequate inflow head. Its inlet and outlet distribution points are located at a height of about 2m.

The low-level tank is also supplied with water from the high-level tank. It is used for the self-priming side channel pump. A float valve ensures an adequate water level. All pumps transfer the water back to the high-level tank via the piping system.

All materials in the tank system are fully corrosion-proof, as they are all manufactured from plastic.

The assembly stand (HL 962), tank system (HL 962.30) and piping system (HL 962.32) are interconnected by way of flanges. It is possible to expand the system and connect more assembly stands.

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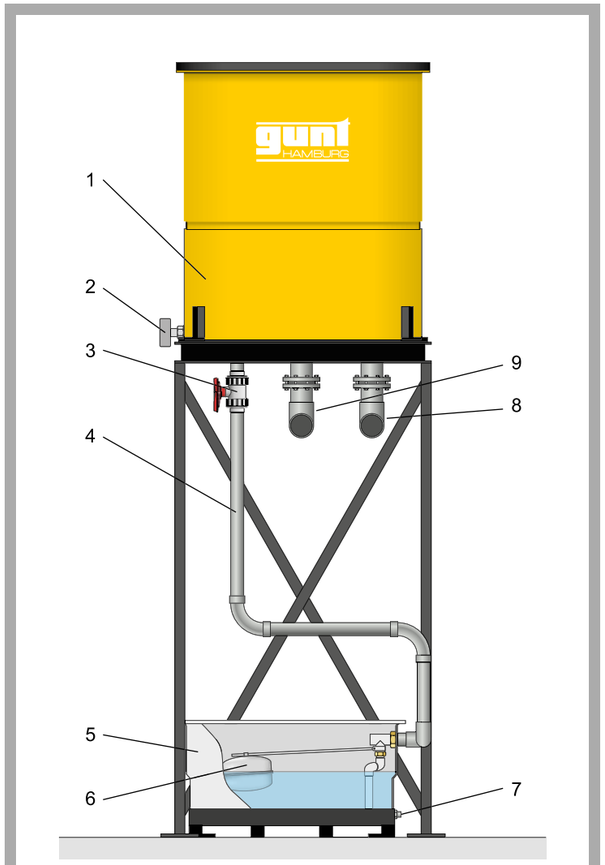
HL 962.30 Tank System



1 high-level tank, 2 manometer, 3 ball valve, 4 pipe to low-level tank, 5 low-level tank, 6 float valve, 7 connection for side channel pump, 8 distributor tank outlet, 9 distributor tank inlet

Specification

[1] water supply for a complex piping and pump system
[2] high-level tank with cover and manometer on solid frame for supply to normally primed pumps
[3] low-level tank with cover and float valve to supply the self-priming side channel pump HL 962.03
[4] PVC piping to supply the low-level tank from the high-level tank
[5] connection between the HL 962.30, HL 962.32 and HL 962 elements via flanges
[6] high-level tank with frame

Technical Data

High-level tank with cover
- capacity: 1500L
- material: polyethylene
- distributor to pipes in base
- height of delivery side distributor: approx. 2m
- 1 manometer on supply tank: 0...1,6mWC

Low-level tank with cover
- capacity: 280L
- material: glass fibre-reinforced plastic

2 manometers to check the pressure at inlet of the side channel pump HL 962.03: -1...1,5bar

PVC pipes from HL 962.32
- tank inlet and outlet: DN80
- connection to side channel pump: DN32

Dimensions and Weight

LxWxH: 1350x1350x3860mm
Weight: approx. 350kg

Scope of Delivery

1 mounting frame
1 high-level tank with cover
1 low-level tank with cover
1 PVC pipe to interconnect the two tanks
1 set of assembly drawings

Order Details

065.96230 HL 962.30 Tank System

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RT 395 Maintenance of Valves and Fittings and Actuators

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

*** Trainer for maintenance work on industrial valves and fittings**

*** Comparison of 4 different actuators**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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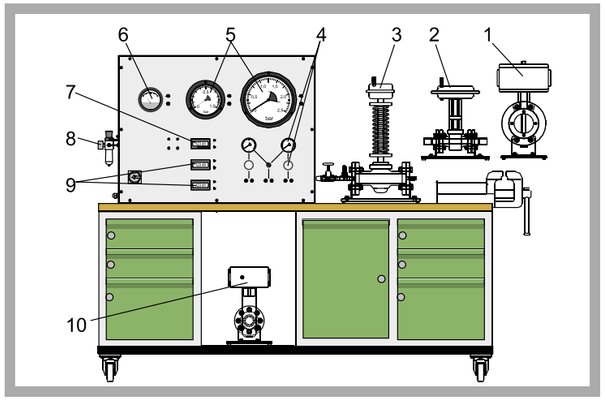
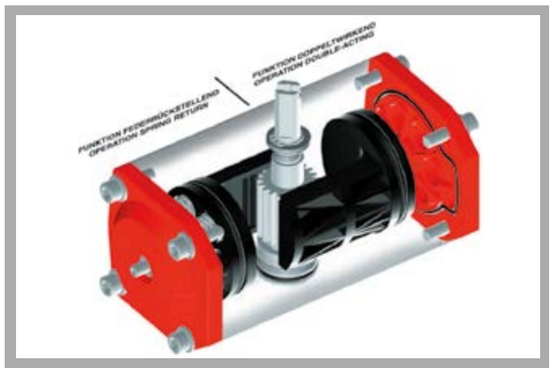
RT 395 Maintenance of Valves and Fittings and Actuators



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

Segmented ball valve with single-action pneumatic swivel drive



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

Specification

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

Technical Data

Pneumatic swivel drive
- single-action with spring return

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

Dimensions and Weight

LxWxH: 2200x750x1660mm
Weight: approx. 321kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.39500	RT 395	Maintenance of Valves and Fittings and Actuators

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RT 396 Pump and Valves and Fittings Test Stand

*** Plotting characteristics of industrial valves and fittings**

*** Comparison of different valves and fittings**

*** Characteristics of a centrifugal pump**

Technical Description

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

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

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

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

Learning Objectives / Experiments

- characteristics of a centrifugal pump
- behaviour during operation and function of
  * ball valve
  * butterfly valve
  * shut-off valve
  * wedge gate valve
  * control valve
  * safety valve
  * dirt trap
- valve characteristics
- determining the Kvs value of the control valve
- pressure losses at the dirt trap depending on the filter and its load
- planning, execution and assessment of maintenance and repair operations
- reading and understanding engineering drawings and operating instructions

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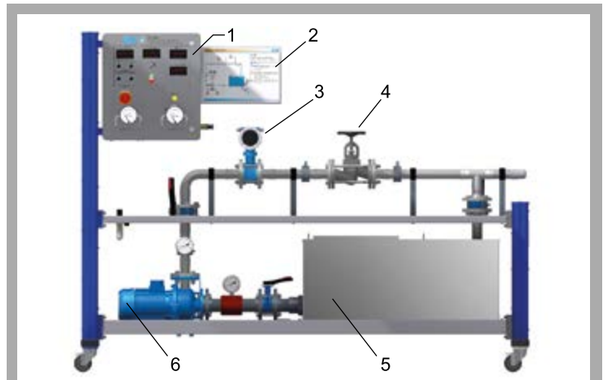
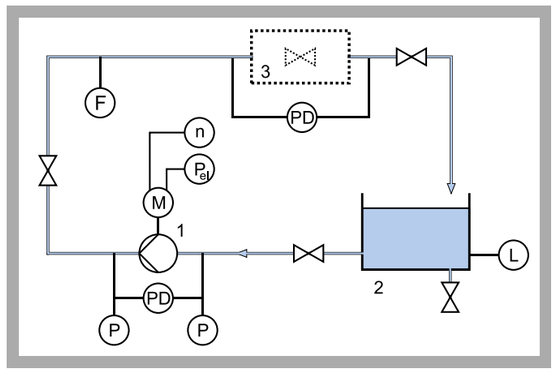
RT 396 Pump and Valves and Fittings Test Stand



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

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



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

Specification

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

Technical Data

Centrifugal pump
- power consumption: 4kW
- max. flow rate: 72m³/h
- max. head: 26,5m
- speed: 1450...2900min^{-1}

Supply tank with cover: capacity: 400L
Test valves and fittings:
- safety valve 1", 1,5bar
- shut-off valve DN50 / PN16
- ball valve with pneumatic drive DN50
- butterfly valve DN50 / PN16
- wedge gate valve DN50 / PN16
- electric control valve DN50 / PN16
- dirt trap DN50 / PN16 with 2 filter elements

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

Dimensions and Weight

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

Required for Operation

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

Scope of Delivery

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

Order Details

080.39600	RT 396	Pump and Valves and Fittings Test Stand

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MT 210 Assembly & Maintenance Exercise: Refrigeration

*** Study project with high practical relevance**

*** Suitable for training in metal and electrical professions**

*** Interdisciplinary and covering several subject areas**

*** Setup of a refrigeration system from individual components**

Technical Description

Using MT 210 trainees can learn working within a complex project. This involves the planning, implementation and checking of processes related to assembly, commissioning and maintenance. The assembly relates to refrigeration installation: installation of the LP and HP pressure switches, the expansion valve and the pipework of the refrigeration circuit. The pipe joints are not soldered but bolted. The electrotechnical installation includes the wiring and connection of all units and switching elements.

For assembly the tool set ET 150.02, for commissioning the system the filling and evacuation equipment ET 150.01 are required.

The fully assembled system MT 210 represents a fully functional, temperature-controlled refrigeration system with refrigeration chamber and electrical thermostat. Repeated assembly and disassembly are possible.

The experiment is arranged on a workbench with drawers for storing the components and tools. Assembly panel and refrigeration chamber are mounted on a frame. Frame, condensing unit and switch cabinet are bolted permanently to the working surface. The refrigeration and electrical components are attached to the aluminium assembly panel.

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

Learning Objectives / Experiments

- reading and understanding technical documentation
- planning and executing assembly steps and processes
- making pipe joints in accordance with a system diagram
- carrying out electrical installation in accordance with a circuit diagram
- commissioning and checking the refrigeration system after successful assembly (in conjunction with ET 150.01)
- familiarisation with the function of a refrigeration system as a system and its components as system components
- fault analysis: fault finding, fault evaluation and repair
- planning, executing and evaluating maintenance processes

In conjunction with ET 150.01
- evacuating and filling refrigeration systems

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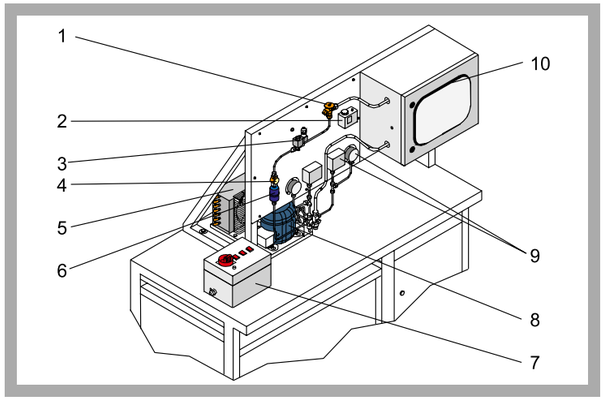
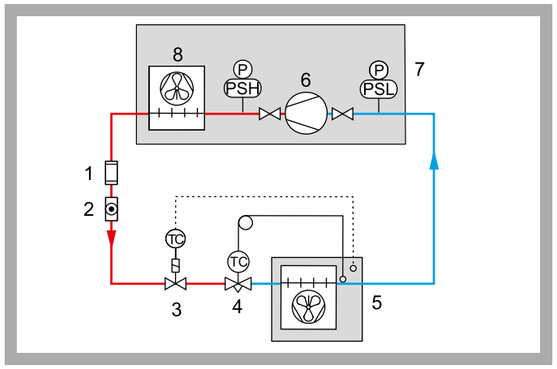
MT 210 Assembly & Maintenance Exercise: Refrigeration



1 expansion valve, 2 thermostat, 3 solenoid valve, 4 sight glass, 5 condenser with fan, 6 filter/drier, 7 switch cabinet, 8 compressor, 9 pressure switch with manometer, 10 refrigeration chamber with sight window and integrated evaporator



1 filter/drier, 2 sight glass, 3 thermostat, 4 expansion valve, 5 refrigeration chamber with evaporator, 6 compressor, 7 condensing unit, 8 condenser; P pressure, PSL, PSH pressure switch; blue: low pressure, red: high pressure

Leak test at the expansion valve of the fully assembled system

Specification

[1] assembly project for the training of mechatronics engineers for refrigeration
[2] setup of a refrigeration system with refrigeration chamber from a complete set of components
[3] temperature control via thermostat
[4] air-cooled condensing unit with compressor
[5] refrigeration chamber with integrated show case evaporator and fan
[6] refrigeration chamber with large sight window
[7] assembly panel to mount the refrigeration and electrical components
[8] electrical assembly in accordance with the circuit diagram
[9] easy pipeworking of the refrigeration circuit using bolted pipe joints
[10] workbench with drawers to store the components
[11] refrigerant R134a, CFC-free
[12] the training set is part of the GUNT practical series for assembly, service and maintenance

Technical Data

Condensing unit
- power consumption: 190W
- refrigeration capacity: 373W at 5°C evaporation temperature
- receiver: approx. 1L

Show case evaporator
- capacity: 50W at t_0=-6°C, ΔT=8K
- transfer area: 1,06m²

Refrigeration chamber with sight window
- LxWxH: 480x280x390mm

Aluminium assembly panel
- LxW: 710x500mm

Thermostatic expansion valve, adjustable
Thermostat, adjustable: -30...15°C

Dimensions and Weight

LxWxH: 1530x750x1670mm
Weight: approx. 155kg

Required for Operation

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

Scope of Delivery

1 workbench with drawers, switch cabinet, condensing unit, assembly panel and refrigeration chamber
1 kit consisting of all necessary components and installation material
1 set of instructional material, consisting of: technical system description, set of drawings with individual components and parts list, description of the assembly, service and maintenance processes

Order Details

051.21000 MT 210 Assembly & Maintenance Exercise: Refrigeration

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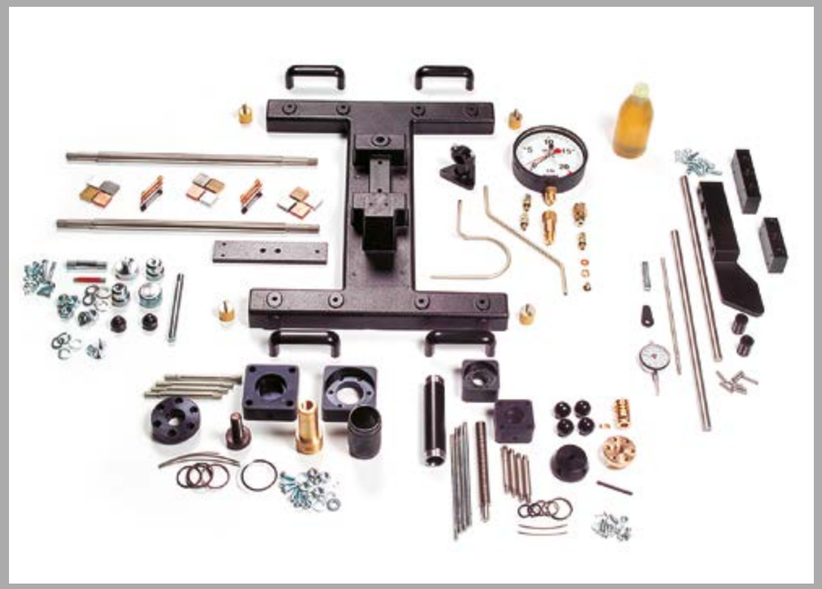
MT 190 Assembly Project: Materials Tester



*** Highly practice-oriented assembly project for training in the metalworking trades**

*** Assembly kit to build a unit for carrying out materials testing experiments**

*** Range of tasks can be expanded to include electronic data acquisition (MT 190.01)**

*** Comprehensive, well-structured instructional material**

Technical Description

The fully assembled MT 190 system presents an actual fully functional materials tester which can be used for a wide range of materials testing. The test force is generated using a hand-operated hydraulic system. The test force is displayed using a large dial gauge indicator. The elongation of the test specimen is recorded on a dial gauge.

Using MT 190, students can develop skills in the carrying out of complex project work. In the course of the project they independently develop an appreciation for the fundamentals and correlations involved, then contribute to the overall outcome using teamworking skills. The skills acquired are the planning, execution and checking of assembly, commissioning, and maintenance operations.

MT 190 is supplied in kit form. The kit contains all the mechanical components, measuring devices, hydraulic components complete with sealing elements, and piping material complete with all connecting elements.

The assembly process involves basic mechanical construction, hydraulic assembly of the two cylinders, and assembly of the piping. All the necessary tools and aids, as well as comprehensive instructional material, are included.

Learning Objectives / Experiments

- reading and understanding technical documentation
- planning and execution of assembly operations and sequences
- familiarisation with machine elements and components
- commissioning and checking of a materials tester following assembly
- planning, execution and assessment of maintenance operations
- fault analysis: troubleshooting, fault assessment and repair

After assembly:
- tensile test of metallic specimens
- recording of stress-elongation diagrams
- Brinell hardness test

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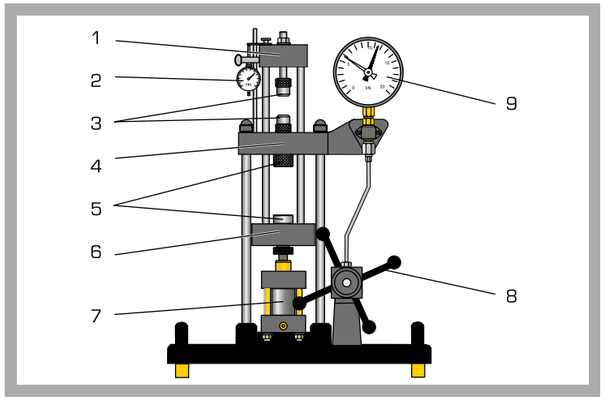
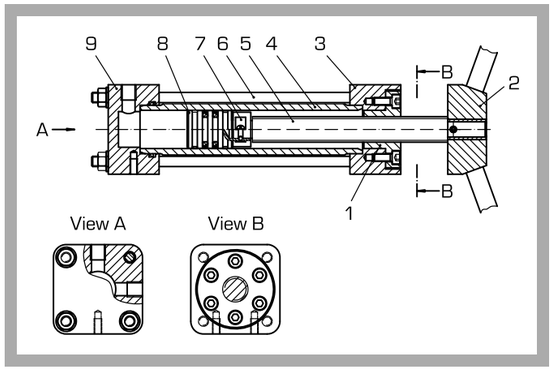
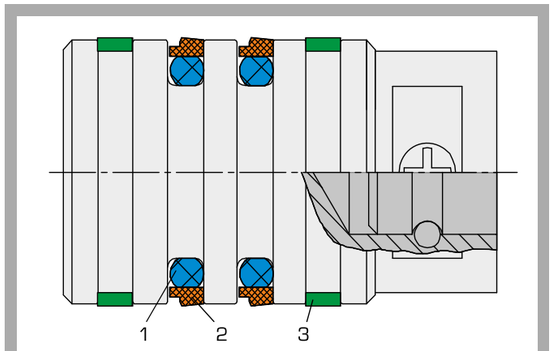
MT 190 Assembly Project: Materials Tester



1 top cross-member, 2 dial gauge for deformation travel, 3 grip heads, 4 crosshead, 5 thrust pad and compression plate, 6 bottom cross-member, 7 hydraulic master cylinder, 8 hand wheel, 9 force indicator



Sectional drawing of the horizontal hydraulic cylinder: 1 trapezoidal nut, 2 hand wheel axle, 3 crank side flange, 4 cylindrical tube, 5 trapezoidal threaded spindle, 6 clamping bolt, 7 retainer, 8 piston, small, 9 delivery side flange



Piston in detail: 1 O-ring, 2 piston sealing ring, 3 guide ring

Specification

[1] assembly project for training in the metalworking trades
[2] complete set of parts for a universal materials tester
[3] force generation using hand-operated hydraulic system, no power supply necessary
[4] cross-member frame with ground steel pillars, compressive and tensile force can be generated
[5] precise pillar guide located in linear ball bearings
[6] hydraulic assembly of 2 cylinders
[7] hydraulic system piping assembly
[8] grey cast iron machine base
[9] 2 measuring gauges: displacement dial gauge and dynamometer
[10] space available for test specimens 165x65mm
[11] complete assembly tool kit
[12] the assembly project forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Max. test force: 20kN
Max. stroke: 45mm
Space available for test specimens: 165x65mm
Dynamometer: 0...20kN, graduations: 0,5kN
Displacement gauge: 0...20mm, graduations: 0,01mm
Tensile specimens: B6x30 DIN 50125
Test sphere diameter for Brinell test: D=10mm

Dimensions and Weight

LxWxH: 610x520x850mm (assembled)
Weight: approx. 51kg

Scope of Delivery

1 complete set of materials tester parts
1 dynamometer
1 displacement dial gauge
1 set of tools and assembly aids
1 set of small and replacement parts (e.g. seals)
1 set of tensile specimens
1 set of instructional material, consisting of
- technical description of system, complete set of drawings with individual parts and parts list, description of maintenance and repair processes, suggested exercises

Order Details

051.19000 MT 190 Assembly Project: Materials Tester

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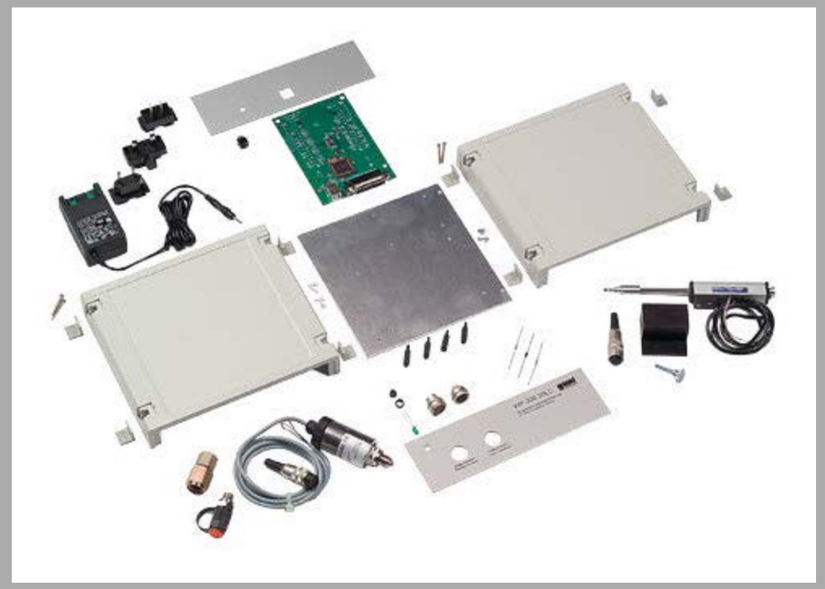
MT 190.01 Assembly Project: Data Acquisition for Materials Tester



*** Educational project with high practical affinity for training in metalworking and electrical trades**

*** Interdisciplinary mechanical and electrical engineering assembly kit covering multiple learning fields**

*** Fully functional data acquisition for a materials tester with USB port and software**

Technical Description

The fully assembled MT 190.01 presents a real, fully functional data acquisition system for the measurement of pressure (forces) on, and changes in length of, a test specimen. The acquired data is processed by evaluation software on a PC. The data acquisition system significantly enhances the possibilities offered by the MT 190 assembly project. The two systems together form a state-of-the-art materials tester with data acquisition, suitable for a wide range of experiments.

Using MT 190.01, students can develop skills in the completion of a complex project. In the course of the project they independently develop an appreciation for the fundamentals and correlations involved, then contribute to the overall outcome using their teamworking skills. The skills acquired are the planning, execution and checking of assembly, commissioning, and maintenance operations.

MT 190.01 is supplied in kit form. The kit contains all the components and materials required to construct a professional data acquisition system.

The assembly process includes the basic mechanical construction and wiring as per the circuit diagram. All the necessary tools and aids, as well as comprehensive instructional material, are included.

Learning Objectives / Experiments

- fundamentals of data acquisition
  familiarisation with sensors, electronics for recording and outputting data, interfacing, software
- reading and understanding technical documentation
- planning and execution of assembly operations and sequences
- commissioning and checking a data acquisition system following assembly
- system integration: linking of materials tester and data acquisition

In conjunction with MT 190
- recording of force-elongation diagrams and stress-strain diagrams
- processing, display and storage of data
- output of diagrams to printer

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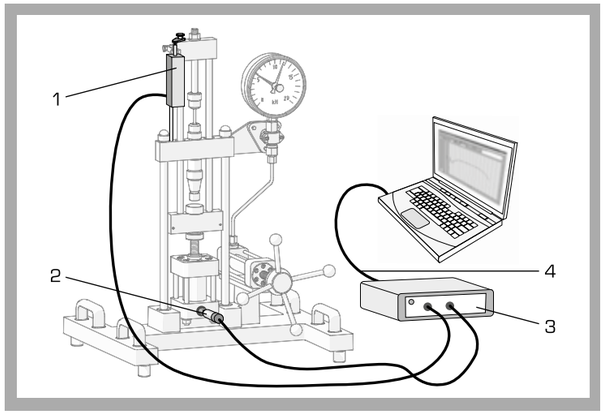
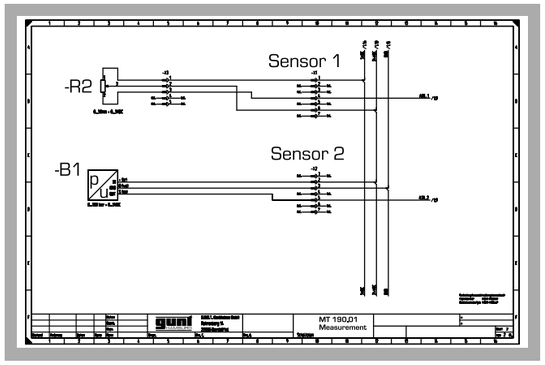
MT 190.01 Assembly Project: Data Acquisition for Materials Tester



Connection of data acquisition system to base unit: 1 displacement sensor, 2 pressure sensor for force measurement, 3 measuring amplifier, 4 USB cable

Fully assembled data acquisition system with software CD
foreground: left: pressure sensor; right: displacement sensor



Circuit diagram: connection of pressure and displacement sensors

Specification

[1] assembly project for training in metalworking and electrical trades
[2] complete parts set to construct a data acquisition system for a materials tester
[3] assembly tool kit
[4] linear potentiometer to measure displacement
[5] force measurement by pressure sensor
[6] GUNT software for data acquisition via USB under Windows Vista or Windows 7
[7] software for acquisition, processing and storage of stress-strain diagrams
[8] the assembly project forms part of the GUNT assembly, maintenance and repair practice line

Technical Data

Pressure sensor for force measurement
- 0...100bar

Displacement sensor
- 0...50mm

Measuring amplifier with USB port
- input: 0...5V
- resolution: 12bit

Dimensions and Weight

LxWxH: 225x200x75mm (amplifier)
Weight: approx. 5kg

Scope of Delivery

1 complete set of measuring amplifier parts
1 pressure sensor, 1 displacement sensor
1 set of assembly tools
1 data acquisition program
1 set of instructional material, consisting of technical description of system, complete set of drawings with individual parts and parts list, circuit diagram, description of maintenance and repair processes, suggested exercises

Order Details

051.19001	MT 190.01	Assembly Project: Data Acquisition for Materials Tester

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GUNT training systems are proved and tested for many, many years. Go ahead and apply them.

Developping technical and professional skills in maintenance

- Establishing fundamentals
- Performing assembly exercises
- Getting familiar with real-life maintenance procedures

ASSEMBLY PROJECTS – MAINTENANCE

You educate apprentice tradesmen in technical schools and factories...

...we offer you practice-oriented teaching and training systems for your education relating to

Assembly | *Maintenance* | *Repair*

INDUSTRIAL TRAINING AND VOCATIONAL QUALIFICATION

Maintenance is a Key Area in Apprentice Training

Plant and machinery should be operational…

Therefore maintenance is an essential part of production and machine management.

…not sitting idle

You must have:

- Strategies and methods in place
- Qualified and trained staff

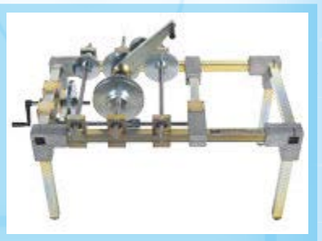
GUNT supports you with our proven teaching systems regarding Assembly Projects and Maintenance. Our service will help you to make the education of your staff much more practice-oriented.

This is hands-on tuition in practice.

A Selection of Assembly Exercises

MT 152

MT 154



GL 430

…there is much more at GUNT. On the following pages we show you some detailed examples.

MT 156

MT 157

MT 158

MT 140.02

MT 140.01

MT 110.02

MT 180

MT 181

MT 182

MT 183

MT 184

MT 185

Learning Concepts Relating to Industrial Maintenance

The maintenance

of industrial plant and machinery is a key field of activity for technicians and skilled tradesmen working in mechanical and electrical engineering.

Key area in technical training

The level of attention devoted to the subject of maintenance by the curricula is therefore high.

TEACHING AND LEARNING SYSTEMS RELATING TO MAINTENANCE

GUNT-Gerätebau GmbH offers you a wide range of wholly practice-oriented teaching and training systems relating to technical maintenance with which you can cover essential learning content:

Use of specific manufacturer's documentation for maintenance, inspection and repair	Planning and assessing maintenance sequences and steps
Reading and understanding engineering drawings	Practical execution and documentation of maintenance operations
Familiarisation with machine and system components	Testing and commissioning of repaired systems
Understanding maintenance as the interaction between inspection, maintenance and repair	Assessment of malfunctions, detection of faults

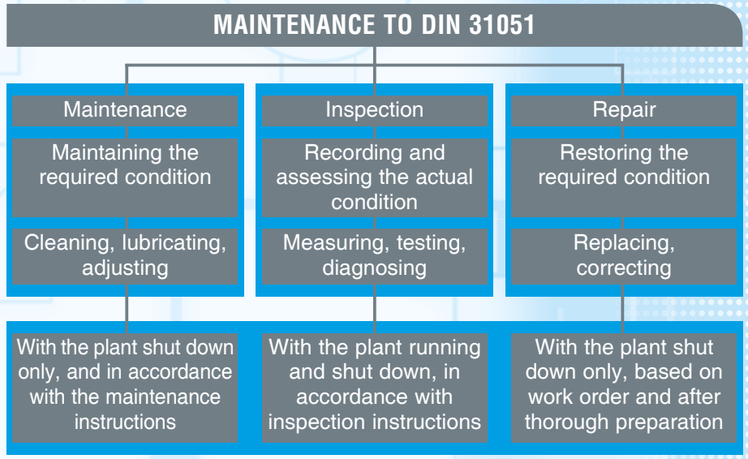
The GUNT training systems are ideally suitable for students' group working, and of course for project-oriented working methods.

Things don't have to get this bad

It's possible to do something in time

What is maintenance?

'Maintenance' as defined by German industry standard DIN 31051 is a complex field, so the range of teaching and training systems we offer in this area is very diverse.



This theme should be read in close conjunction with the GUNT catalogue no. 2

LEARNING THROUGH PRACTICE...

This chapter deals with the process of familiarisation with component and their functions, reading and understanding engineering drawings or operating instructions, and familiarisation with technical terminology and language. The assembly exercises can be conducted in relatively short periods of time (within lesson units) and do not as yet require any particular technical experience. Fault diagnosis and maintenance measures are not yet central to the training systems.

ASSEMBLY PROJECTS

MAINTENANCE

The real, industrial nature of the exercises is higher than in the Assembly Projects. Typical maintenance methods and testing procedures are offered as learning content. Some of the exercises take a lot of time to complete and amount to substantial project work. Demands are made on technical skills.

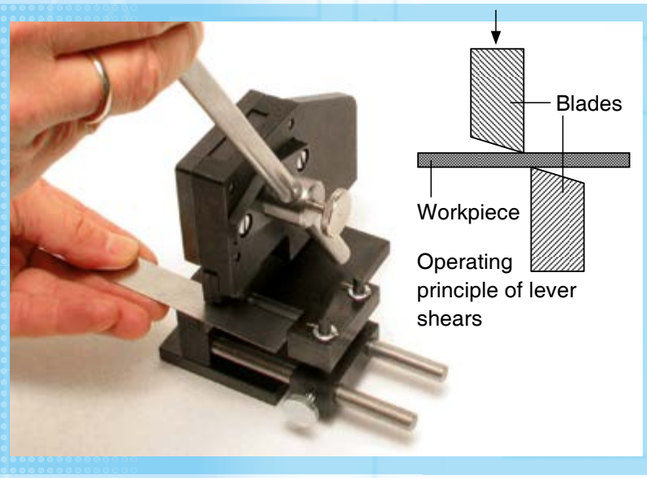
MACHINERY DIAGNOSIS

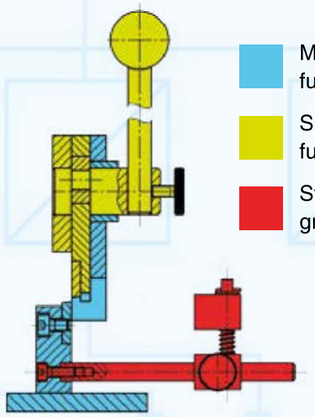
The teaching systems familiarise trainees with the specific methods of monitoring plant/machinery condition, such as the early detection of bearing or gear damage. We work primarily with vibration analysis methods which constitute diagnostic steps for preventive maintenance or targeted repair.

...SO THE THEORY IS EASY!

TZ 200.71 Lever Shears Assembly Kit

Coverage of the fundamentals: An assembly kit for introducing a course

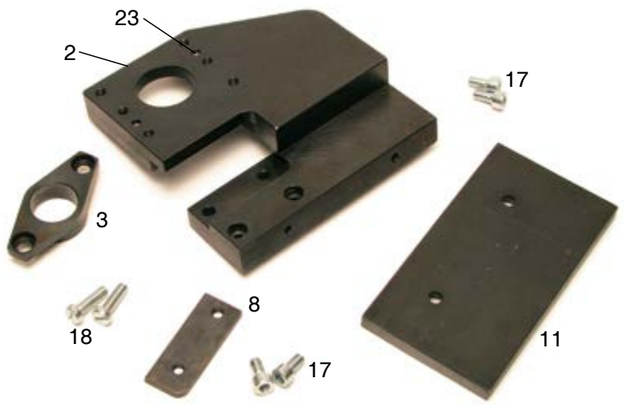




Lever shears function groups

- Interdisciplinary teaching possibilities.
- Learning in a small team is an effective learning format.
- Excellent instructional materials, including a CD, for printing and presentation.

Function group	Partial function	Movement
Main body	Carries, supports and guides all other parts	None
Stop	Sets the length to be cut off	None
Shear body	Transmits the shearing force to the workpiece	Rotary & linear motion



Assembly step 1 (Main body) – Parts required for assembly

Pos.	Name	Pos.	Name
2	Main body	17	Cheese head screw
3	Bearing flange	18	Cheese head screw
8	Lower blade	23	Paralell pin
11	Base plate		

Learning Objectives / Experiments

- Introduction to technical drawing:
  - reading and understanding technical drawings
  - three-plane views
  - sectional views
  - drawing types
  - 3D views
  - parts lists
  - dimensioning
  - surface finish and tolerance specifications
  - differentiation between standard and production parts
  - material specifications
- Planning and execution of simple assembly operations:
  - planning and describing work sequences
  - assessing results
- Measurement exercises:
  - length measurements
  - angle measurements
- Manufacturing methods:
  - operational examples of handmade production and production on machine tools

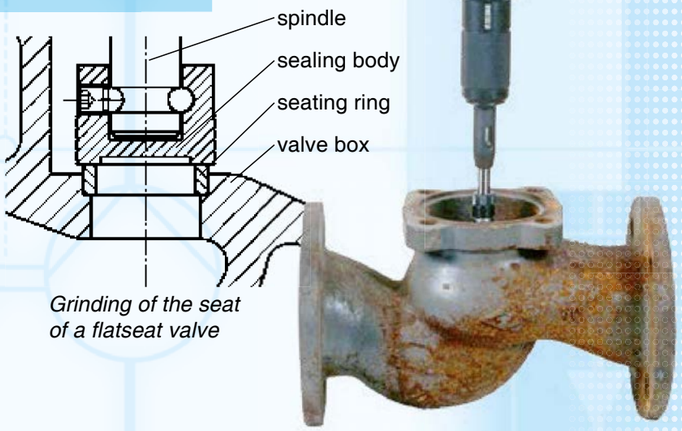
MT 158 Assembly Exercise: Ball Valve and Shut-off Valve

The assembly kit

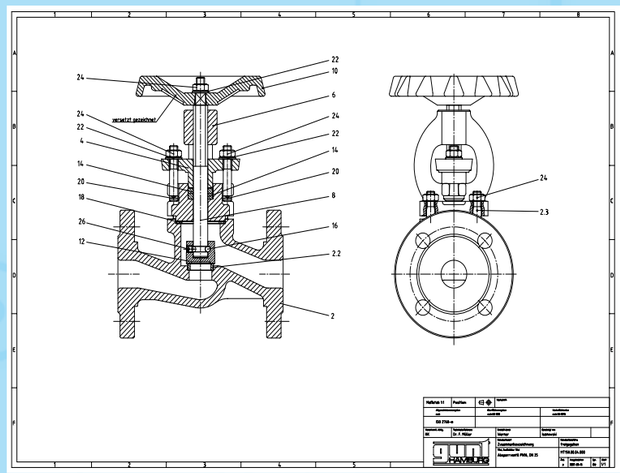
Two different valves and fittings in one assembly kit.

Parts are clearly and perfectly arranged.

- Exercises can be conducted in a classroom – no workshop environment necessary.
- Assembly exercises can be conducted in relatively short periods of time (within lesson units).
- Comprehensive and well-structured instructional material will impress you.



Grinding of the seat of a flatseat valve



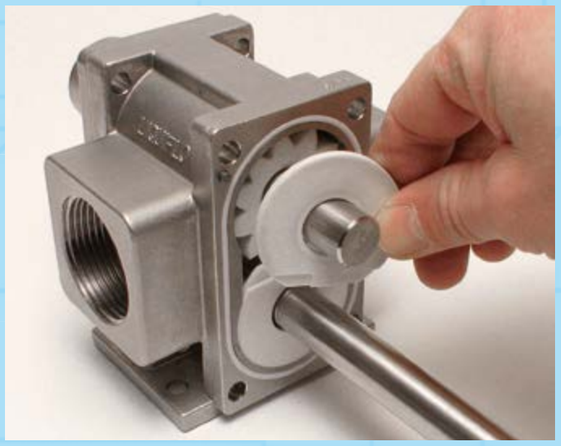
Replacement parts available according to part lists and drawings

Learning Objectives / Experiments

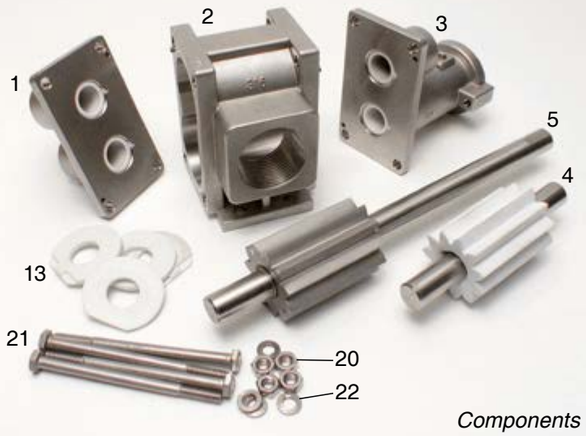
- Design and function of a ball valve
- Design and function of a valve
- Assembly and disassembly, including for the purposes of maintenance and repair
- Replacing components (e.g. seal)
- Comparison of 2 different valves and fittings
- Reading and understanding engineering drawings and operating instructions
- Leak testing (together with hydraulic valves and fittings test stand MT 162)

MT 186 Assembly & Maintenance Exercise: Gear Pump

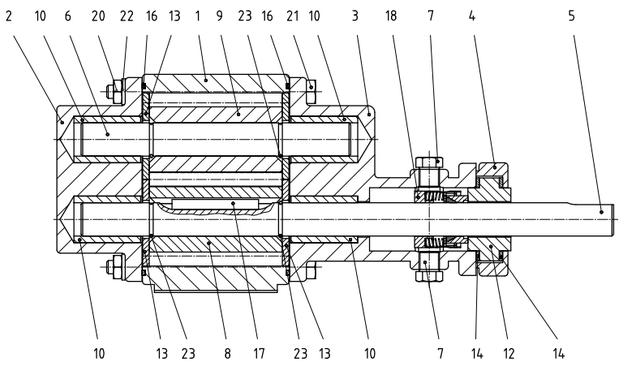
Installing the driven shaft



Mounting the wearing discs



Components included in the assembly kit



Learning Objectives / Experiments

- Design and function of a gear pump and its components
- Assembly and disassembly for maintenance and repair purposes
- Replacing components (e.g. seals)
- Troubleshooting, fault assessment
- Planning and assessment of maintenance and repair operations
- Reading and understanding engineering drawings and operating instructions

MT 140.02 Assembly Exercise: Piston Compressor

Students studying the assembly

Crankcase, crankshaft, oil distribution ring

An assembled compressor, to the right individual parts, exploded view in the background

Learning Objectives / Experiments

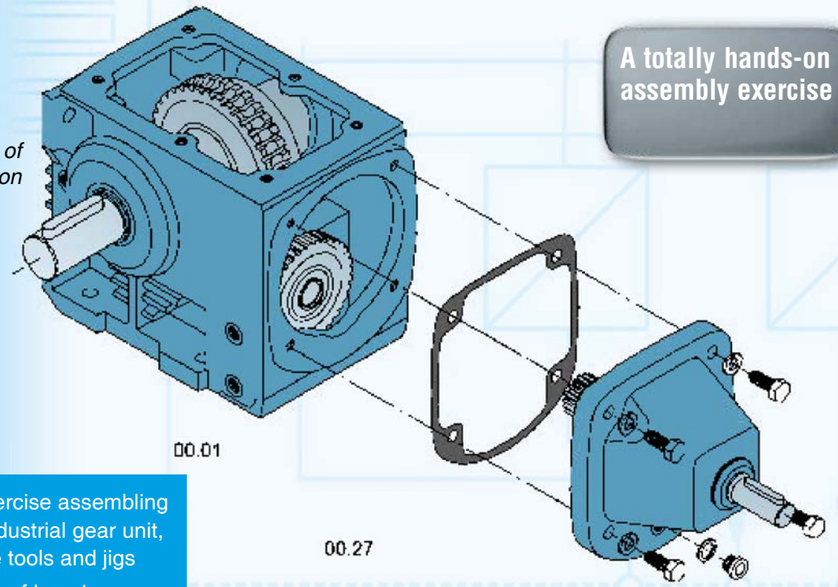
- Design and function of a compressor
- Reading and understanding engineering drawings
- Familiarisation with components and assemblies, their design features and functions
- Dimensioning exercises, gauging of parts
- Work planning, particularly planning and presentation of the assembly process
- Familiarisation with assembly aids and jigs
- Assembly exercises: component and complete unit assembly
- Analysis of faults and damage, in conjunction with maintenance and repair steps
- Material selection criteria

In conjunction with MT 140.01:

- Functional testing of the assembled compressor

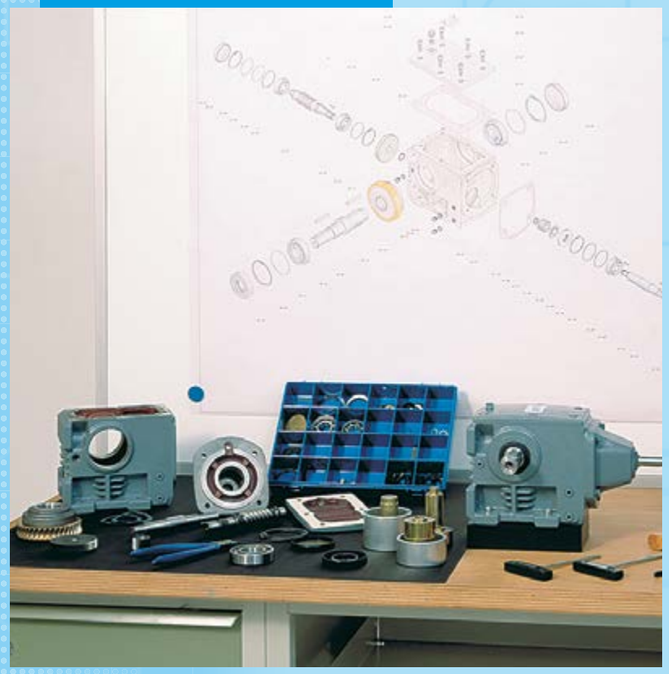
MT 110.02 Assembly Exercise: Spur Wheel/Worm Gear Mechanism

An example of assembly section



A totally hands-on assembly exercise

- Practical exercise assembling a modern industrial gear unit, using simple tools and jigs
- Broad scope of learning presenting interdisciplinary problems
- Comprehensive and well-structured instructional material



Left hand: single parts of the gear
Right hand: fully assembled multistage gear

Learning Objectives / Experiments

- Design and function of a multistage gear combination
- Reading and understanding engineering drawings
- Familiarisation with component and assemblies, their design features and functions
- Dimensioning exercises, gauging of parts
- Work planning, particularly planning and presentation of the assembly process
- Familiarisation with assembly aids and jigs
- Assembly exercises: component and complete unit assembly
- Analysis of faults and damage, in conjunction with maintenance and repair steps
- Material selection criteria

In conjunction with MT 172:

- Functional testing of the assembled gear unit

MT 190 Assembly Project: Materials Tester

Build your own materials tester

This is the assembly kit...

...and this is the result

Learning Objectives / Experiments

- Reading and understanding technical documentation
- Planning and execution of assembly operations and sequences
- Familiarisation with machine elements and components
- Commissioning and checking of a materials tester following assembly
- Planning, execution and assessment of maintenance operations
- Fault analysis: Troubleshooting, fault assessment and repair

After assembly:

- Tensile test of metallic specimens
- Recording of stress-elongation diagrams
- Brinell hardness test

MT 210 Assembly & Maintenance Exercise: Refrigeration

Fully assembled MT 210 unit

1 Fully hermetic compressor
2 Filter drier
3 Sight glass with humidity indicator
4 Delivery side manometer
5 HP (high pressure) pressure switch
6 LP (low pressure) pressure switch
7 Intake side manometer
8 Cooling chamber with evaporator and fan 2
9 Thermostat
10 Expansion valve
11 Assembly panel
12 Solenoid valve
13 Condenser with fan 1
14 Service valves
15 Electrical switch box

Leak testing at expansion valve

Maintenance, repair, troubleshooting of a refrigeration system ...totally practice-oriented

Learning Objectives / Experiments

- Reading and understanding technical documentation
- Planning and execution of assembly operations and sequences
- Making piping connections as per system diagram
- Electrical installation as per circuit diagram
- Commissioning and checking of a refrigeration unit following assembly (in conjunction with ET 150.01)
- Familiarisation with the function of the components of a refrigeration system and of the complete system
- Fault analysis: troubleshooting, fault assessment and repair
- Planning, execution and assessment of maintenance operations

In conjunction with ET 150.01:

- Evacuation and filling of refrigeration units

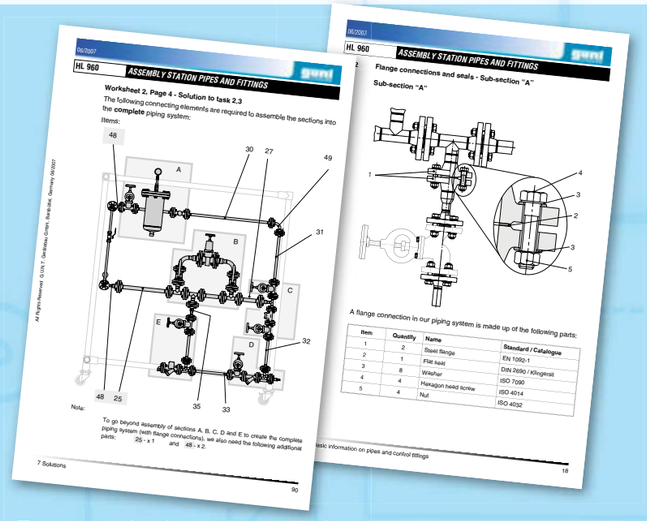
HL 960 Assembly Station: Pipes and Valves and Fittings

Service technician at work

Practically oriented assembly of piping and system installations

Maintenance Repair

...it is difficult to imagine a more hands-on training system



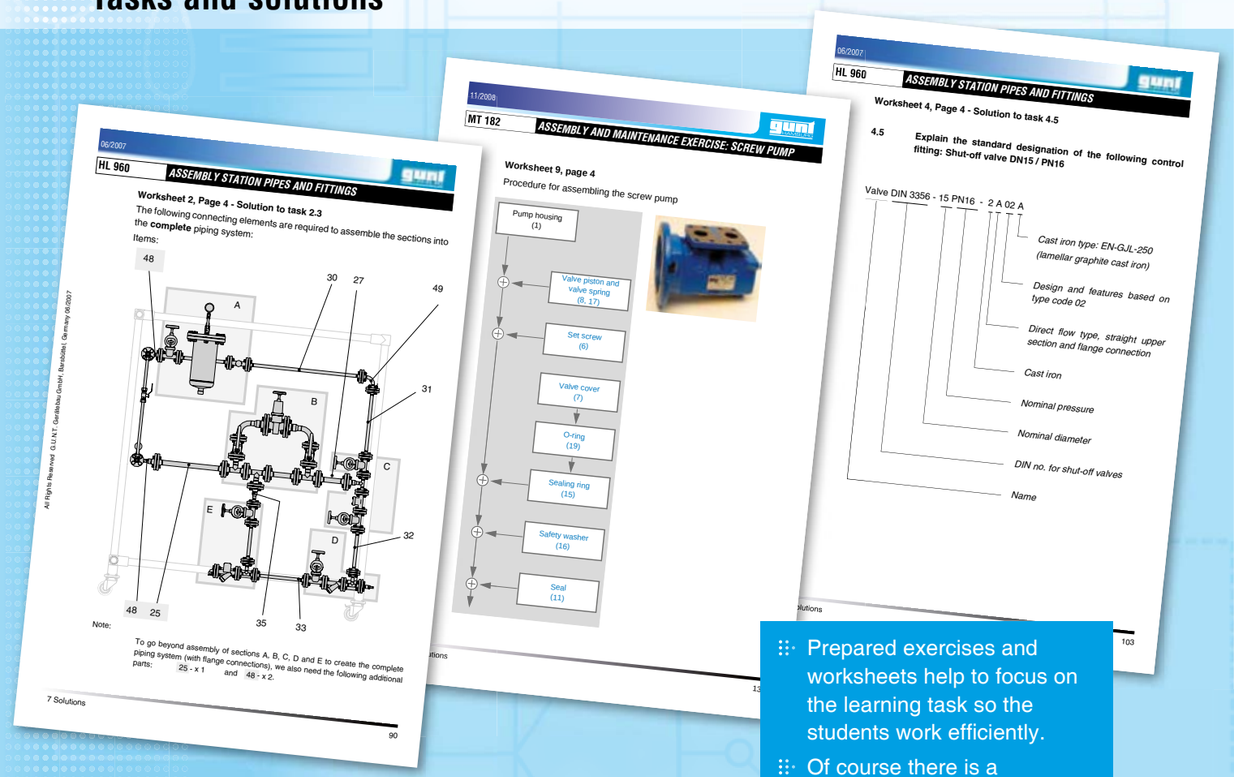
Two examples from our comprehensive training documentation

Learning Objectives / Experiments

- Design and function of valves and fittings, piping elements and system components
- Planning of piping and system installations according to specification, e.g. a process schematic
- Selection of components and drafting of requirement lists
- Technically correct preparation and execution of system assembly
- Reading and understanding engineering drawings and technical documentation
- Operational testing of the constructed systems (in conjunction with suitable water supply and disposal)

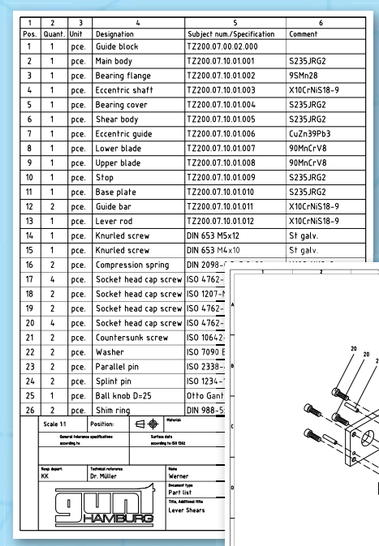
The Instructional Material will Impress You

Tasks and solutions



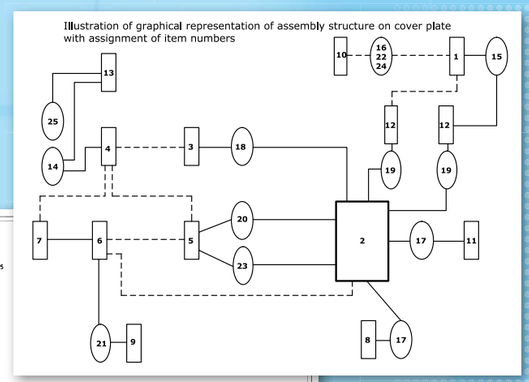
- Prepared exercises and worksheets help to focus on the learning task so the students work efficiently.
- Of course there is a recommended solution for every exercise.

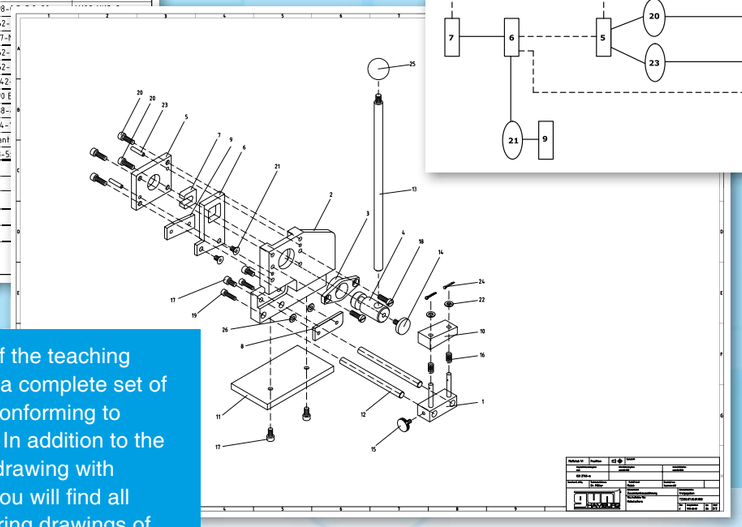
Complete set of drawings



Pos.	Quant.	Unit	Designation	Subject num./Specification	Comment
1	1	pce.	Guide block	TZ200.07.00.02.000	
2	1	pce.	Main body	TZ200.07.10.01.001	S235JRG2
3	1	pce.	Bearing flange	TZ200.07.10.01.002	9SMn28
4	1	pce.	Eccentric shaft	TZ200.07.10.01.003	X10CrNiS18-9
5	1	pce.	Bearing cover	TZ200.07.10.01.004	S235JRG2
6	1	pce.	Shear body	TZ200.07.10.01.005	S235JRG2
7	1	pce.	Eccentric guide	TZ200.07.10.01.006	CuZn39Pb3
8	1	pce.	Lower blade	TZ200.07.10.01.007	90MnCrV8
9	1	pce.	Upper blade	TZ200.07.10.01.008	90MnCrV8
10	1	pce.	Stop	TZ200.07.10.01.009	S235JRG2
11	1	pce.	Base plate	TZ200.07.10.01.010	S235JRG2
12	2	pce.	Guide bar	TZ200.07.10.01.011	X10CrNiS18-9
13	1	pce.	Lever rod	TZ200.07.10.01.012	X10CrNiS18-9
14	1	pce.	Knurled screw	DIN 653 M5x12	St galv.
15	1	pce.	Knurled screw	DIN 653 M4x10	St galv.
16	2	pce.	Compression spring	DIN 2098-[illegible]	
17	4	pce.	Socket head cap screw	ISO 4762-[illegible]	
18	2	pce.	Socket head cap screw	ISO 1207-[illegible]	
19	2	pce.	Socket head cap screw	ISO 4762-[illegible]	
20	4	pce.	Socket head cap screw	ISO 4762-[illegible]	
21	2	pce.	Countersunk screw	ISO 1064-[illegible]	
22	2	pce.	Washer	ISO 7090 [illegible]	
23	2	pce.	Parallel pin	ISO 2338-[illegible]	
24	2	pce.	Splint pin	ISO 1234-[illegible]	
25	1	pce.	Ball knob D=25	Otto Ganz	
26	2	pce.	Shim ring	DIN 988-[illegible]	

Scale 1:1 | Position | Material | General tolerances specifications according to | Surface data according to ISO 1302 | Name dept. KK | Technical reference Dr. Müller | Name Werner | Document type Part list | Title, Additional title Lever Shears



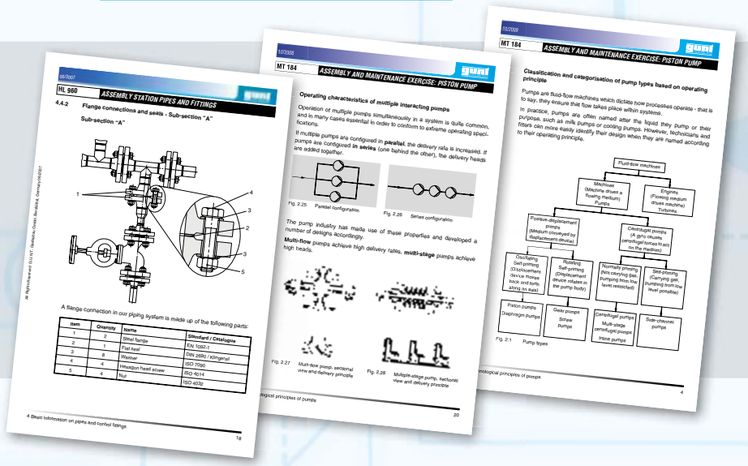


- The core of the teaching material is a complete set of drawings conforming to standards. In addition to the assembly drawing with parts list, you will find all manufacturing drawings of the individual parts.
  So you are able to produce your own parts, or have them manufactured for you.

The complete material on CD (PDF)

The complete instructional material is delivered in hardcopy form in a clearly arranged folder.

Additionally you receive the complete material as PDF-files. It includes all texts, graphics and drawings. That way you can conveniently print or present.



Fundamental principles presented in detail

The basic principles and technical descriptions are professionally illustrated with lots of graphics, photos and clear text.

The pages are suitable for printing out or using with a video projector.

MACHINERY DIAGNOSIS

GUNT is innovative

We are continuously monitoring trends in technological development in both the scientific and industrial fields. Our aim is to translate key topics and developments into teaching and training systems that provide schools, colleges and universities and their trainees and students with access to the latest state-of-the-art technologies.

There is frequent scientific co-operation between GUNT and academic institutions in specific fields. A prime example of this is the training systems covering the subject of plant and machinery condition monitoring.

Visit our website www.gunt.de

PT 500 – MACHINERY DIAGNOSTIC SYSTEM

Industrial plant

Vibrational analyser

Evaluation of vibrational signals

The purpose of modern-day machinery diagnosis is to carry out needs-based maintenance or repair and to minimise the repair and other servicing downtimes of a machine. The aim is to detect damage as it occurs.

The condition of a machine or of machine components can be accurately diagnosed from the nature and extent of its vibration. Accordingly, vibrations are measured, recorded and evaluated using sensors and recording equipment.

Correct interpretation of the measurement signals requires a thorough understanding of the mechanisms at work and a degree of experience.

The GUNT PT 500 machinery fault trainer is a modular system which deals with this complex and highly topical issue in technical tuition, developing it through experimentation.

A thorough treatment of the subject requires an engineer's know-how. However, skilled tradesmen and maintenance fitters can use the training system to familiarise themselves with this field of technology at a more practice-oriented level.

The PT 500 machinery fault trainer can be used to selectively simulate, measure and evaluate vibration signals generated by typical malfunctions and damage, thus allowing thorough interpretation of the measurement signals to be carried out.

The computerised vibration analyser supports effective learning notably.

BASE UNIT

A range of training exercises relating to machinery diagnosis and monitoring can be carried out using just the PT 500 base unit together with the computerized vibration analyser PT 500.04.

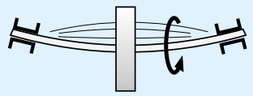
As well as the exercises in the measurement of the vibration (amplitude, velocity and acceleration in the time or frequency domains), field balancing of rigid rotors and alignment of shafting can also be practised.

The base unit includes a vibration-damped workholder plate, a speed-controlled drive motor with a tachometer, a shaft with two mass discs and two bearing units, a coupling and balancing weights.

A wide range of accessories enables almost any subject area relating to machinery diagnosis to be covered.

ACCESSORY SETS OPTIONALLY COUPLED TO THE BASE UNIT

PT 500.10 *Elastic Shaft*



Unbalanced mass vibration of a flexurally elastic shaft; resonance, critical rotation speed, balancing

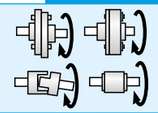
PT 500.11 *Crack Detection in Rotating Shaft*

Vibration behaviour of a cracked shaft, identification of the crack from the vibration signal

PT 500.12 *Roller Bearing Faults*

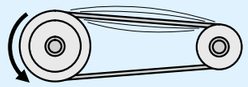
Identification of bearing damage from running noise.
Various pre-damaged roller bearings

PT 500.13 *Couplings*



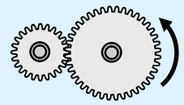
Properties of different coupling types, influence of eccentricity, wobble and pitch fault on vibration behaviour

PT 500.14 *Belt Drive*



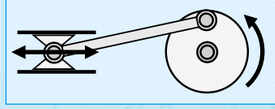
Vibration in belt drives, resonance and critical rotation speeds, influence of belt tension, eccentricity and misalignment

PT 500.15 *Damages to Gears*



Identification of gear damage from the vibration signal, influence of toothing type and lubrication

PT 500.16 *Crank Mechanism*



Vibration in crank drives, free inertia forces, bumps and jolts resulting from bearing play and wear

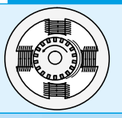
PT 500.17 *Cavitation in Pumps*

Noise and damage resulting from cavitation, conditions for cavitation inception

PT 500.18 *Vibrations in Fans*

Vibration in fans, demonstration of vibration excitation by blade passage, influence of centrifugal force

PT 500.19 *Electromechanical Vibrations*



Interaction of electromagnetic/ mechanical elements of system, influence of load, gap geometry and electrical asymmetry

PT 500 *Machinery Diagnostic System, Base Unit*

The illustration shows the base system PT 500 ready for conducting experiments, together with the trolley PT 500.01.

*** Base unit for setting up wide ranging experiments in machinery diagnostics using modular accessory sets**

*** Aluminium base plate with slots for quick, flexible assembly of different experimental setups**

*** Speed controlled drive motor with frequency converter; control unit with digital power and speed display**

*** Modern and well-structured instructional material**

Technical Description

The machinery diagnostic system can be used to simulate certain types of damage and investigate its effects on the vibration spectrum.

The PT 500 base unit permits vibration measurement exercises (measurement of vibration displacement, velocity and acceleration in the time/frequency range). Field balancing of rigid rotors and alignment of shafts can also be practiced.

The key components of the base unit are the mechanical elements (clutch, bearing blocks and shaft with rotors), the drive motor with variable speed via frequency converter and tachogenerator, and the display and control unit with digital displays for power output and speed.

The motor base plate is mounted on a carriage, enabling the motor to be aligned. The large aluminium base plate with locating slots allows quick, flexible and precise assembly of the system components. A transparent protective cover provides the necessary safety during operation, and enables clear system viewing during experiments.

All parts are clearly laid out and well protected in a storage box.

To measure and evaluate all experiments, the computerised vibration analyser PT 500.04 is required. The accessory sets PT 500.10 - PT 500.19 enable repeatable simulation of the different types of damage.

Use of the trolley PT 500.01 is recommended for flexible deployment of the training system.

Learning Objectives / Experiments

- introduction to vibration measurement methods on rotating machinery systems
  - * fundamentals of measurement of shaft and bearing vibrations
  - * basic variables and parameters
  - * sensors and measuring devices
  - * influences of speed and shaft layout
  - * influence of transducer positioning
- field balancing of rigid shafts
- influence of alignment between motor and coupling
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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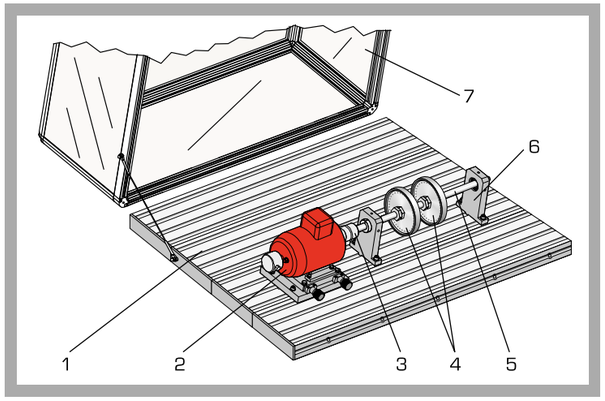
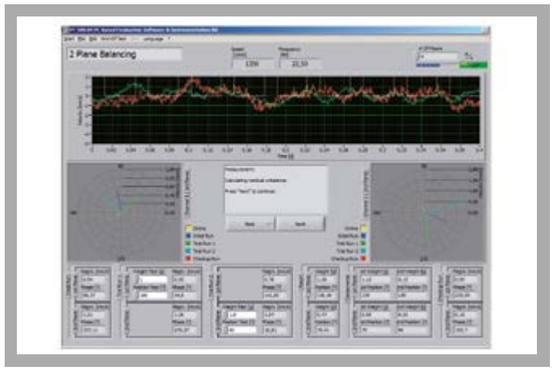
PT 500 *Machinery Diagnostic System, Base Unit*



1 base plate, 2 drive motor with adjustable carriage, 3 coupling, 4 bearing unit, 5 shaft, 6 unbalanced flywheel, 7 transparent hood

The illustration shows the components in the storage box.



Screenshot of evaluation software: field balancing in two planes.

Specification

[1] base unit for machinery diagnostic training system
[2] rigid base plate with workpiece holder slots
[3] drive motor with variable speed via frequency converter
[4] digital speed and power display
[5] 2 shafts: 1x short, 1x long
[6] 2 unbalanced flywheels with interchangeable balance weights
[7] bearing blocks, roller bearings, interchangeable
[8] fixing holes for vibration measurement transducer
[9] flexible claw coupling and Controlflex^{R} coupling
[10] motor can be aligned obliquely and transversally
[11] transparent protective hood
[12] stackable box for components

Technical Data

Asynchronous motor with frequency converter
- drive power output: 0,37kW
- nominal speed: 2800min^{-1}
Speed range via frequency converter
- 100...6000min^{-1}
Display and control unit with digital power and speed display

2 shafts: D=20mm, length 300mm, 500mm
2 unbalanced flywheels
- D=150mm, each 1675g, with interchangeable balance weights (bolts)
2 bearing blocks with roller bearings 6004 (can be exchanged)
Controlflex^{R} coupling: nominal torque: 15Nm

Dimensions and Weight

LxWxH: 1100x800x500mm (base plate + hood)
LxWxH: 475x415x195mm (control unit)
LxWxH: 600x390x325mm (storage box)
Weight: approx. 95kg (complete system)

Required for Operation

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

Scope of Delivery

1 base plate with protective hood
1 display and control unit
1 asynchronous motor with frequency converter
2 shafts, 2 unbalanced flywheels, 2 clutches
2 bearing units
1 holder plate, 2 clamp sets
1 set of tools
1 storage box with foam inlay
1 set of instructional material

Order Details

052.50000	PT 500	Machinery Diagnostic System, Base Unit

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PT 500 - Classification: Experimentation kits and required/optional components

Experiments \ Components	PT 500.05 Brake & Load Unit	PT 500.10 Elastic Shaft Kit	PT 500.12 Roller Bearing Faults Kit	PT 500.14 Belt Drive Kit	PT 500.15 Damages to Gears Kit	PT 500.01 Laboratory Trolley	PT 500.04 Computerised Vibration Analyser	PT 500 Machinery Diagnostic System, Base Unit
PT 500.10 Elastic Shaft Kit						optional	required*	required
PT 500.11 Crack Detection in Rotating Shaft Kit		required		required		optional	required	required
PT 500.12 Roller Bearing Faults Kit				required		optional	required	required
PT 500.13 Couplings Kit	optional					optional	required	required
PT 500.14 Belt Drive Kit	required					optional	required	required
PT 500.15 Damages to Gears Kit	required					optional	required	required
PT 500.16 Crank Mechanism Kit				optional	optional	optional	required	required
PT 500.17 Cavitation in Pumps Kit				optional		optional	required	required
PT 500.18 Vibrations in Fans Kit				optional		optional	required	required
PT 500.19 Electromechanical Vibrations Kit	required					optional	required	required

* PT 500.41 Two Displacement Sensors additionally required

PT 500.01 *Laboratory Trolley*

The illustration shows PT 500.01 together with the base plate with protective hood from the base unit PT 500.

*** Trolley for base unit**

*** 4 castors guarantee mobility**

Specification

[1] trolley for the modular machinery diagnostic training system
[2] blocan section, aluminium
[3] 4 castors, with brake

Technical Data

Top area, LxW: 1100x770mm

Dimensions and Weight

LxWxH: 1100x770x820mm
Weight: approx. 39kg

Scope of Delivery

1 trolley, complete

Technical Description

This laboratory trolley together with the PT 500 base unit permits the construction of a mobile experimental unit. The trolley features two shelves on which measuring equipment and other accessories can be placed. The sturdy trolley structure is manufactured from anodised aluminium section. The shelves are made from anodised aluminium sheet.

Order Details

052.50001 PT 500.01 Laboratory Trolley

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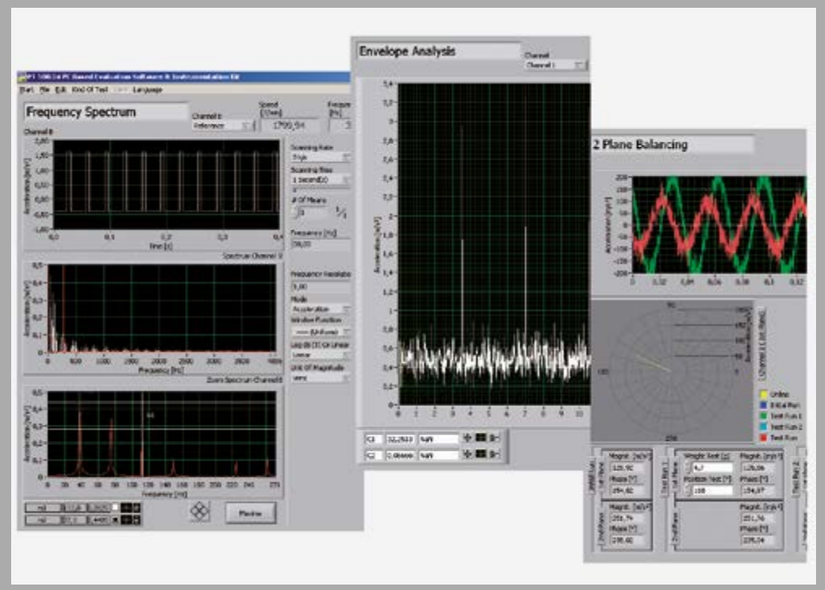
PT 500.04 Computerised Vibration Analyser



*** Versatile, powerful software for vibration analysis**

*** Supports all machinery diagnosis experiments of the PT 500 series**

*** Suitable for field balancing of rotors in 1 and 2 planes**

Technical Description

The computerised vibration analyser was developed specially to support analysis of machinery diagnosis experiments of the PT 500 series. The analyser can also be used in many other vibration experiments (such as TM 150).

The system comprises two acceleration sensors, a measuring amplifier with adjustable gain, a USB box and the analysis software.

The analysis software offers the following features: Two-channel oscilloscope for investigations in the time range; two-channel spectrum analyser for investigations in the frequency range; vibration measuring device; envelope analysis for bump effects and roller bearing damage; travelling filter to record run-up curves; orbit display; and a balancing module for field balancing of rigid rotors in 1 and 2 planes.

The software permits various analytical methods to be applied to a vibration signal and compared in terms of their efficacy. This enables the advantages and disadvantages of the various techniques to be effectively discovered. The balancing process is presented step-by-step.

The software features an intuitive user interface, and is highly user-friendly. An online help function provides guidance on the various functions. Measurement results can be printed out.

Cables, brackets and fixings are supplied.

Learning Objectives / Experiments

Within the context of the experiments in the complete PT 500 series, the following learning can be covered:

- familiarisation with vibration signals
- correct application of FFT analysis
- measurement of rotation speed, vibration displacement, vibration velocity and acceleration
- assessment of the vibration state of a machine
- damage analysis of roller bearings and gears by means of envelope spectra
- detection of cracks in shafts by means of run-up curves and order analysis
- measurement of imbalance vibrations and field balancing of rigid rotors in 1 and 2 planes

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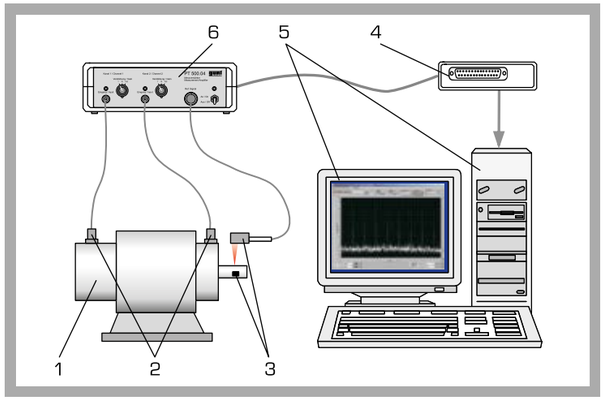
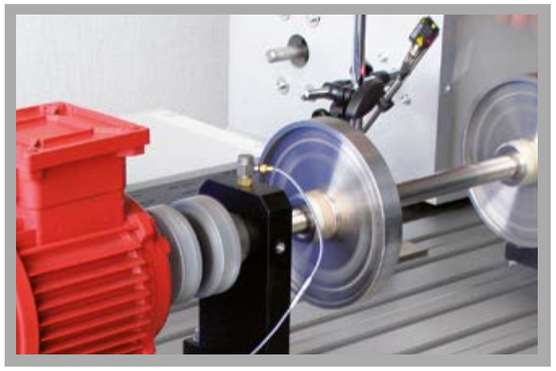
PT 500.04 Computerised Vibration Analyser



1 vibrating machinery, 2 acceleration transducers, 3 shaft with reference sensor, 4 USB box, 5 PC (PC not included), 6 amplifier / filter



Application of the sensors: acceleration sensor on the black bearing support, speed sensor with holder

Screenshot of the software working as oscilloscope

Specification

[1] computerised vibration analyser for representation and evaluation of experiments with the PT 500 "Machinery diagnosis" series
[2] 2 acceleration sensors to record vibration displacement, vibration velocity and acceleration
[3] optical sensor to record rotation speed
[4] 2-channel measuring amplifier with adjustable gain
[5] analysis software programmed in LabVIEW
[6] software features: 2-channel oscilloscope; 2-channel FFT analyser; envelope analysis; run-up curve and order analysis; 2-plane field balancing
[7] 2 displacement sensors PT 500.41 can be connected
[8] suitable for general vibration measurement tasks
[9] connection to PC via USB
[10] stackable storage system to house the components

Technical Data

Acceleration sensor
- frequency range: 1...10000Hz
- sensitivity: 100mV/g
- resonance frequency: 32kHz

Optical speed sensor
- sampling width: 3...150mm
- laser class II, 675nm

Measuring amplifier
- adjustable gain: x1, x10, x100
- powered by 12VDC power supply unit
- LxWxH: 230x220x80mm

USB box
- 16x analogue in, 2x analogue out
- each 4x digital in/out

System requirements: Windows Vista or Windows 7

Dimensions and Weight

LxWxH: 600x400x220mm (storage system)
Weight: approx. 6kg

Required for Operation

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

Scope of Delivery

2 acceleration sensors, 1 speed sensor with holder, 1 amplifier, 1 CD with evaluation software, 1 USB box + data cable, 1 combination wrench, AF 13, 1 storage system with foam inlay, 1 manual

Order Details

052.50004	PT 500.04	Computerised Vibration Analyser

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PT 500.05 Brake & Load Unit

*** Generation of a loading torque**

*** Two speed and torque ranges**

*** Vented magnetic particle brake with display and control unit**

Technical Description

Many vibration phenomena can only be achieved when the system is under load. The brake and load unit is used to generate vibration as a function of torque, e.g. in toothed gearing mechanisms or electric motors.

It consists of a magnetic particle brake and an electric display and control unit. The braking torque can be finely adjusted on the display and control unit. The exciter current is applied as a measure of the braking torque and is indicated digitally on a display.

An integrated belt drive, with a free shaft, provides the brake with two torque and speed ranges. The energy is converted by the brake into heat and discharged to the ambient air by a fan.

The brake can be quickly and precisely mounted on the slotted plate of the PT 500 base unit.

PT 500.05 is used with the following kits:
PT 500.13 Couplings
PT 500.14 Belt drive
PT 500.15 Damage to gears
PT 500.19 Electromechanical vibrations

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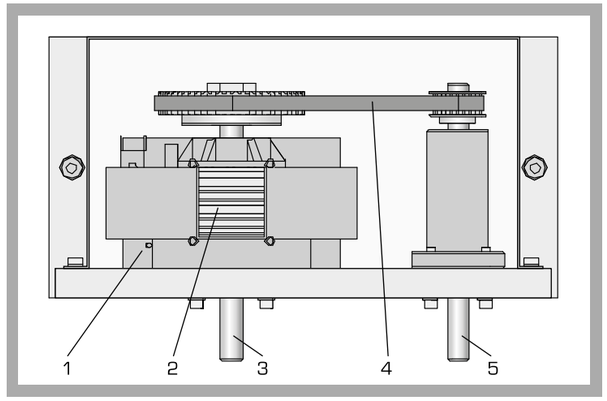
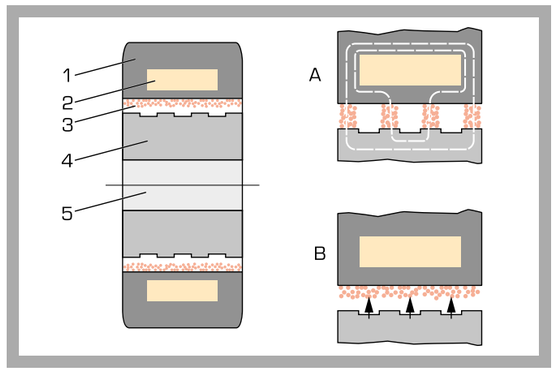
PT 500.05 Brake & Load Unit



1 magnetic particle brake, 2 fan, 3 shaft for direct connection of brake, 4 belt drive, 5 shaft for connection of brake via belt drive



Section through a magnetic particle brake: 1 stator, 2 exciter coil, 3 gap with magnetic particles, 4 rotor, 5 shaft; A current flows, B current flow is interrupted

The illustration shows PT 500.05 together with PT 500, PT 500.01, PT 500.15 and PT 500.04.

Specification

[1] brake and load unit for the machinery diagnostic training system
[2] magnetic particle brake
[3] display and control unit with exciter current display
[4] potentiometer to adjust braking torque
[5] integrated belt drive for second speed and torque range
[6] temperature protection and fan overheating protection
[7] stackable storage system to house the components

Technical Data

Continuous braking power: approx. 450W/3000min^{-1}

Transmission ratio between brake shafts: i=3

Direct brake operation
- speed range: 200...2000min^{-1}
- braking torque: 1...10Nm

Operation via belt drive
- speed range: 600...6000min^{-1}
- braking torque: 0,3...3,3Nm

Dimensions and Weight

LxWxH: 460x410x200mm (display and control unit)
LxWxH: 600x400x320mm (storage system)
Weight: approx. 30kg

Required for Operation

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

Scope of Delivery

1 magnetic particle brake
1 display and control unit
1 storage system with foam inlay
1 manual

Order Details

052.50005 PT 500.05 Brake & Load Unit

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PT 500.10 *Elastic Shaft Kit*

*** Flexural vibration of the elastic shaft**

*** Resonance and critical speed**

Technical Description

This accessory setup enables the response of an elastic rotor to unbalanced excitation to be studied. The subcritical, supercritical and resonance running states can be demonstrated. A comparison of the orbits (path curves) in the subcritical and supercritical range is of particular interest.

The field balancing of elastic rotors is another area which can be investigated. The supplied pendulum ball bearings ensure full mobility of the shaft. The retainer bearing limits the amplitudes to harmless values at speeds close to resonance.

The accessory setup is mounted on the base plate of the machinery diagnostic PT 500 base system.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 and two displacement sensors PT 500.41 are required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- familiarisation with the terms 'critical speed' and 'resonance'
- influence of unbalanced excitation
- balancing the elastic rotor
- influence of alignment errors
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

together with two displacement sensors PT 500.41

- study of the orbit in the subcritical and supercritical range

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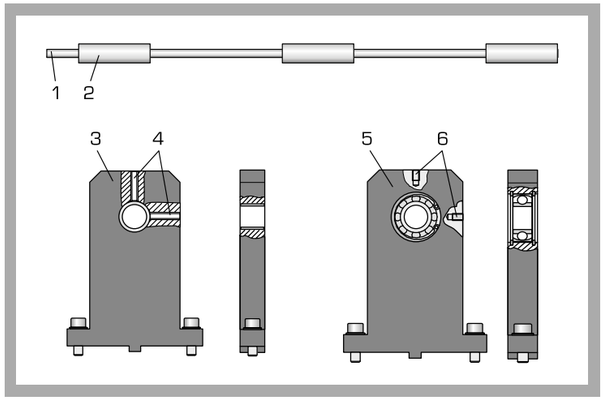
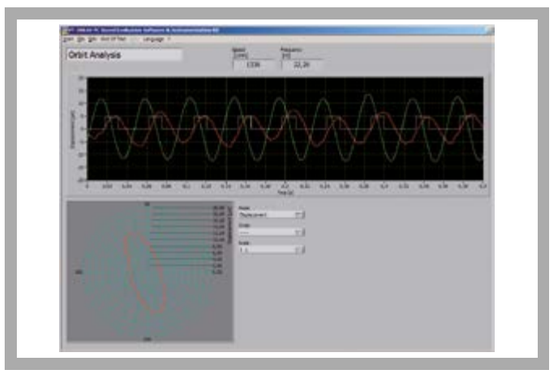
PT 500.10 *Elastic Shaft Kit*



1 elastic shaft, 2 bearing, 3 retainer bearing, 4 bores for position sensors, 5 bearing block with pendulum ball bearing, 6 bores for acceleration sensors

The illustration shows PT 500.10 together with PT 500, PT 500.01 and PT 500.04.



Screenshot of evaluation software
above: vibration signals as a function of time
below: orbit view for vibration on two planes

Specification

[1] investigation of flexural vibration of an elastic shaft
[2] stainless steel elastic shaft
[3] 2 bearing blocks with pendulum ball bearing
[4] 1 retainer bearing
[5] bearing blocks and retainer bearing with bores for sensor mounting
[6] accessory set for PT 500 machinery diagnostic training system
[7] stackable storage system to house the components

Technical Data

Elastic shaft
- min. diameter: D=10mm
- diameter at bearings: D=20mm
- length: 530mm
- nominal length between bearings: 450mm

Dimensions and Weight

LxWxH: 600x400x120mm (storage system)
Weight: approx. 6kg

Scope of Delivery

1 elastic shaft
2 bearing blocks
1 retainer bearing
1 storage system with foam inlay
1 manual

Order Details

052.50010 PT 500.10 Elastic Shaft Kit

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PT 500.11 Crack Detection in Rotating Shaft Kit

*** Vibration behaviour of shaft with radial crack**
*** Identification of damage**

Technical Description

Cracks due to material fatigue are very dangerous for rotating machines. Early detection of any crack is therefore essential before permanent rupture and often fatal consequences can occur. The crack influences the vibration behaviour of the shaft by changing its rigidity. Using suitable analysis software, this change can be registered and inspection of the machine organised in good time.

In the experiment, the crack is simulated by an asymmetric flange joint. Variable tightening of the flange bolts produces a temporary gaping of the butt joint, which closely approximates to the behaviour of a crack.

The accessory setup includes two shafts of different lengths: one short and one long. The short shaft simulates a protruding shaft end, and is loaded with the PT 500.14 belt drive. The long shaft is used in conjunction with a retainer bearing from PT 500.10 and an inertia disk from the base unit to investigate the effects of a crack in a shaft on the elastic rotor.

The accessory setup is mounted on the base plate of the machinery diagnostic base system PT 500.

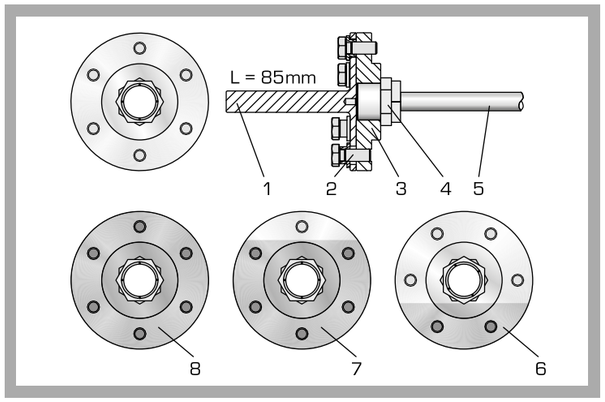
To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- change in characteristic vibration behaviour (natural frequency, resonance speed, amplitude and phase of vibrations) due to a crack
- crack identification from the change in vibration spectrum
- detection of cracks in rotating shafts at the protruding shaft end
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

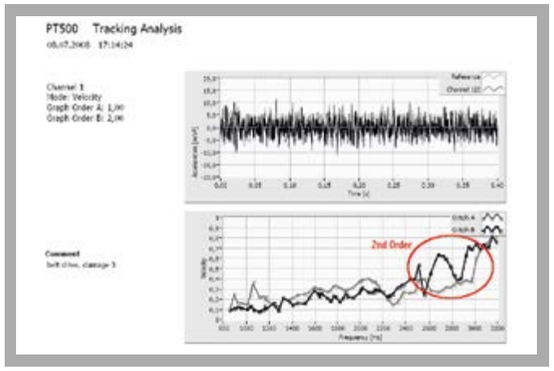
in conjunction with a retainer bearing (e.g. from PT 500.10 - elastic shaft accessory setup)
- detection of cracks in rotating shafts (the elastic rotor)

PT 500.11 Crack Detection in Rotating Shaft Kit



1 flange with short shaft (loaded by belt drive), 2 bolt, 3 pick-up disk, 4 clamp set, 5 driving shaft, 6 shaft with maximum crack (flange joint with 2 load-bearing bolts), 7 shaft with small crack (flange joint with 5 load-bearing bolts), 8 shaft with no crack (flange joint with 6 load-bearing bolts)

The illustration shows PT 500.11 together with PT 500, PT 500.01, PT 500.14 and PT 500.04.



Tracking analysis of a rotor with crack: significant rise in amplitude in 2nd order (marked red)

Specification

[1] investigation of the vibration behaviour of a cracked shaft
[2] crack adapter in flange form
[3] simulation of the crack by opening bolt joints
[4] 4 different sized cracks can be simulated
[5] short shaft to simulate a protruding shaft end
[6] long shaft to simulate an elastic rotor
[7] PT 500.14 (belt drive) generates required bending torque
[8] accessory setup for PT 500 machinery diagnostic training system
[9] stackable storage system to house the components

Technical Data

Flange diameter: D=90mm
6 hexagon flange bolts M8x20
Shafts
- diameter: D=20mm
- short shaft: L=85mm
- long shaft: L=200mm
- max. permissible bending torques
  short shaft for belt pulley: 15,9Nm
  long shaft for mass disk: 3,9Nm

Dimensions and Weight

LxWxH: 600x400x120mm (storage system)
Weight: approx. 3kg

Scope of Delivery

1 pick-up disk
1 long shaft
1 short shaft
1 centering arbor for alignment of shafts in experimental setup
6 bolts
1 clamp set
1 storage system with foam inlay
1 manual

Order Details

052.50011 PT 500.11 Crack Detection in Rotating Shaft Kit

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PT 500.12 Roller Bearing Faults Kit

Technical Description

Vibration analysis is a key tool in estimating the condition of a roller bearing. The slow change in the vibration spectrum provides indications of the remaining life of a bearing and can be used as a criterion for its replacement. The spectral distribution can deliver accurate information on the type and location of the damage.

This accessory setup contains six roller bearings on which different faults can be detected and explained. The radial load on the bearing can be set within broad limits using the belt drive accessory set PT 500.14 (setting of belt tension; fixed load).

The accessory setup is mounted on the base plate of the machinery diagnosis base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- vibrational spectrum of the running noise of roller bearings
- familiarisation with the envelope analysis
- influence of damage to outer race, inner race or roller body, on the spectrum
- estimating service lives of roller bearings
- influence of the lubricant on the vibration spectrum
- detection of faulty roller bearings
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

*** Assessment of bearing condition by vibration analysis**

*** Comparison of bearings with different faults**

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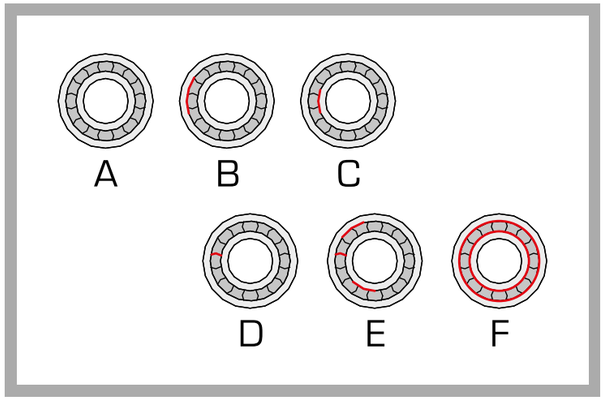
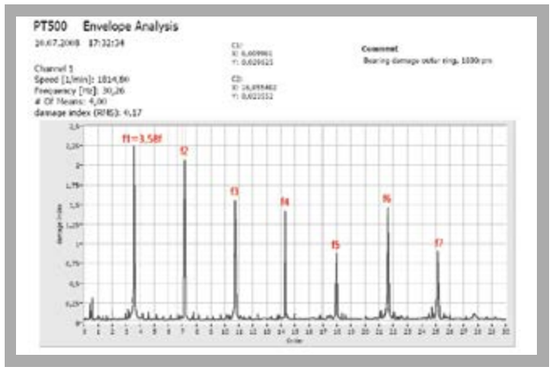
PT 500.12 Roller Bearing Faults Kit



A) undamaged bearing, B) bearing with damage to outer race, C) bearing with damage to inner race, D) bearing with damage to a roller body, E) bearing with damage to roller body, outer and inner race, F) heavily worn bearing

The illustration shows PT 500.12 together with PT 500, PT 500.01, PT 500.14 and PT 500.04.



Envelope analysis of the bearing with damage on outer ring (B) at f=1.800min^{-1}, damage frequency f_1=3,58f, harmonic wave f_2 to f_7

Specification

[1] investigation of the vibrations of roller bearings
[2] roller bearings with damaged outer race
[3] roller bearings with faulty inner race
[4] roller bearings with damaged rolling element
[5] roller bearings with combined damage
[6] long-running roller bearings
[7] new and undamaged roller bearings
[8] radial loading of bearings with PT 500.14 (belt drive)
[9] accessory set for PT 500 machinery diagnostic training system
[10] stackable storage system to house the components

Technical Data

Pendulum ball bearing of type NU204-E-TVP2
- inside diameter: d=20mm
- outside diameter: D=47mm
- width: 14mm
- number of rollers: 12

Dimensions and Weight

LxWxH: 600x400x120mm (storage system)
Weight: approx. 4kg

Scope of Delivery

6 roller bearings
1 bearing block
2 circlips
1 circlip pliers
1 storage system with foam inlay
1 manual

Order Details

052.50012 PT 500.12 Roller Bearing Faults Kit

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PT 500.13 Couplings Kit

The illustration shows PT 500.13 together with the claw coupling of PT 500.

*** Vibration analysis of couplings**

*** Eccentricity, wobble and pitch fault**

*** Properties of different coupling types: pin coupling, curved teeth coupling, flange coupling, claw coupling**

Technical Description

Rotating machine elements are interconnected by way of couplings. A coupling exhibiting production or assembly faults generates machine vibrations which can be analysed to give an indication of specific faults or damage.

The PT 500.13 accessory set can be used to simulate various faults and investigate their effects on vibration behaviour. The properties of various coupling types can also be compared. The curved teeth, pin, flange and claw coupling types are investigated. The couplings are installed between the motor and the shaft. The PT 500.05 load unit will also be required to investigate the behaviour of the couplings under load.

The accessory setup is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- effects of alignment errors on different coupling types
  * pin coupling with offset
  * claw coupling with offset
- effects of production faults such as eccentricity, wobble and pitch fault, on the running of the machine
  * flange coupling with no fault
  * flange coupling with eccentricity
  * flange coupling with wobble
  * pin coupling with no fault
  * pin coupling with pitch fault
- identification of coupling faults from the vibration signal
- load dependency of running behaviour
- influence of gear rim hardness on claw couplings
- comparison of curved teeth, pin, flange and claw couplings
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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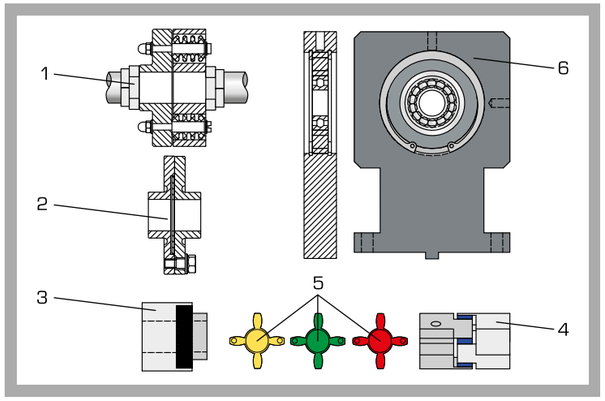
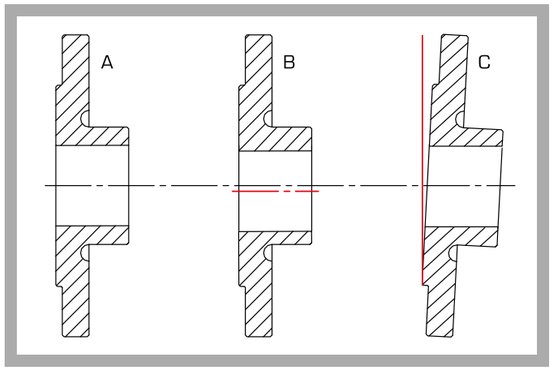
PT 500.13 Couplings Kit



1 pin coupling, 2 flange coupling, 3 curved teeth coupling, 4 claw coupling with coupling star (both from PT 500), 5 coupling stars, 6 bearing block with elastic bearing



Flange coupling halves: A without fault, B eccentricity, C wobble

The illustration shows PT 500.13 together with PT 500, PT 500.01, PT 500.05 and PT 500.04.

Specification

[1] investigation of the vibration behaviour of various coupling types with and without faults
[2] curved teeth coupling
[3] 3 different coupling stars for the elastic claw coupling of the base unit PT 500
[4] flange coupling with no fault
[5] flange coupling with eccentricity
[6] flange coupling with wobble
[7] pin coupling with and without pitch fault
[8] experimental setup can be used with brake and load unit PT 500.05
[9] accessory set for PT 500 machinery diagnosis training system
[10] stackable storage system to house the components

Technical Data

Pin coupling
- 1x centric pin
- 1x eccentric pin
  eccentricity of pin: 1mm
- max. pitch fault: 180° +/-1,909°

Coupling stars for claw coupling
- 98 Shore A (red)
- 92 Shore A (yellow)
- 64 Shore D (green)
- 80 Shore A (blue, included in PT 500)

Flange coupling
- eccentricity (centre offset): 0,2mm
- wobble: 0,4 +/-0,1mm

Dimensions and Weight

LxWxH: 400x300x170mm (storage system)
Weight: approx. 6kg

Scope of Delivery

1 curved teeth coupling
1 flange coupling with no fault
1 flange coupling with eccentricity
1 flange coupling with wobble
1 pin coupling with adjustable pitch fault
3 coupling stars
1 bearing block
1 set of tools
1 storage system with foam inlay
1 manual

Order Details

052.50013 PT 500.13 Couplings Kit

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PT 500.14 Belt Drive Kit

*** Vibrations in belt drives**

*** Resonance and critical speed**

Technical Description

When properly designed, manufactured, and correctly set; belt drives are low-maintenance, low-noise, long-life drive units. It is important that the belt should not vibrate and/or slip.

The PT 500.14 accessory setup can be used to investigate conditions that cause vibration or slip. The effect of disparate elongation on multiple belt drives can be demonstrated by means of individually-adjustable tensioning rollers. The belt drive is a dual belt drive with a belt tensioner. It can, however, also be operated with only one belt. An eccentrically-bored small belt pulley and a damaged V-belt enhance the range of possible experiments.

The brake and PT 500.05 load unit is required to conduct the experiment. The accessory set PT 500.14 can also be used to apply transverse loads in other experiments.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- influence of belt tension on vibration behaviour
- influence of speed on vibration behaviour
- influence of pulleys running untrue, and off-track running
- power split across multiple belt drive
- influence of slip on vibration running spectrum
- comparison between fault-free and damaged belts
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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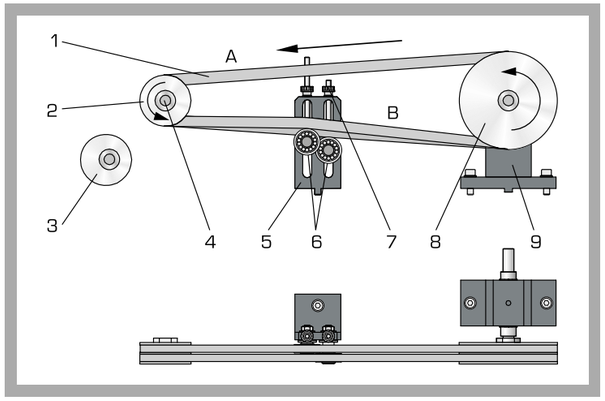
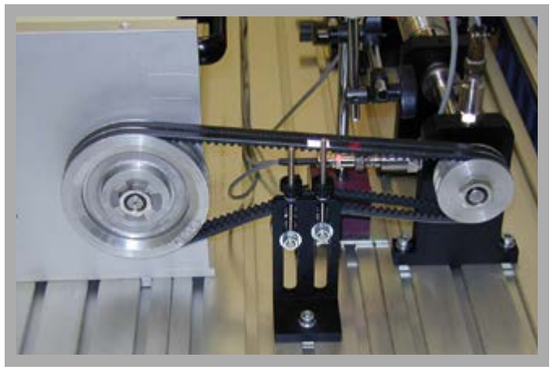
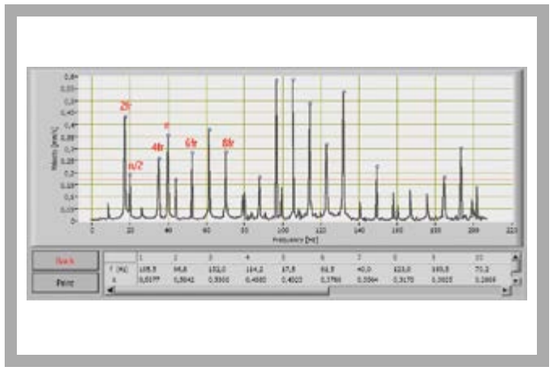
PT 500.14 Belt Drive Kit



1 belt, 2 small belt pulley (driving), 3 small eccentric V-belt pulley, 4 clamp set, 5 belt tensioner, 6 tensioning rollers, 7 adjustment of V-belt tension, 8 large V-belt pulley, 9 bearing block



The illustration shows PT 500.14 together with PT 500.05.



Frequency spectrum on the belt drive
belt frequency f_r with harmonic waves $2f_r$, $4f_r$, $6f_r$. drive speed n, n/2

Specification

[1] investigation of the vibrations of belt drives
[2] dual belt drive with V-belt
[3] belt drive can be operated with one belt
[4] individually-adjustable tensioning rollers
[5] belt drive with eccentricity
[6] damaged V-belt
[7] belt pre-tension measuring device 0...150N
[8] suitable for applying transverse loads on other systems within the accessory sets of the PT 500 series
[9] brake and load unit PT 500.05 required for experiments on the belt drive
[10] accessory set for PT 500 machinery diagnostic training system
[11] stackable storage system to house the components

Technical Data

V-belt pulleys
- large: D=125mm
- small: D=63mm
- small, eccentric: D=63mm

Axle centres: 300mm
V-belt
- SPZ, approx. 10mm wide
- belt length: 912mm

Dimensions and Weight

LxWxH: 600x400x170mm (storage system)
Weight: approx. 6kg

Scope of Delivery

3 V-belts
3 belt pulleys
1 tensioning roller set
1 belt pre-tension measuring device
1 storage system with foam inlay
1 manual

Order Details

052.50014 PT 500.14 Belt Drive Kit

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PT 500.15 Damage to Gears Kit

*** Vibration analysis of gearing damage**

*** Fault localisation on gears**

Technical Description

The PT 500.15 accessory setup is used to simulate typical damage to gears and study its effects on vibration behaviour. Various gear sets with tooth damage are supplied for this purpose. Undamaged gear sets are provided for comparative purposes. The difference between spur toothed and helical gearing can also be demonstrated. The influence of the centre distance and backlash can be studied using adjustable bearing plates. The type of lubrication has a significant influence on the vibration signal, so grease or gear oil can be used for lubrication.

The housing, with holes to accommodate sensors, is used for vibration experiments. The transparent housing cover allows the gear to be observed in operation without taking vibration measurements.

The PT 500.05 brake and load unit will be required to subject the gear unit to load.

The accessory setup is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- identification of gear damage from vibration behaviour
- influence of gearing type
  * spur toothed
  * helical
- localisation of damage
- influence of lubrication
- influence of centre distance and of backlash
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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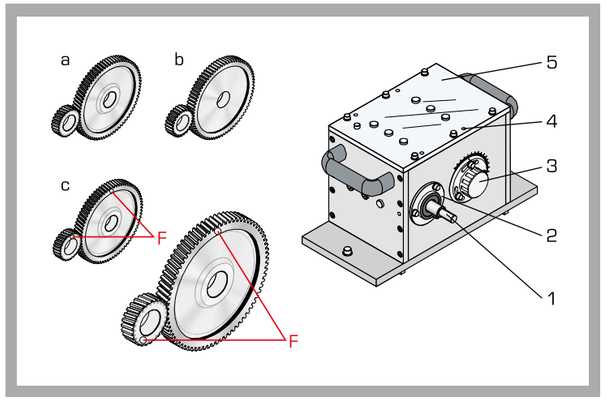
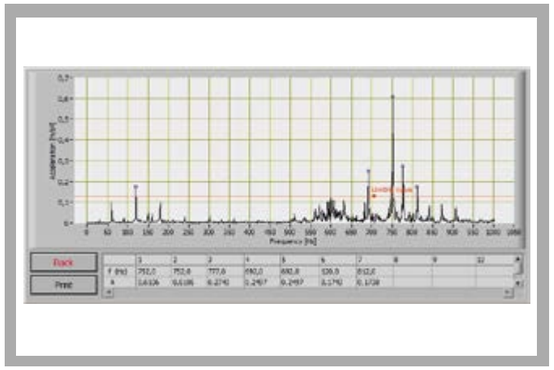
PT 500.15 Damage to Gears Kit



1 shaft end, 2 bearing cover with shaft gland, 3 bearing cover with centre distance adjustment facility, 4 tapped hole for vibration sensor, 5 transparent gear unit cover; a helical gear set, b spur toothed gear set, 4 damaged gear sets, F fault

The illustration shows PT 500.15 together with PT 500, PT 500.01, PT 500.05 and PT 500.04.



Spectrum of a spur toothed gear at 1800min^{-1}: tooth gearing frequency 752Hz

Specification

[1] investigation of the vibration behaviour of gears
[2] two-shaft gear unit
[3] 2 damaged and 2 undamaged gear sets
[4] spur toothed and helical gearing
[5] housing with sensor holes
[6] transparent housing cover
[7] gear can be lubricated with grease or oil
[8] loading of experimental setup with brake and load unit PT 500.05
[9] accessory set for PT 500 machinery diagnostic training system
[10] stackable storage system to house the components

Technical Data

Transmission ratio i: 1:3
Centre distance adjustable
Reference profile to DIN 867
Spur toothed gear sets
- gear wheel: 75 teeth on each, m=2mm
- pinion: 25 teeth on each, m=2mm

Helical gear sets
- gear wheel: 75 teeth on each, m=2mm
- pinion: 25 teeth on each, m=2mm
- helix angle: 10°

Dimensions and Weight

LxWxH: 600x400x320mm (storage system)
Weight: approx. 25kg

Scope of Delivery

1 gearbox
1 transparent housing cover
1 housing cover with sensor holes
4 gear wheels
4 pinions
1.5L motor oil SAE 10W 40
1 storage system with foam inlay
1 manual

Order Details

052.50015 PT 500.15 Damage to Gears Kit

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PT 500.16 Crank Mechanism Kit

*** Vibrations of crank drives**

*** Bearing clearance or slack in oscillating machine components**

Technical Description

Crank drives are frequently used in compressors and pumps. They cause vibration due to the oscillating masses and forces. Under the alternating stress in the drive mechanism, bearing clearance, for example, can generate shock impacts with high-frequency exciter spectra. In addition, free mass forces generate harmonic vibrations due to their non-linear kinematics.

The PT 500.16 accessory set enables the stroke, mass balance and bearing clearance on the crosshead to be adjusted. The speed is adjusted using the base unit PT 500. Gas pressure forces such as occur in compressors or combustion engines can be simulated using springs. Experiments with gas pressure forces require higher torques which are attained by reducing the speed of the drive motor from the base unit PT 500. This reduction is achieved either with the PT 500.14 belt drive or the PT 500.15 gear unit.

The transmission of alternating torque in toothed gearing mechanisms can be investigated together with accessory set PT 500.15 (for investigating damage to gears).

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- experimental modal analysis of mechanical systems
- familiarisation with the envelope analysis
- influence of bearing clearance and shock impact
- inconsistent torque characteristic
- wear measurement on piston rods
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

in conjunction with PT 500.15
- transmission of alternating torque in toothed gearing mechanisms

in conjunction with PT 500.14 or PT 500.15
- influence of gas pressure forces on the vibration spectrum

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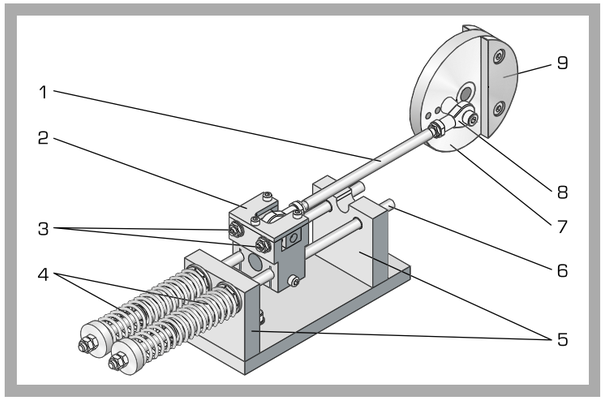
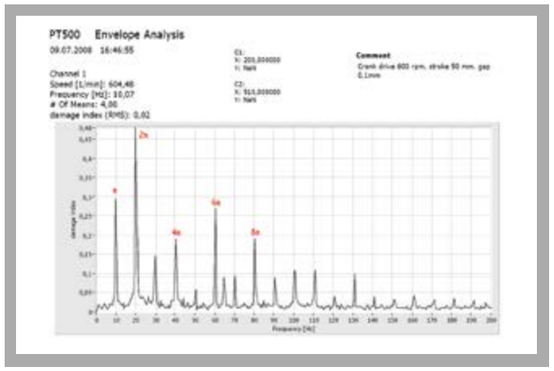
PT 500.16 Crank Mechanism Kit



1 connecting rod, 2 crosshead, 3 adjustment of bearing clearance, 4 pressure spring, 5 bearing block with journal bearing, 6 piston rod, 7 crank disk, 8 articulated head, 9 balance mass

The illustration shows PT 500.16 together with PT 500, PT 500.01 and PT 500.04.



Envelope analysis on crank drive with clearance at 600min^{-1}.
Dominant is the 2nd order 2n with harmonic waves 4n, 6n, 8n usw.

Specification

[1] investigation of the vibrations of crank drives
[2] crank drive with adjustable stroke
[3] interchangeable bearing bushes permit simulation of bearing clearance
[4] springs simulate gas pressure forces
[5] can be used together with gear damage accessory set PT 500.15
[6] belt drive PT 500.14 or gear unit PT 500.15 required for experiment with gas pressure forces
[7] accessory set for PT 500 machinery diagnostic training system
[8] stackable storage system to house the components

Technical Data

Stroke: 50 - 75 - 100mm
Balance mass total
- 490g, rated for operation with 50mm stroke

Bearing clearance: 0...1mm

Pressure spring
- relaxed length: 170mm
- spring stiffness: R=0,55N/mm

Dimensions and Weight

LxWxH: 600x400x170mm (storage system)
Weight: approx. 8kg

Scope of Delivery

1 crank drive
2 springs
2 balance masses
1 set of tools
1 storage system with foam inlay
1 manual

Order Details

052.50016 PT 500.16 Crank Mechanism Kit

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PT 500.17 Cavitation in Pumps Kit

*** Observation and measurement of cavitation**

*** Understanding conditions for cavitation**

Technical Description

Cavitation can play a major role in the vibration of pumps during operation.

With the PT 500.17 accessory set, cavitation can be experimentally induced and its influence on the vibration spectrum investigated.

The principal elements of the accessory set are a single-stage centrifugal pump and a storage tank. The pump and tank are interconnected by hoses. Valves and manometers in the delivery and intake lines allow various operating conditions to be set. The transparent plastic pump housing provides a view into the interior of the pump during operation. This enables the formation of cavitation bubbles to be observed. Stroboscopic analysis is specially recommended (stroboscope not supplied).

The pump can be driven directly through a flexible coupling on the base system PT 500 or by the PT 500.14 belt drive.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- observing and understanding cavitation in a centrifugal pump
  - * visually
  - * stroboscopically (stroboscope available as accessory)
  - * by vibration analysis
- investigation of the operating vibrations of a centrifugal pump
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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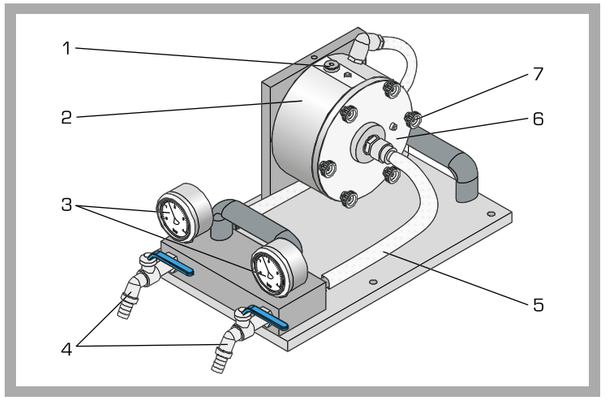
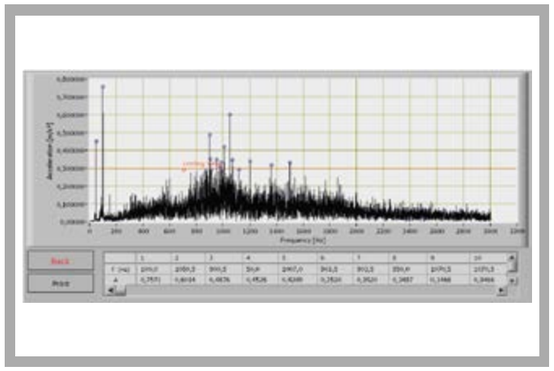
PT 500.17 Cavitation in Pumps Kit



1 pump housing vent screw, 2 pump housing, 3 manometer, 4 valve, 5 intake side hose, 6 housing cover, 7 thumb screw to open the housing cover

The illustration shows PT 500.17 together with PT 500 and PT 500.01.



Frequency spectrum in cavitation, measurement location: axial on pump cover
f_D rotational frequency, f_K frequency of cavitation, f_S blade passing frequency

Specification

[1] investigation of the conditions for cavitation in pumps
[2] single-stage centrifugal pump
[3] flow control valves permit the inception of cavitation
[4] manometers on intake and delivery side
[5] transparent housing
[6] pump driven via coupling (PT 500) or with belt drive PT 500.14
[7] accessory set for PT 500 machinery diagnostic training system
[8] stackable storage system to house the components

Technical Data

Centrifugal pump
- max. flow rate at 3.300min^{-1}: 17L/min
- max. head at 3.300min^{-1}: 12m
- impeller with 3 blades
- min. speed for cavitation: approx. 2.240min^{-1} (with restriction on intake side)

Tank
- material: HDPE
- capacity: 20L

Manometer
- delivery side: 0...4bar
- intake side: -1...1,5bar

Dimensions and Weight

LxWxH: 600x400x320mm (storage system)
Weight: approx. 16kg

Scope of Delivery

1 pump
1 tank
1 set of hoses
1 storage system with rubber mat
1 manual

Order Details

052.50017 PT 500.17 Cavitation in Pumps Kit

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PT 500.18 Vibrations in Fans Kit

*** Vibration measurements on fans**

*** Simulation of blade-induced vibrations**

Technical Description

Vibration measurements on fans and blowers play a major role in field monitoring operations. In addition to the usual signals caused by bearings and imbalance, the vibrations induced by the fan blades can be measured. The vibrations are induced by inhomogeneous flow fields.

The PT 500.18 accessory set induces the vibrations magnetically. Three fan rotors with differing numbers of blades can be investigated. A guard plate covers the rotating fans. An obliquely-mounted inertia disk is used to investigate the gyroscopic effect. Just as in actual practice, the fan model can also be driven directly via a flexible coupling or by the belt drive PT 500.14.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- vibration measurement on fans
- measurement of blade pass frequency
- identification of the vibration induced by the blades from the vibration spectrum
- effect of dynamic imbalance on the fan
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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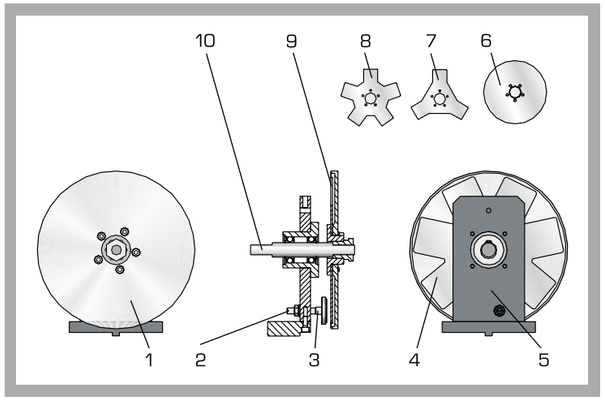
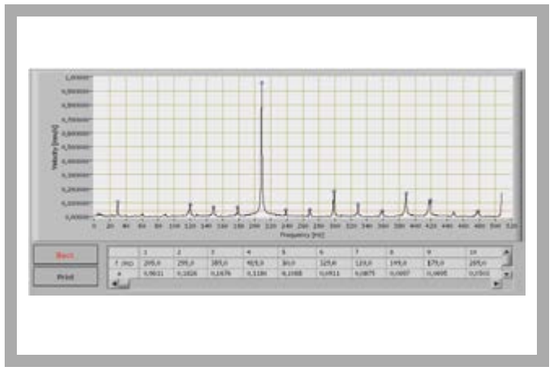
PT 500.18 Vibrations in Fans Kit



1 guard disk, 2 adjuster screw for gap between magnet and blades, 3 permanent magnet, 4 fan rotor with 7 blades, 5 bearing block, 6 mass disk to simulate axial forces, 7 fan rotor with 3 blades, 8 fan rotor with 5 blades, 9 fan blade, 10 fan shaft

The illustration shows PT 500.18 together with PT 500 and PT 500.01.



Frequency spectrum of a fan rotor with 7 blades: clear blade passing frequency at 210Hz

Specification

[1] investigation of the vibrations of fans
[2] model of an axial fan with blades
[3] magnetic induction of blade forces
[4] obliquely-mounted inertia disk to investigate gyroscopic effects
[5] 3 fan rotors with different numbers of blades
[6] guard disk for fan rotors
[7] gap between magnet and blades adjustable
[8] can be used with belt drive PT 500.14
[9] accessory set for PT 500 machinery diagnosis training system
[10] stackable storage system to house the components

Technical Data

Sheet-steel fan rotor
- 3 blades
- 5 blades
- 7 blades
- diameter: 204mm
- max. speed: 3.000min^{-1}

Protective disk, made of aluminium
- D=220mm

Dimensions and Weight

LxWxH: 400x300x320mm (storage system)
Weight: approx. 6kg

Scope of Delivery

3 fan rotors
1 mass disk
1 holder
1 guard disk
1 storage system with foam inlay
1 manual

Order Details

052.50018 PT 500.18 Vibrations in Fans Kit

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PT 500.19 *Electromechanical Vibrations Kit*

*** Interaction of electromagnetic and mechanical elements of the system**

*** Adjustable asymmetric gap between stator and rotor**

*** Electromagnetic asymmetry with winding that can be switched off**

Technical Description

Asynchronous motors are in widespread use as drive mechanisms. These motors can generate machine vibrations. If there is an asymmetric gap, the circulating magnetic forces induce rotational and bending vibrations. The same applies to partial failure of the electrical windings. In this case, the asymmetrical magnetic field also induces mechanical vibrations.

The PT 500.19 accessory set features an adjustable centering device to adjust an asymmetrical gap. A winding that can be switched off generates an electromagnetic asymmetry. The display and control unit of the PT 500 base system powers the asynchronous motor and permits the speed to be adjusted. The motor is subjected to load by the PT 500.05 brake and load unit.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT500.

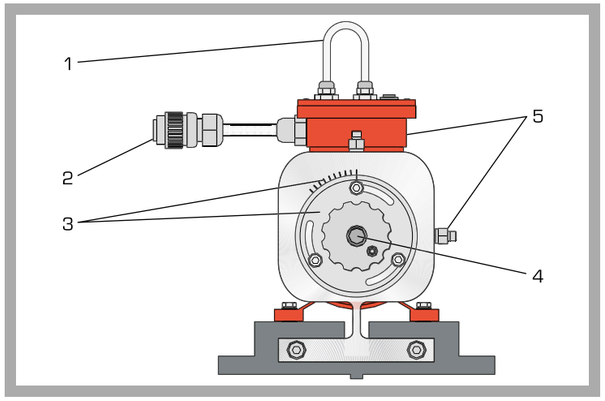
To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- influence of the gap on vibration behaviour
- influence of electromagnetic asymmetry on vibration behaviour
- influence of the load on the level of vibration
- influence of the gap on electromagnetic losses and efficiency
- influence of speed on vibration behaviour
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

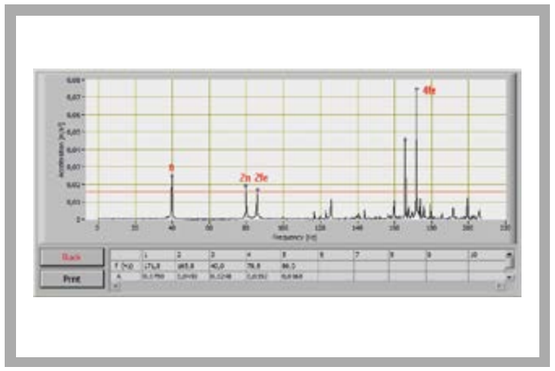
in conjunction with a current measuring probe
- measurement of current consumption per phase

PT 500.19 *Electromechanical Vibrations Kit*



1 current measuring probe tap for the 3 phases, 2 connection to the display and control unit of PT 500, 3 bearing cover with adjustable centering and scale, to adjust gap, 4 motor shaft, 5 adapter for acceleration sensors

The illustration shows PT 500.19 together with PT 500, PT 500.01 and PT 500.05.



Typical spectrum of an electric motor
rotary frequent vibration with n, 2n because of balance error
power frequent vibration with 2fe, 4fe because of magnetic forces

Specification

[1] investigation of vibration behaviour of an electric motor
[2] asynchronous motor with adjustable gap
[3] asymmetric magnetic field by winding with shut-off facility
[4] variable speed via frequency converter of base unit
[5] speed display on display and control unit of base unit PT 500
[6] power display on display and control unit of base unit PT 500
[7] accessory set for PT 500 machinery diagnostic training system
[8] stackable storage system to house the components

Technical Data

Asynchronous motor with variable speed
- speed range: 100...6000min^{-1}
- nominal power output: 370W

Eccentricity of armature: 0...0,2mm

Dimensions and Weight

LxWxH: 400x300x320mm (storage system)
Weight: approx. 11kg

Scope of Delivery

1 electric motor with terminal box
1 storage system with foam inlay
1 manual

Order Details

052.50019 PT 500.19 Electromechanical Vibrations Kit

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Certificate DE04/52774

The management system of

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D-22885 Barsbüttel
Germany

has been assessed and certified as meeting the requirements of

ISO 9001:2008

For the following activities

Developing, Manufacturing and Supply of Equipment with Emphasis on Equipment and Systems for Engineering Education

Further clarifications regarding the scope of this certificate and the applicability of ISO 9001:2008 requirements may be obtained by consulting the organization

This certificate is valid from 30/11/2013 until 29/11/2016
Issue 7. Certified since 17/07/1998

Mark Pinkerell
Managing Director

Christian Rathje
Head Of Certification Body

SGS-International Certification Services GmbH
Rödingsmarkt 16 D-20459 Hamburg (Germany)

TGA-ZM-17-93-00

Page 1 of 1

Our quality management system has been certified since 1998.

SGS-ICS ZERTIFIZIERTES QUALITÄTSMANAGEMENTSYSTEM
DIN EN ISO 9001
SGS

PT 500 MACHINERY DIAGNOSTIC SYSTEM

Training in machine condition monitoring:
Generating, measuring and evaluating mechanical vibrations

- *Up to date*
- *Practical*
- *Modular*
- *Compact*

THE SYSTEM FOR AN EASY INTRODUCTION TO A DEMANDING TOPIC

What is Machine Diagnosis?

Industrial plant

Vibrational analyser

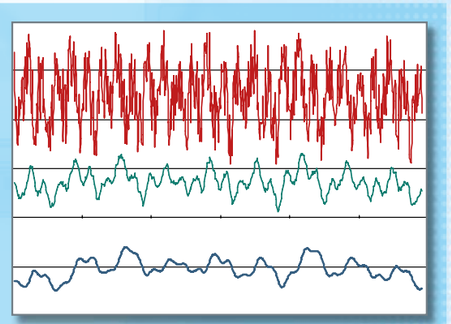
Evaluation of vibrational signals

The internal forces and energies in the machine are of interest for fault identification and diagnosis. These variables cannot be measured directly, but their effects – vibrations – can.

Vibration measurement and analysis is therefore an attempt to obtain a picture of these forces. This can be used to identify their structure, the causes of them and their behaviour over time. Vibrations are normally frequency mixtures that result from superimposition of several vibrations.

Some of these vibrations are part of the machine's normal operation, while others are intensified, or actually generated by defects. With sufficient experience, the condition of the machine can be assessed and a defect on the machine identified.

When it comes to machine condition monitoring, it is important to differentiate between parameter monitoring and frequency analysis.



Typical vibration signals in the time domain

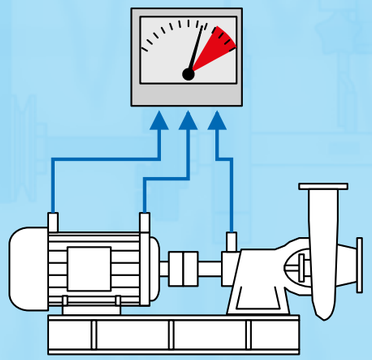
The purpose of modern-day machine condition monitoring systems (CMS) is to carry out needs-based maintenance or repairs and thus to minimise the repair and other servicing downtimes of a machine. This increases the overall equipment effectiveness (OEE) and optimises the cost structure.

The aim ist to detect damage as it occurs, allowing scheduled repairs or maintenance to be carried out.

The mechanical condition of a machine or of machine components can be accurately diagnosed from the nature and extend of vibrations they generate. Accordingly, vibrations are measured, recorded and evaluated using sensors and recording equipment.

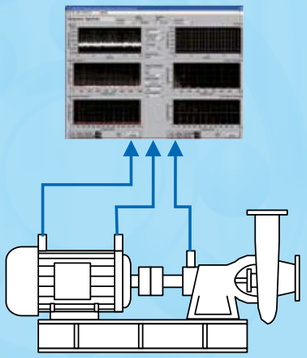
Convenient PC software makes it easy to display the measured values clearly.

PARAMETER MONITORING



Parameter monitoring involves measurement of the vibration amplitude and comparison with a predefined limit value. Parameter monitoring can be carried out continuously and automatically. It is easy to implement and requires only little specialist knowledge.
On simple standard equipment, parameter monitoring is often sufficient.

FREQUENCY ANALYSIS



The use of **analysis in the frequency domain** is much more complex but also more powerful. This analysis enables the nature of a defect to be identified, which allows targeted repair measures to be initiated. However, performing frequency analysis requires a good understanding of the operating mechanisms and sufficient experience.
Frequency analysis is mainly used as a supplementary method in conjunction with parameter monitoring.

Teaching Concept and Learning Content

The PT 500 system provides you with a flexible and modular learning platform offering an introduction to the complex and demanding subject of machine diagnosis. The target group is students in mechanical engineering/machine dynamics, but it also includes other professional people as part of on-the-job training and development in maintenance and servicing.

The close links between practical work on the experimental unit and theoretical/analytical aspects of diagnosis foster integrated learning.

Successful work with the PT 500 requires knowledge of the basic principles from the fields of mathematics, machine dynamics, mechanical vibrations and measurement technology.

In contrast to the widespread practice of solely learning on-the-job, the effects to be investigated can be represented in isolation and are reproducible. This makes it easier to provide a step-by-step introduction to the topic and targeted development of relevant experience in diagnosis.

Training using the PT 500 thus supplies a basis for effective and successful work in practical industrial situations.

When used in conjunction with on-the-job training and development, the intensive practice that is possible with the PT 500 significantly speeds up learning in the area of machine diagnosis.

LEARNING CONTENT

Mechanical vibrations	Causes, formation mechanisms, imbalance, Laval shaft, resonance, damping, impact
Vibration measuring technology	Measurement sensor, measuring amplifier, representation, oscilloscope, speed measurement
Vibration analysis	Acceleration, vibration speed, vibration displacement amplitude, parameters, representation in time and frequency domains, spectrum, FFT, orders, tracking analysis, envelope analysis, orbit, path curve
Machine diagnosis	Bearing and shaft vibrations, permissible vibration amplitude, roller bearing defects, electromagnetic vibrations, imbalance vibrations and balancing, gear defects, vibrations on belt drives, cavitation in pumps, blade vibrations, vibrations and impacts in crank drives, speed-dependent vibrations

In addition, practical skills and experience in handling and assembling machine components such as bearings, shafts and couplings are gained. The construction of mechanical machines can also be studied.

Questions such as:

- Which measurement sensor do I use?
- Where can I expect a usable measuring signal?
- How do I effectively mask interference signals?

provide value experience for subsequent practical work in industry.

PT 500.04 Computerised Vibration Analyser

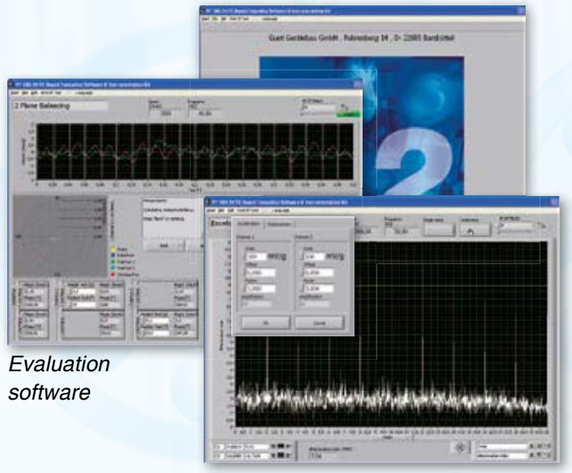
The core of our machine diagnosis system is the PT500.04 vibration analyser, which consists of the following components:

- Measurement amplifier
- USB interface for data acquisition
- Analysis software
- Vibration sensor
- Reference sensor

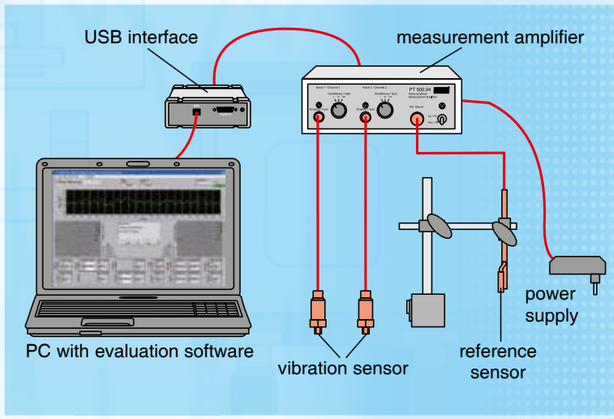
The measurement amplifier supplies the acceleration and displacement sensors with power and provides adjustable pre-amplification. Output sockets also allow the vibration signal to be output as a voltage signal. This allows you to integrate your own measuring instruments, e.g. an oscilloscope, into the measurement set-up.

The measurement amplifier also provides the opportunity to connect the displacement sensors PT 500.41, available as an accessory.

The analysis software runs on any standard PC under Windows XP or Windows Vista. The USB interface provides an easy connection to the PC or laptop.



Evaluation software



Measuring system set-up

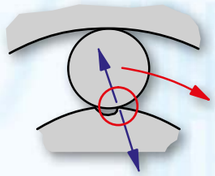
ICP acceleration sensors are used as vibration sensors. The advantage of ICP sensors is that they have an integral amplifier and thus guarantee that processing of the measured signal is insensitive to interference. The industrial quality sensors used are robust, have stable connecting cables and plugs and are therefore ideally suited for use in harsh training situations.

The reference sensor is used for speed measurement and phase information. A laser sensor with a large scanning range is used here, which delivers a reliable signal even in poor lighting conditions and with difficult access to the rotating shaft. A self-adhesive reflective strip acts as the reference mark.

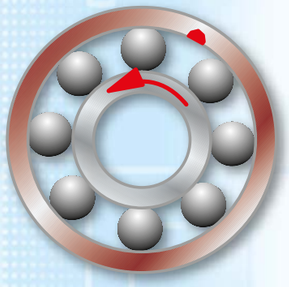
Example: Identification of Bearing Defects

Bearing defects

Each rolling bearing has characteristic damage frequencies for the inner race, rolling bearing and outer race. These frequencies depend on the speed Ω, the geometric dimensions and the number of rolling elements. Thus, with a known impact frequency the type of damage and the defective bearing can be identified.



Impact force while running over bearing surface damage



Bearing surface damage to the outer race, frequency 3,58 Ω

Bearing surface damage to the inner race, frequency 5,42 Ω

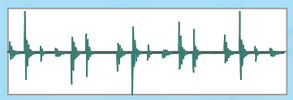
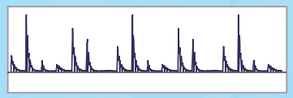
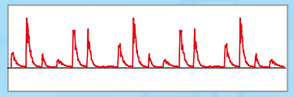
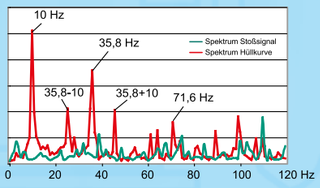
A damaged rolling ball element, frequency 4,65 Ω

Envelope analysis

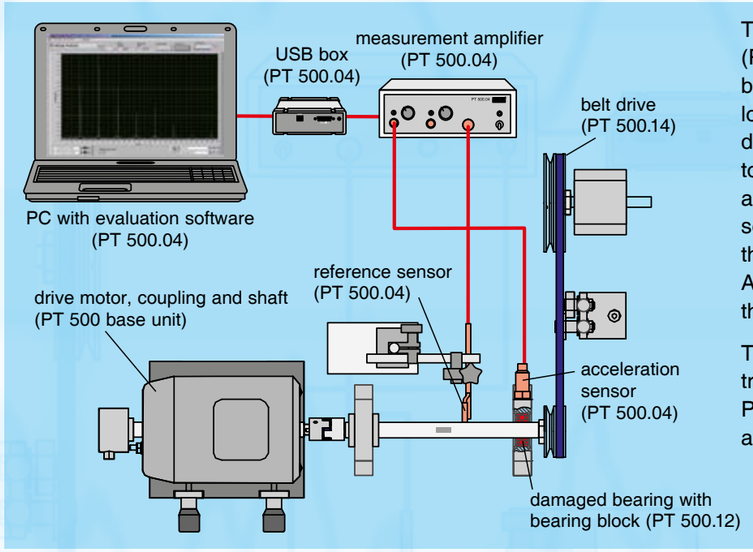
Envelope analysis is used to identify defects, for example on rolling bearings and gears. The defects generate impacts with very high frequency vibration components.

The low frequency impact frequency relevant for diagnosis of the damage is difficult or even impossible to identify in the normal spectrum. Envelope analysis demodulates the high frequency impact signal, thus allowing the impact frequency to be measured.

ENVELOPE ANALYSIS PROCESS

Measurement of the high frequency impact signal and high pass filtration to suppress low frequency interference signals (imbalance, alignment errors).	
Rectification of high frequency signal	
Extracting the envelope of the rectified signal using a low pass filter	
Performance of FFT to obtain the spectrum of the envelope. The speed (10 Hz) and the impact frequency (35,8 Hz) can be clearly identified. The side bands at the same spacing as the speed (35,8 -10, 35,8 +10) indicate an amplitude modulation. This represents an outer race defect with a rotating load.	

Experimental set-up for the identification of bearing defects



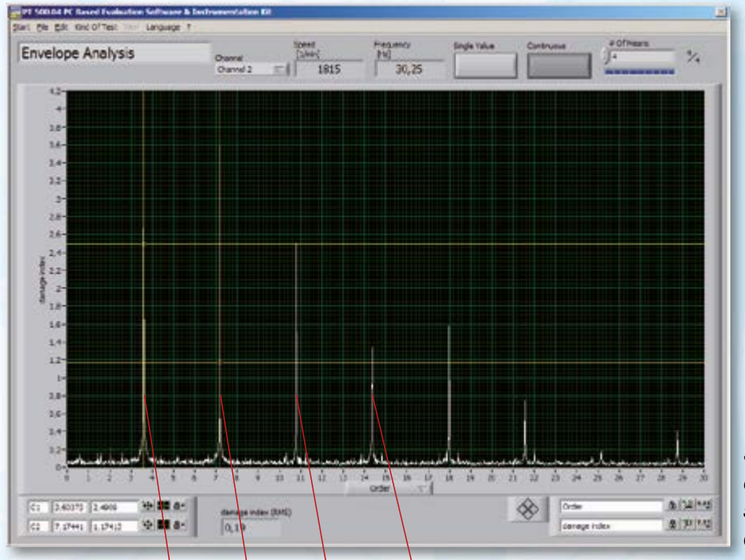
The bearing to be investigated (PT 500.12) is fitted in a vice. Because bearing defects are only apparent under load, the belt force of the tensioned belt drive (PT 500.14) presents a radial load to the bearing. The shaft is powered by a variable speed motor. An acceleration sensor on the bearing block measures the impacts caused by the bearing defect. A reference sensor is used to measure the speed.

The measurement amplifier (PT 500.04) transfers the measuring signals to the PC. The software performs the envelope analysis.

Typical experimental results

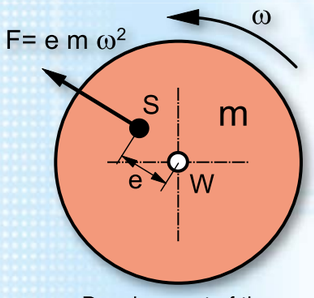
The illustration shows the envelope spectrum for a typical bearing defect. To obtain a representation independent of the rotary frequency, the order has been selected as the X coordinate. A rotary frequency signal has an order of 1. Frequency lines with an order of 3,58 are read when multiplying.

This indicates an outer race defect in the bearing. The lack of side band lines with the same spacing as an order indicates a constant force direction – the belt tension in this case – and no rotating imbalance load.



Screenshot of an envelope analysis showing outer race damage

Example: Field Balancing



Development of the imbalance force

If the centre of gravity of a rotating machine component does not correspond to the axis of rotation, i.e. it is not centred, the rotating mass of the machine component generates centrifugal or imbalance forces. These forces are transferred via the bearing to the entire machine and surroundings and stimulate vibrations, whose frequency corresponds to the speed. Because centrifugal forces depend on the square of the speed, they become much stronger as the speed increases.

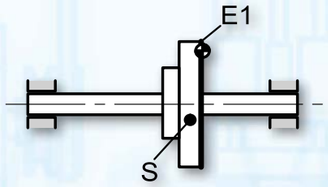
Imbalance vibrations can be prevented or at least reduced by balancing. We differentiate between **balancing on special balancing machines,** which is carried out during production, and so-called **field balancing** on a machine that is already in operation.

The PT 500 can be used to practice field balancing.

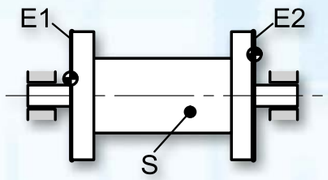
Balancing involves an attempt to bring the centre of gravity of the rotor back into alignment with the axis of rotation. To do this, weights are added to or removed from the rotor. To determine the position and mass of the required balancing weights, the unknown imbalance must first be determined. Unfortunately, the imbalance cannot be directly measured but has to be determined indirectly from the measurable bearing vibrations. To do this, we use the bearing vibration to determine the amplitude and phasing (vector) of the component with a rotary frequency. All other vibration components are filtered out. The balancing process is carried out as follows:

- Measurement of bearing vibrations on imbalanced machine (original out of balance run U)
- Measurement of bearing vibrations after an additional, known imbalance has been applied to the machine (test imbalance T)
- Comparison of the two measurements enables the original imbalance to be calculated
- Calculation of the mass and position of the balancing weights to be added or removed
- Control measurement (A) after weight correction

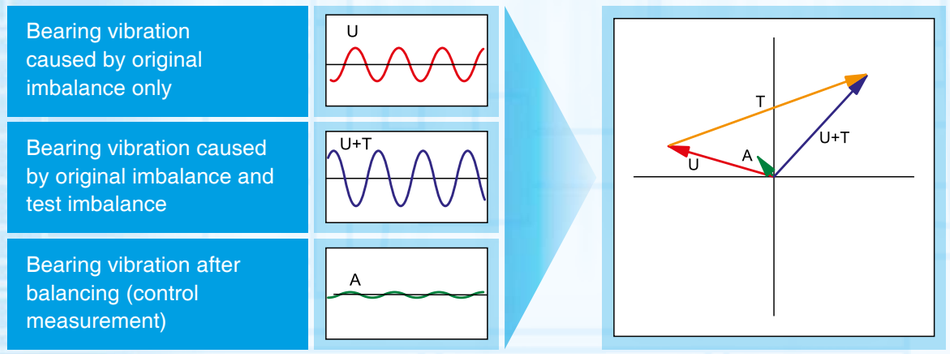
Depending on the success of the balancing, this procedure is repeated until the desired limits for the bearing vibration are achieved.



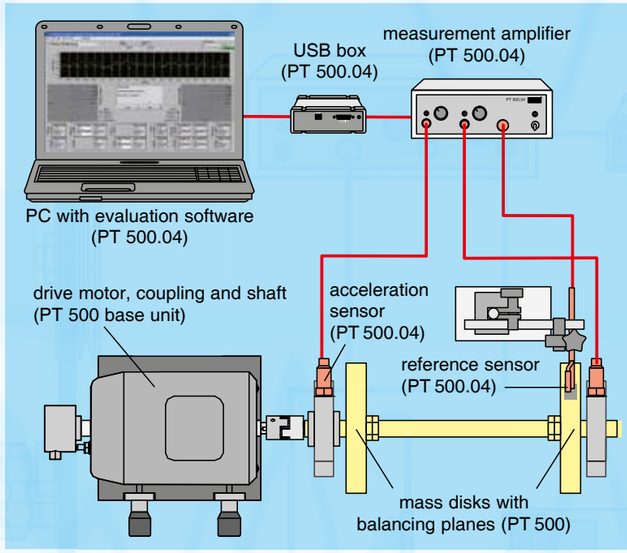
One-plane balancing



Two-plane balancing



Experimental set-up for the balancing in two planes

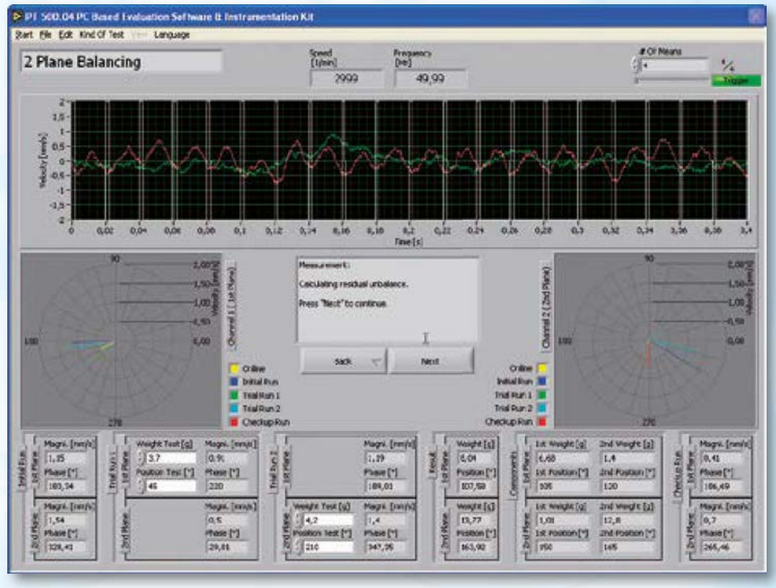


The experimental set-up requires only the basic PT 500 unit and the PC-based PT 500.04 vibration analysis unit. The experimental set-up illustrated shows a rotor with two weights for carrying out two-plane balancing. The acceleration sensors measure the bearing vibrations directly adjacent to the weights. A reflective mark on one of the weights acts as a reference for the angle information. As balancing determines the transmission behaviour between the weight and the measuring point, the individual measurements are carried out at exactly the same speed. To simulate an original imbalance, small additional weights are screwed onto the disk. The same applies to the test and compensating weights.

Typical experimental results

The illustration shows the software user interface after a complete balancing process. In the upper window, the vibration signal is displayed directly for monitoring purposes. The two diagrams on the left and right show the imbalance signals from the individual measurements as vectors. Between them, a dialog box indicates the next step to be performed.

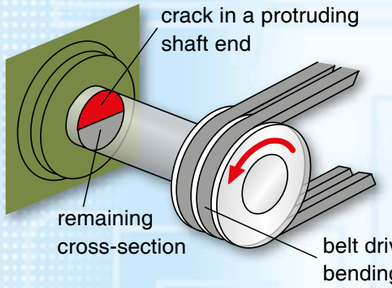
The lower section of the screen shows the results of the measurements, the position and mass of the test weights and the position and mass of the calculated compensating weights.



Screenshot: Balancing in two planes

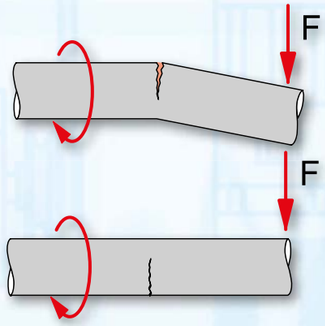
Example: Identification of Cracks in Shafts

Cracks in shafts are amongst the most dangerous of defects. If a crack is not detected in good time, the shaft can break. As this usually happens at high speeds and loads, the consequences are disastrous and often result in the total destruction of the machine. In the past, machines were totally dismantled at fixed intervals and the rotor was subjected to an extensive crack test. The costs of this kind of inspection are huge. Modern machine condition monitoring methods enable cracks to be identified while the machine is still in place.



Cracks are caused by material faults, material fatigue and the concentration of stress at surface faults. The continuous flexural fatigue stress when the shaft is rotating then causes the crack to develop constantly until the remaining healthy cross-section finally yields to a forced fracture.

The crack reduces the rigidity of the shaft. This reduction in rigidity is modulated by the rotation of the shaft, which means that the rigidity is slightly higher if the crack runs parallel to the load direction than perpendicular to it. In addition, the crack can continuously open and close while rotating.



Opening and closing of the crack during a rotation

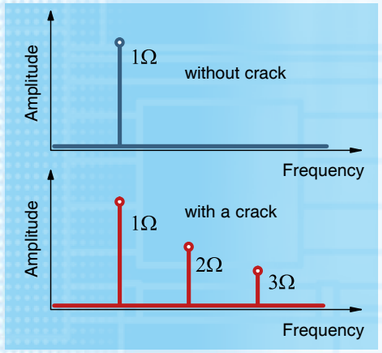
Analysis methods

The phenomena mentioned generate a characteristic vibration signal, which can be used to identify the existence of the crack. In particular the second order harmonic rises sharply compared to that for an undamaged shaft. Frequency analysis, tracking analysis and orbit analysis are all appropriate analysis methods.

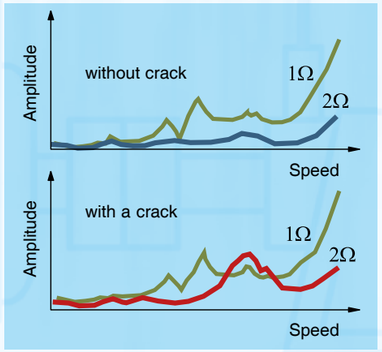
Frequency analysis involves looking at the frequency spectrum of the signal at a fixed speed. If there is a crack, additional frequency lines occur in the spectrum.

Tracking analysis involves recording the vibration signal over a wider speed range and investigating it for the different orders of rotary frequency using a special filter.

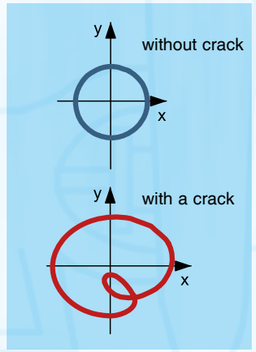
Orbit analysis involves investigating the path of the shaft measured using two displacement sensors. Second order components can be discerned here by the formation of loops in the path.



Frequency analysis

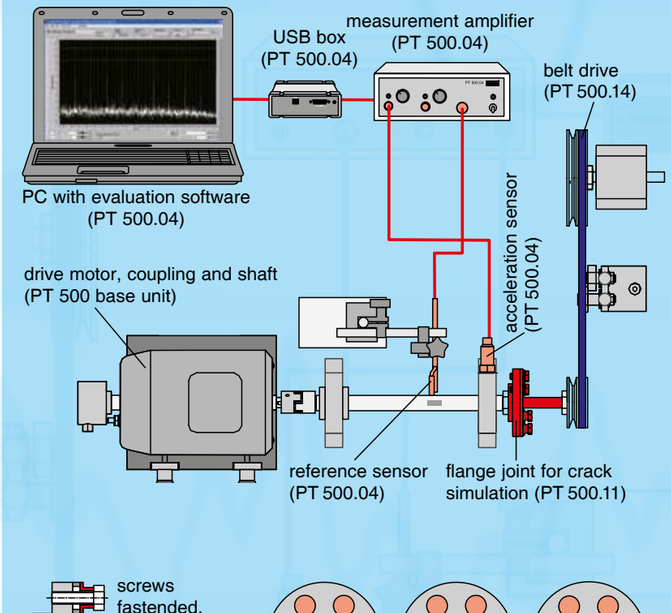


Tracking analysis



Orbit analysis

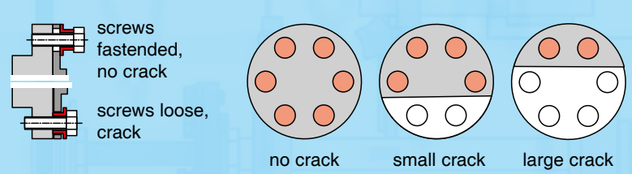
Experimental set-up



The PT 500.11 crack detection in rotating shaft accessory kit can be used to create two different experimental set-ups:

- Crack in a projecting shaft under external load
- Crack in a Laval shaft under own weight load

The experimental set-up with a projecting shaft is shown here. The external load is simulated by the pretensioning of the V belt. To simulate a crack with a variable depth, a special flange coupling is inserted into the shaft. Depending on the installation position of the specially designed gaps, either fixed clamping or a loose connection with clearance is created at the connecting screws. The number of loose screws can thus be used to simulate a crack of different depths.



Simulation of a crack via a flange joint

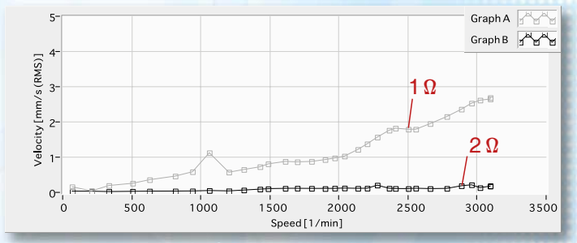
Typical experimental results

The two figures show the result of a tracking analysis. The measurements were carried out on the experimental set-up shown, with the projecting shaft. Graph A shows the first order bearing vibration component (1 Ω), graph B the second order component (2 Ω).

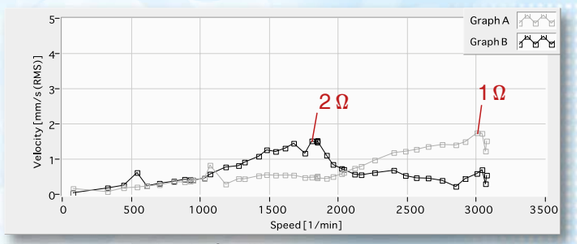
In the top figure, all screws at the flange connection were tight, corresponding to the condition with no crack. The first order bearing vibrations increase quite normally as the speed rises due to the imbalance.

The second order bearing vibrations are minimal.

In the lower figure, a deep crack is simulated. Here, only two of the six screws were fully tightened. While the first order bearing vibrations demonstrate similar behaviour to a shaft without a crack, there is a very sharp rise in the second order in the middle speed range, clearly indicating the presence of a crack.



Tracking analysis shaft without crack



Tracking analysis shaft with crack

Modular System

PT 500 BASE UNIT

A range of training exercises relating to machinery diagnosis and monitoring can be carried out using just the PT 500 base unit together with the computerized vibration analyser PT 500.04.

As well as the exercises in the measurement of the vibration (vibration displacement, velocity and acceleration in the time or frequency domains), field balancing of rigid rotors and shaft alignment exercises can also be carried out.

The base unit includes a vibration-damped workholder plate, a speed-controlled drive motor with a tachometer, a shaft with two mass discs and two bearing units, a coupling and balancing weights.

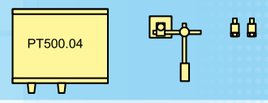
A wide range of accessories enables almost any subject area relating to machinery diagnosis to be covered.

The overview below shows how you can flexibly combine the accessories outlined for different experiments.

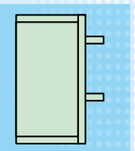
- Basic accessories are used repeatedly.
- The modular system enables you to easily create your own experiment configurations.
- If a special measuring technique is already in use, this can be integrated into the system with no problems.

BASIC ACCESSORIES ARE REQUIRED FOR NUMEROUS APPLICATIONS

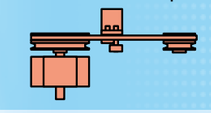
The computerised vibration analyser PT 500.04 is required for every application.



Because many defects only become apparent under load, the brake and load unit PT 500.05 is useful in many of the experiments.

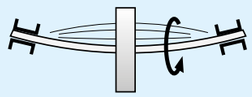


The belt drive PT 500.14 is also used to generate static loads or to allow the speed to be reduced in many experiments.



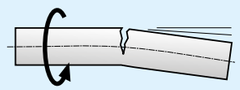
PT 500 ACCESSORY KITS

PT 500.10 *Elastic Shaft*



Unbalanced mass vibration of a flexurally elastic shaft; resonance, critical rotation speed, balancing

PT 500.11 *Crack Detection in Rotating Shaft*

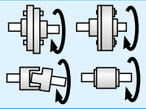


Vibration behaviour of a cracked shaft, identification of the crack from the vibration signal

PT 500.12 *Roller Bearing Faults*

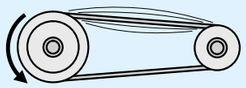
Identification of bearing damage from running noise. Various pre-damaged roller bearings

PT 500.13 *Couplings*



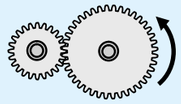
Properties of different coupling types, influence of eccentricity, wobble and pitch fault on vibration behaviour

PT 500.14 *Belt Drive*



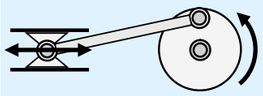
Vibration in belt drives, resonance and critical rotation speeds, influence of belt tension, eccentricity and misalignment

PT 500.15 *Damages to Gears*



Identification of gear damage from the vibration signal, influence of toothing type and lubrication

PT 500.16 *Crank Mechanism*



Vibration in crank drives, free inertia forces, bumps and jolts resulting from bearing play and wear

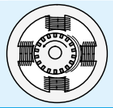
PT 500.17 *Cavitation in Pumps*

Noise and damage resulting from cavitation, conditions for cavitation inception

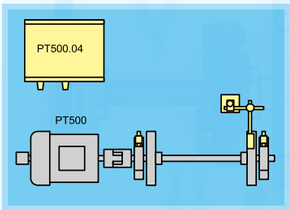
PT 500.18 *Vibrations in Fans*

Vibration in fans, demonstration of vibration excitation by blade passage, influence of centrifugal force

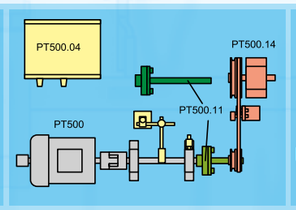
PT 500.19 *Electromechanical Vibrations*



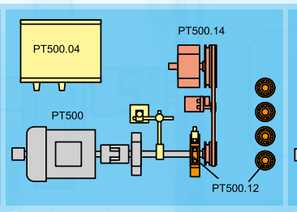
Interaction of electromagnetic/ mechanical elements of system, influence of load, gap geometry and electrical asymmetry



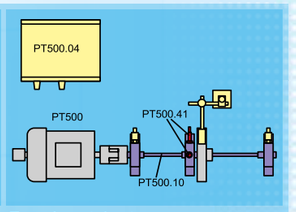
Experimental set-up bearing vibrations and balancing



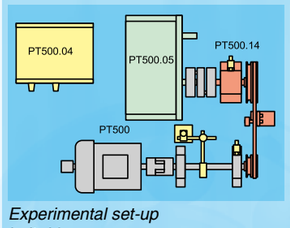
Experimental set-up shaft with crack



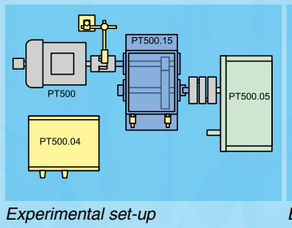
Experimental set-up bearing damages



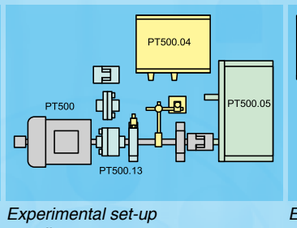
Experimental set-up elastic shaft



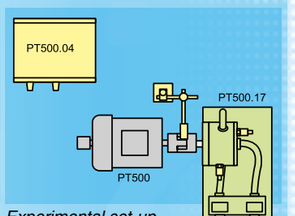
Experimental set-up belt drive



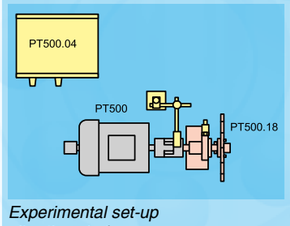
Experimental set-up gears



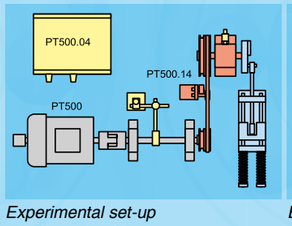
Experimental set-up coupling



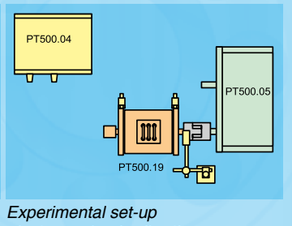
Experimental set-up cavitation



Experimental set-up vibrations in fans



Experimental set-up crank mechanism



Experimental set-up electromechanic vibrations

Analysis Software

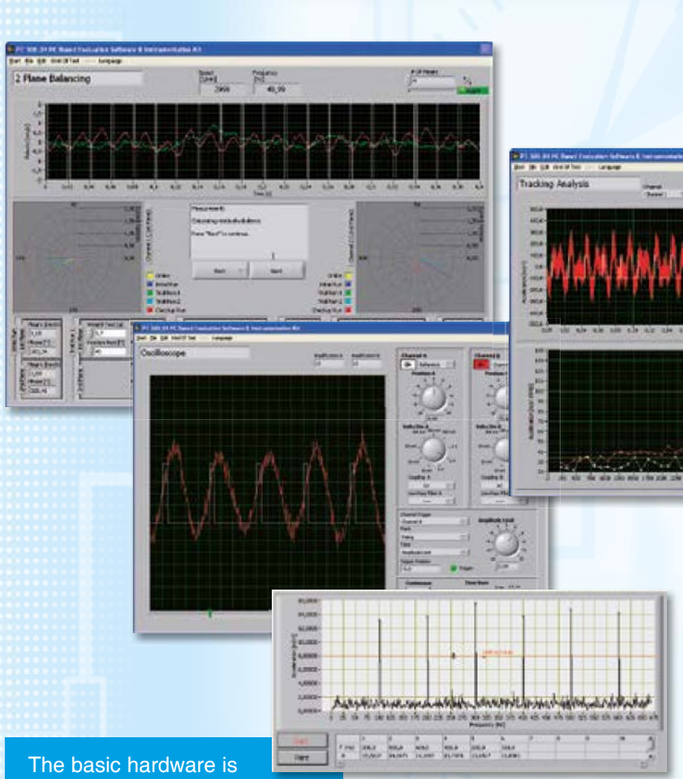
An analysis software has been specially developed for the machine diagnostic system to fully include the required teaching demands of a training system.

Standard systems for industrial use focus on the collection of data, statistical functions and comprehensive adaptation to a variety of tasks. In contrast to these industrial systems, our software features clearly laid out and easy operation and quick changes between different analysis methods. This enables the advantages and disadvantages of the various methods to be highlighted during a measurement process.

For example, a signal can be represented using different methods (time lapse, spectrum, orbit, order analysis). Likewise, the characteristics of acceleration, speed and displacement signals can be clearly represented. The influence of the scanning rate, recording time, sensitivity and time base can also be demonstrated.

This enables the trainee to develop a feel for the processes involved in vibration analysis.

Complicated adjustments and configurations, such as those on industrial systems, are not required.



The basic hardware is a measurement amplifier for connection of two ICP acceleration sensors, two inductive displacement sensors and an optical reference sensor.

A USB data acquisition system allows a PC to be connected directly without making any adjustments on the computer.

The following analysis methods are available:

- Oscilloscope
- Spectrum analysis
- Vibration amplitude measurement
- Tracking analysis
- Orbit representation
- Envelope analysis
- Field balancing in one plane
- Field balancing in two planes

Of course, the software is in four languages and has an integrated help function.

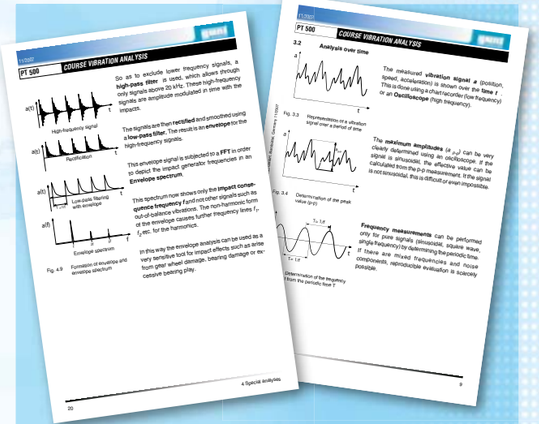
Instructional Material

We have developed extensive instructional material for the PT 500 series. This provides you with an easy introduction to the demanding area of machine diagnosis.

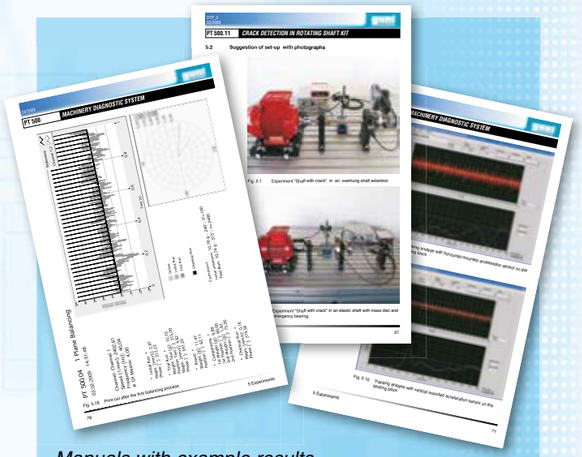
- A representation of the vibration measurement method shows the different vibration signals and gives an introduction to the measuring technique. The capabilities of the different analysis methods are explained in detail, with their advantages and disadvantages.
- Detailed, illustrated recommended set-ups for practical experiments in each of the areas of the topic are included. Example measured results make it easier to correctly evaluate independent experiments and to identify mistakes.
- A comprehensive presentation (slides, CD) outlining the basic principles of machine diagnosis provides an excellent teaching resource.

The instructional material is professionally designed using clear graphics, and easily understandable text. The principles of vibration measurement can be printed for student handouts.

However, for sustained learning success in this complex and demanding area, we recommend a solid engineering grounding in machine dynamics, vibration and mathematics.

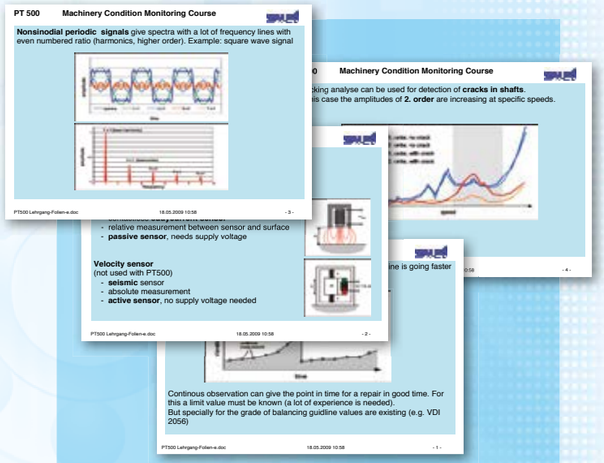


Fundamentals vibration measurement methods



Manuals with example results

When you buy the PT 500 training system, you will receive first rate documentation and teaching materials.

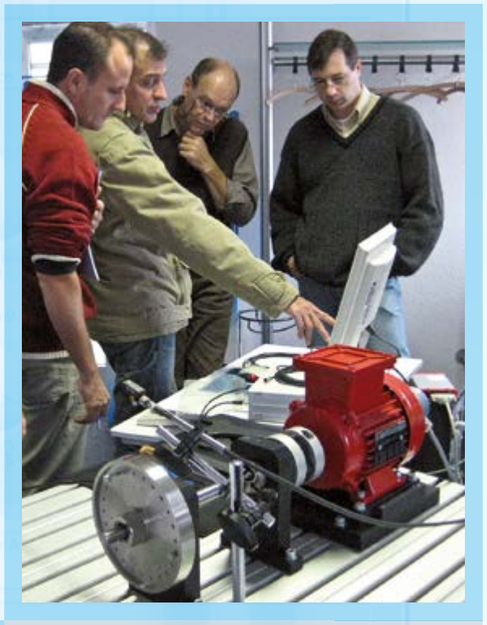


Easily understandable presentation

Commissioning and Training

Commissioning and training are carried out by our experienced GUNT personnel. As well as testing the products supplied, this includes instruction for the customer in the operation of the equipment. The possibilities of the system are demonstrated in detail using reference experiments. This enables you to quickly incorporate this training system into your own teaching programme.

A typical training plan (depending on accessories):	
Day 1	Unpacking and assembly of system Testing functionality Instruction in operation of system Instruction in software functions
Day 2	Exercise: Vibration measurement on a rotor, vibration amplitude, tracking analysis, frequency analysis Exercise: Field balancing of a rotor, one and two-plane balancing Exercise: Identification of different bearing defects, frequency analysis, envelope analysis
Day 3	Exercise: Forces on crank mechanism, influence of bearing clearance, spectrum, envelopes Exercise: Vibrations on gears, meshing frequency, tooth damage, spectrum, envelope analysis



Many domestic and international customers are already successfully using our PT500 training system including:

- HAW Hochschule für Angewandte Wissenschaften [University of Applied Sciences], Hamburg / Germany
- Hochschule für Technik und Wirtschaft [University of Technology and Business], Dresden / Germany
- Reinhold-Würth University, Künzelsau / Germany
- Sonatrach IAP-CU, Skikda / Algeria
- INTECAP Instituto Technica de Capacitatión y Productividad / Guatemala
- Virumaa College of TUT, Kothla-Järve / Estonia
- Addis Ababa University, Engineering Faculty / Ethiopia
- RFPC Training Center, Bandar Iman / Iran
- Warsaw University, Warsaw / Poland
- Eftimie Murgu University of Resita / Romania

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G.U.N.T. Gerätebau GmbH
Hanskampring 15-17
D-22885 Barsbüttel · GERMANY
phone: +49 40 67 08 54 - 0
fax: +49 40 67 08 54 - 42
web: www.gunt.de
e-mail: sales@gunt.de

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also available:

THE GUNT LEARNING CONCEPTS IN PROCESS CONTROL ENGINEERING

- Fundamentals of Control Engineering
- Components and Calibration
- Simple Process Engineering Control Systems
- Complex Process Engineering Control Systems

AUTOMATION

SENSORS / INSTRUMENTATION

PLC AND PLC APPLICATIONS

FUNDAMENTALS OF PNEUMATICS AND HYDRAULICS

CONTROLLERS, CONTROLLED SYSTEMS, NETWORKING

PROCESS CONTROL DEMONSTRATION AND EXPERIMENTATION MODELS

MODULAR PROCESS AUTOMATION TRAINING SYSTEM

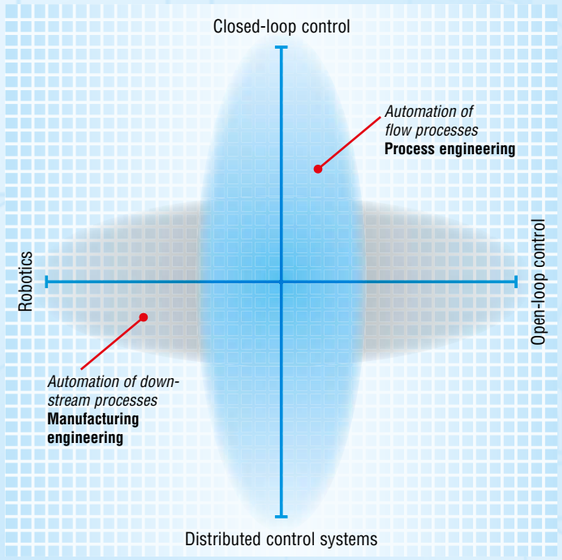
CNC AND ROBOTICS

FUZZY CONTROL

INTRODUCTION TO CHAPTER “AUTOMATION”

Today, automation plays a key role in every technical field, and as such is always a core element of technical training. However, there is no single unified understanding of the concept of automation – it has many different directions and embodiments.

This is our understanding of automation



Different weighting of automation elements.

Most teaching and training systems deal almost exclusively with applications from the fields of manufacturing engineering and handling systems. We at GUNT see things differently!
GUNT is more strongly committed to the vertical area highlighted in blue, oriented more towards process engineering applications, with the emphasis on closed-loop control and distributed control systems.

Training systems that have been tried and tested in practice, derived from university laboratories and lectures.

Our academic partner in automation:

HOCHSCHULE harz
Hochschule für angewandte Wissenschaften (FH)
University of Applied Studies and Research
Fachbereich Automatisierung und Informatik
Faculty of Automation and Computer Sciences

This co-operation agreement combines basic research and application to create intelligent, tried and tested training systems.

STRUCTURES

COMPUTERS

COMPONENTS

Sensors	closed-loop control
Actuators	open-loop control

MODELS

PROGRAMMES

COMMUNICATION

MAN-MACHINE SYSTEMS

APPLICATIONS

CNC	Robotics
AI systems	Recipe control

PROJECTS

Basic techniques (not dependent on process type)

Basic techniques (dependent on process type)

Elements of automation
Light-coloured: Integration techniques
Dark-coloured: Basic techniques
Definition: Prof. Dr.-Ing. Reinhard Langmann

We use this definition to establish a structure and order to the wide diversity of our teaching and training systems.

Although the GUNT teaching and training systems for automation primarily address the basic techniques shown here, the integration techniques are also always incorporated. This link is unbreakable.

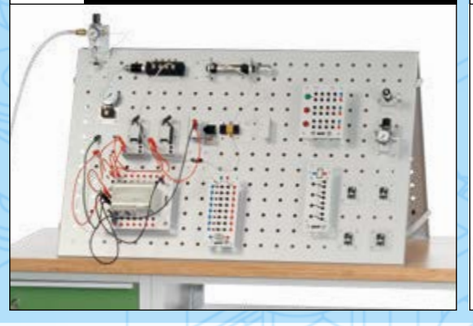
Our well ordered and clearly structured accompanying didactic material will help you to integrate the models and training systems effectively into your teaching strategy.

IA 130 *PLC Module*

IA 210 *PLC Application: Materials Handling Process*

RT 350 *Operation of Industrial Controllers*

RT 770 *Training System: Pneumatics, Electro-Pneumatics and PLC*



RT 010 *Training System: Level Control, HSI*

RT 800 *PLC Application: Mixing Process*

IA 520 *Computer Integrated Manufacturing and Handling System*

RT 122 *Fuzzy Control: Inverted Pendulum*

RT 121 *Fuzzy Control: Ball-on-Beam*

IA 120 Principles of Industrial Sensors

*** Familiarisation with key sensors: mode of operation and application**

*** All components are protected in a sturdy case**

Technical Description

This training kit can be used to investigate a selection of different sensor types commonly used in industrial automation: Optical, capacitive and inductive proximity switches to record displacement and proximity. These sensors are mounted on a base plate with the relevant accessories. The trigger distance is determined by moving the sensor holder. The base plate is provided with a scale for this purpose. A separate supply unit powers the sensors and displays the switching state by way of light-emitting diodes.

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

Learning Objectives / Experiments

Mode of operation and application of different sensors
- one-way photoelectric barrier
- reflex photoelectric barrier
- inductive proximity switch
- capacitive proximity switch
- reflex photoelectric proximity switch, infrared
- reflex photoelectric proximity switch, red light
- limit switch
- reed contact

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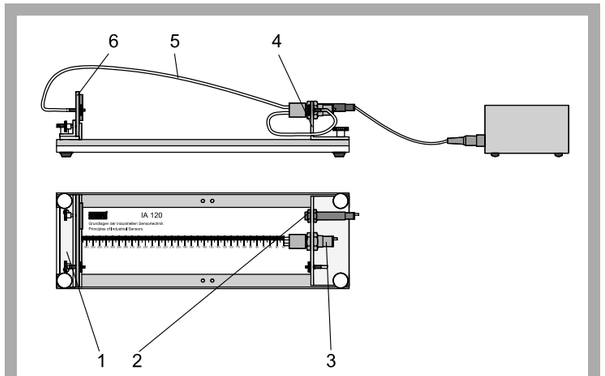
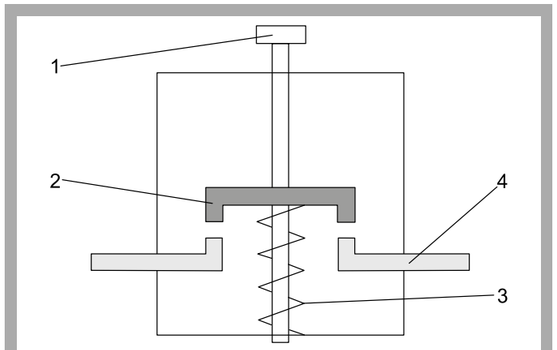
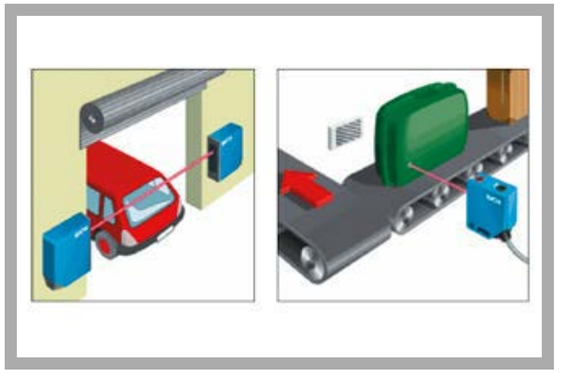
IA 120 Principles of Industrial Sensors



1 slide, 2 reflex photoelectric barrier, 3 light guide, 4 sensor holder (interchangeable), 5 fibre-optic cable, 6 reflector holder



Electric limit switch: 1 momentary-contact switch, 2 switching element, 3 spring, 4 connection



Left: transmissive photoelectric switch, right: reflex photoelectric switch

Specification

[1] training kit for familiarisation with position and displacement sensors
[2] base plate with scale
[3] sensor supply unit with 4 light-emitting diodes
[4] sensors mounted on adjustable fixture
[5] 5 measuring plates
[6] all mountings and components housed in aluminium storage case

Technical Data

Measuring plates, LxW: 145x70mm
- aluminium sheet: d=2mm, smooth, black
- steel sheet: d=2mm, textured, matt black
- steel sheet: d=2mm, smooth, silver
- plexiglas plate: d=5mm, transparent
- plastic plate: d=5mm, smooth, white

Gauge screw: 0...25mm
Sensors
- reflex photoelectric barrier: pnp, dark-switching
- light guide: pnp, dark-switching
- reflex photoelectric proximity switch: pnp, light-switching, 5...150mm
- photoelectric proximity switch: pnp, light-switching
- inductive proximity switch: pnp, NO contact
- capacitive proximity switch: NO contact, 1...8mm
- limit switch: 1 NO contact, 1 NC contact
- reed contact: switching distance: 5mm, max. 1W at 24V

Power supply
- output voltage: 3...12VDC, graduated
- output current 1000mA

Dimensions and Weight

LxWxH: 510x410x200mm (case)
LxWxH: 460x150x27mm (base plate)
LxWxH: 160x85x140mm (sensor supply)
Weight: approx. 14kg

Required for Operation

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

Scope of Delivery

1 experimental unit, complete
1 storage case with foam inlay
1 set of instructional material

Order Details

058.12000 IA 120 Principles of Industrial Sensors

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FL 100 Strain Gauge Training System

*** Basic introduction to measurement with strain gauges**

*** Test bars for tension, bending and torsion with strain gauge measuring points as full bridge**

*** Universal 1-channel measuring amplifier**

Technical Description

Strain gauges are used extensively in sensor systems to detect forces, moments and deformations.

The FL 100 experimental unit provides a wide-ranging introduction to the fundamentals of measurement by strain gauges. Three test specimens for tension, bending and torsion are each fitted with four strain gauge measuring points. The strain gauges are wired in the full bridge. The specimens are loaded incrementally allowing for the strain reading to be sequentially monitored.

The specimens can be inserted quickly and precisely into the frame. The strain gauge measuring range is protected by a Plexiglas cover, which also makes it clearly visible for inspection purposes. The measuring amplifier supplies the bridge supply voltage, and displays the load-dependent "bridge detuning" digitally in voltage values. The digital display also features a zero balancing function to allow for any preloading.

The various elements of the experiment are clearly laid-out and housed securely in a storage system.

Three additional tension bars are available as accessories, in brass (FL 100.01), copper (FL 100.02) and aluminium (FL 100.03), enabling the modulus of elasticity to be ascertained in experiments.

Learning Objectives / Experiments

- fundamentals of measuring with strain gauges
- strain gauge types and application techniques
- calculation of the mechanical deformations under tension, bending and torsion
- correlation between mechanical strain and electrical resistance in a strain gauge

With FL 100.01, FL 100.02, FL 100.03
- determination of the modulus of elasticity for various materials from the measurement data of a tensile test

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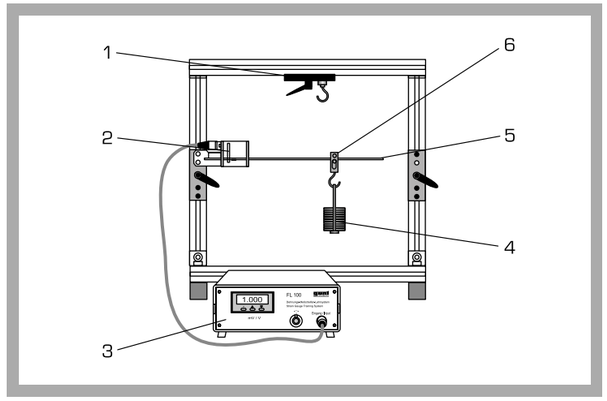
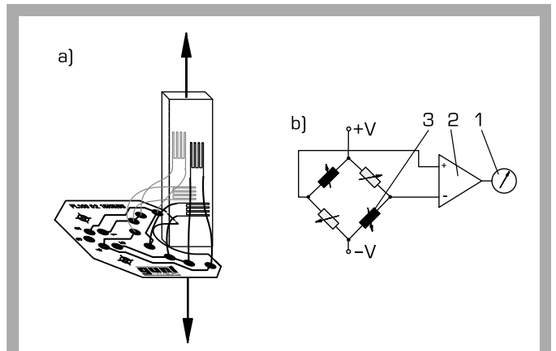
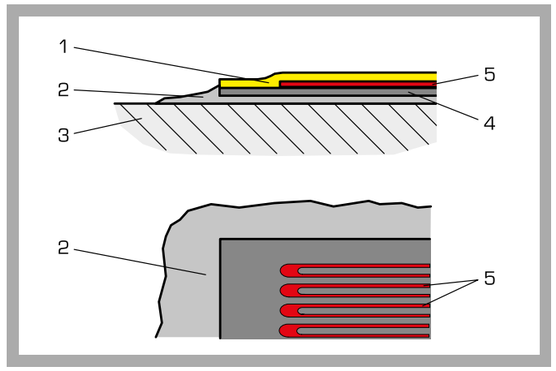
FL 100 Strain Gauge Training System



1 fixture, 2 strain gauge measuring point, 3 measuring amplifier, 4 weight, 5 bending bar, 6 adjustable rider



a) strain gauge arrangement on the tension bar (full bridge),
b) full bridge circuit: 1 display, 2 amplifier, 3 active strain gauge



Layout of a strain gauge measuring point: 1 cover sheet, 2 adhesive, 3 component, 4 substrat, 5 gauge measuring grid

Specification

[1] experimental unit investigating the fundamentals of strain gauge measurement
[2] tension, bending and torsion tests each with strain gauge measuring points in full bridge circuit
[3] strain gauge application areas protected by Plexiglas cover
[4] steel test bodies
[5] measuring amplifier with 4-digit digital display
[6] frame to house the measuring objects
[7] determination of modulus of elasticity on various materials using measuring objects FL 100.01, FL 100.02, FL 100.03
[8] storage system to house the components

Technical Data

Tension bar
- measuring length: 50mm
- cross-section: 2x10mm

Bending bar
- length: 385mm
- cross-section: 5x20mm

Torsion bar
- length: 500mm
- d=10mm

Weights, small: 10x 0,5N, 1x 1N (hanger)
Weights, large
- 1x 5N, 2x 10N, 1x 20N, 1x 5N (hanger)

Strain gauge measuring point: full bridge, 350Ω
Amplifier
- measuring range: +/-2mV/V
- resolution: 1µV/V
- zero balancing adjustment range: +/-1mV
- supply voltage: 10VDC

Frame opening WxH: 480x450mm

Dimensions and Weight

LxWxH: 560x410x610mm (frame)
LxWxH: 600x400x320mm (storage system)
Weight: approx. 20kg

Required for Operation

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

Scope of Delivery

1 frame
3 strain gauge test specimens
2 sets of weights
2 hexagon socket wrenches
1 measuring amplifier with strain gauge connecting cable
1 storage system with foam inlay
1 set of instructional material

Order Details

021.10000 FL 100 Strain Gauge Training System

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WL 202 Fundamentals of Temperature Measurement

*** Experimental introduction to temperature measurement: methods, areas of application, characteristics**

*** Clearly laid out unit primarily for laboratory experiments, also suitable for demonstration purposes**

Technical Description

Recording temperature is one of the basic tasks in metrology. Electric temperature sensors are the most widely used in automation applications but conventional thermometer types are still widely applied in many areas. The WL 202 experimental setup covers the full range of temperature measurement methods. As well as non-electrical measuring methods, such as gas- and liquid-filled thermometers and bimetallic thermometers, all typical electric measuring methods are covered in the experiments. The electrically measured temperatures are displayed directly on programmable digital displays. A temperature-proportionate output voltage signal (0...10V) is accessible from lab jacks, enabling temperature characteristics to be recorded with, for example, a plotter. For measuring the relative air humidity a psychrometer with two thermometers is available, one of the thermometers measures the dry bulb. The wet bulb thermometer is covered in a wet cotton cloth and measures the evaporative cooling. The temperature difference allows the relative air humidity to be determined.

A digital multimeter with precision resistors is used to calibrate the electrical measuring devices. Various heat sources or storage units (immersion heater, vacuum flask and laboratory heater) permit relevant temperature ranges to be achieved for the sensors being tested. A tool box houses the sensors, cables, temperature measuring strips and immersion heater.

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

Learning Objectives / Experiments

- learning the fundamentals of temperature measurement by experimentation
- familiarisation with the various methods, their areas of application and special features
  - * non-electrical methods: gas- and liquid-filled thermometers, bimetallic thermometers and temperature measuring strips
  - * electric methods: thermocouple, resistance temperature detector Pt100, thermistor (NTC)
- determining air humidity with a psychrometer
- calibrating electric temperature sensors

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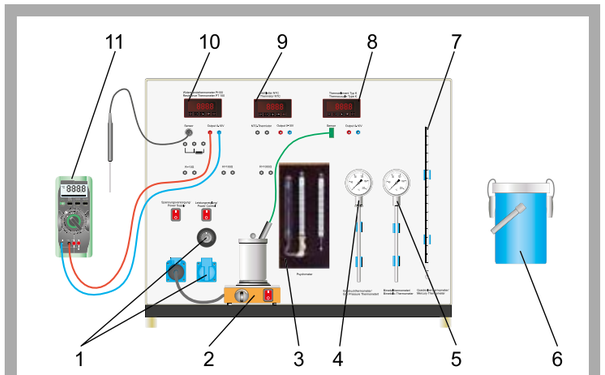
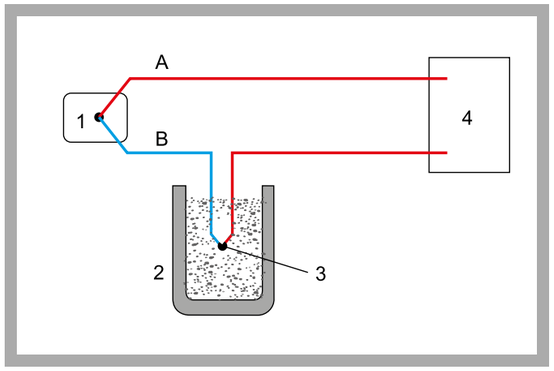
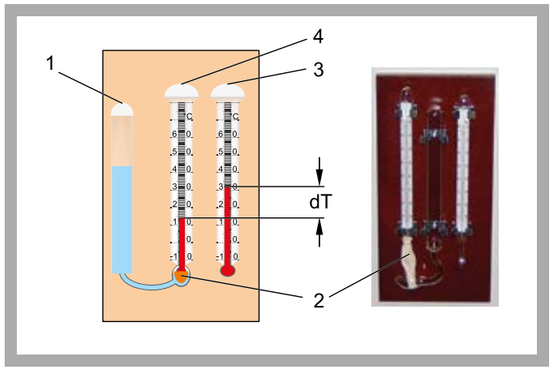
WL 202 Fundamentals of Temperature Measurement



1 power-regulated socket, 2 laboratory heater for water and sand, 3 psychrometer to determine air humidity, 4 gas pressure thermometer, 5 bimetal thermometer, 6 vacuum flask, 7 mercury thermometer, 8 digital display, thermocouple type K, 9 digital display, thermistor (NTC), 10 digital display, Pt100, 11 multimeter



Temperature measurement with a thermocouple type K: A) nickel chrome, B) nickel; 1 measuring point, 2 tank at constant temperature, 3 reference point, 4 voltmeter



Psychrometer: 1 water tank, 2 wet cotton cloth for covering the wet bulb thermometer, 3 dry bulb thermometer, 4 wet bulb thermometer; dT temperature difference

Specification

[1] experiments in the fundamentals of temperature measurement with 7 typical measuring devices
[2] various heat sources or storage units: laboratory heater, immersion heater, vacuum flask
[3] calibration units: precision resistors and digital multimeter
[4] mercury, bimetallic and gas pressure thermometers
[5] temperature sensors: Pt100, thermocouple type K, thermistor (NTC)
[6] various temperature measuring strips
[7] psychrometer for humidity measurement
[8] tool box for sensors, cables, measuring strips and immersion heater

Technical Data

Immersion heater
- power output: 300W
- adjustment of power feed via power-regulated socket

Laboratory heater with thermostat
- power output: 450W
- max. temperature: 425°C

Vacuum flask: 1L

Measuring ranges
- resistance temperature detector Pt100: 0...100°C
- thermocouple type K: 0...1000°C
- thermistor (NTC): 20...55°C
- mercury thermometer: -10...300°C
- bimetallic, gas pressure thermometer: 0...200°C
- temperature measuring strips: 29...290°C

Precision resistors: 10Ω, 100Ω, 1000Ω

Psychrometer:
- 2x temperature: 0...60°C
- rel. humidity: 3...96%

Dimensions and Weight

LxWxH: 800x450x650mm (experimental unit)
Weight: approx. 45kg

Required for Operation

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

Scope of Delivery

1 experimental unit
1 tool box
1 set of cables
1 laboratory heater
1 immersion heater
1 vacuum flask
1 digital multimeter
1 set of instructional material

Order Details

060.20200	WL 202	Fundamentals of Temperature Measurement

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IA 110 Calibrating a Pressure Sensor

*** Test-pressure generated with dead-weight piston manometer**

*** Electronic pressure sensor with ceramic measuring cell**

*** Plotting a calibration curve**

*** Compact experimental unit for group working or demonstration**

Technical Description

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

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

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

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

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

Learning Objectives / Experiments

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

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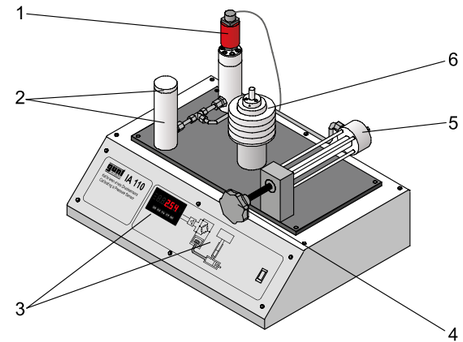
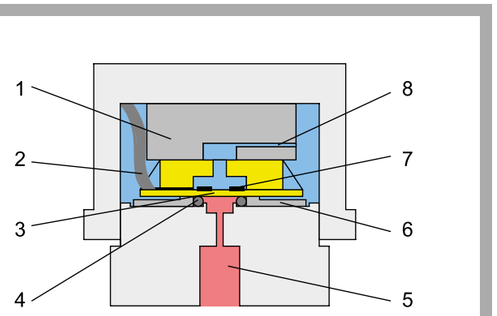
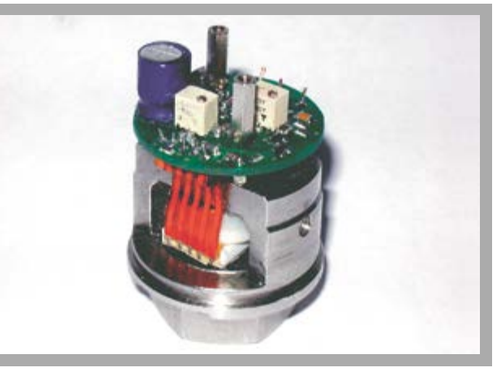
IA 110 Calibrating a Pressure Sensor



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



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



Interior layout of an electronic pressure sensor

Specification

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

Technical Data

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

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

Digital display: 4 1/2 digits

Hydraulic oil: HLP ISO 32

Dimensions and Weight

LxWxH: 600x450x450mm
Weight: approx. 20kg

Required for Operation

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

Scope of Delivery

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

Order Details

058.11000 IA 110 Calibrating a Pressure Sensor

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IA 210 PLC Application: Materials Handling Process

*** Automation fundamentals system**
*** Handling demonstrator**
*** Simulation of a punching process**
*** Simulation of workpiece control**

Technical Description

IA 210 is a compact teaching and practice unit for the control of a materials handling process using a PLC. Two processes can be simulated: a punching process, or workpiece control in the form of a sort operation. All components are in a clearly laid out design.

Black and white cylindrical workpieces are fed from a container onto a conveyor belt. On the belt is a reflex photoelectric proximity switch which differentiates between light and dark and feeds the white items to the pre-selected process (punching or sorting). The black workpieces are always carried to the end of the belt, where they drop into a collector. Three 5/2-way solenoid valves, three double-acting cylinders and a pneumatic roller pushbutton can be operated via the PLC to execute the necessary steps: releasing the workpiece from the container; pushing the workpiece onto the conveyor belt; sorting or punching the workpiece. For punching, the workpiece is brought to a predefined position. The working cylinder can switch between sorting and punching modes by a simple sequence of actions.

The unit is designed for operation in conjunction with a PLC module. Use of PLC module IA 130 is recommended.

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

Learning Objectives / Experiments

- familiarisation with and analysis of an automated materials handling process
  * understanding and analysis of the mechanical, pneumatic and electrical functions
  * familiarisation with the symbols, terms and modes of representation of pneumatic and electrical function diagrams
  * familiarisation with automation components: cylinders, solenoid valves, photoelectric proximity switches
- familiarisation with the use of a PLC
  * basic methods of programming
  * adapting the program to the given handling process
- simulation of a punching process
  * conveyor belt is stopped for punching
  * conveyor belt also stops as soon as workpiece drops from belt end
- workpiece control simulation
  * light-coloured workpieces are separated out; dark items reach the belt end

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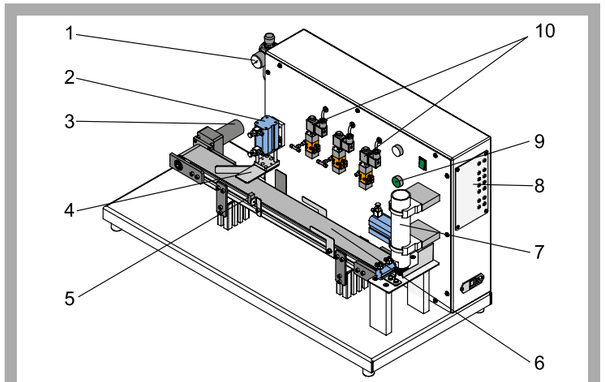
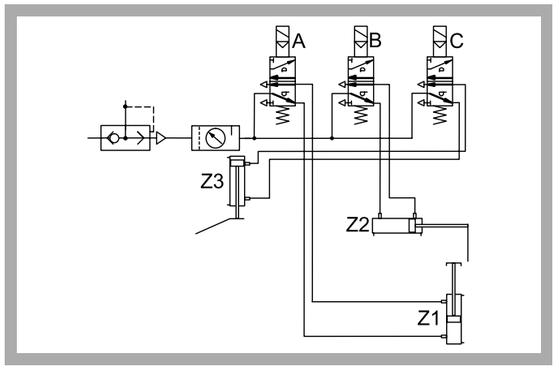
IA 210 PLC Application: Materials Handling Process



1 maintenance unit, 2 double-acting cylinder, 3 conveyor belt drive motor, 4 punching or sorting device, 5 reflex photoelectric proximity switch, 6 conveyor belt, 7 container for 11 workpieces, 8 electrical connections for solenoid valves and sensors, 9 display of limit switch, 10 5/2-way solenoid valve



Pneumatic connection diagram

Electrical connections of the solenoid valves and sensors

Specification

[1] compact unit for experiments in the field of automation
[2] handling device with solenoid valves
[3] double-acting cylinder (15mm stroke): fixing / discharge of workpieces to container
[4] double-acting cylinder (80mm stroke): pushes workpiece onto conveyor belt
[5] double-acting cylinder (40mm stroke): executes the process (sorting or punching)
[6] conveyor belt with guide plates and DC motor
[7] cylindrical Plexiglas storage container holding 11 workpieces
[8] 15 workpieces made of Polyoxymethylene (POM): 10x white, 5x black
[9] pneumatic components fitted with quick-release couplings for 4mm hoses
[10] operation of actuators with compressed air
[11] lab jacks to external PLC
[12] set of laboratory cables and pneumatic hoses
[13] compressed air supply: max. 6bar, 3bar recommended

Technical Data

3 electrically operated 5/2-way valves
- with spring return
- with pilot valve

Reflex photoelectric proximity switch
- pnp, light-switching
- 5...150mm

Geared DC motor
- reduction ratio: 142,5:1
- nominal torque 5,92Nm
- nominal speed: 22min^{-1}

Polyester weave conveyor belt
Workpieces, DxH: 40x20mm

Dimensions and Weight

LxWxH: 1000x450x580mm
Weight: approx. 46kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase
Compressed air supply: max. 6bar, 3bar recommended

Scope of Delivery

1 experimental setup, complete,
15 workpieces
1 set of laboratory cables
2 collector bins
1 set of instructional material

Order Details

058.21000 IA 210 PLC Application: Material Handling Process

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RT 800 PLC Application: Mixing Process

*** Trainer for control of discontinuous mixing processes by PLC**

*** Use of standard industrial components**

*** Capacitive proximity switches as level sensors**

*** Built-in power supply unit to power all the components and the PLC**

Technical Description

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

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

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

Learning Objectives / Experiments

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

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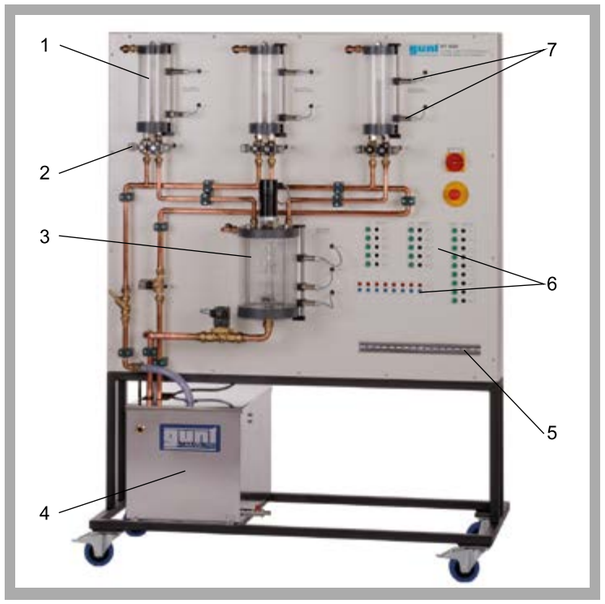
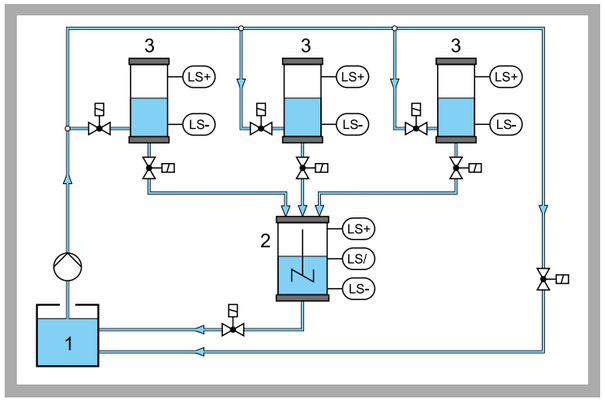
RT 800 PLC Application: Mixing Process



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



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

Specification

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

Technical Data

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

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

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

Dimensions and Weight

LxWxH: 1380x610x1850mm
Weight: approx. 145kg

Required for Operation

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

Scope of Delivery

1 trainer
1 set of instructional material

Order Details

080.80000 RT 800 PLC Application: Mixing Process

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IA 130 PLC Module

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

Technical Description

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

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

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

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

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

Learning Objectives / Experiments

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

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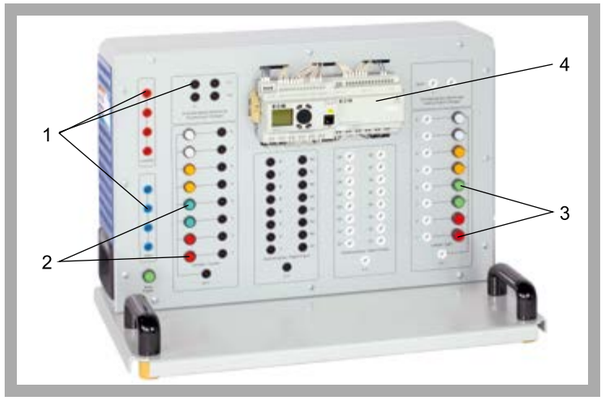
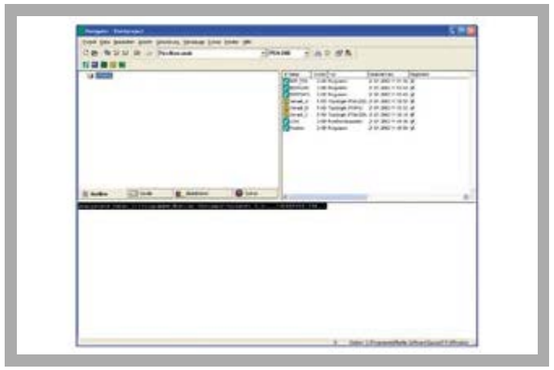
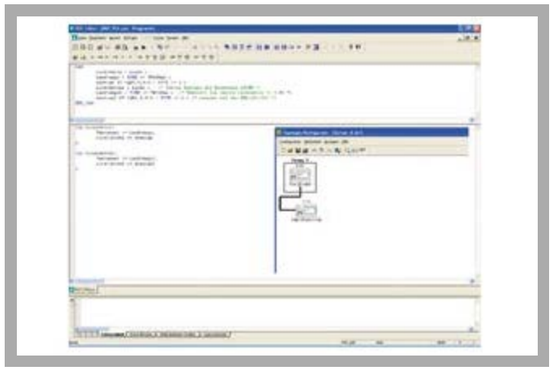
IA 130 PLC Module



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



Screenshot of PLC software: start screen



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

Specification

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

Technical Data

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

Software
- graphical user interfaces
- programming languages to IEC/EN 61131-3:
  * statement list (STL)
  * ladder diagram (LD)
  * function block diagram (FBD)
  * structured text (ST)
- multiple dialogue languages (German, English, French, Spanish)
- graphical topology configurator
- system requirements: Windows Vista or Windows 7

Dimensions and Weight

LxWxH: 620x350x450mm
Weight: approx. 15kg

Required for Operation

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

Scope of Delivery

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

Order Details

058.13000 IA 130 PLC Module

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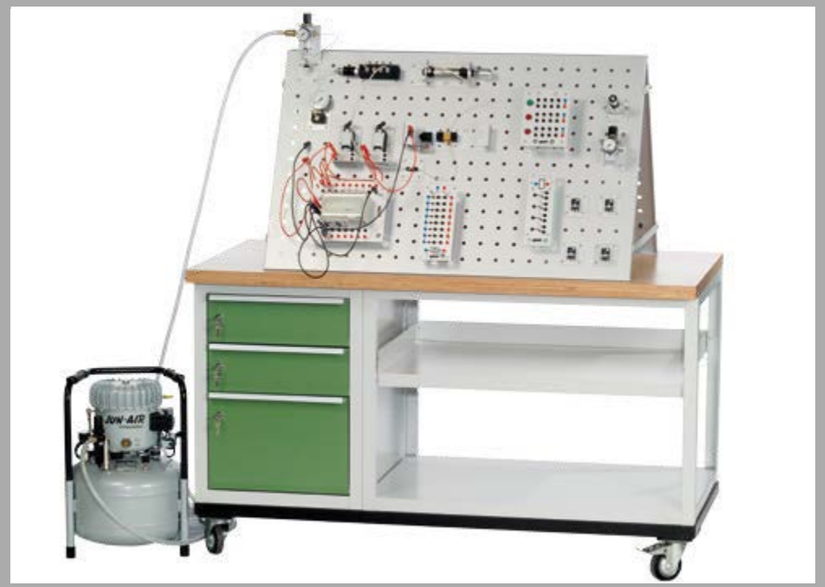
RT 770 Training System: Pneumatics, Electro-Pneumatics and PLC



*** Complete training system providing an experimental introduction to the fundamentals of pneumatics and electro-pneumatics - with PLC**

*** Experiment scope and configuration based on the tried and proven concept course developed by the Bundesinstitut für Berufsbildung (BIBB; Federal Institute for Vocational Training)**

*** 2 large-format metal assembly panels for fast, secure component mounting**

*** Sturdy base construction, mobile, with drawer system for storage**

Technical Description

The RT 770 is a fully equipped training system with all necessary components and aids to conduct a comprehensive training course in the fundamentals of pneumatic and electro-pneumatic controls. The didactic structure of the course is based on the long-established BIBB training concept. In addition to the BIBB course experiments, RT 770 also includes a PLC (programmable logic controller).

The system comprises standard industrial components. The board-mounted components are securely attached to the assembly panels by a special quick-clamping system. The assembly area consists of two panels that are arranged in a roof-like configuration and can be used simultaneously. Pneumatic and electro-pneumatic circuits are constructed with the aid of pneumatic hoses and laboratory cables. A miniature compressor supplies the experiments with compressed air.

The sturdy trolley provides clearly laid out storage for the components.

An extensive package of literature and media is supplied.

Learning Objectives / Experiments

- physical principles of pneumatics and electro-pneumatics
- fundamentals of, and terms used in, process control
- design and function of pneumatic components
- logic elements, logic diagram
- multi-way valves, pressure, shut-off and flow control valves
- controls with starting and setup conditions (automatic/manual/jog mode)
- controls with boundary conditions
- routing and time controls (process and time controlled sequencers)
- position-dependent controls
- troubleshooting and commissioning

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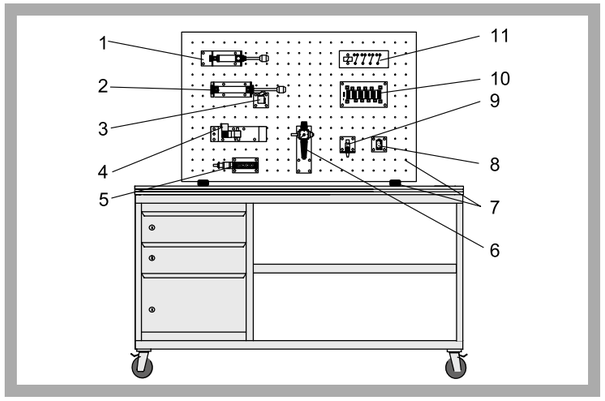
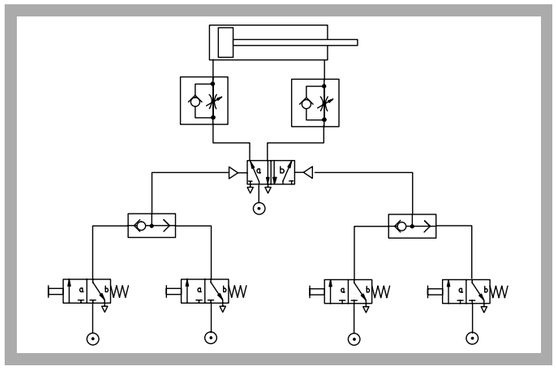
RT 770 Training System: Pneumatics, Electro-Pneumatics and PLC



1 cylinder, single-acting, 2 cylinder, double-acting, 3 3/2-way valve with roller lever, 4 3/2-way valve, 5 distributor block with hand valve, 6 maintenance unit, 7 assembly panel, 8 dual pressure valve (AND gate), 9 quick-vent valve, 10 sequencer, 11 relay board



Circuit diagram of experimental setup for logical OR element

Relay board

Specification

[1] comprehensive trainer for demonstration and exercises in pneumatics, electro-pneumatics and PLCs
[2] 2 perforated metal panels for quick component fixing
[3] standard industrial pneumatic and electro-pneumatic components
[4] various multi-way valves, pressure, shut-off and flow control valves
[5] electric limit switch, various proximity switches, solenoid valves, signal board
[6] PLC with programming software
[7] integrated power supply unit to supply the electro-pneumatics and the PLC
[8] 2x maintenance units + distributor block for simultaneous use of both panels
[9] hoses, cables and tools to construct the experiments
[10] miniature compressor for compressed air supply

Technical Data

2 assembly panels, LxH: 1100x700mm each
Compressor
- tank: 24L
- intake capacity: 50L/min
- power output: 32L/min at 8bar
- max. pressure: 8bar
- motor: 0,34kW

PLC with display
- inputs: 8
- outputs: 4
- EEPROM
- programming software

Size of components: nominal width 3
Pneumatic hose: 4/2mm
Power supply unit: 24VDC, 4A

Dimensions and Weight

LxWxH: 1530x750x1540mm
Weight: approx. 160kg

Required for Operation

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

Scope of Delivery

1 training system, complete
1 miniature compressor
1 PLC with software
1 set of instructional material

Order Details

080.77000	RT 770	Training System: Pneumatics, Electro-Pneumatics and PLC

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RT 700 Training System: Fundamentals of Hydraulics

Technical Description

RT 700 is a fully equipped training system with all necessary components and aids to conduct a comprehensive training course in the fundamentals of hydraulic controls. The didactic structure of the course is based on the long-established BIBB concept of training in hydraulic drive engineering.

The central element of the unit is the large assembly panel. Here, two different circuits can be easily constructed using items from the kit of modern standard industrial components and connecting hoses. A special quick-clamping system ensures all components are securely attached. The component connections face outward to allow easy interconnection by means of quick-couplers. An oil drip tray is positioned beneath the full width of the assembly panel. The sturdy mobile base unit houses the hydraulic unit and the electrical switch box. There is generous space for all the system components to be accommodated in drawers and cabinets.

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

Learning Objectives / Experiments

Comprehensive experimental introduction to the fundamentals of hydraulic drive and control engineering
- familiarisation with terms and symbols
- representation of hydraulic circuits
- drive unit
- multi-way valves and drives
- shut-off and flow control valves
- pressure valves and pressure switches
- hydraulic accumulators
- application circuits
- commissioning and maintenance

*** Complete training system providing an experimental introduction to the fundamentals of hydraulics**

*** Experimental scope and configuration based on the tried and proven concept course developed by the Bundesinstitut für Berufsbildung (BIBB; Federal Institute for Vocational Training)**

*** Large-format metal assembly panel for quick and safe component mounting**

*** Solid base construction with oil drip tray, hydraulic unit and component storage system**

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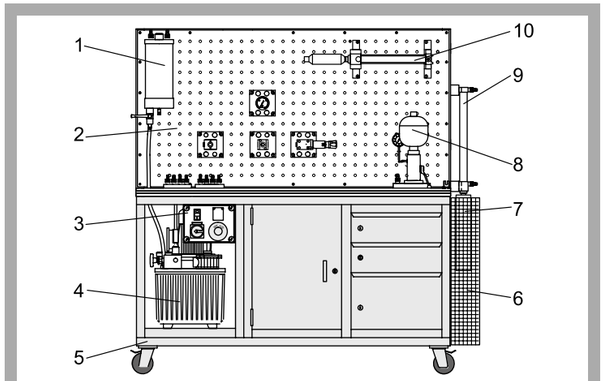
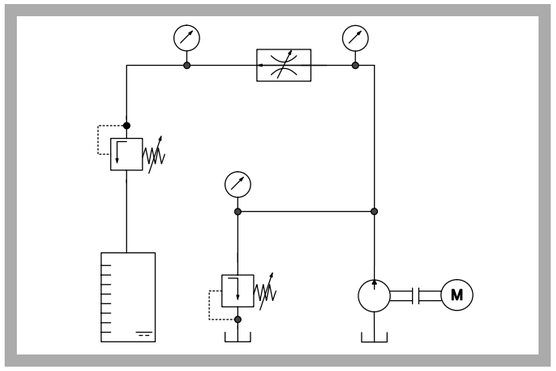
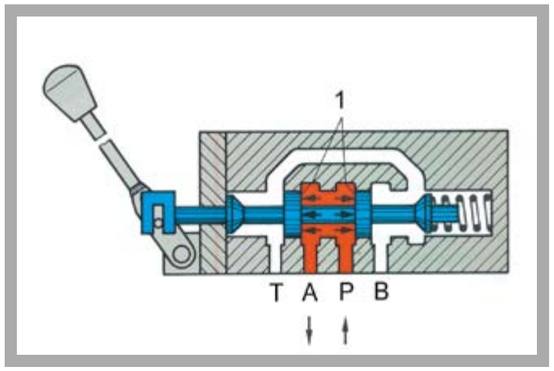
RT 700 Training System: Fundamentals of Hydraulics



1 measuring tank, 2 assembly panel, 3 switch box, 4 drive unit with gear pump, 5 mobile built-under unit, 6 guard grille, 7 weight, 8 diaphragm accumulator, 9 loaded cylinder, 10 differential cylinder



Circuit diagram of experimental setup for 2-way flow control valve



Sectional drawing of a 4/2-way valve: 1 control piston, force-equalised

Specification

[1] training system providing an introduction to the fundamentals of hydraulic control engineering, BIBB concept
[2] perforated metal panel for quick component fixing
[3] oil drip tray
[4] standard industrial hydraulic components
[5] various multi-way valves, pressure limiting, check, restrictor, flow control and non-return valves
[6] hydraulic motor
[7] diaphragm accumulator
[8] weighted piston with guard
[9] pressure hoses with self-closing quick-couplers
[10] drive unit with gear pump

Technical Data

Assembly panel, LxH: 1420x700mm
Drive unit
- with gear pump
- working pressure: 100bar
- flow rate: 4cm³ per revolution
- power output: 1,5kW
- speed: 1500min^{-1}

Oil tank capacity: 25L
Measuring tank: 3L, transparent
Diaphragm accumulator
- 1L, opening pressure: 140bar

Pressure hoses, type 1SN DN 6, max. 225bar
Emergency-off button

Dimensions and Weight

LxWxH: 1700x740x1700mm
Weight: approx. 350kg

Required for Operation

230V, 60Hz, 3 phases or 400V, 50/60Hz, 3 phases

Scope of Delivery

1 training system, complete
1 set of instructional material

Order Details

080.70000	RT 700	Training System: Fundamentals of Hydraulics

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RT 770 *Training System: Pneumatics, Electro-Pneumatics and PLC*

The station includes the following components:

1x single-acting cylinder
2x double-acting cylinder with end position damping
2x double-acting cylinder with end position damping and 2 limit switches (NO contacts)
2x maintenance unit
2x 8-way distributor block with manual slider valve
2x 3/2-way valve with push-button, locked at rest position
1x 3/2-way valve with mushroom-type button, locked at rest position
1x 3/2-way valve with push-button, open at rest position
2x 3/2-way valve with tipping roller lever, locked at rest position
4x 3/2-way valve with roller lever, locked at rest position
1x 3/2-way valve, pressurised on one side
1x 3/2 delay valve, locked at rest position
1x 5/2-way valve with hand lever, locked at rest position
3x 5/2-way valve dual-pressurised
1x 5/3-way valve with spring-centred mid position, all connections locked
2x one-way restrictor, adjustable
1x quick-vent valve with sound absorber
2x changeover valve (OR)
5x dual pressure valve (AND)
1x 3/2-way valve with pressure sequence actuator (pressure input valve)
1x pressure reducing valve with drain
1x device for pulling load
1x sequencer for 4 steps
3x manometer, 0...10bar

Components for electro-pneumatic experiments:

1x 3/2-way solenoid valve with spring return, locked at rest position
3x 5/2-way solenoid valve with spring return, locked at rest position
3x 5/2-way solenoid valve, impulse
3x relay board, 4 changeover contacts
2x electric limit switch (roller touch contact, can be used as NC contact and NO contact)
1x proximity switch, inductive (NO contact)
1x proximity switch, capacitive, with LED (NO contact)
1x proximity switch, optical, with LED (NO contact)
2x signal board (1x touch contact, locking, 2x touch contact, non-locking)
1x pressure switch
1x signalling unit and distributor

1x PLC with programming software

1x power supply unit, 24VDC
20x T-piece, flash connection
1x pneumatic hose 4/2mm, PA/colourless, 25m roll
1x hose cutter
20x laboratory cable, 1000mm, red
20x laboratory cable, 1000mm, black
20x laboratory cable, 500mm, red
20x laboratory cable, 500mm, black

RT 700 *Training System: Fundamentals of Hydraulics*

The kit includes the following components:

1x hydraulic accumulator
2x pressure limiting valve, directly controlled, pressure range: 4...160bar
1x adjustable restrictor valve
1x double-acting cylinder, stroke 250mm
1x double-acting cylinder, stroke 400mm, weight 19,5kg
1x measuring tank
4x manometer 0...160bar
1x gear motor
3x check valve
1x 2/2-way valve, locked at rest position
1x 2/2-way valve with jockey roller
1x 3/2-way valve, locked at rest position
1x 4/2-way valve, hand-operated, continuous at rest
1x 4/3-way valve with latch lock, hand-operated
1x 4/3-way valve mid position P and T connected, hand-operated
1x non-return valve, hydraulic releasing
2x non-return valve
2x one-way restrictor, adjustable
1x 2-way flow control valve
1x 3-way pressure reducing valve
1x accumulator filling device
1x pressure limiting valve, pre-controlled
2x metering valve pre-controlled

1x hose set
1x resistance line NG6, screw fitting
1x resistance line NG6, elbowed
1x resistance line NG4, elbowed
1x guard grille
2x screwdriver
1x single-end wrench, size 9 (DIN 894)
2x Allen key, size 4, 6

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RT 710 Hydraulic Servo System

*** Complete model of a hydraulic servo control loop**
*** Position control with adjustable load conditions**
*** Hydraulic cylinder with directly mounted control valve**
*** Vibration-damped mounting**
*** Electronic servo amplifier**
*** GUNT software including oscilloscope and frequency generator**

Technical Description

Servo systems are closed-loop control systems. In many industrial applications it is often required to convert small mechanical motions into a different motions with increased force. Hydraulic systems are particularly suitable for applications where large actuation forces are required. The RT 710 unit allows the operation of a hydraulic servo system to be investigated in detail. A carriage with a mass of 50kg is moved by a hydraulic cylinder. Additional springs and an adjustable hydraulic damper permit static and dynamic loads to be simulated. The displacement of the carriage is established using a potentiometric position sensor and compared against the reference variable. The control deviation is processed in a separate servo amplifier. Depending on the direction of the deviation, a control valve is activated in forward or reverse direction, which in turn produces a corresponding movement of the hydraulic cylinder and the carriage.

All variables can also be tapped as voltage signals. The GUNT software contains among other features an oscilloscope, a frequency generator and a voltmeter. In dynamic processes, for example, the displacement signal can be represented on the oscilloscope. Via the software, the reference variable can also be applied to the system in the form of a voltage. This implies that, with the frequency generator, dynamic tests can be performed and the frequency response recorded.

The trainer is a mobile unit. Measuring devices can be housed in the built-under cabinet unit.

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

Learning Objectives / Experiments

- familiarisation with the mode of operation of a hydraulic position control loop with adjustable load conditions
- reading and understanding circuit diagrams
- replacing springs and adjusting the damper
- influence of load and system pressure on control accuracy
- influence of the amplifier constants on the stability of the closed control loop
- recording the frequency response

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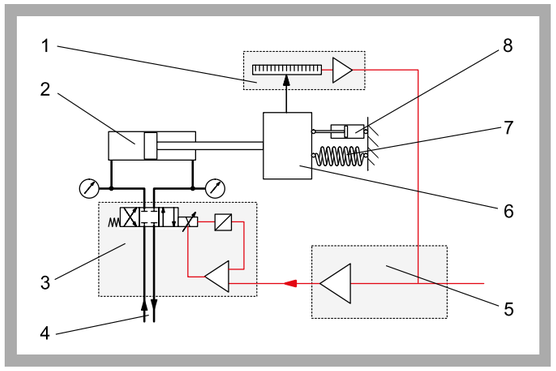
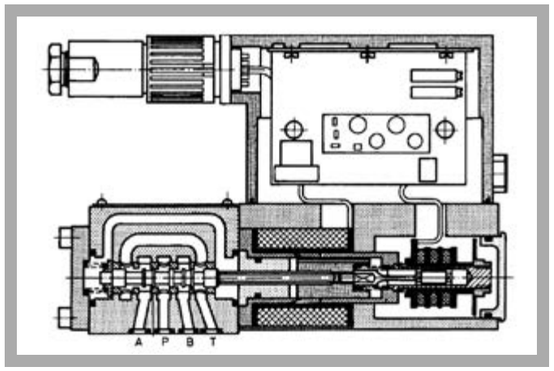
RT 710 Hydraulic Servo System

1 servo amplifier, 2 cylinder pressure manometer, 3 hydraulic cylinder with control valve, 4 switch box, 5 pump and oil tank, 6 carriage, 7 damper, 8 hand wheel for spring pre-tension, 9 springs



Process schematic: 1 position sensor, 2 hydraulic cylinder, 3 control valve, 4 pressurised oil supply, 5 servo amplifier, 6 carriage, 7 spring, 8 damper



Control valve with position control capability

Specification

[1] self-contained training system of a complete hydraulic position control loop with adjustable loading conditions
[2] oil circuit with hydraulic unit, hydraulic accumulator, 2 manometers, control valve and hydraulic cylinder to move a weighted carriage
[3] operation of the electromagnetic control valve for position control by servo amplifier
[4] servo amplifier with adjustable gain
[5] all control variables available as voltage signals
[6] potentiometric displacement sensor
[7] adjustable load conditions on carriage using two springs with hand wheel and adjustable damping
[8] low-friction ball bearing-mounted carriage
[9] mobile steel profile trolley with built-under unit
[10] GUNT software via USB under Windows Vista or Windows 7

Technical Data

Hydraulic unit
- power output: 1,1kW
- flow rate: 4,3L/min
- head: 1500m
- tank capacity: 10L

Hydraulic accumulator capacity: 2L
Accumulator charging valve: max. 40L/min
Hydraulic cylinder
- piston diameter: d=40mm
- stroke: 150mm
- mass moved: 50kg

Control valve NG6
- nominal flow rate: 24L/min
- activation: +/-10V

Potentiometric position sensor
- measuring range: 150mm
- output: 0 …10V

Dimensions and Weight

LxWxH: 1680x670x1600mm
Weight: approx. 420kg

Required for Operation

Hydraulics: 400V, 50Hz, 3 phase
Servo amplifier: 230V, 50Hz, 1 phase

Scope of Delivery

1 hydraulic servo system, complete
1 GUNT software CD + USB cable
1 set of accessories
1 set of instructional material

Order Details

080.71000 RT 710 Hydraulic Servo System

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RT 350 – RT 380 TRAINERS FOR PROCESS AUTO MATION

RT 350 *Operation of Industrial Controllers*

RT 360 *Networking of Industrial Controllers*

RT 370 *Setup of Field Bus Systems*

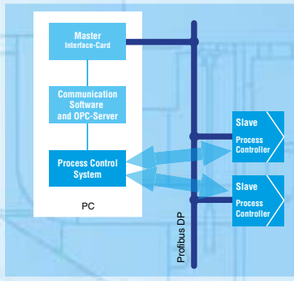
RT 380 *Optimization of Control Loops*

Nowadays most industrial processes are automated. Process controllers are at the heart of the automation of process applications. State-of-the-art digital process controllers offer a level of functionality which would have been inconceivable some years ago. Alongside extensive configuration and parameter setting functions to adapt to the control task, they also permit interconnected networking. Thus, process automation by way of centralised process control systems or distributed control systems (DCS) is possible. This range of equipment provides a step-by-step introduction to process automation and process control engineering based on process controllers and field bus systems.

NETWORKING IN PROCESS AUTOMATION

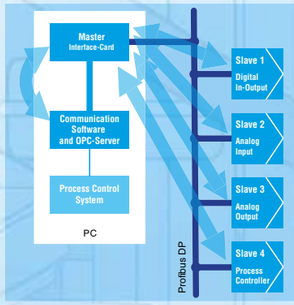
RT 350 OPERATION OF INDUSTRIAL CONTROLLERS

The RT 350 is used to practice parameter setting and configuration of a state-of-the-art process controller. This can be carried out either manually by way of the front panel buttons or from a PC by means of a special software programme via an interface. In this case the controller is linked to the PC by a serial port.



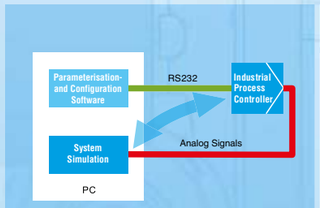
RT 360 NETWORKING OF INDUSTRIAL CONTROLLERS

The RT 360 allows the function of a simple process control system to be demonstrated. The network interconnection is over a field bus (Profibus DP). The PC with its interface card is the master, and the two process controllers are the slaves. The trainer can be used to demonstrate how the controller parameters can be configured from the process control system (adaptive control), and how the process data can be uploaded from the controllers to the process control system and visualised.



RT 370 SETUP OF FIELD BUS SYSTEMS

The RT 370 enables a field bus (Profibus DP) to be set up with various slaves (digital input and output modules, analogue input and output module, process controllers) and a master (PC with interface card). The definitions of the topology, the variables and the protocols are shown. Subjects such as the GSD file, system configurator, OPC server and tags are dealt with in detail. The objective is to interchange data between various field bus-compatible terminal devices and the PC.



RT 380 OPTIMIZATION OF CONTROL LOOPS

Tuning of a controller for optimal control system performance can be practised with the RT 380. The controller works together with a simulated system model. The simulation is created on a PC using a special software programme. A wide variety of system models are available. A configuration programme enables user-friendly, intuitive parameter setting of the controller from the PC.

RT 350 Operation of Industrial Controllers

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

Technical Description

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

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

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

Learning Objectives / Experiments

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

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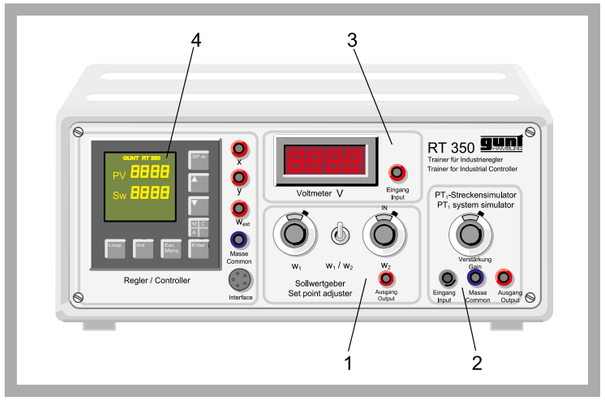
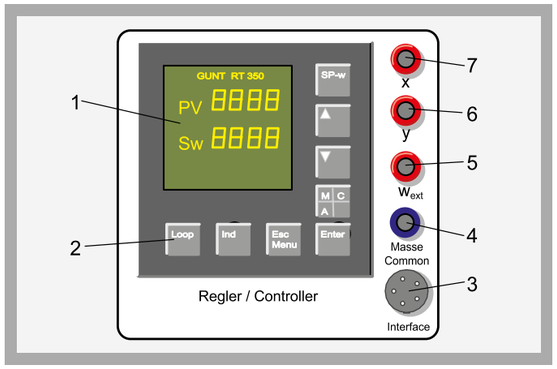
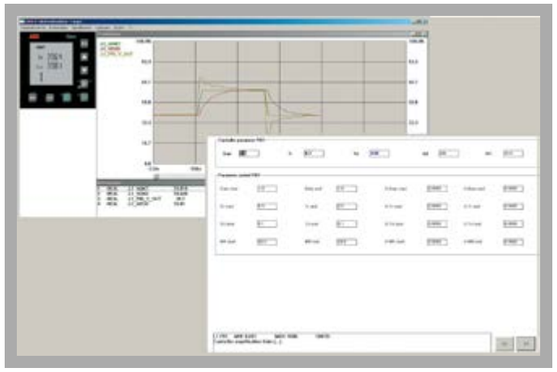
RT 350 Operation of Industrial Controllers



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



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



Configuration software with time log window and parameter selection

Specification

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

Technical Data

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

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

Reference variables generator
- 2 voltages selectable
- output voltage: 0...10V

Controlled system simulator
- controlled system type: first order lag
- time constant: 20s
- controlled system gain: 1...10
- process variables as analogue signals: 0...10V

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

Dimensions and Weight

LxWxH: 370x330x150mm
Weight: approx. 5kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.35000	RT 350	Operation of Industrial Controllers

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RT 360 Networking of Industrial Controllers

*** Process control system**

*** Networking of industrial controllers**

*** Controller parameter setting via field bus system**

*** Profibus DP field bus system**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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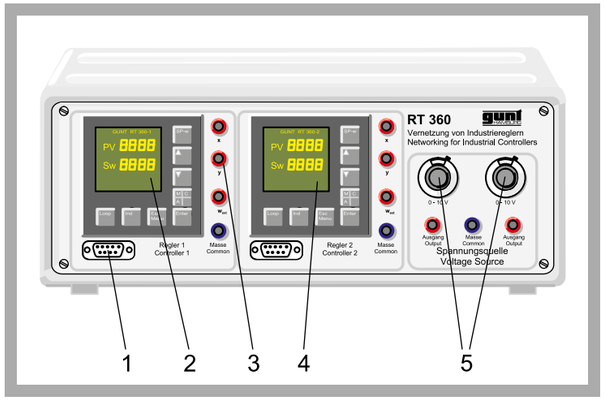
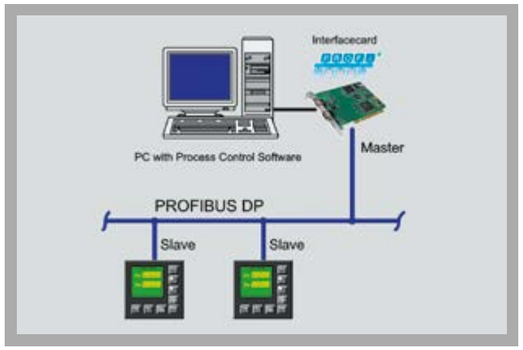
RT 360 Networking of Industrial Controllers



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



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

GUNT process control software with recorder function and controller operation

Specification

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

Technical Data

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

Process variables as analogue signals: 0...10V
Signal generator: 0...10V
Connection of external instruments (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 450x450x150mm
Weight: approx. 10kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.36000 RT 360 Networking of Industrial Controllers

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RT 370 Setup of Field Bus Systems

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

Technical Description

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

This experimental unit is used to teach the initial basic steps in field bus technology based on the example of Profibus DP. Various terminal devices (slaves) are activated and read by a PC with a Profibus DP interface (master). The required hardware is largely pre-configured. Students are able to concentrate on the software programming of the field bus system. The following specific topics can be covered: System configurator with DMF (**D**evice **M**aster **F**ile), bus topology, communication protocols, tags, OPC (**O**LE for **P**rocess **C**ontrol) server, input and output of process data, and much more.

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

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

Learning Objectives / Experiments

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

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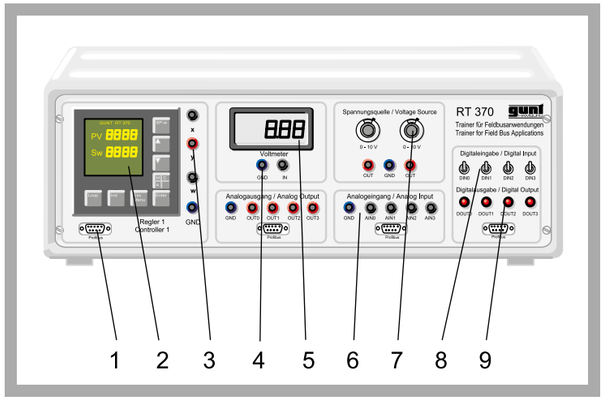
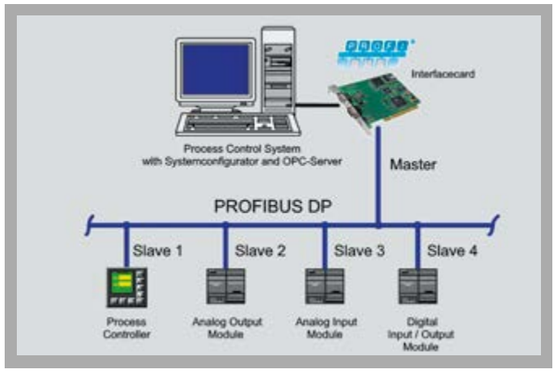
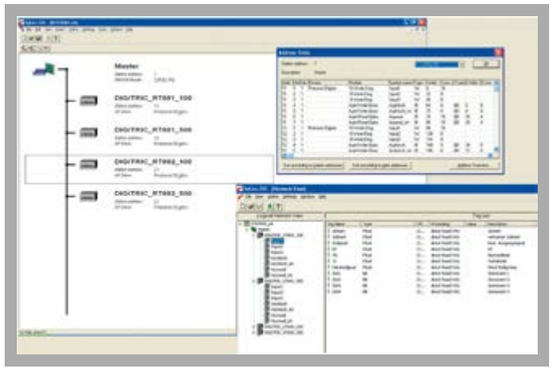
RT 370 Setup of Field Bus Systems



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



Topology of the field bus used, with master and slaves



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

Specification

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

Technical Data

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

Signal generator: 0...10V
Digital voltmeter: 0...20V
Process variables as analogue signals: 0...10V
4 analogue inputs: 0...10V
2 analogue outputs: 0...10V
4 digital inputs, 4 digital outputs
Connection of external instruments (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 480x450x150mm
Weight: approx. 10kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.37000 RT 370 Setup of Field Bus Systems

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RT 380 Optimization of Control Loops

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

Technical Description

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

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

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

Learning Objectives / Experiments

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

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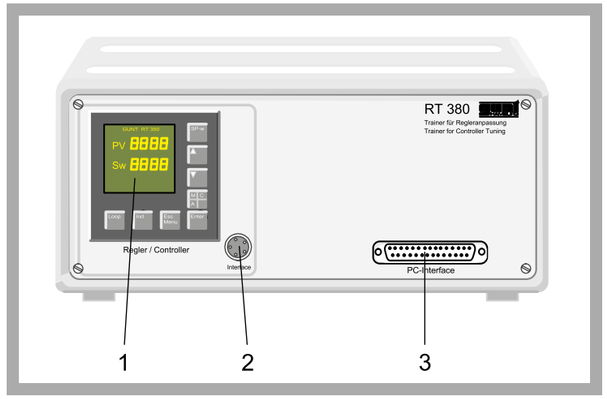
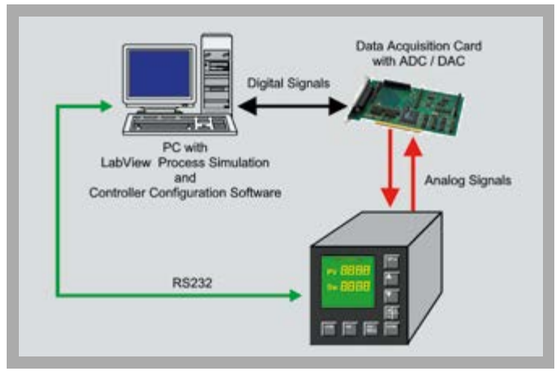
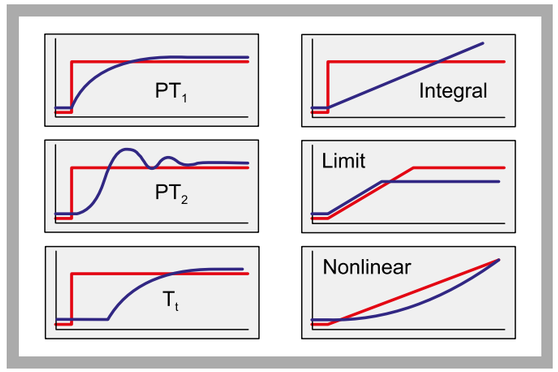
RT 380 Optimization of Control Loops



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



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



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

Specification

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

Technical Data

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

Process variables as analogue signals: 0...10V
Controlled system simulation models with proportional, integral, first-order lag, second-order lag
Time-delayed response, non-linearity and limitation possible

Dimensions and Weight

LxWxH: 370x330x150mm
Weight: approx. 5kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.38000 RT 380 Optimization of Control Loops

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RT 010 – RT 060 EXPERIMENTS IN THE FUNDAMEN TALS OF PROCESS CONTROL

RT 020 *Training System: Flow Control, HSI*

RT 030 *Training System: Pressure Control, HSI*

RT 040 *Training System: Temperature Control, HSI*

RT 050 *Training System: Speed Control, HSI*

RT 060 *Training System: Position Control, HSI*

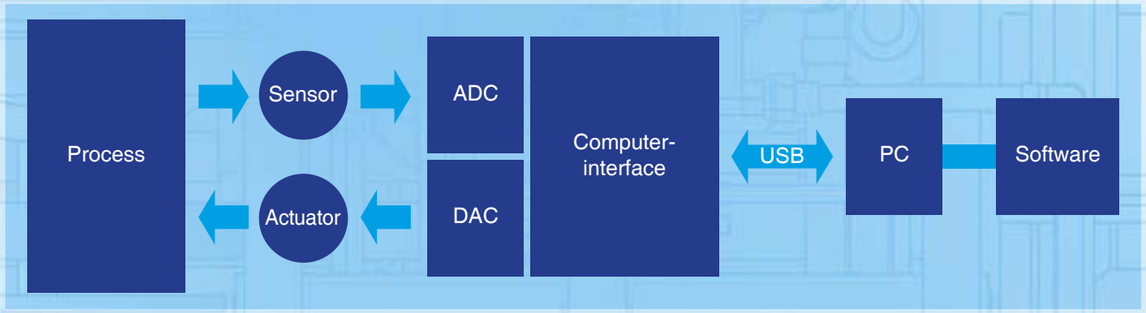
Process control is a key area in any study of automation.

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

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

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

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



Advantages

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

Comprehensive experiment programme for each trainer:

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

Comprehensive instruction material sets out the fundamentals and provides a step-by-step guide through the experiments.

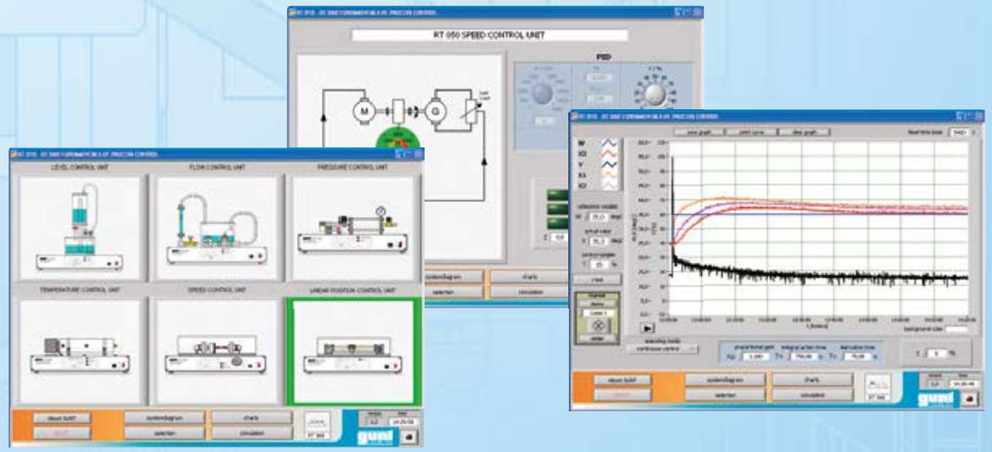
Software

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

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

Software functionality

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



RT 010 Training System: Level Control, HSI

*** Experimental unit with clear level control system**

*** Extensive range of experiments on fundamentals of control engineering**

*** State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**

*** Software-based simulation of the controlled system**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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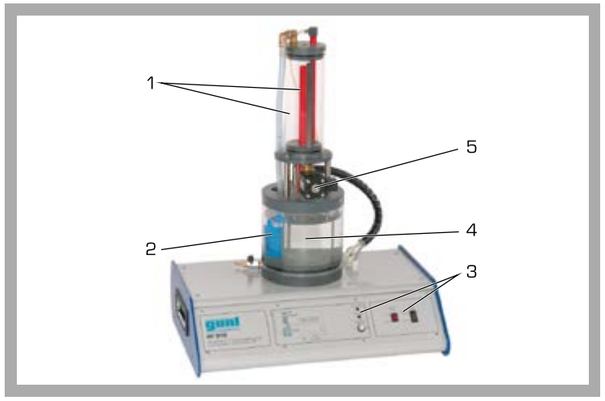
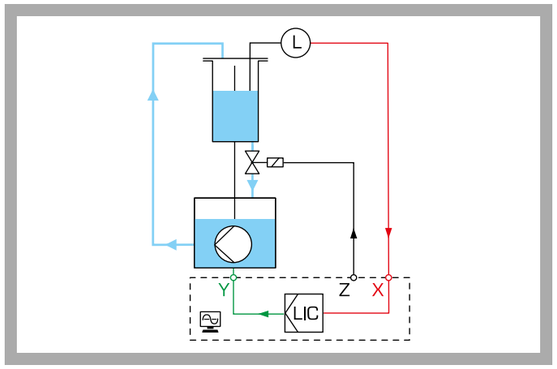
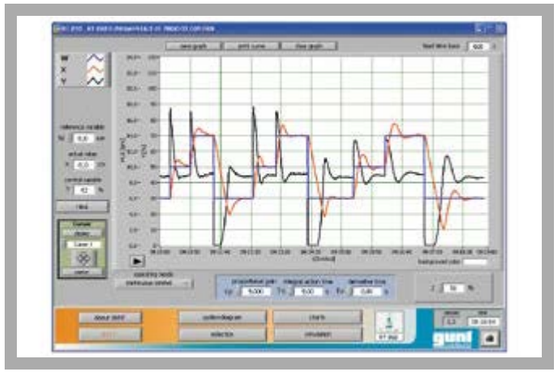
RT 010 Training System: Level Control, HSI



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



Process schematic



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

Specification

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

Technical Data

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

Dimensions and Weight

LxWxH: 600x450x800mm
Weight: approx. 22kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.01000	RT 010	Training System: Level Control, HSI

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RT 020 Training System: Flow Control, HSI

*** Experimental unit with clear flow control system**

*** Extensive range of experiments on fundamentals of control engineering**

*** State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**

*** Software-based simulation of the controlled system**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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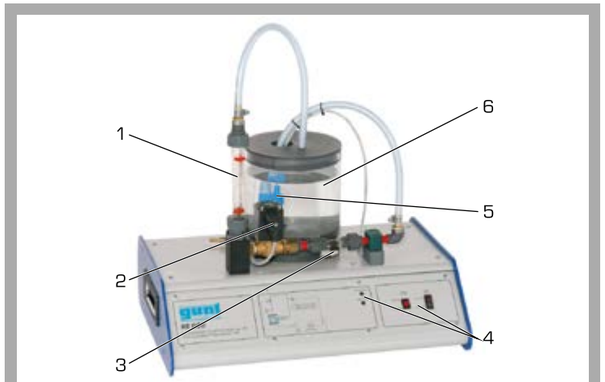
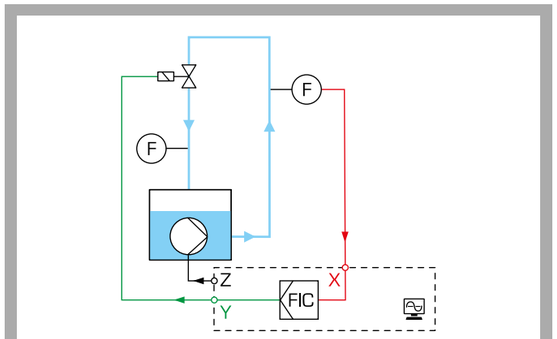
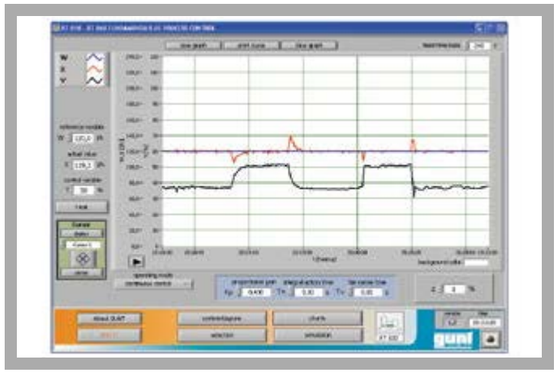
RT 020 Training System: Flow Control, HSI



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



Process schematic



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

Specification

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

Technical Data

Storage tank
- capacity: approx. 3000mL

Pump
- power consumption: 18W
- max. flow rate: 8L/min
- max. head: 6m

Rotameter: 20...250L/h
Proportional valve: Kvs: 0,7m³/h
Flow sensor: 0,5...3L/min
Software controller configurable as P, PI, PID and switching controller
Software
- process schematic with controller type selection (manual, continuous controller, two- or three-point controller, programmer)
- time functions
- simulation function
- disturbance variable input

Dimensions and Weight

LxWxH: 600x450x600mm
Weight: approx. 21kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.02000 RT 020 Training System: Flow Control, HSI

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RT 030 Training System: Pressure Control, HSI

*** Experimental unit with diaphragm gas pump and pressure tank**

*** Extensive range of experiments on fundamentals of control engineering**

*** State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**

*** Software-based simulation of the controlled system**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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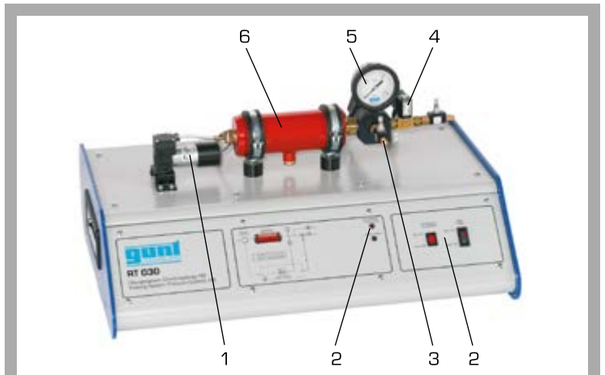
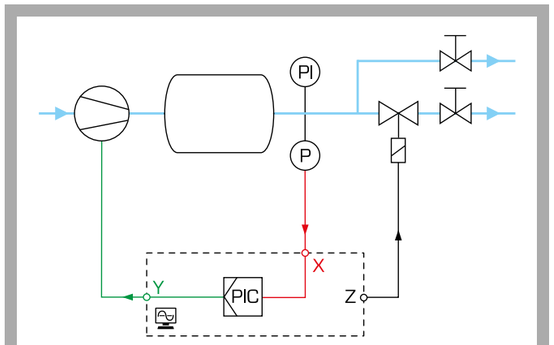
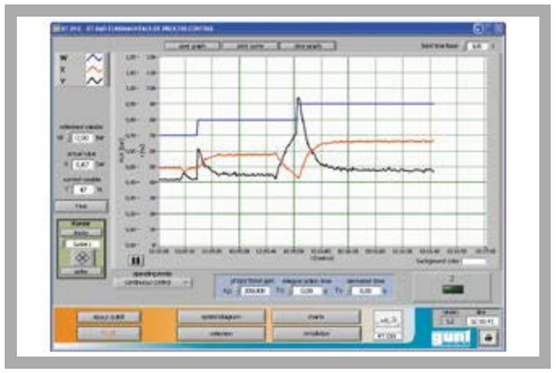
RT 030 Training System: Pressure Control, HSI



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



Process schematic



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

Specification

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

Technical Data

Diaphragm gas pump
- max. flow rate: 3L/min
- max. positive pressure: 1bar
- max. negative pressure: 250mbar abs.

Pressure tank
- capacity: 400mL
- operating pressure: 1bar
- max. pressure: 10bar

Pressure control range: 0...1bar
Solenoid valve: Kvs: 0,11m³/h
Pressure transducer: 0...1bar
Manometer: 0...1bar
Software controller configurable as P, PI, PID and switching controller
Software
- process schematic with controller type selection (manual, continuous controller, two- or three-point controller, programmer)
- time functions
- simulation function
- disturbance variable input

Dimensions and Weight

LxWxH: 600x450x340mm
Weight: approx. 18kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.03000	RT 030	Training System: Pressure Control, HSI

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RT 040 Training System: Temperature Control, HSI

*** Experimental unit with temperature control system**

*** Extensive range of experiments on fundamentals of control engineering**

*** Heating and cooling with Peltier element**

*** State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**

*** Software-based simulation of the controlled system**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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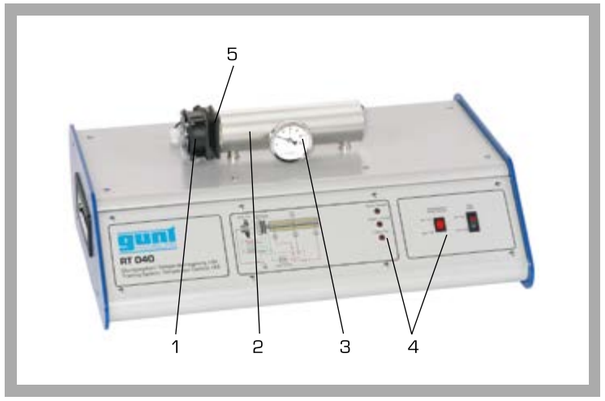
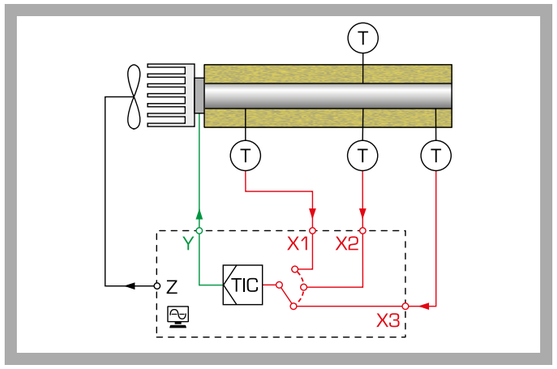
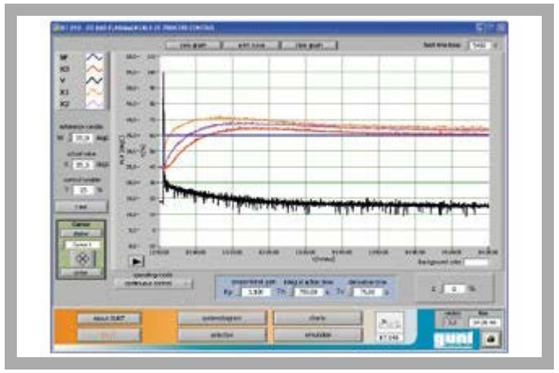
RT 040 Training System: Temperature Control, HSI



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



Process schematic



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

Specification

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

Technical Data

Heated bar: DxL: 20x200mm, aluminium
Peltier element
- power consumption depending on temperature
  power at 300K: 38,2W
  power at 50°C: 44,3W
- operated by DC voltage

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

Temperature sensor: 0...100°C
Thermometer: 0...100°C
Temperature control range: 0...100°C
Software controller configurable as P, PI, PID and switching controller
Software
- process schematic with controller type selection (manual, continuous controller, two- or three-point controller, programmer)
- time functions
- simulation function
- disturbance variable input

Dimensions and Weight

LxWxH: 600x450x260mm
Weight: approx. 16kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.04000	RT 040	Training System: Temperature Control, HSI

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RT 050 Training System: Speed Control, HSI

*** Experimental unit with speed control system**

*** Extensive range of experiments on fundamentals of control engineering**

*** State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**

*** Software-based simulation of the controlled system**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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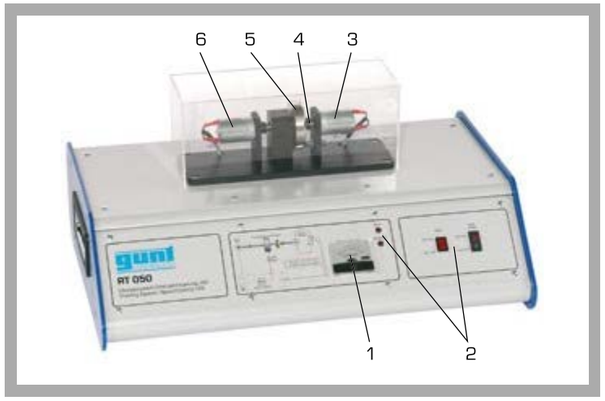
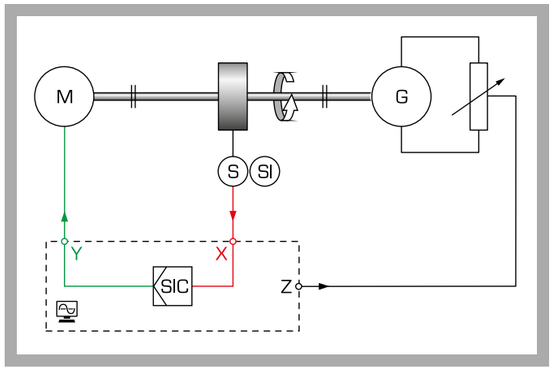
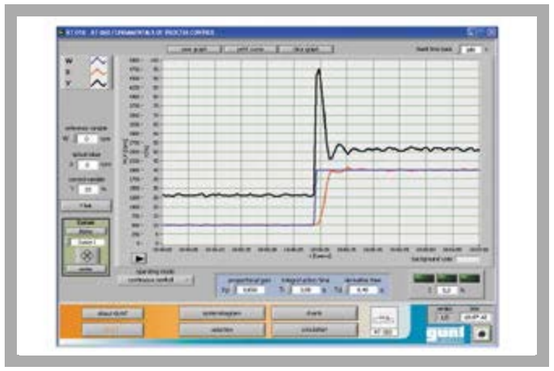
RT 050 Training System: Speed Control, HSI



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



Process schematic



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

Specification

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

Technical Data

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

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

Tachometer (analogue): 0...6000min^{-1}
Software controller configurable as P, PI and PID controller
Software
- process schematic with controller type selection (manual, continuous controller, programmer)
- time functions
- simulation function
- disturbance variable input

Dimensions and Weight

LxWxH: 600x450x310mm
Weight: approx. 18kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.05000 RT 050 Training System: Speed Control, HSI

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RT 060 Training System: Position Control, HSI

*** Experimental unit with clear linear position control system**

*** Extensive range of experiments on fundamentals of control engineering**

*** State-of-the-art software for all experimental units of the RT 010 - RT 060 series, with extensive controller and recorder functions**

*** Software-based simulation of the controlled system**

Technical Description

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

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

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

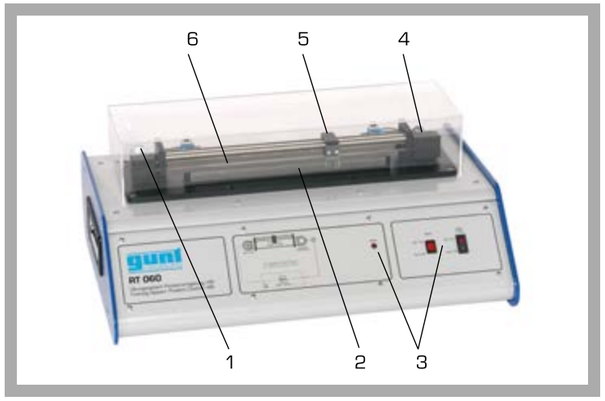
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

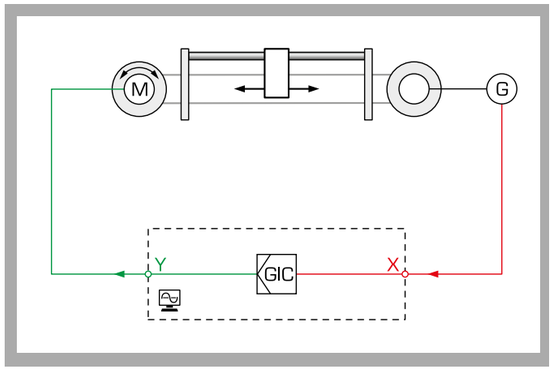
- fundamentals of control engineering based on the example of a linear position control system with integral control action
- open loop control response
- effects of different controller parameters and methods on the response of the closed loop system
- recording of step responses
  * reference variable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

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

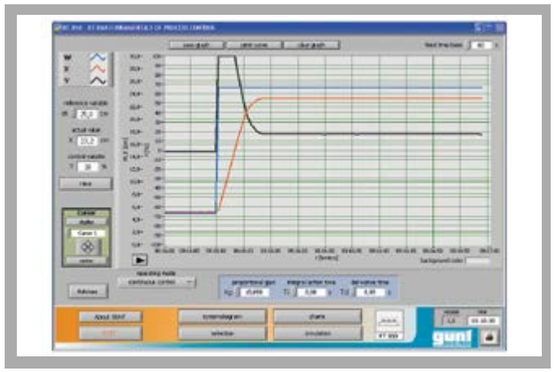
RT 060 Training System: Position Control, HSI



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



Process schematic



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

Specification

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

Technical Data

DC motor
- transmission ratio: i=50
- speed: 85min^{-1}
- torque: 200Nmm

Travel: max. 300mm
Max. traverse rate: 45mm/s
Scale: 0...300mm
Software controller configurable as P, PI, PID
Software
- process schematic with controller type selection (manual, continuous controller, programmer)
- time functions
- simulation function

Dimensions and Weight

LxWxH: 600x450x280mm
Weight: approx. 20kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.06000 RT 060 Training System: Position Control, HSI

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

INSTRUCTIONAL MATERIAL AND SOFTWARE

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

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

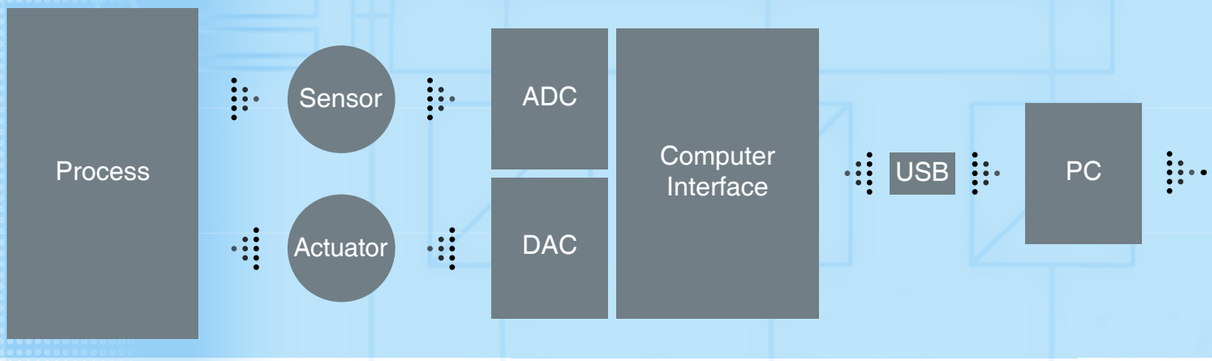
FUNDAMENTALS OF PROCESS CONTROL

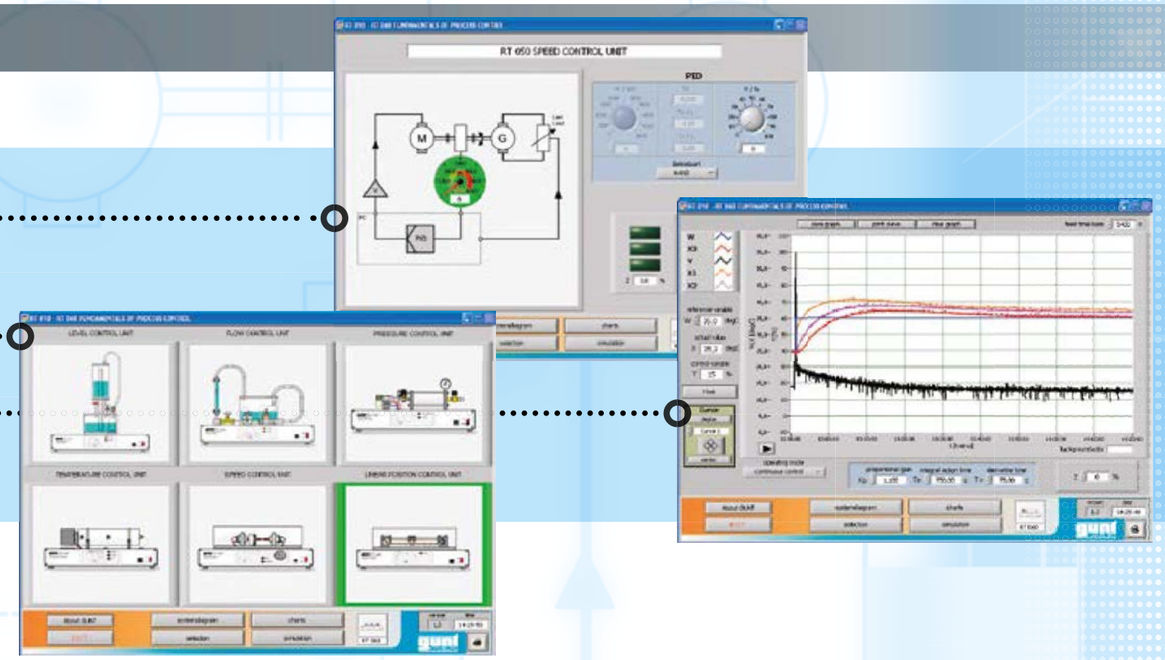
Simple, quickly understandable controlled system models with extensive software functions

- *Temperature*
- *Level*
- *Flow*
- *Pressure*
- *Speed*
- *Position*

THE SERIES PROVIDING AN EASY INTRODUCTION TO A COMPLEX SUBJECT

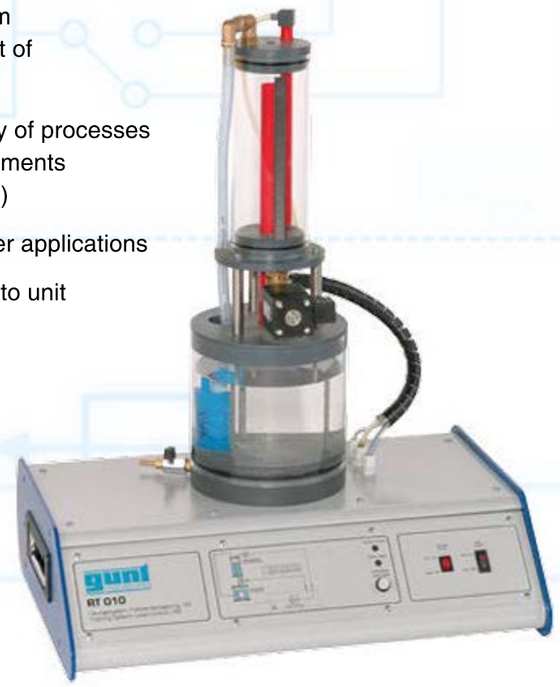
The Equipment Concept with Hardware/Software Integration (HSI)





Hardware

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

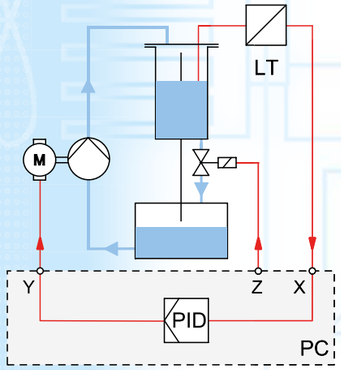


RT 010 *Level Control*

Software

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

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

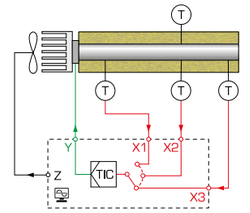


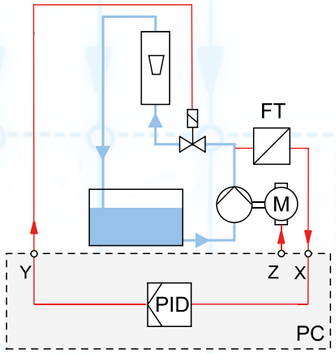
RT 010 *Level Control*

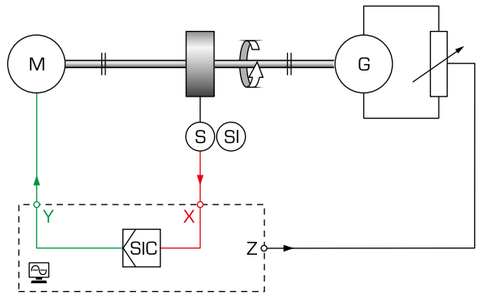
- Level recording by pressure sensor
- Level control by speed of pump
- Electromagnetic valve to generate disturbance variables

RT 040 *Temperature Control*

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





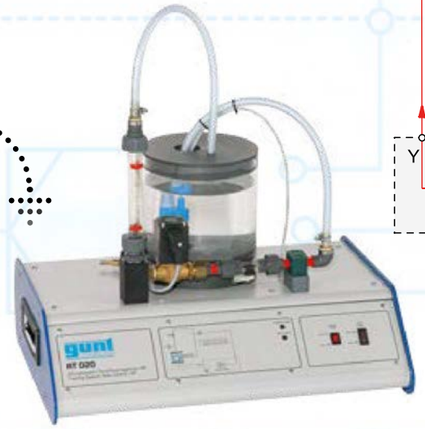


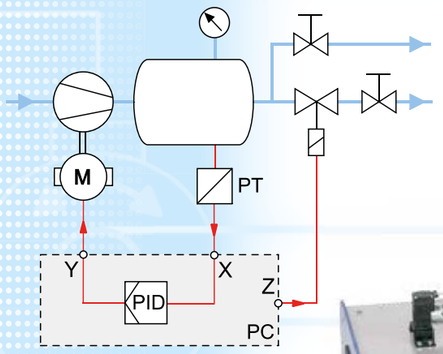
RT 050 *Speed Control*

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

RT 020 *Flow Control*

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



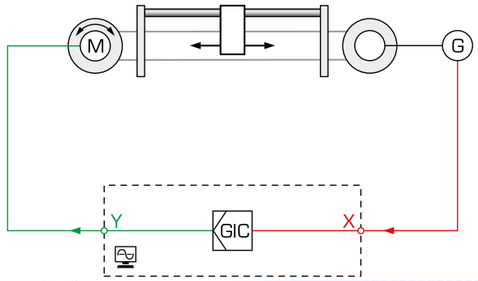


RT 030 *Pressure Control*

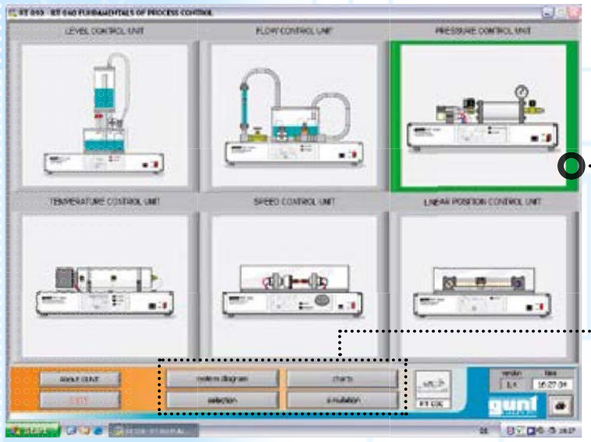
- Electronic pressure sensor
- Speed controlled diaphragm pump as actuator
- Solenoid valve to generate disturbance variables

RT 060 *Position Control*

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

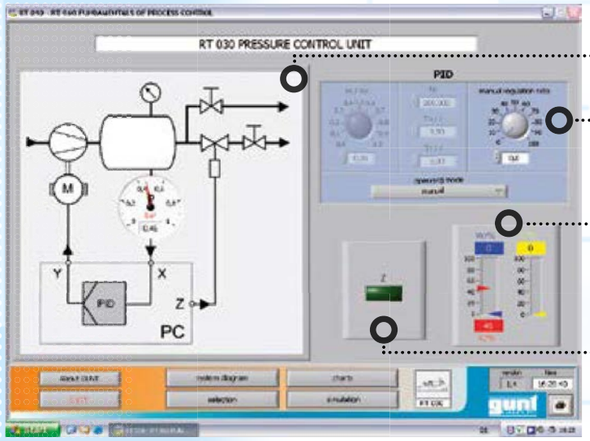


The Software: Easy Operation with Selectable User Interfaces



Unit Selection

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



System Diagram

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

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

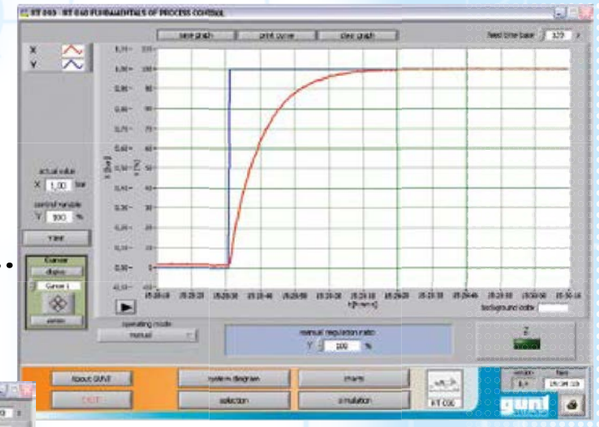
Variations in Time

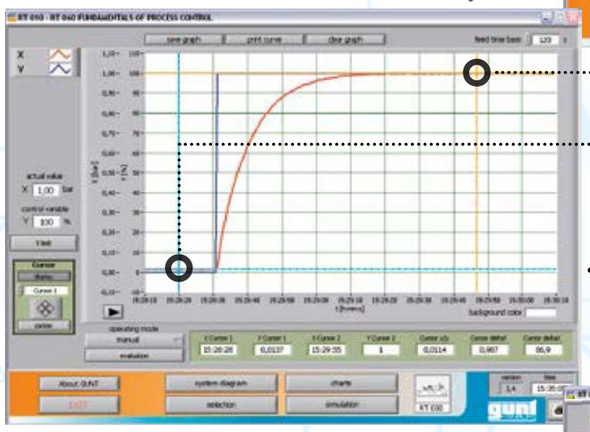
- Representation of control parameters as a function of time
  - Reference variable (yellow)
  - Controlled variable (red)
  - Manipulating variable (green)
  - Freely selectable colours of backgrounds and lines

Identification of a Real Controlled System and Adaptation of Controller Parameters

Recording of step response (pressure control system RT 030):

- Manipulating variable in blue
- Controlled variable in red

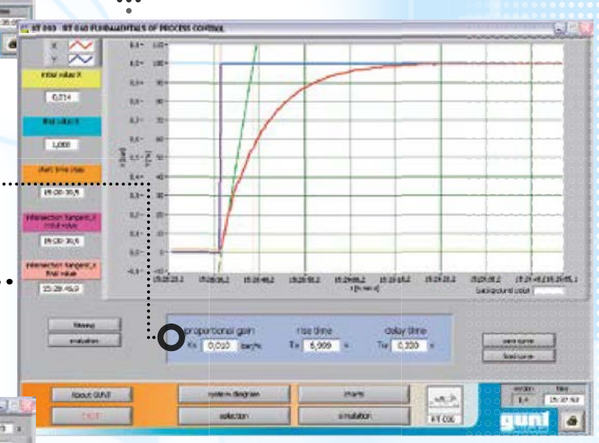


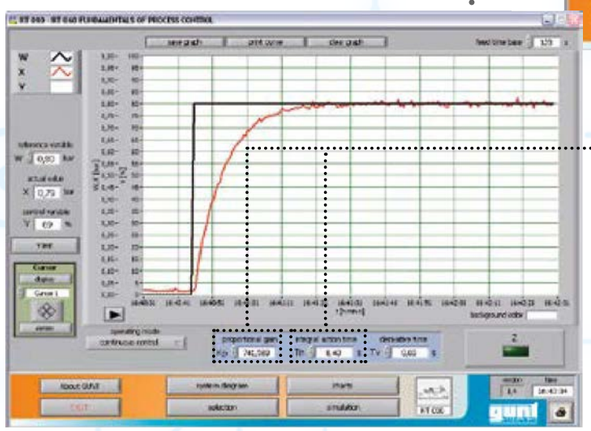


- Positioning of cursors before and after the controlled variable step as preparation for inflectional tangent method

Automatic identification of controlled system by inflectional tangent method

Output of controlled system parameters



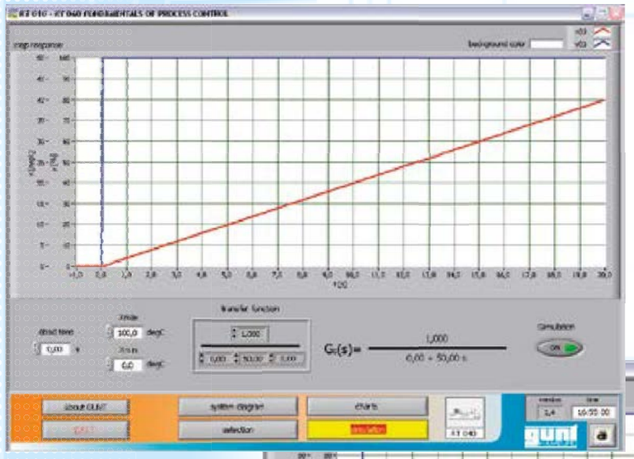


- Parameter setting of a PI controller:
- Calculation of gain and integral-action time from determined system parameters
- Observation of control behaviour of this controller after reference variable step:
  - Reference variable in black
  - Controlled variable in red

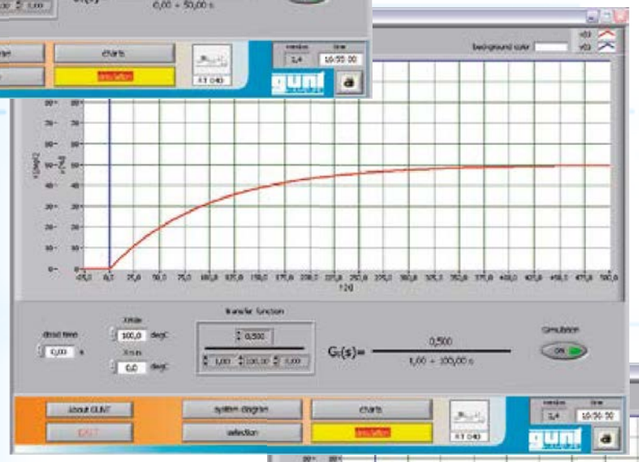
Simulation of Controlled Systems

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

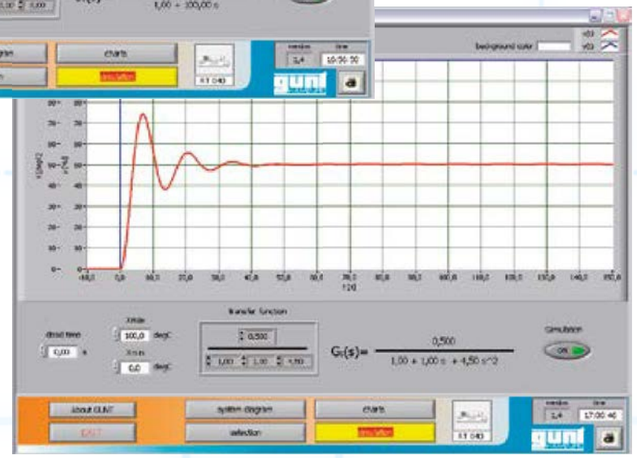
Real controlled systems usually have complex properties. The simulation mode enables elemental transfer functions to be entered and investigated.
It is therefore possible to teach the fundamentals of process control in a simple way.



Integral behaviour



PT_1 behaviour



PT_2 behaviour

Features of the Simulation Mode

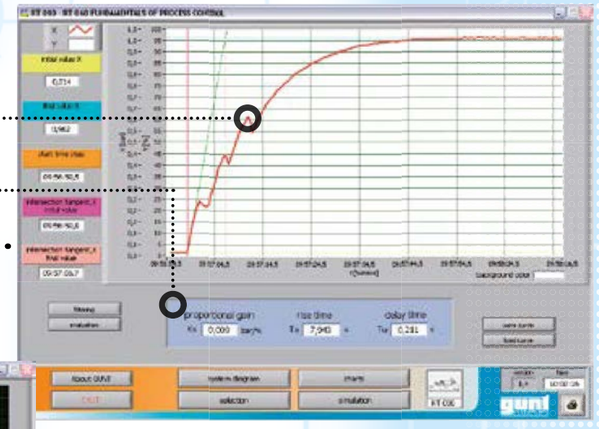
- In simulation mode, the controlled system is defined by input of a transfer function
- Step responses of the simulated system are automatically displayed
- All software controller types can be applied to the simulated system
- The behaviour of the simulated system can be investigated in the same way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

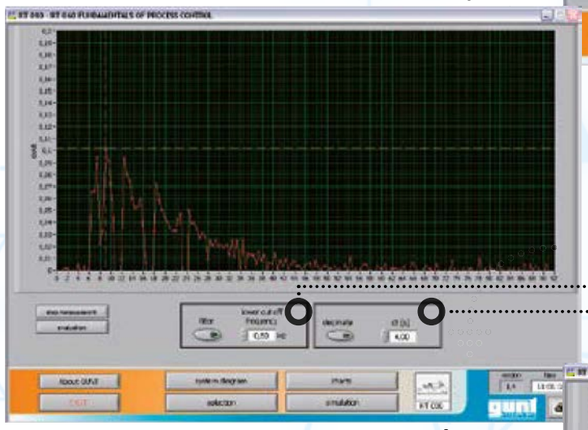
Editing of Step Responses by Filtering and Decimation

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

During recording of the step response a disturbance was repeatedly generated

The determined system parameters characterise the disturbed system

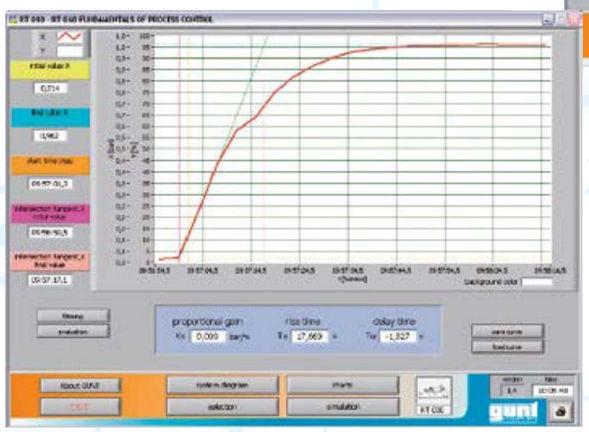




- Differentiation of the disturbed step response in “Filtering” mode
- Possible editing of the step response in two ways:
  - Activating a low-pass filter with input of the lower limit frequency
  - Decimation with input of the increment

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

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



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

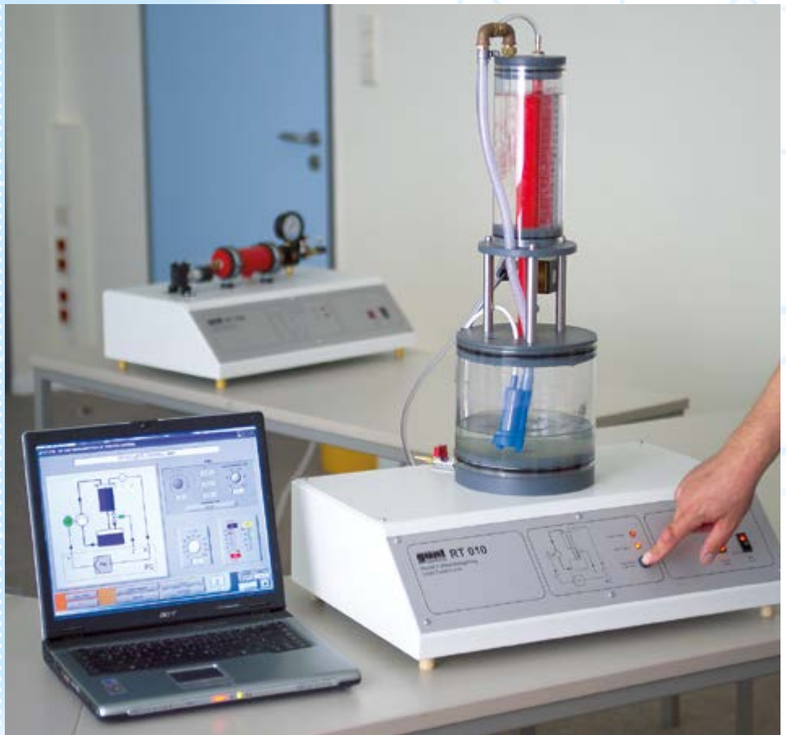
- Run of a curve is smoother compared to the unedited step response
- The new run of a curve causes a change in the determined system parameters

Easy Switching in between the Units of this Series:

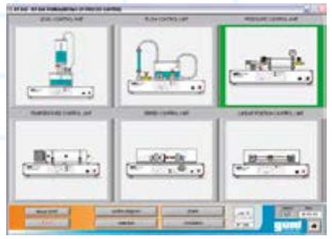
- *ONE software for ALL units*
- USB connection

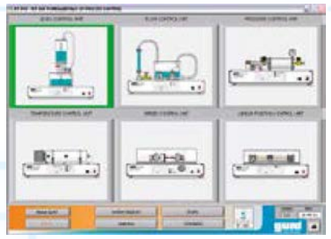
The **RT 030** ***Pressure Control*** unit is still running.

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



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



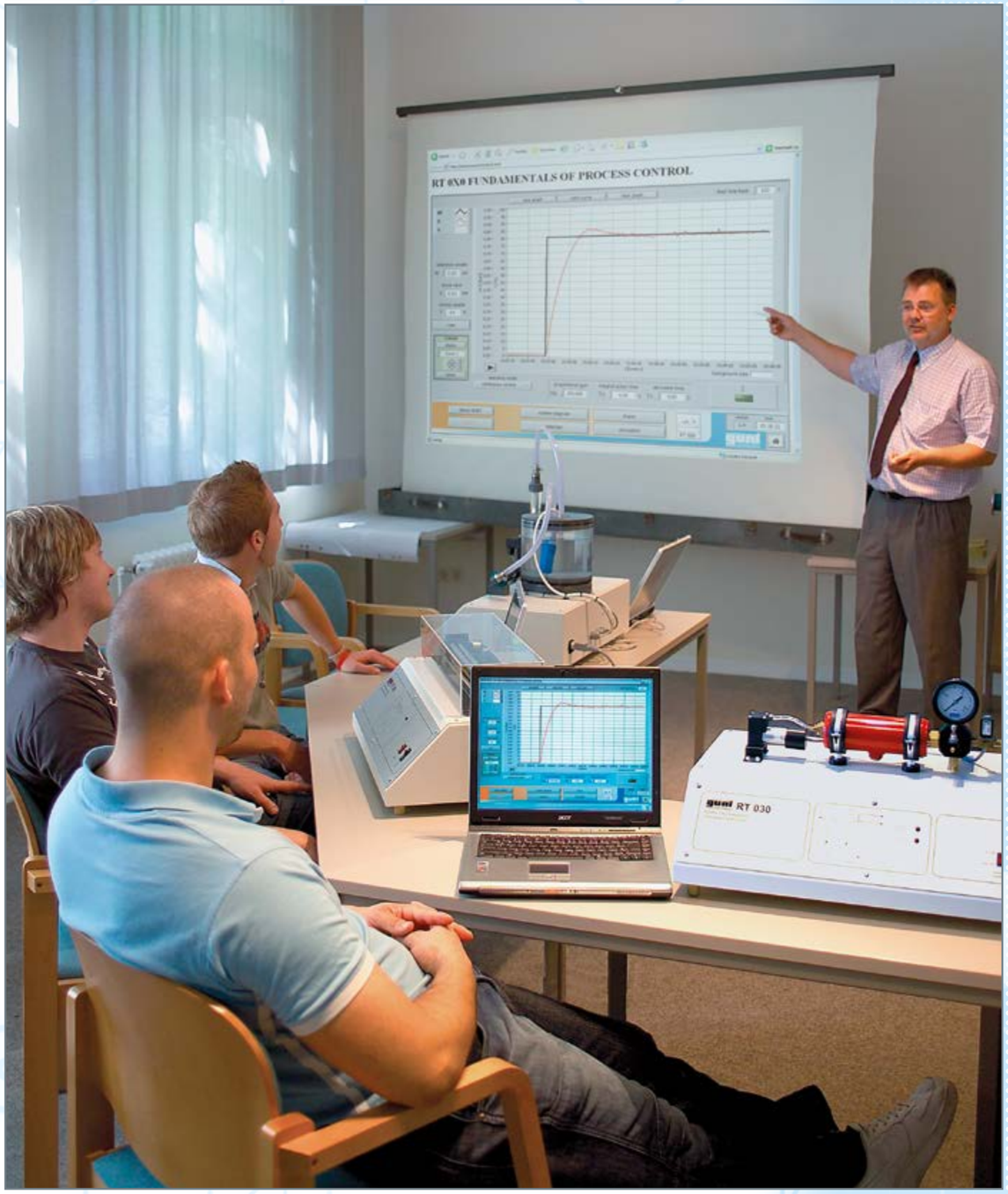


The green frame indicates the active unit.

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

Access to Single-User Workstations via Local Network:

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



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

RT 614 – RT 674 INTRODUCTION TO INDUSTRIAL PROCESS CONTROL

RT 614 *Level Control Demonstration Unit*

RT 624 *Flow Control Demonstration Unit*

RT 634 *Pressure Control Demonstration Unit*

RT 674 *Flow / Level Control Demonstration Unit*

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

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

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

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

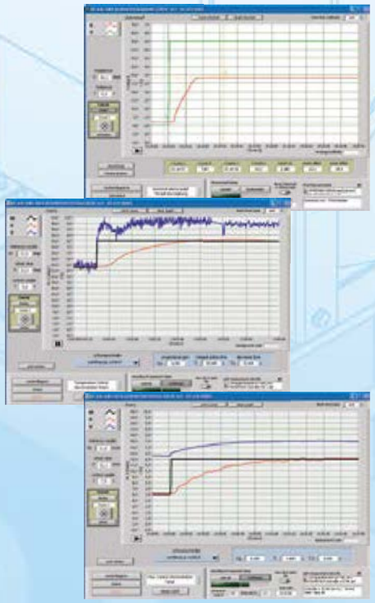
The systems are suitable for two learning situations: demonstration by the tutor or independent laboratory experimentation by the students.

RT 644 *Temperature Control Demonstration Unit*

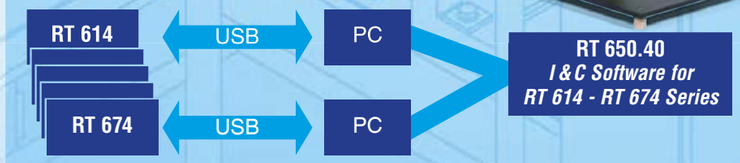
Didactic goals and exercises

- Introduction to the fundamentals of process control based on experimentation
- Familiarisation with different types of controlled system (if multiple training rigs are available)
- Familiarisation with current industrial process control components: controllers, transducers, actuators
- User control and parameter setting of a state-of-the-art digital industrial controller
- Multi-variable control (cascade control with RT 674)
- Downstream processing of process variables with external recording devices: chart recorder, oscilloscope
- Familiarisation with and use of instrumentation and control software (accessory RT 650.40)

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



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



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

RT 614 Level Control Demonstration Unit

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

*** Construction of the system with components commonly used in industry**

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

*** Optional I&C software RT 650.40 via USB**

Technical Description

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

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

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

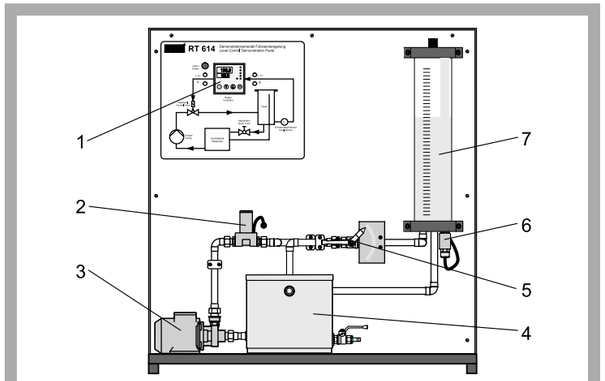
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

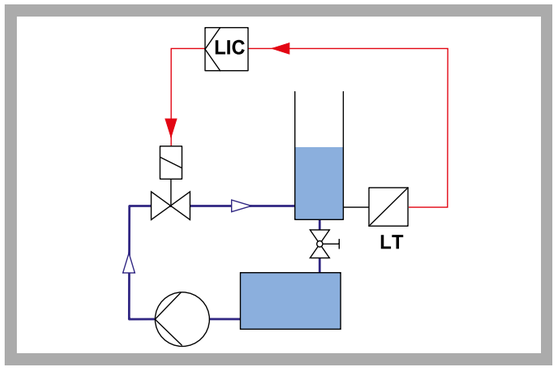
- fundamentals of control engineering
- latest industrial control engineering components: controllers, transducers, actuators
- operation and parameter setting of a multi-functional state-of-the-art digital controller: e.g. parameter setting as P, PI and PID controller
- investigation of disturbance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

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

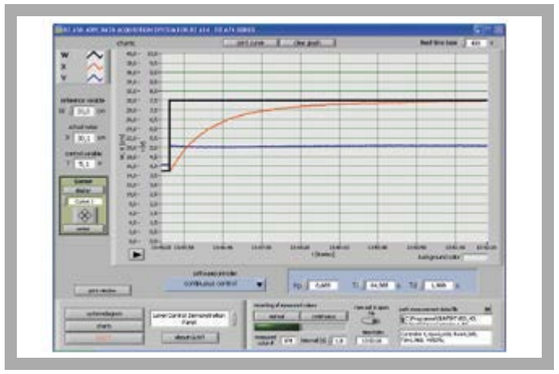
RT 614 Level Control Demonstration Unit



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



Process schematic



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

Specification

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

Technical Data

Storage tank
- stainless steel
- capacity: 15L

Pump, 3-stage
- power consumption: 100W
- max. flow rate: 70L/min
- max. head: 5,6m

Pressure sensor: 0...100mbar
Electromagnetic proportional valve: Kvs: 1,1m³/h
Controller: parameterisable as P, PI or PID controller
Process variables as analogue signals: 0...10V
Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 1000x500x1070mm
Weight: approx. 73kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.61400	RT 614	Level Control Demonstration Unit

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 624 Flow Control Demonstration Unit

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

*** Construction of the system with components commonly used in industry**

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

*** Optional I&C software RT 650.40 via USB**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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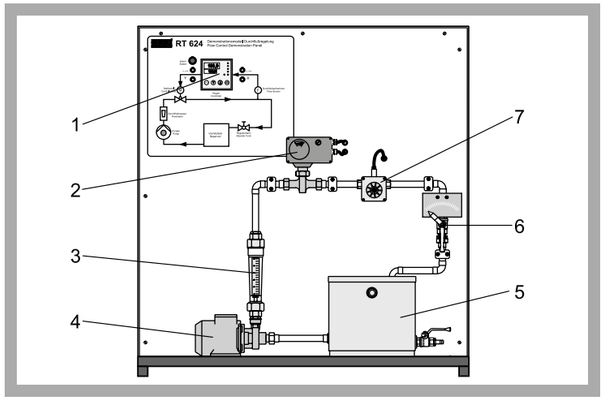
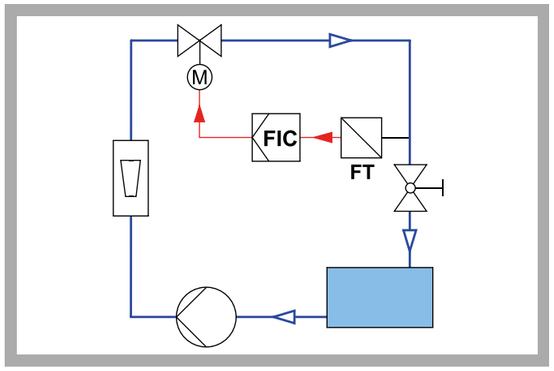
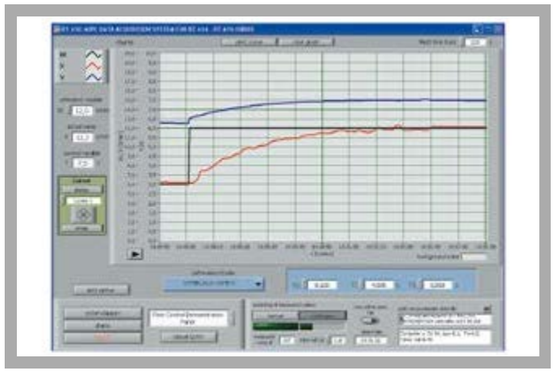
RT 624 Flow Control Demonstration Unit



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



Process schematic



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

Specification

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

Technical Data

Storage tank
- stainless steel
- capacity: 15L

Pump, 3-stage
- power consumption: 90W
- max. flow rate: 83L/min
- max. head: 6m

Paddle-wheel sensor: 3...50L/min
Electric control valve: Kvs: 5,7m³/h
Controller parameterisable as P, PI or PID controller
Process variables as analogue signals: 0...10V
Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 1000x500x1070mm
Weight: approx. 72kg

Required for Operation

230V, 50Hz, 1 phase

Scope of Delivery

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

Order Details

080.62400	RT 624	Flow Control Demonstration Unit

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RT 634 Pressure Control Demonstration Unit

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

*** Construction of the system with components commonly used in industry**

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

*** Optional I&C software RT 650.40 via USB**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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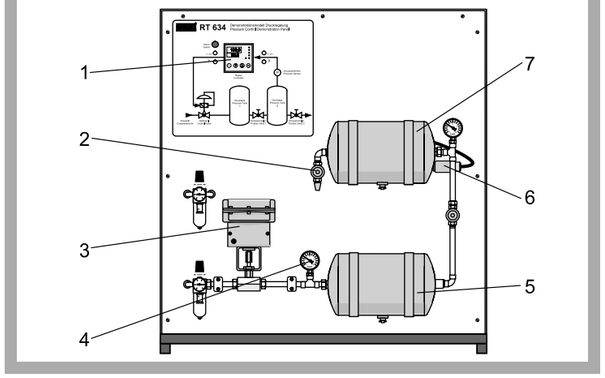
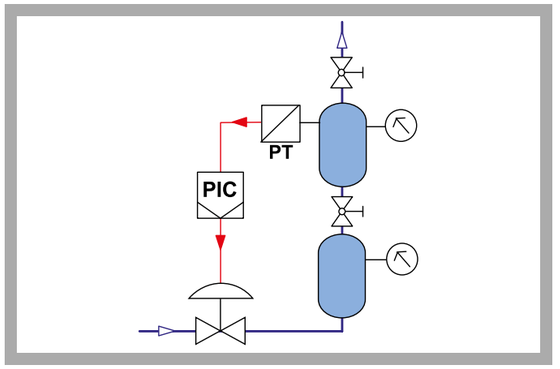
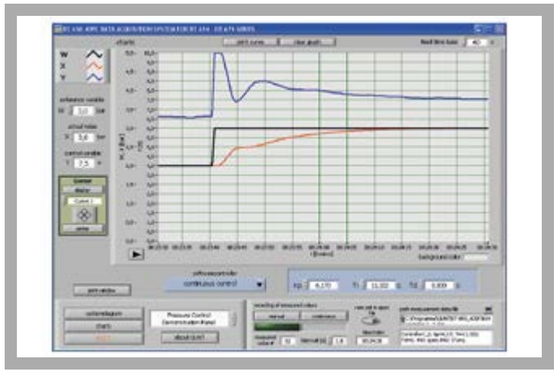
RT 634 Pressure Control Demonstration Unit



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



Process schematic



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

Specification

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

Technical Data

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

Dimensions and Weight

LxWxH: 1000x500x1070mm
Weight: approx. 57kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.63400 RT 634 Pressure Control Demonstration Unit

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RT 644 Temperature Control Demonstration Unit

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

*** Construction of the system with components commonly used in industry**

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

*** Optional I&C software RT 650.40 via USB**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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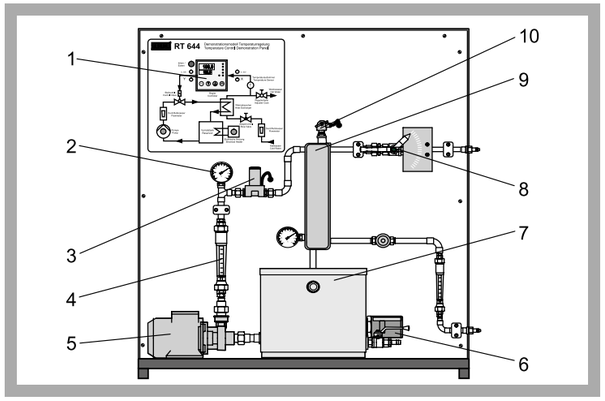
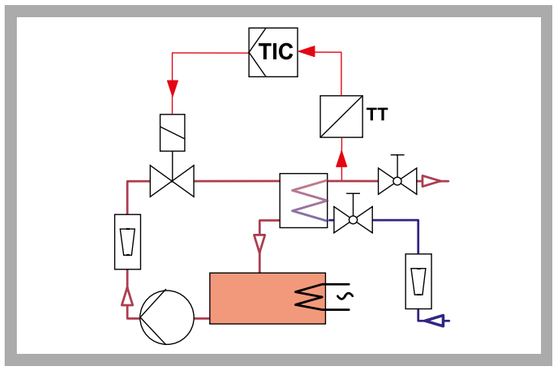
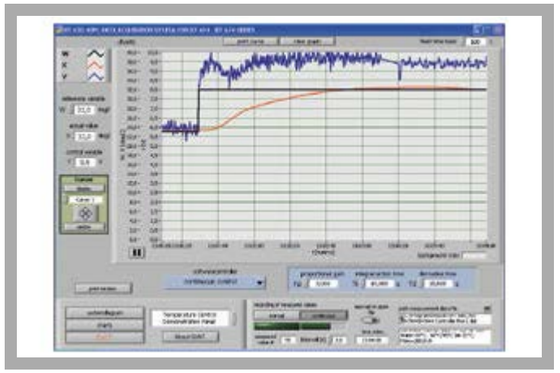
RT 644 Temperature Control Demonstration Unit



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



Process schematic



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

Specification

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

Technical Data

Tank
- stainless steel
- capacity: 15L

Heater
- power output: 2kW
- thermostat: 20...80°C

Pump, 3-stage
- power consumption: 90W
- max. flow rate: 83L/min
- max. head: 6m

Temperature sensor: Pt100: -50...400°C
2x dial-gauge thermometers (bimetal type): 0...80°C
2x rotameters: 30...320L/h
Electromagnetic proportional valve: Kvs: 0,8m³/h
Digital controller, can be parameterised as P, PI or PID controller
Process variables as analogue signals: 0...10V
Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 1000x500x1070mm
Weight: approx. 85kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.64400	RT 644	Temperature Control Demonstration Unit

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 674 Flow / Level Control Demonstration Unit

*** Experimental introduction to control engineering using an example of flow and / or level control**

*** Two controllers permit control in cascade mode**

*** Construction of the system with components commonly used in industry**

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

*** Optional I&C software RT 650.40 via USB**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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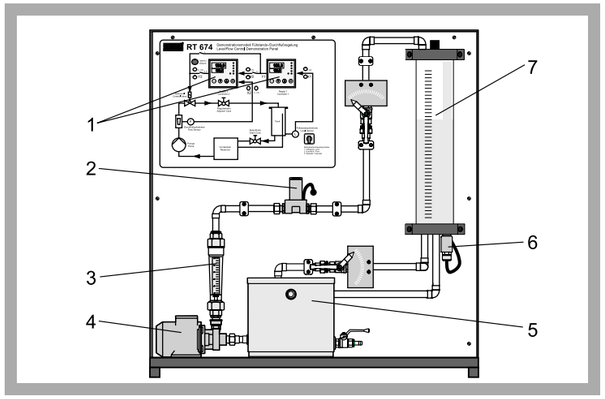
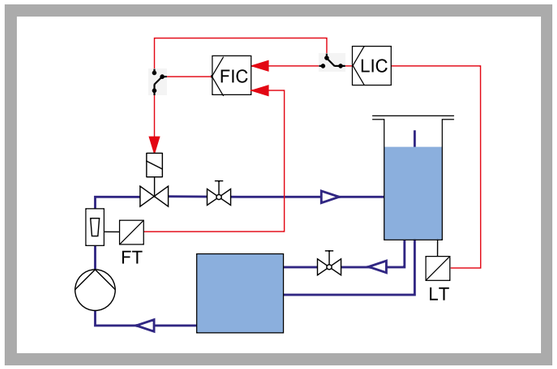
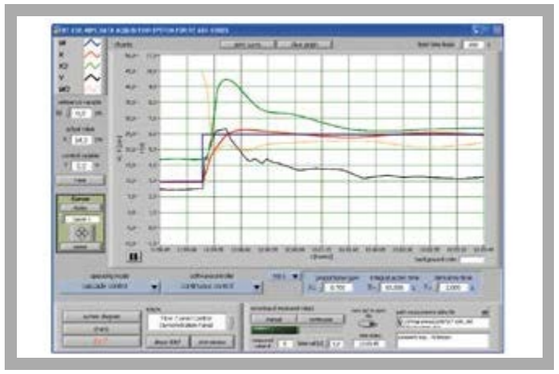
RT 674 Flow / Level Control Demonstration Unit



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



Process schematic



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

Specification

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

Technical Data

Storage tank
- stainless steel
- capacity: 15L

Pump, 3-stage
- power consumption: 90W
- max. flow rate: 83L/min
- max. head: 6m

Pressure sensor: 0...100mbar
Rotameter with electrical output: 0...600L/h
Electromagnetic proportional valve: Kvs: 1,1m³/h
2x controllers: parameterisable as P, PI or PID controller
Process variables as analogue signals: 0...10V
Connection of external recording devices (e.g. oscilloscope, line recorder) via lab jacks

Dimensions and Weight

LxWxH: 1000x500x1080mm
Weight: approx. 73kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.67400	RT 674	Flow / Level Control Demonstration Unit

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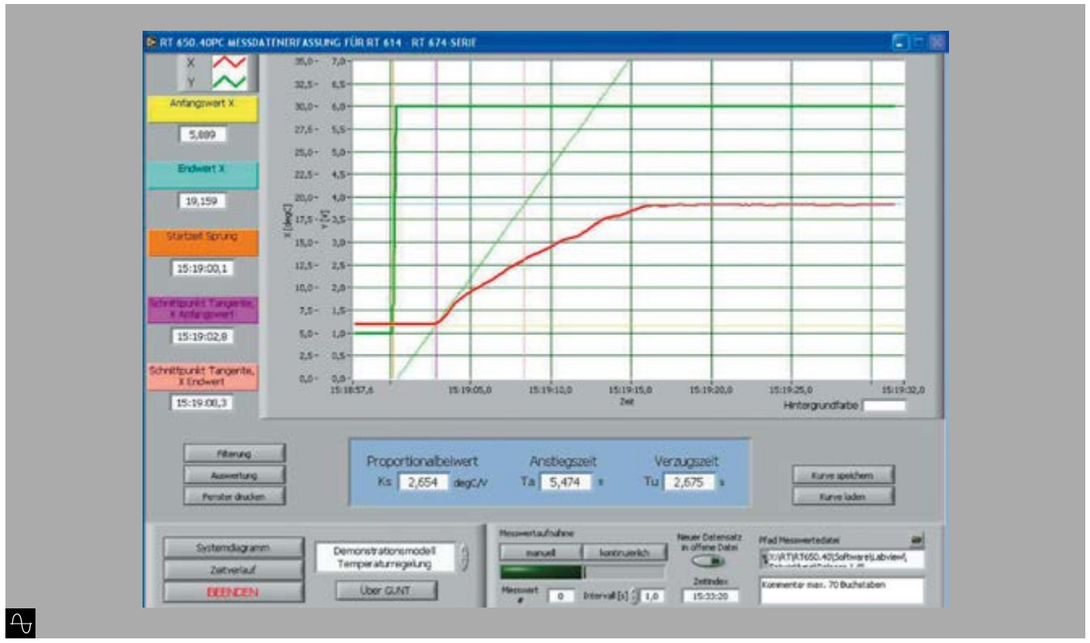
RT 650.40 I&C Software for RT 614 - RT 674 Series



*** Software controller with freely settable parameters**

*** Continuous and switching controller selectable**

*** Language freely selectable**

*** Process schematic with display of real-time data**

*** Recorder functions**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

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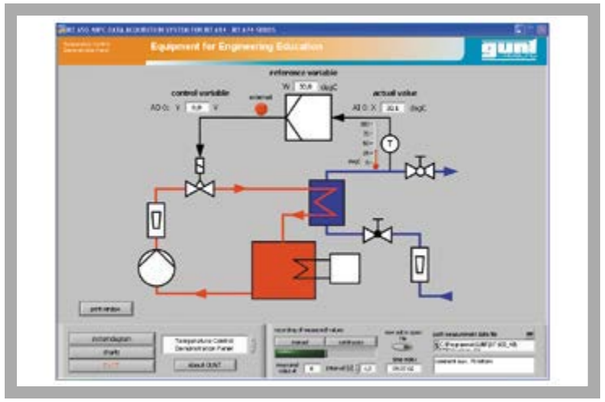
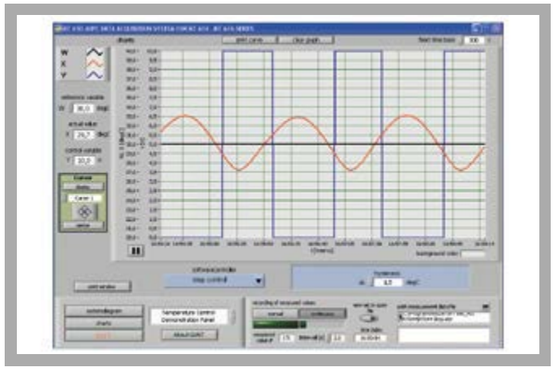
RT 650.40 I&C Software for RT 614 - RT 674 Series



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



Screenshot: 2-point temperature control

USB interface module

Specification

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

Technical Data

Software controller (continuous mode)
- configurable as P, PI or PID controller
- cascade control

Software controller (switching mode)
- 2-point response
- input of reference variable and hysteresis

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

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

Software basis
- LabVIEW
- system requirements: Windows Vista or Windows 7, USB port

Scope of Delivery

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

Order Details

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

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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.

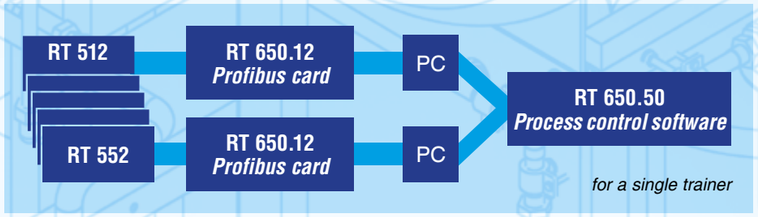
Process Control Software

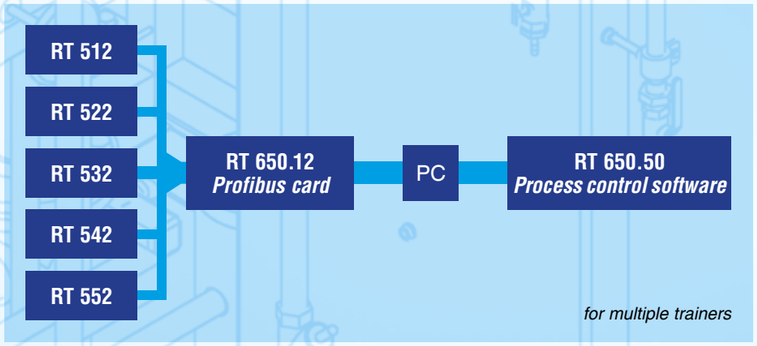
State-of-the-art LabVIEW-based process control software for Windows, featuring extensive monitoring and visualisation functionality:

- 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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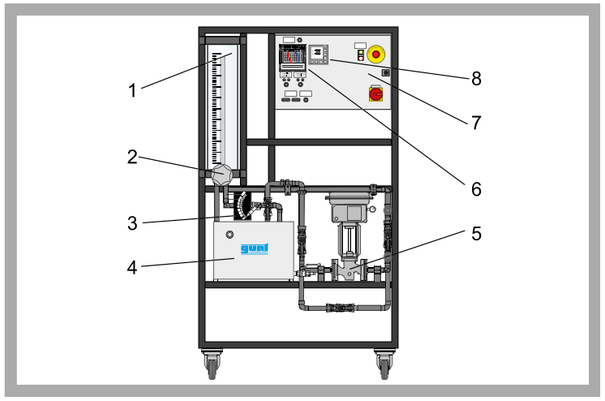
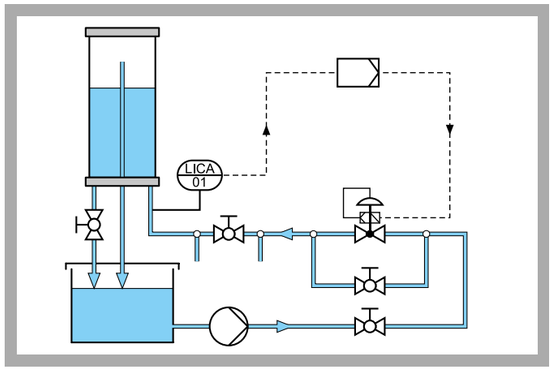
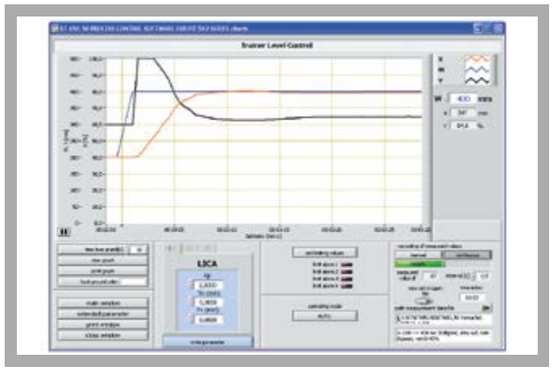
RT 512 Level Control Trainer



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

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 522 Flow Control Trainer

*** 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**

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 rate. 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)

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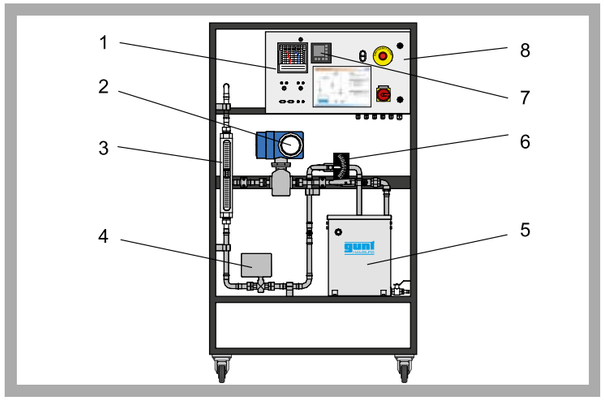
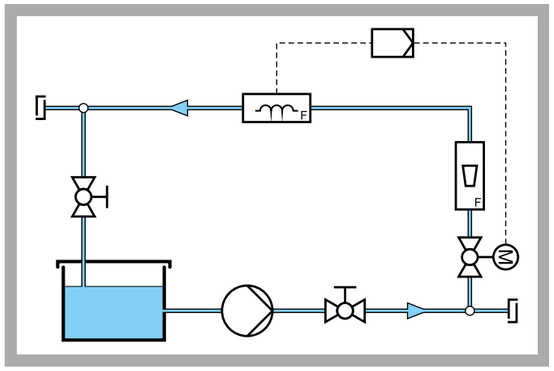
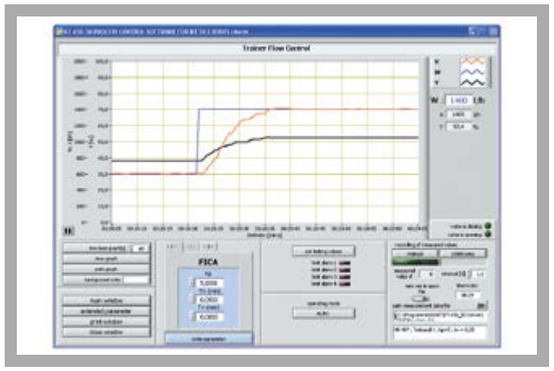
RT 522 Flow Control Trainer



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 rate
[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.

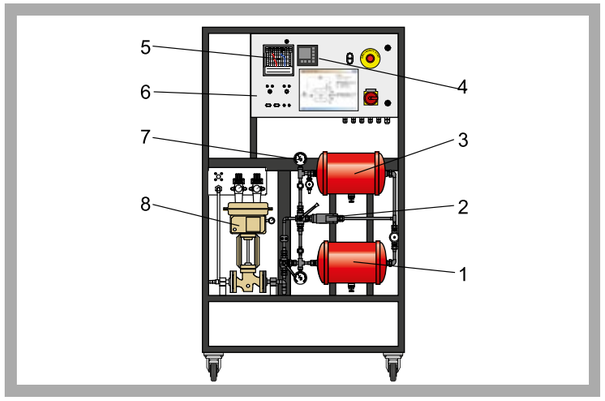
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

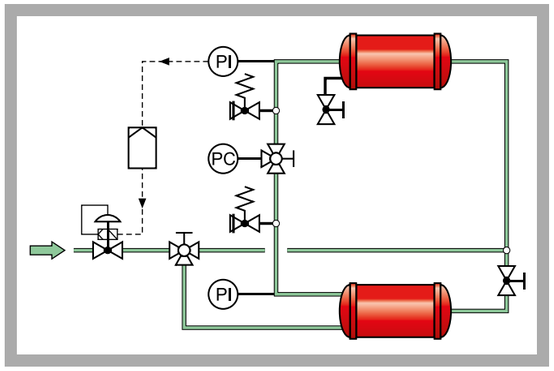
- fundamentals of control engineering
- real industrial control engineering components: controllers, transducers, actuators
- operation and parameterisation of the local industrial controller
  * manually (by keyboard)
  * using the RT 650.50 process control software
- control response to
  * 1st order 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)

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

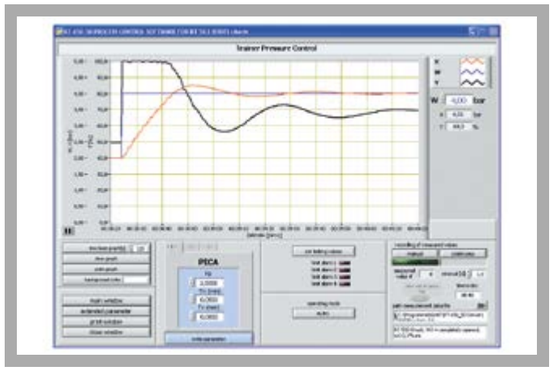
RT 532 Pressure Control Trainer



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

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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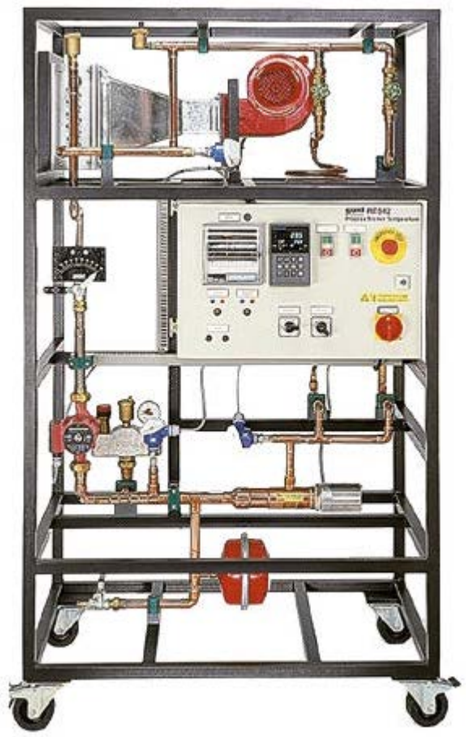
RT 542 Temperature Control Trainer



- *** 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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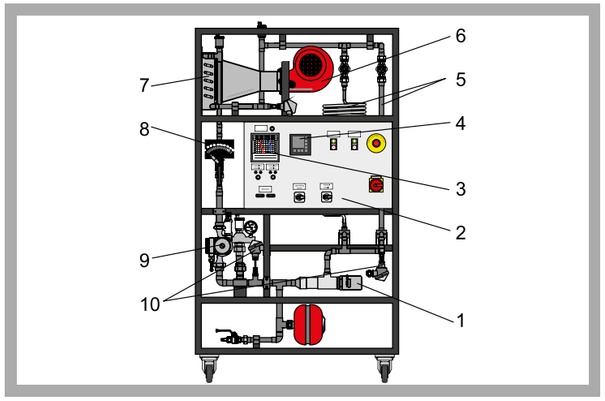
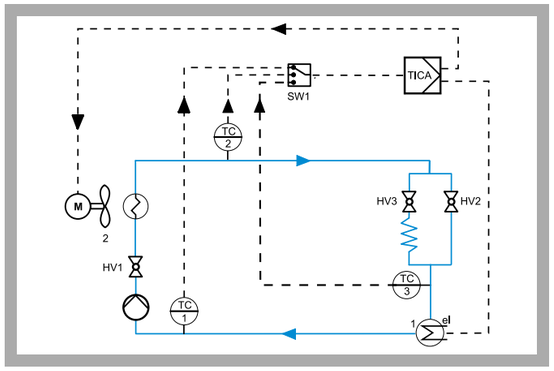
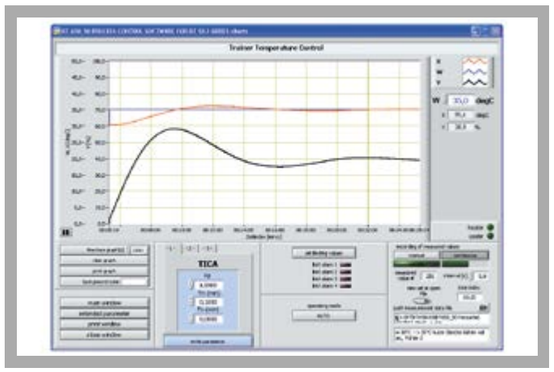
RT 542 Temperature Control Trainer



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

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 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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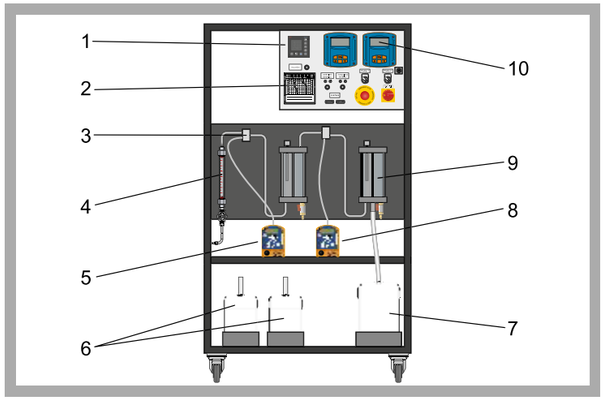
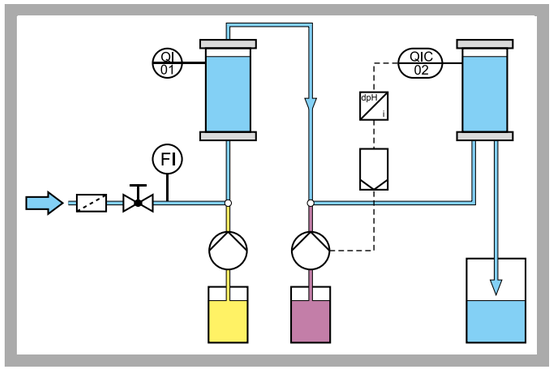
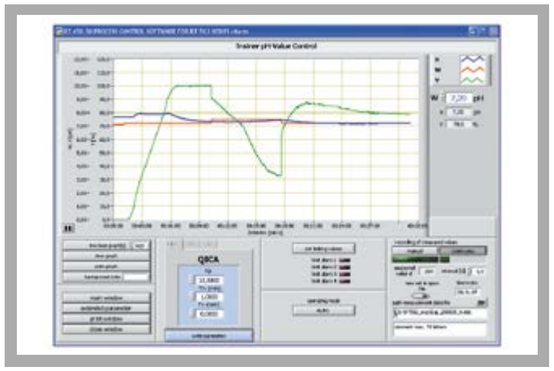
RT 552 pH Value Control Trainer



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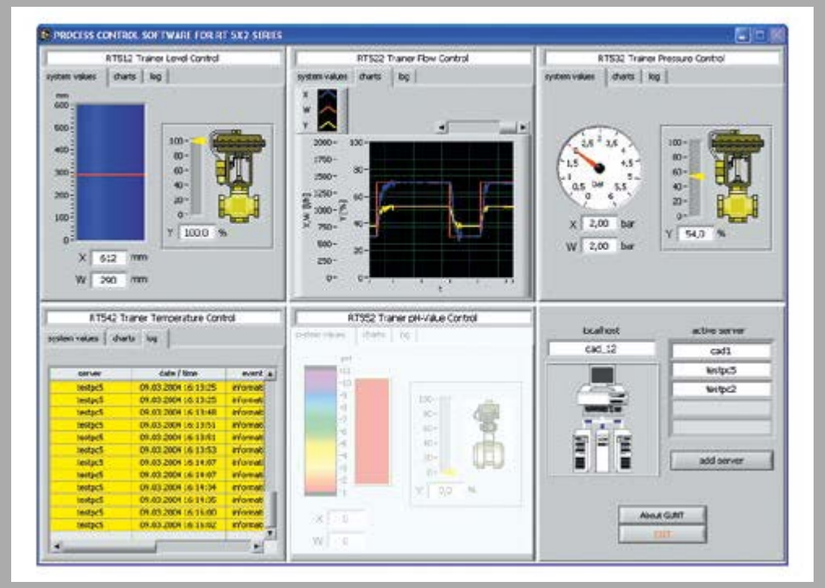
RT 650.50 Process Control Software for RT 512 - RT 552 Series



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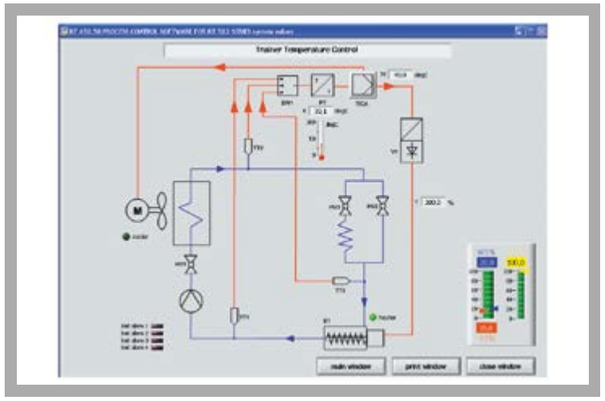
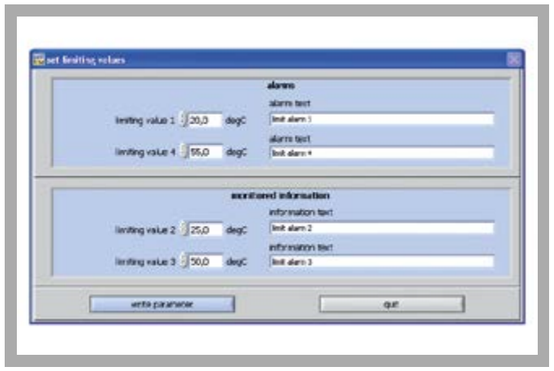
RT 650.50 Process Control Software for RT 512 - RT 552 Series



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

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

PROCESSES


Level Control


Pressure Control


Temperature Control


Flow Control

PROCESSES

COMPONENTS

RT 450.34 *Flow Rate Sensor: Electromagnetic*

RT 450.12 *Chart Recorder Module*

RT 450.42 *Part of the PLC Module*

The technological structure of the system

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

DETAILS

A highly expandable system

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

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

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

Our comprehensive and clearly structured instruction material will provide you and your students with a step-by-step introduction to a new technology field.


Industry-standard, flexible cabling


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

RT 450 Process Automation Training System: Base Module

*** Modular training system providing an introduction to the fundamentals of process automation**

*** Base module with large frame for preassembled components**

*** Extensive range of accessories available: process application modules, sensors, actuators, controllers, PLCs etc.**

*** Software for data acquisition, operator control and parameter setting optionally available**

Technical Description

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

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

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

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

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

Learning Objectives / Experiments

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

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

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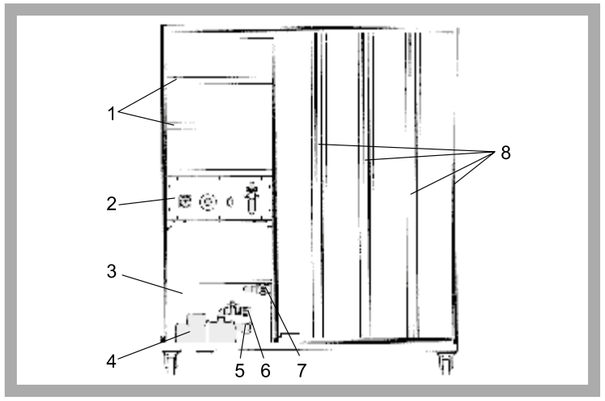
RT 450 Process Automation Training System: Base Module



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

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

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

Specification

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

Technical Data

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

24VDC supply for components

Dimensions and Weight

LxWxH: 1650x850x1950mm
Weight: approx. 120kg

Required for Operation

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

Scope of Delivery

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

Order Details

080.45000	RT 450	Process Automation Training System: Base Module

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RT 450 *Process Automation Training System: Base Module*

Available Accessories:

CONTROLLED SYSTEM MODULES:

Product no.	Order details
080.45001	RT 450.01 Controlled System Module: Level
080.45002	RT 450.02 Controlled System Module: Flow
080.45003	RT 450.03 Controlled System Module: Pressure
080.45004	RT 450.04 Controlled System Module: Temperature

CONTROLLER AND RECORDER MODULES:

Product no.	Order details
080.45010	RT 450.10 Continuous Controller Module
080.45011	RT 450.11 Switching Controller Module
080.45012	RT 450.12 Chart Recorder Module
080.45013	RT 450.13 Digital Display
080.45042	RT 450.42 PLC Module with Software

recommended accessory for controller modules:

080.45014	RT 450.14 Software for Controller Configuration

CONTROL VALVES:

Product no.	Order details
080.45020	RT 450.20 Control Valve, Pneumatically Driven, Kvs 0,4
080.45021	RT 450.21 Control Valve, Pneumatically Driven, Kvs 1,0
080.45023	RT 450.23 Control Valve, Electrically Driven, Kvs 0,4
080.45024	RT 450.24 Control Valve, Electrically Driven, Kvs 1,0

SENSORS:

Product no.	Order details
080.45030	RT 450.30 Pressure Sensor, 0...6bar
080.45031	RT 450.31 Pressure Sensor, 0...2bar
080.45032	RT 450.32 Pressure Sensor, 0...100mbar
080.45033	RT 450.33 Orifice with Differential Pressure Sensor
080.45034	RT 450.34 Flow Rate Sensor: Electromagnetic
080.45035	RT 450.35 Level Sensor: Capacitive
080.45036	RT 450.36 Temperature Sensor Pt100
080.45037	RT 450.37 Thermocouple (K) with Head Transmitter

PC CONNECTION:

Product no.	Order details
080.45040	RT 450.40 Visualisation Software

required accessory for usage of Visualisation Software:

080.45041	RT 450.41 Profibus DP Module for Controller

or

080.45043	RT 450.43 Profibus DP Module for PLC

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


Level Control


Pressure Control


Flow Control


Temperature Control

LEVEL CONTROL

- RT 450.01 *Controlled System Module: Level*
  - RT 450 *Process Automation Training System: Base Module*
  - RT 450.21 *Control Valve, Pneumatically Driven, Kvs 1,0*
    RT 450.10 *Continuous Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.24 *Control Valve, Electrically Driven, Kvs 1,0*
    RT 450.11 *Switching Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.35 *Level Sensor: Capacitive*
    - RT 450.32 *Pressure Sensor, 0...100mbar* — ALTERNATIVELY

FLOW CONTROL

- RT 450.02 *Controlled System Module: Flow*
  - RT 450 *Process Automation Training System: Base Module*
  - RT 450.21 *Control Valve, Pneumatically Driven, Kvs 1,0*
    RT 450.10 *Continuous Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.24 *Control Valve, Electrically Driven, Kvs 1,0*
    RT 450.11 *Switching Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.34 *Flow Rate Sensor: Electromagnetic*
    - RT 450.33 *Orifice with Differential Pressure Sensor* — ALTERNATIVELY

PRESSURE CONTROL

- RT 450.03 *Controlled System Module: Pressure*
  - RT 450 *Process Automation Training System: Base Module*
  - RT 450.20 *Control Valve, Pneumatically Driven, Kvs 0,4*
    RT 450.10 *Continuous Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.23 *Control Valve, Electrically Driven, Kvs 0,4*
    RT 450.11 *Switching Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.30 *Pressure Sensor, 0...6bar*

TEMPERATURE CONTROL

- RT 450.04 *Controlled System Module: Temperature*
  - RT 450 *Process Automation Training System: Base Module*
  - RT 450.21 *Control Valve, Pneumatically Driven, Kvs 1,0*
    RT 450.10 *Continuous Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.24 *Control Valve, Electrically Driven, Kvs 1,0*
    RT 450.11 *Switching Controller Module*
    - RT 450.42 *PLC Module with Software* — ALTERNATIVELY
  - RT 450.36 *Temperature Sensor Pt100*
    - RT 450.37 *Thermocouple (K) with Head Transmitter* — ALTERNATIVELY

OPTIONAL ACCESSORIES

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

RECOMMENDED ACCESSORY

- RT 450.14 *Software for Controller Configuration*

RT 450.01 Controlled System Module: Level

Specification

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

Technical Data

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

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

Dimensions and Weight

LxWxH: 510x330x800mm
Weight: approx. 30kg

Scope of Delivery

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

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

Technical Description

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

Learning Objectives / Experiments

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

Order Details

080.45001	RT 450.01	Controlled System Module: Level

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RT 450.02 Controlled System Module: Flow

Specification

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

Technical Data

Rotameter: 0...2,5m³/h

Dimensions and Weight

LxWxH: 250x180x700mm
Weight: approx. 10kg

Scope of Delivery

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

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

Technical Description

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

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

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

Learning Objectives / Experiments

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

Order Details

080.45002	RT 450.02	Controlled System Module: Flow

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RT 450.03 Controlled System Module: Pressure

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

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

Technical Description

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

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

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

Learning Objectives / Experiments

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

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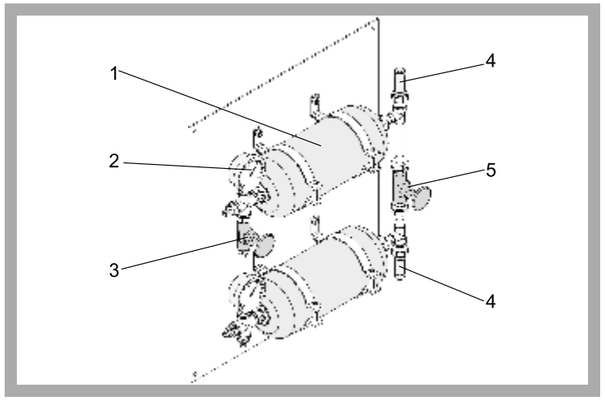
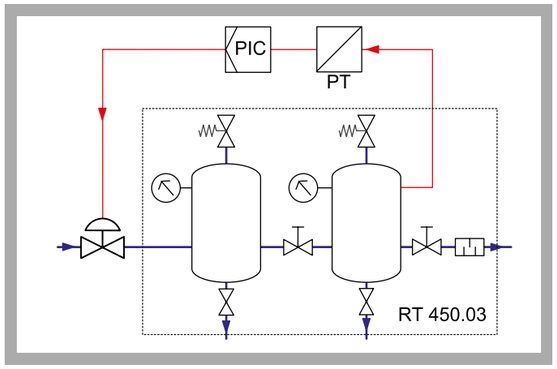
RT 450.03 Controlled System Module: Pressure



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



Process schematic

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

Specification

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

Technical Data

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

Safety valve: adjustable to max. 10bar

Dimensions and Weight

LxWxH: 510x175x600mm
Weight: approx. 15kg

Required for Operation

Compressed air supply via RT 450

Scope of Delivery

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

Order Details

080.45003	RT 450.03	Controlled System Module: Pressure

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RT 450.04 Controlled System Module: Temperature

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

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

Technical Description

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

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

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

Learning Objectives / Experiments

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

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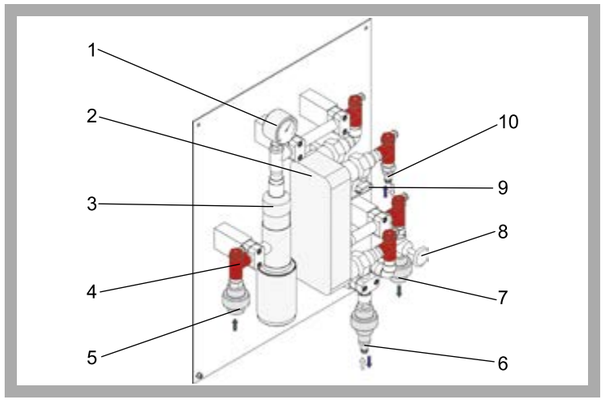
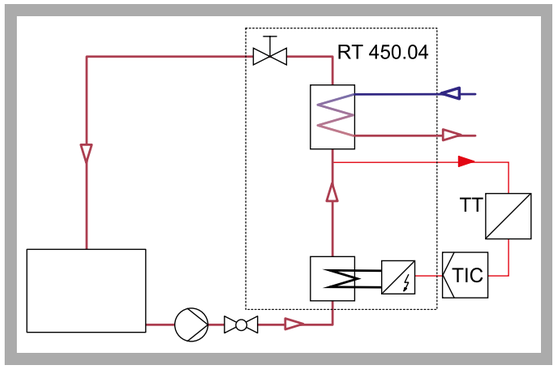
RT 450.04 Controlled System Module: Temperature



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



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

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

Specification

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

Technical Data

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

Heater with thermostat and dry-running protection
- power output: 2kW
- temperature limitation by thermostat: 65°C

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

Dimensions and Weight

LxWxH: 510x200x650mm
Weight: approx. 20kg

Required for Operation

Water connection: max. 3m³/h

Scope of Delivery

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

Order Details

080.45004	RT 450.04	Controlled System Module: Temperature

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 450.10 Continuous Controller Module

*** Digital process controller with extensive functionality**

*** Operation and parameterisation optionally via keyboard, configuration software or visualisation software (Profibus)**

Technical Description

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

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

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

Learning Objectives / Experiments

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

Scope of Delivery

1 controller module

Specification

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

Technical Data

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

Dimensions and Weight

LxWxH: 180x240x240mm
Weight: approx. 2kg

Required for Operation

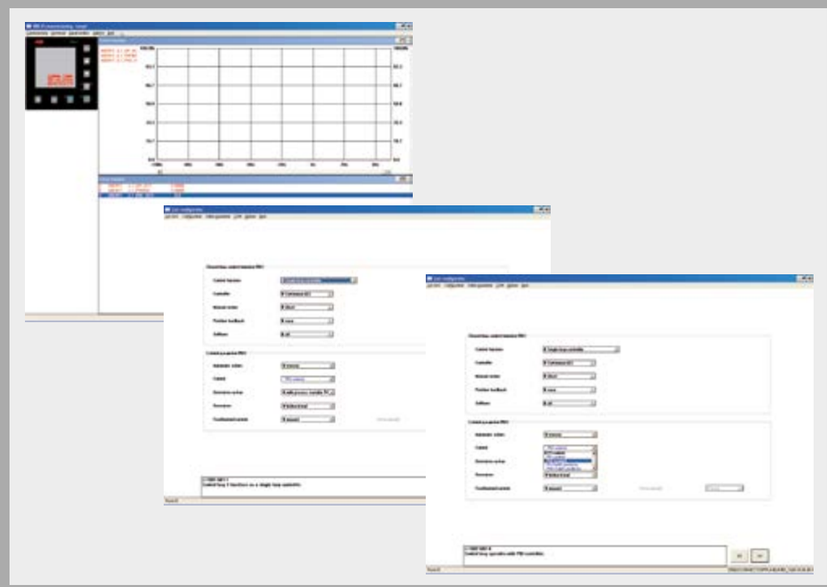
24VDC

Order Details

080.45010	RT 450.10	Continuous Controller Module

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

RT 450.14 Software for Controller Configuration



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

*** User-friendly menu guidance and systematic project management**

Technical Description

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

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

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

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

Learning Objectives / Experiments

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

Scope of Delivery

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

Specification

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

Technical Data

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

Order Details

080.45014	RT 450.14	Software for Controller Configuration

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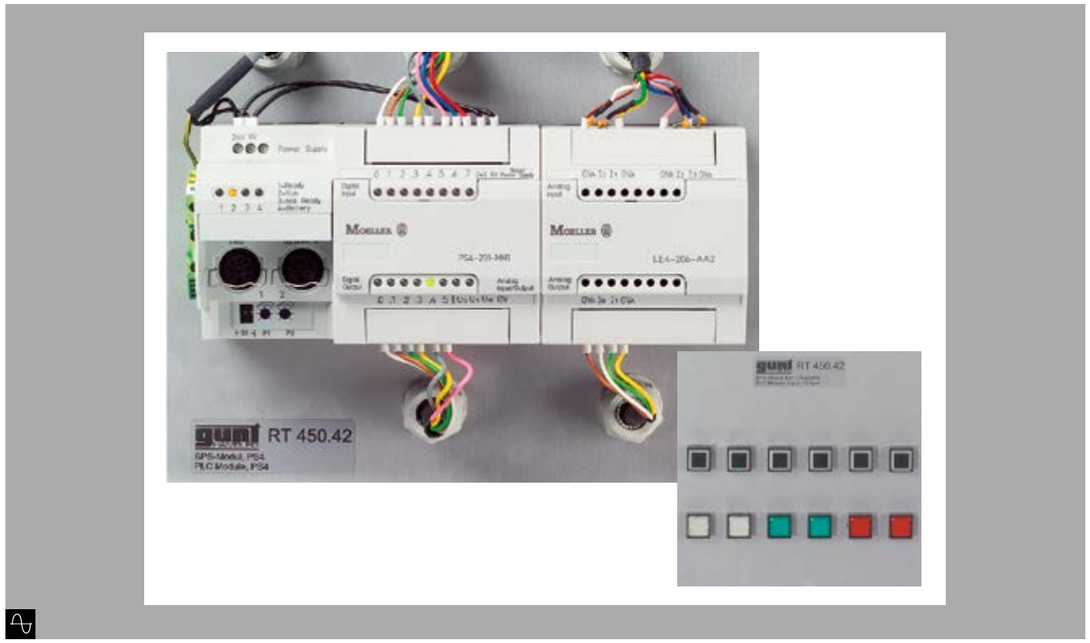
RT 450.42 PLC Module with Software



*** PLC with included programming software**

*** Module for Profibus communication available**

Technical Description

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

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

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

Learning Objectives / Experiments

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

Scope of Delivery

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

Specification

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

Technical Data

PLC
- 8 digital inputs: 24VDC
- 4 analog inputs: 10-bit, 4...20mA
- 6 digital outputs: 24VDC, max. 100mA
- 2 analog outputs: 12-bit, 4...20mA
- program memory: 24kB

Software
- programming language conforming to IEC61131-3

Dimensions and Weight

LxWxH: 215x86x110mm
Weight: approx. 1kg

Required for Operation

24VDC

Order Details

080.45042 RT 450.42 PLC Module with Software

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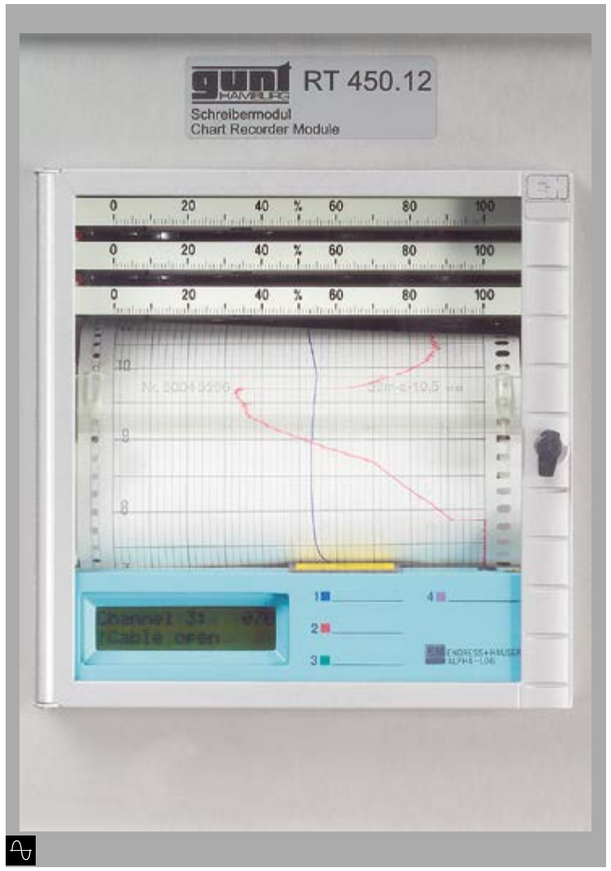
RT 450.12 Chart Recorder Module



The illustration shows a similar unit.

*** Colour 3-channel process recorder**

*** Analog recording of process variables conforming to the variables being measured or in the range 0...100%**

Technical Description

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

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

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

Learning Objectives / Experiments

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

Specification

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

Technical Data

Recorder module
- 3 channels
- measuring range: 4...20mA
- sampling time: 240ms per channel
- basic accuracy: +/- 0,1% of final value

Paper
- recorder drum
- feed rate: 0, 5, 10, 20, 60, 120, 240, 300, 360, 600, 720, 1800, 3600, 7200mm/h; also freely programmable

Pens
- blue, red, green

Dimensions and Weight

LxWxH: 240x144x144mm
Weight: approx. 4kg

Required for Operation

24VDC

Scope of Delivery

1 recorder module

Order Details

080.45012 RT 450.12 Chart Recorder Module

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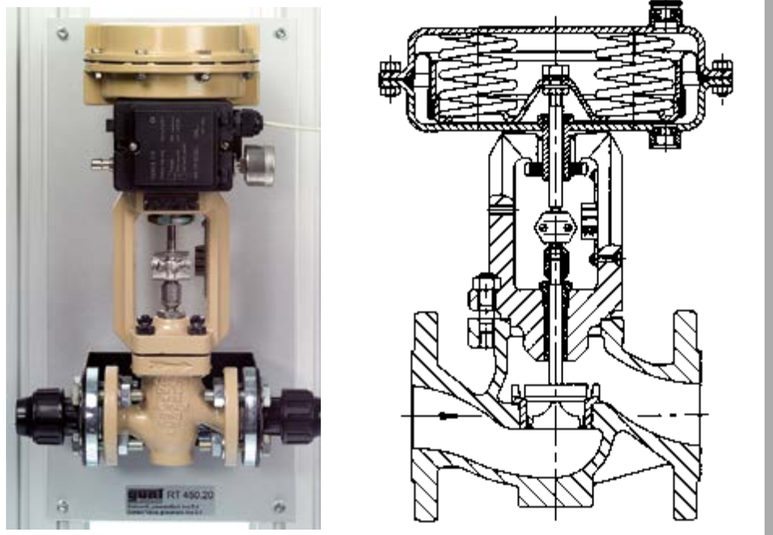
RT 450.20 Control Valve, Pneumatically Driven, Kvs 0,4



*** Industrial control valve with electro-pneumatic positioner**

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

Technical Description

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

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

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

Learning Objectives / Experiments

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

Scope of Delivery

1 control valve with electro-pneumatic positioner

Specification

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

Technical Data

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

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

Dimensions and Weight

LxWxH: 426x168x326mm
Weight: approx. 6kg

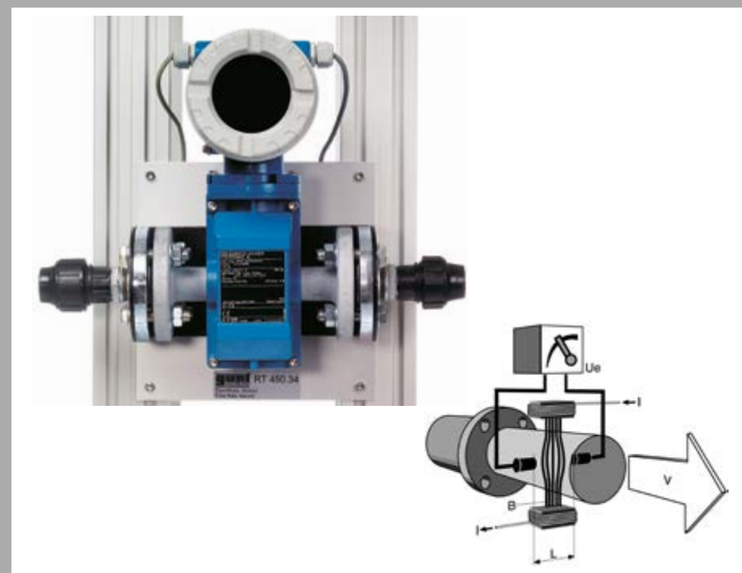
Required for Operation

Compressed air supply via RT 450

Order Details

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

RT 450.34 Flow Rate Sensor: Electromagnetic



*** Industrial flow rate sensor with measurement based on electromagnetic induction**

*** Negligible pressure loss**

Technical Description

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

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

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

Learning Objectives / Experiments

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

Scope of Delivery

1 flow rate sensor

Specification

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

Technical Data

Flow rate sensor
- measurement principle: electromagnetic
- measuring range: 0...2,5m³/h
- output signal: 4...20mA
- measuring tube diameter: D=24mm
- temperature range: 0...60°C

Measuring medium
- pressure of measuring medium: max. 16bar
- minimum conductivity of medium: 50µS/cm

Dimensions and Weight

LxWxH: 200x180x350mm
Weight: approx. 10kg

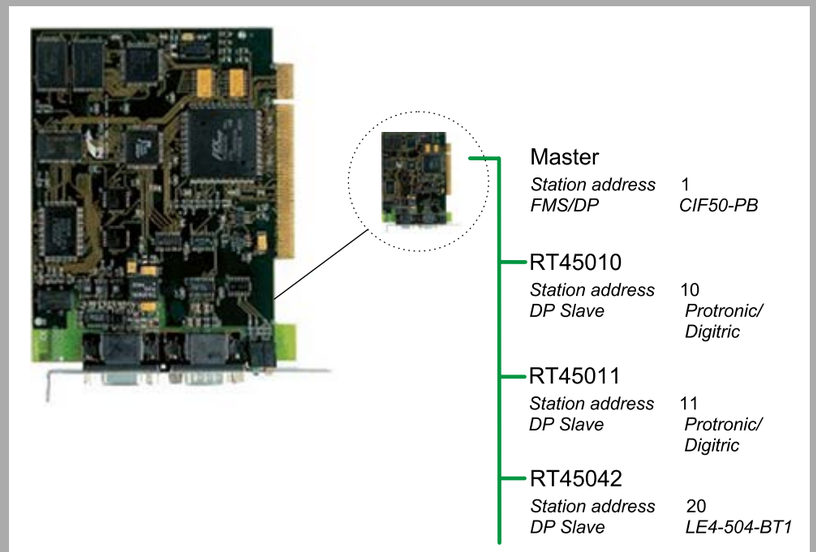
Required for Operation

24VDC

Order Details

080.45034 RT 450.34 Flow Rate Sensor: Electromagnetic

RT 450.40 Visualisation Software



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

*** Profibus card as field bus master**

*** Communication with controllers and PLC**

*** User-friendly GUNT visualisation software**

Technical Description

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

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

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

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

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

Learning Objectives / Experiments

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

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RT 450.40 Visualisation Software

GUNT visualisation software: start menu

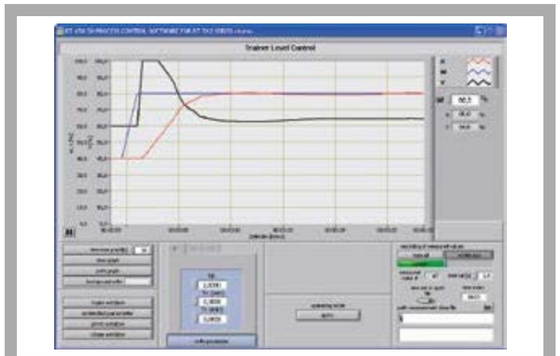
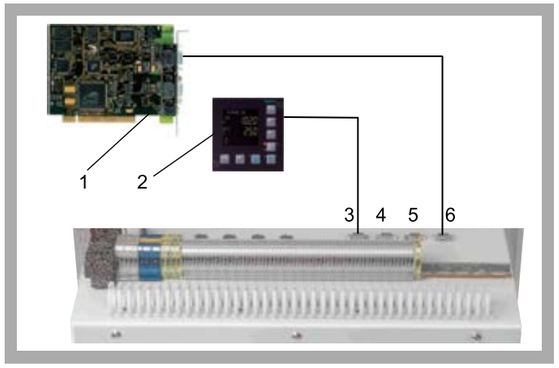


Chart feature to represent time functions in a control system



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

Specification

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

Technical Data

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

System requirements: Windows Vista or Windows 7

Scope of Delivery

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

Order Details

080.45040 RT 450.40 Visualisation Software

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also available:

THE GUNT LEARNING CONCEPTS IN PROCESS CONTROL ENGINEERING

- Fundamentals of Control Engineering
- Components and Calibration
- Simple Process Engineering Control Systems
- Complex Process Engineering Control Systems

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

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

Flexible | *Practical* | *Modular Expandable* | *Various Learning Levels*

THE SYSTEM PROVIDING AN EASY INTRODUCTION TO A COMPLEX SUBJECT

Teaching Concept and Learning Content

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.

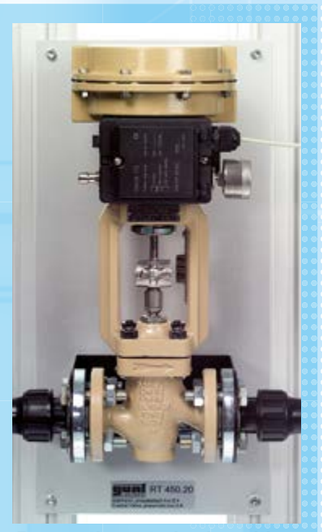
You can teach systematically categorised learning content or just as well combine complex material into integrated project work. For successful deployment of RT 450 the fundamentals of the subject should already have been taught in advance.

LEARNING TOPICS	SPECIFIC LEARNING CONTENT	Page
Industrial Automation Components	⁝· Controllers (open/closed loop) ⁝· Recorders, displays ⁝· Actuators, sensors	355
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	356
Familiarisation with Set-Up Procedures	⁝· Operation, configuration and parameterisation of a digital industrial controller: manually via keypad or using configuration software ⁝· Setting a 3-channel line recorder with digital menu guidance ⁝· Programming a PLC	357
Specific Control Applications	⁝· Pressure, level, flow, temperature ⁝· Cascade control	358
Planning and Displaying	Reading, editing and creating ⁝· Circuit diagrams ⁝· Wiring diagrams and plans of terminal connections ⁝· Work and process schematics ⁝· Plant installation diagrams	362
Practical Exercises	⁝· Making pipe connections ⁝· Making electrical connections, particularly signal links ⁝· Preparing plant for operation ⁝· Troubleshooting	363
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	364

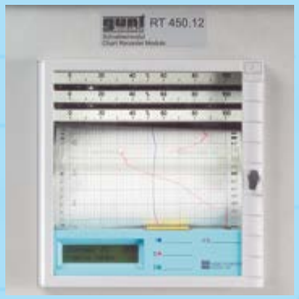
Learning Topics: Industrial Automation Components

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?

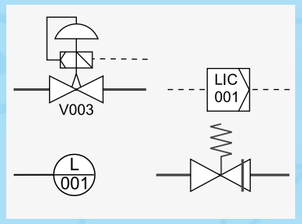
⁝· What input signals are accepted?

⁝· How are the components symbolically represented?

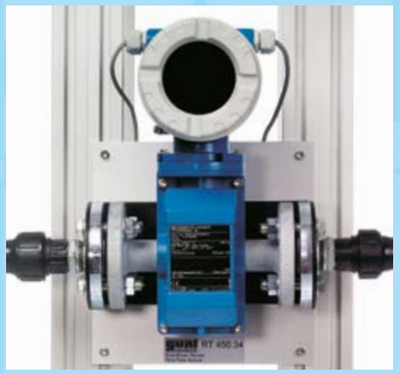
…and much more.

Pressure sensor

Temperature sensor, Pt100



Process engineering symbols

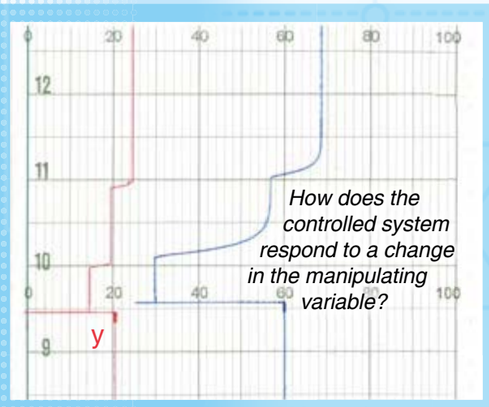


Flow rate sensor, electromagnetic

Level sensor, capacitive

Learning Topics: Learning the Fundamentals of Control Engineering by Experimentation

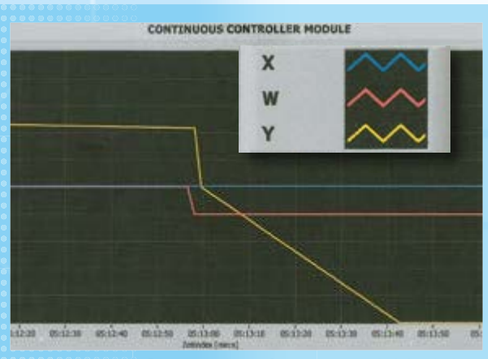
Operation and parameterisation of a digital controller via keypad



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 RT 010, RT 030 and RT 350 training systems.

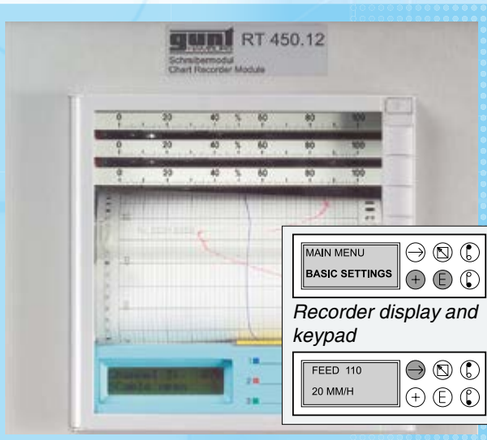
Learning Topics: Familiarisation with Set-Up Procedures

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

Examples of learning content
(all taught by practical exercise)

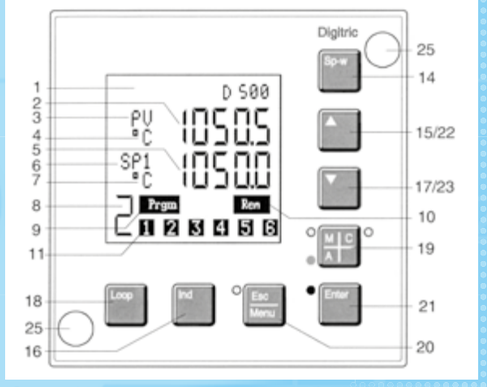
- Basic concepts of set-up
  - Operating level
  - Parameter level
  - Configuration level
- Setting an industrial digital controller
  - Operation
    manual/automatic, setpoint changes
  - Parameterisation
    e. g. select P, I and D components of the controller
  - Configuration
    e. g. set controller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

  ... and much more
- Setting a digital 3-channel line recorder, e.g.
  - Paper feed rates
  - Input definitions for the individual channels
  - Setting display ranges
- Familiarisation with a software solution for user-friendly setting of industrial digital controllers
  - Parameterisation
  - Configuration
  - Saving and managing projects
  - Data transfer between controller and PC

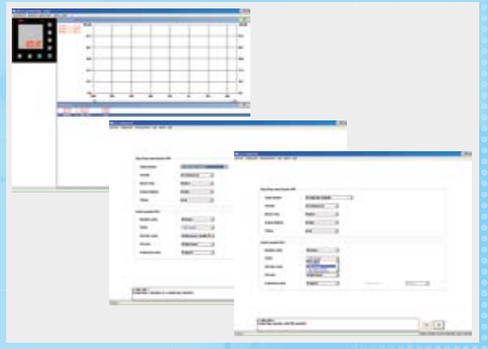


Recorder display and keypad

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.

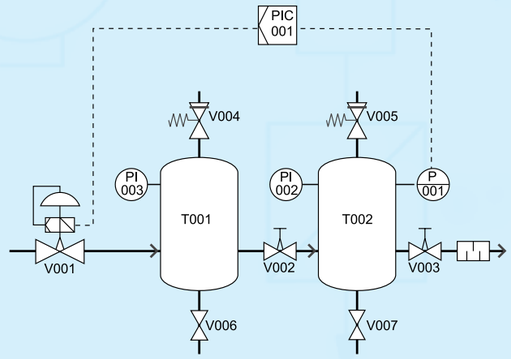
…and of course you can analyse your own ideas and issues by way of experiment.

Examples of learning content

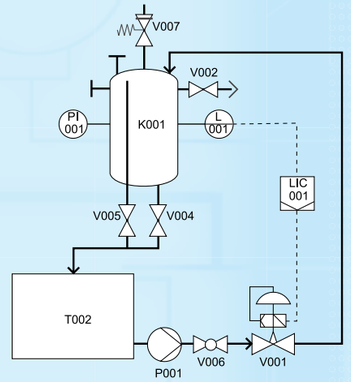
(all taught by experimentation)

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

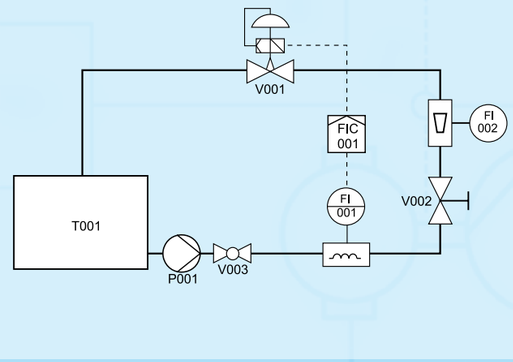
RT 450: Level control with a continuous controller or with a PLC
Windhoek Polytechnic, Namibia



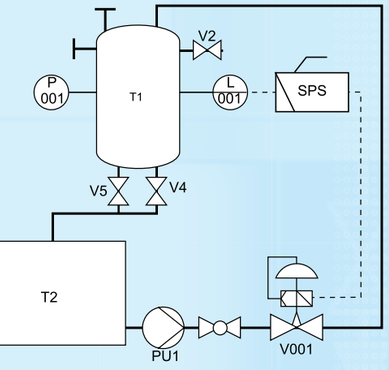
Pressure control



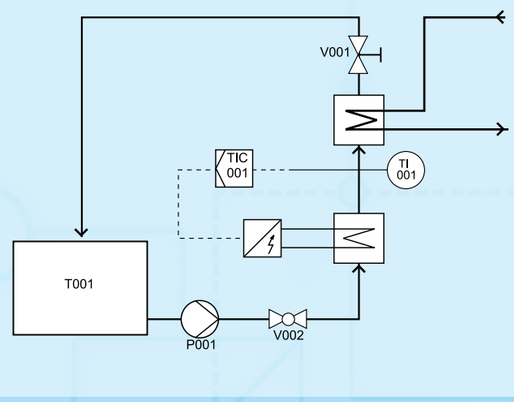
Level control with a continuous controller



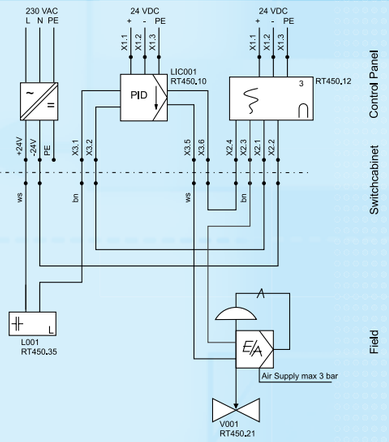
Flow control



Level control with a PLC



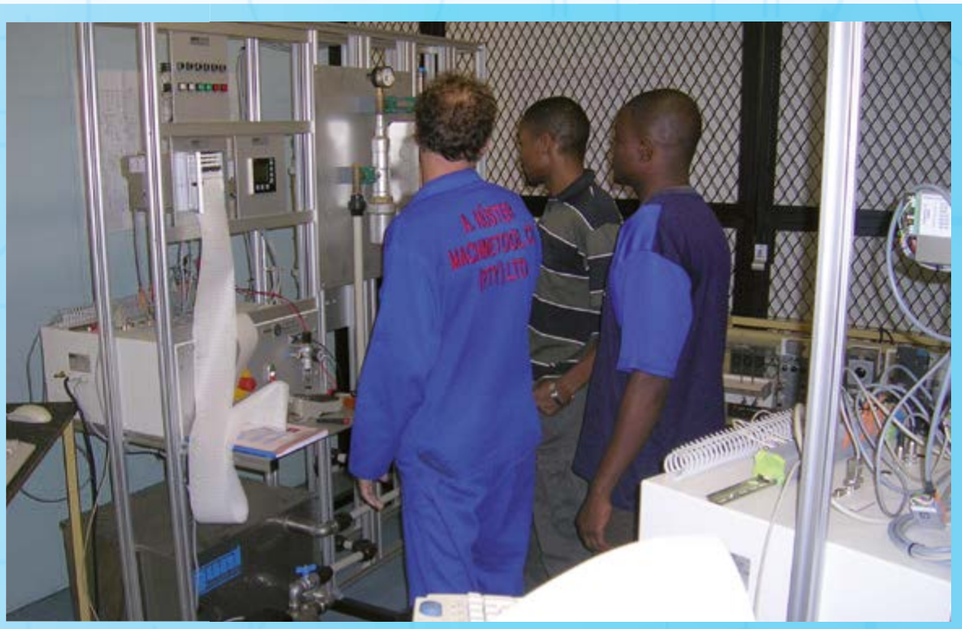
Temperature control with a switching controller



Electrical circuit diagram of a level control system

Polytechnic of Namibia: a Satisfied Customer

Inspection of a recorder chart



Temperature control

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

Level control with a continuous controller or PLC

Temperature control

Setting on a digital controller

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

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

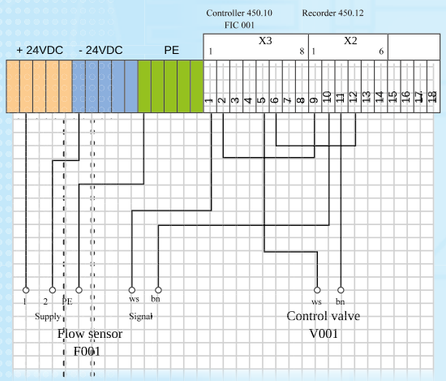
All systems have a Profibus computer communications interface.

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

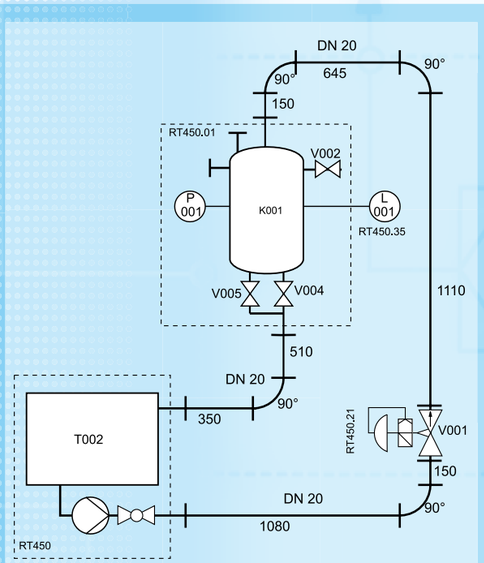
Learning Topics: Planning and Displaying

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.



Plan of terminal connections for flow control



Pipework diagram for level control

Examples of learning content
(all taught by practical exercise)

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

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

Example of a component list

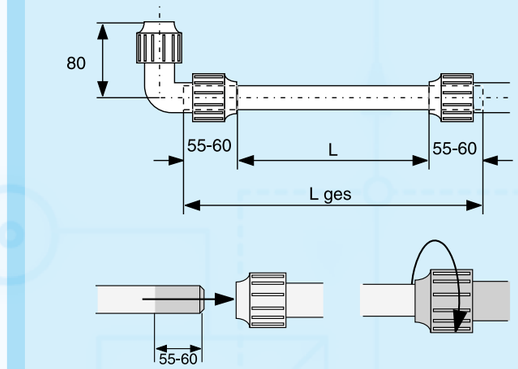
Learning Topics: Practical Exercises

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

Examples of learning content
(all taught by practical exercise)

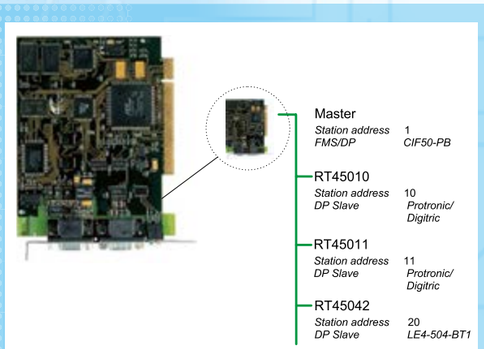
- Mounting the module panels on the mounting profiles of the RT 450 frame
- Making the pipework connection for the water circuit
  - Cutting to length and preparing the pipes
  - Fixing together using clamp fittings
- Cutting to length, laying and connecting compressed air hoses
- Cutting to length and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

Electrical wiring and connections

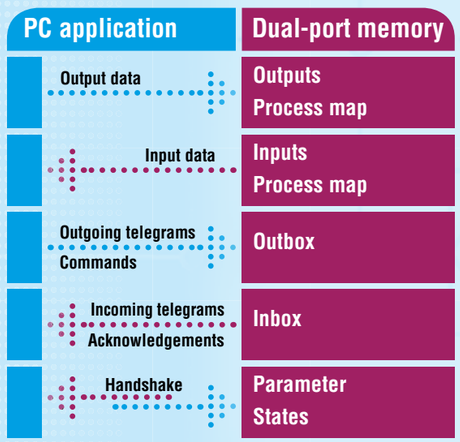


Making connections by plastic pipes

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.



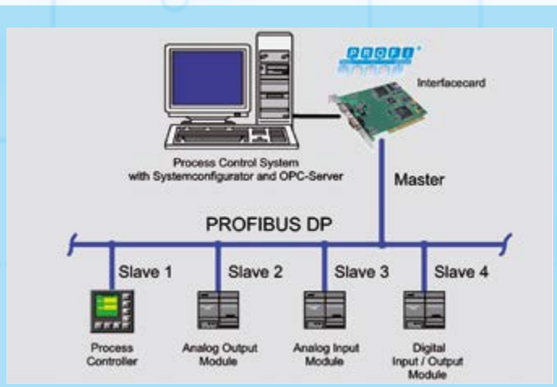
Data interchange between the application and the communications interface is run via a dual-port memory.

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 set-up procedures are usually carried out by dedicated software.

Examples of learning content

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



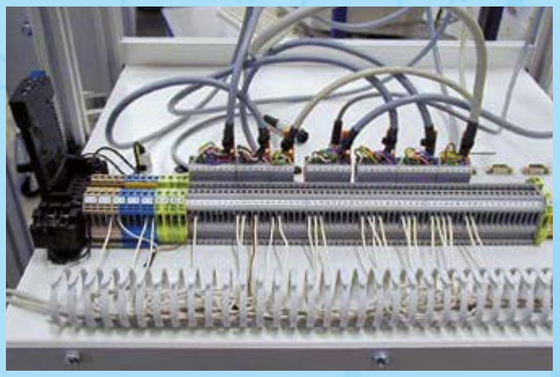
Topology of the field bus used, with master and slaves

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

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

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

Technical Details



Electrical connections – signal connections

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

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

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

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

Process connections

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

The compressed air is supplied via hoses.

The Instructional Material

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

The instructional material comprises

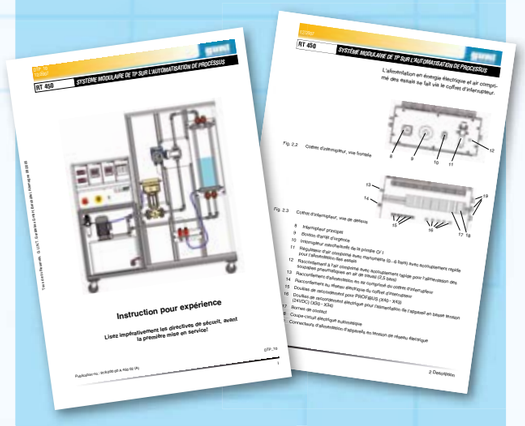
- Manual: RT 450 system description, approx. 130 pages
- Manual: fundamentals of control engineering, approx. 20 pages
- All electrical diagrams for the overall system and for all components
- Completed reference experiments and sample exercises, approx. 25 worksheets and relevant answers
- Materials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

Updates

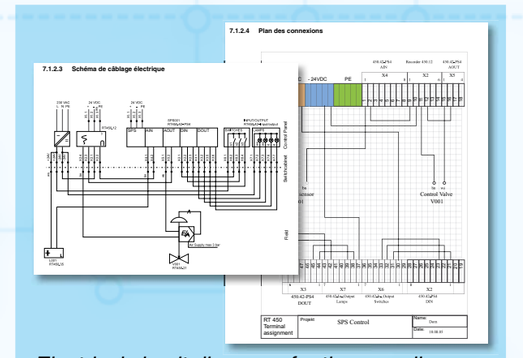
When any updates or additions to the RT 450 system are made – in particular with regard to the instructional material and the software – you, as a GUNT customer, will be notified accordingly.

Training

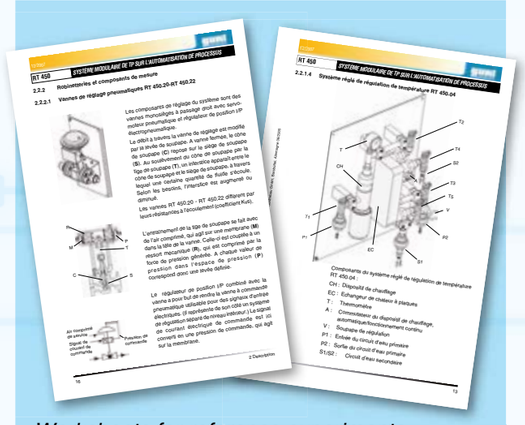
If you require installation or training services for the training system, we will be glad to help.



Manuals: RT 450 system description and fundamentals of control engineering

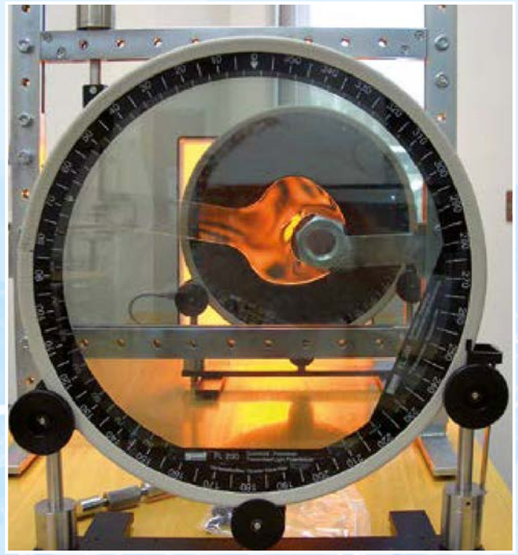


Electrical circuit diagrams for the overall system and all components



Worksheets for reference experiments and sample exercises

A LOOK INSIDE OUR CUSTOMERS' LABORATORIES



GUNT demonstration and experimentation units have been in use for many years at hundreds of technical education and training centres, and have always proved highly satisfactory to our customers

The very finest design and detailing: Working with GUNT demonstration and experimentation units teaches students in an engaging, illustrative manner.

IA 520 Computer Integrated Manufacturing and Handling System

*** Familiarisation with the sequences involved in an automated manufacturing process**

*** PLC and process control software for sequence monitoring**

*** 5-axis servo robot as overhead system**

*** Communication between PLC and control software via USB**

Technical Description

The IA 520 training system presented here represents a fully functional CIM cell (CIM = Computer Integrated Manufacturing). The system allows an automated manufacturing process to be created. The IA 520 demonstrates the basic processes of handling (robots), manufacturing (CNC machining), and control (PLC). An overhead robot on a travel unit supplies two CNC machines with raw parts taken from a magazine. The machined dimensions of the parts are checked in an inspection station before the parts are placed in a finished parts store. Defined planning and control data is used to control various machines. The relevant data is stored in a software program, and is processed by the control units of the individual machines. A PLC system monitors and controls the process. The manufacturing cell is equipped with all necessary sensors and control devices.

The control and programming software for the CNC machines, the robot, the travel unit and the software for the PLC (monitoring and control) are installed on two PCs. The sequences in the CIM cell can be altered by modifying the PLC programming. Using a patchboard, control inputs and outputs can be interconnected such that the machines can be flexibly configured and custom concepts implemented (such as the integration of additional elements). A demo program for a manufacturing process is included.

Safety devices prevent reaching into the working area during operation of the CIM cell.

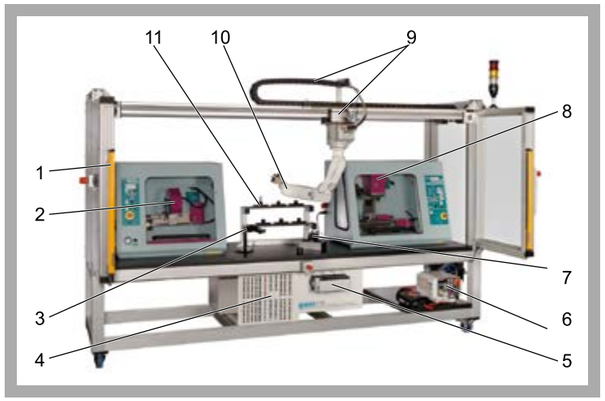
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

Learning Objectives / Experiments

- creating part data
- writing a CNC program
- programming an industrial robot, including teach-in
- programming a travel unit
- programming a PLC
- analysis of process sequences
- intermeshing individual sequences
- investigation of the kinematics of robots
- development of safety concepts
- starting up and shutting down automated systems
- response to malfunctions

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

IA 520 Computer Integrated Manufacturing and Handling System



1 safety device (photoelectric barrier), 2 lathe, 3 stock, 4 patchboard, 5 PLC, 6 robot controller, 7 inspection station, 8 milling machine, 9 travel unit, 10 robot, 11 finished parts store

The illustration shows the robot removing a part from the lathe

The illustration shows the robot storing a machined part on a pallet in the finished parts store

Specification

[1] demonstration of automated processes in a CIM cell
[2] robot with travel unit as overhead system
[3] CNC milling machine with pneumatic vice
[4] CNC lathe with automatic tool changer, pneumatic chuck and pneumatic safety guard opening
[5] stock with gravity feed for spherical material, capacity dependent on diameter of part
[6] inspection station, e.g. for checking part diameter
[7] finished parts store with self-centering pallets and interchangeable part mounts
[8] sequence control of the individual manufacturing steps by PLC and process control software
[9] communication between PLC and PC via USB
[10] programming software for CNC machines, robot, PLC, travel unit under Windows 7
[11] required compressed air supply: 6bar

Technical Data

Travel unit with DC servo motor
- travel: 2700mm
- repeat accuracy: 0,1mm
- max. velocity: 1,4m/s

5-axis robot with AC servomotors
- all 5 axes can be moved simultaneously
- 2-finger gripper: gripping force adjustable via compressed air

CNC lathe
- drive power output: 490W
- distance between centres: 140mm
- height of centres: 20mm
- spindle speed: 200...3200min^{-1}
- programmable feed: 0...1500mm/min

CNC milling machine and drill
- drive power output: 450W
- travel: x=225mm / y=150mm / z=140mm
- spindle speed: 350...3500min^{-1}

PLC
- 40 digital inputs / 1 analogue input
- 40 digital outputs

Dimensions and Weight

LxWxH: 3270x1540x2350mm
Weight: approx. 717kg

Required for Operation

400V, 50/60Hz, 3 phase or 230V, 60Hz/CSA, 3 phase
Compressed air connection: min. 6bar

Scope of Delivery

1 CIM cell
2 PCs
1 set of instructional material

Order Details

058.52000	IA 520	Computer Integrated Manufacturing and Handling System

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

RT 121 – RT 124 TEACHING SYSTEMS FOR FUZZY METHODS IN AUTOMATION

RT 121 *Fuzzy Control: Ball-on-Beam*

RT 122 *Fuzzy Control: Inverted Pendulum*

RT 123 *Fuzzy Control: Ball-on-Plate*

RT 124 *Fuzzy Control: Carrier Vehicle with Inverted Pendulum*

INTRODUCTION TO FAST, DIGITAL REAL-TIME CONTROL BASED ON FUZZY METHODS

Fuzzy methods and microcontrollers have gained greatly in importance in automation over recent years. This has also increased the need for specific training. With its RT 121 to RT 124 systems, GUNT offers clearly laid-out and well-conceived teaching systems specially-developed for this future-oriented field.

Fuzzy methods are particularly suitable for systems that mathematics cannot describe adequately or easily. These include, in particular, multivariable systems, and non-linear or time-variant systems. Fuzzy methods are based on fuzzy logic. In fuzzy logic there is not only **right** or **wrong**, as in conventional logic, but there are also less sharply defined concepts such as **almost right** or a **little wrong**.

This special characteristic of fuzzy methods is similar to the workings of the human mind. Consequently, fuzzy methods are particularly well suited to the automation of processes in which manual control is to be replaced by automatic control.

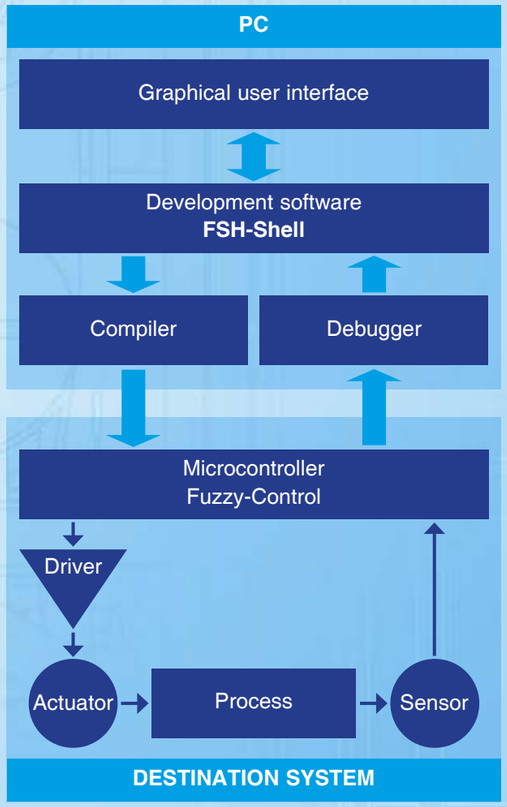
The advantage lies in simple process descriptions based on linguistically defined terms and rules. No complicated mathematical description is necessary.

Four different training systems of increasing complexity

The training systems offer a clearly structured introduction to the design process for microcontroller-based process control systems which are of special relevance to industrial applications. As well as the application of fuzzy methods, they also permit other topics in the field of microcontroller systems to be covered.
The training systems have been produced in close co-operation with **Professor Dr. Kramer from the Department of Automation and Information Technology at the Harz University of Applied Studies and Research**, where the teaching concept and the **FSH-Shell** development software were also developed.
The training content and experimentation instructions contained in the training systems are graded by difficulty according to educational/didactic criteria, and have been successfully deployed in practical teaching at the University.

- Easy familiarisation based on user-friendly development software **FSH-Shell** with graphical user interface
- Rapid implementation of the solution into the mechatronic system based on online compiling and downloading to the destination controller
- Test support by Fuzzy Debugger to visualise selected instrumentation and control variables
- Code- and time-optimised software development based on the special **FSH-Shell** compilation concept

Each training system comprises a mechatronics experimental unit (destination system) with the associated hardware (microcontroller, amplifier, sensors, actuators), the FSH-Shell development software and well structured instructional material.



Structure of the training system

BASIC KNOWLEDGE

FUZZY CONTROL

Fuzzy control is nowadays an important branch of control engineering. Conventional approaches have not been displaced but have been enhanced considerably in some fields of application.

Until now, the fuzzy controller has achieved its greatest success in the industrial and commercial application of fuzzy methods.

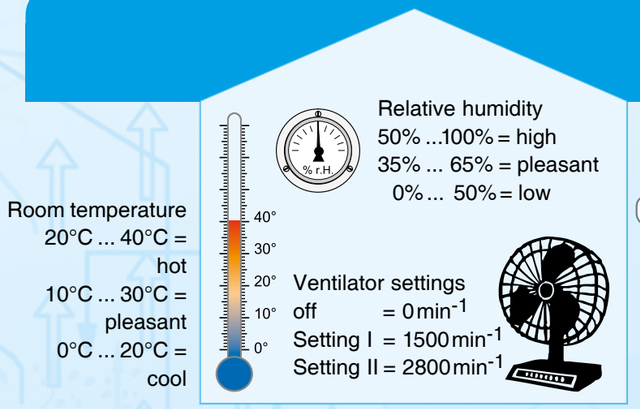
Fuzzy controllers are non-linear controllers. Any non-linearity in the controlled system can be compensated for by an appropriate choice of membership functions and by establishing a rule base. Membership functions are the mathematical models for linguistic terms, such as triangular function, trapezoidal function or Gaussian function.

Like a conventional controller, the fuzzy controller transforms input variables into output variables that then act upon the process or the controlled system. Various input and output variables are linked together to allow complex systems to be easily controlled. The input and output values are crisp values in the form of signals. The fuzzy values that are typical of fuzzy methods only play a role within the controller.

Three processing steps take place within a fuzzy controller: fuzzification, inference and defuzzification.

The design of a fuzzy controller involves the selection of the input/output variables, the determination of the membership functions and the establishment of a rule base.

This simple example shows how a ventilator is used to affect room temperature and air quality. Different ventilator power settings are used depending on room temperature and humidity. The model illustrates the processes within a fuzzy controller and makes no claim to be a realistic implementation.



Sensor

Measured variables

Controlled system (the room)

Actuator (ventilator)

Crisp output value
Speed = 2800 min^{-1}

Reference variable

Crisp input values
Room temperature = 28°C
Relative humidity = 40% r.h.

FUZZY CONTROLLER

The **rule base** contains all the rules in the form "IF a set of conditions is satisfied, THEN a series of consequences follow".
1. Rule **IF** room temperature = tending towards hot **AND** humidity = tending towards pleasant **THEN** ventilator setting II
2. Rule **IF** room temperature = pleasant **AND** humidity = tending towards high **THEN** ventilator setting I
Additional rules...

Processing step: fuzzification

The crisp input values are transformed into fuzzy linguistic terms using mathematical models known as membership functions.

Crisp input value: 28°C ➜ Fuzzy quantity: between pleasant and hot, tending towards hot
Crisp input value: 40% r.h. ➜ Fuzzy quantity: between pleasant and low, tending towards pleasant

Fuzzy input quantities

Processing step: inference

This is the step in which the fuzzy quantities are linked and compared with the individual rules. The result of the inference is a fuzzy output quantity, a fuzzy quantity for the manipulating variable.

1. Rule satisfied ➜ ventilator setting II

Fuzzy output quantity

Processing step: defuzzification

The fuzzy output quantity is transformed back into a crisp output value.

Ventilator setting II ➜ Speed 2800 min^{-1}

Membership function (mathematical model for linguistic terms)

Advantages of fuzzy controllers

- Multivariable control systems can be realised quickly, problem-oriented and comprehensible. This is particularly true if there is no model of the controlled system, or if the model displays an unfavourable non-linear structure.
- The response of a system is described in linguistically defined terms and is therefore simpler to understand than a mathematical one.
- The rule base and the definition of the fuzzy quantity can be added to or modified retrospectively.

Limits of fuzzy controllers

- In conventional control engineering, the controlled system is first modelled. This model is then used to design the controller. By contrast, a fuzzy controller is designed directly from the experiences gained from existing controllers or human input. Errors made during the creation phase are therefore very difficult to correct later.
- As the complexity of the system increases, the amount of work required to develop a fuzzy controller increases superproportionately.
- It's very difficult to find the right defuzzification method. The calculation of the crisp output value is either:
  a) complicated, slow and good
  or
  b) fast, but with a poor result

DIDACTIC RECOMMENDATION

COMPLETE FUZZY CONTROL COURSE

The method of fuzzy control is taught in gradual requirements and the learning content is systematically intensified using the units of the series RT 121 to RT 124. The experimental units are mechatronic systems in which the desired positions and angular positions can be reached as quickly and as exactly as possible. The position or angular position that is reached is held constant against disturbances and any deviations are compensated for.

RT 121 *Ball-on-Beam*

Level 1 – basics: linear, one-dimensional single-variable model
RT 121 provides an introduction to fuzzy control. The knowledge gained with RT 121 is required for further experiments with the other units of this series.

- Introduction to the basic terms fuzzification, rule base, inference, defuzzification
- Working with the development software FSH-Shell
- Testing of a simple fuzzy control on a slow single-variable system
- Optimisation of parameters and online debugging

RT 122 *Inverted Pendulum*

Level 2a:
non-linear,
one-dimensional
single-variable model

- Design of a fuzzy control for an unstable single-variable system with two separate rule bases for the outputs
- Two separate outputs with strong coupling
- Mastering of non-linearities on the actuator side
- More stringent system optimisation requirements

RT 123 *Ball-on-Plate*

Level 2b: linear, two-dimensional multivariable system

- Design of a fuzzy control for a multivariable system without coupling
- Method using two separate fuzzy controls for both directions
- Improved control characteristics by adopting the strategy of coupling both fuzzy control systems

Increasing problem complexity

RT 124 *Carrier Vehicle with Inverted Pendulum*

Level 3: non-linear, one-dimensional multivariable system with a strong coupling

- Design of a fuzzy control for an unstable multivariable system with a strong coupling
- Superposition of pendulum stabilisation and position of the vehicle
- Very high real-time demands
- Develop a strategy to decide what to do in case of conflicting requirements

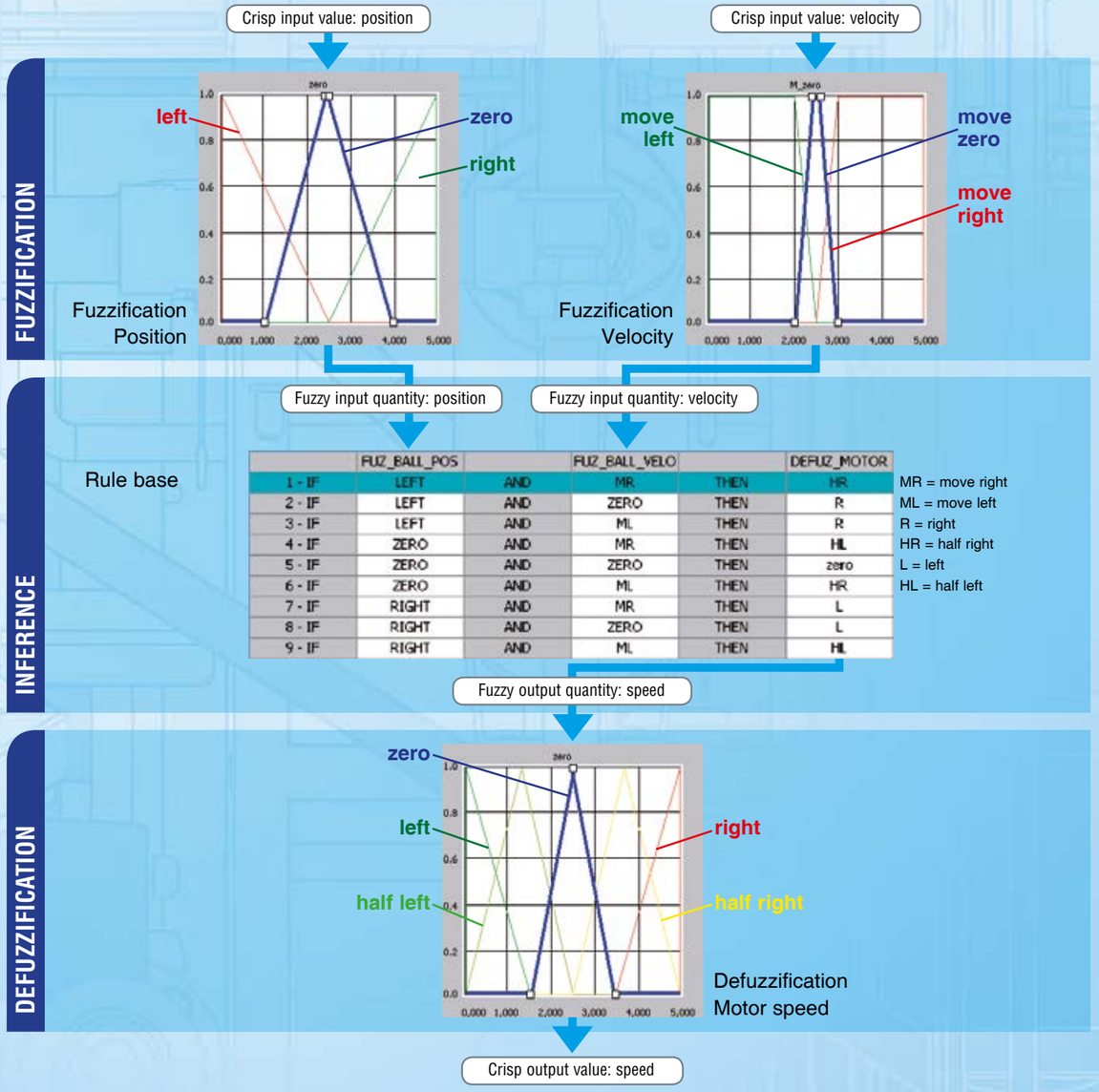
FUZZY CONTROL: SOFTWARE

The individual processing steps of the fuzzy controller are shown using the fuzzy control for the ball-beam system (RT 121) as an example.

Fuzzification
The crisp input values for the position and velocity of the ball are assigned to linguistic terms. Mathematical models such as triangular and trapezoidal functions are used for this purpose.

Inference
The fuzzy input quantities are linked using a rule base and a result is determined.

Defuzzification
Finally, a triangular function is used to transform a fuzzy result back into a crisp output value. This output value is the manipulating variable for the actuator. In the case of an RT 121, the crisp output value is the speed for the motor. This motor changes the inclination of the beam.



	FUZ_BALL_POS		FUZ_BALL_VELO		DEFUZ_MOTOR
1 - IF	LEFT	AND	MR	THEN	HR
2 - IF	LEFT	AND	ZERO	THEN	R
3 - IF	LEFT	AND	ML	THEN	R
4 - IF	ZERO	AND	MR	THEN	HL
5 - IF	ZERO	AND	ZERO	THEN	zero
6 - IF	ZERO	AND	ML	THEN	HR
7 - IF	RIGHT	AND	MR	THEN	L
8 - IF	RIGHT	AND	ZERO	THEN	L
9 - IF	RIGHT	AND	ML	THEN	HL

MR = move right
ML = move left
R = right
HR = half right
L = left
HL = half left

RT 121 Fuzzy Control: Ball-on-Beam

*** Linear, one-dimensional single-variable system with one input and one output**

*** Fast, real-time control using microcontroller**

*** Implementing fuzzy algorithms**

*** Microcontroller-based development process for process control systems**

Technical Description

Fuzzy methods are particularly suitable for systems that mathematics cannot describe adequately or easily. Fuzzy algorithms can offer major advantages, as the control strategy is developed not on the basis of exact mathematical modelling, but on a linguistic description of the process. Additional input variables and the rule base can be easily added.

This experimental unit forms part of a series of teaching systems developed in collaboration with the **Department of Automation and Information Technology at the Harz University of Applied Studies and Research**.

The RT 121 provides an introduction to fast, digital real-time control by fuzzy methods. A ball-beam model acts as a mechanical single-variable system. A fuzzy control is used to attempt to hold the ball in a specific position by tilting the beam, even when the position of the ball is modified by external influences.

The position of the ball is determined using a resistive measuring system. A potentiometer detects the inclination of the beam. These sensors supply crisp signals to the fuzzy controller, where the signals are transformed into fuzzy input values and inferenced before being transformed back into a crisp output value. A servo motor equipped with a drive rod modifies the inclination of the beam and acts as an actuator.

The control algorithms are initially written in the user-friendly development software FSH-Shell and then compiled to generate microcontroller code. The control strategy can be optimised at a later date.

A joystick can be used to control the system manually. This allows the degree of difficulty of the control process to be estimated very accurately.

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

Learning Objectives / Experiments

- introduction to the fundamentals of fuzzy control and microcontroller technology
- working with the development software FSH-Shell
- development of a simple fuzzy control for a single-variable system using the elements
  * fuzzification, rule base, inference, defuzzification
- implementation of fuzzy algorithms in the mechatronic system using microcontrollers
- optimising the algorithms on the mechatronic system using the online debugger

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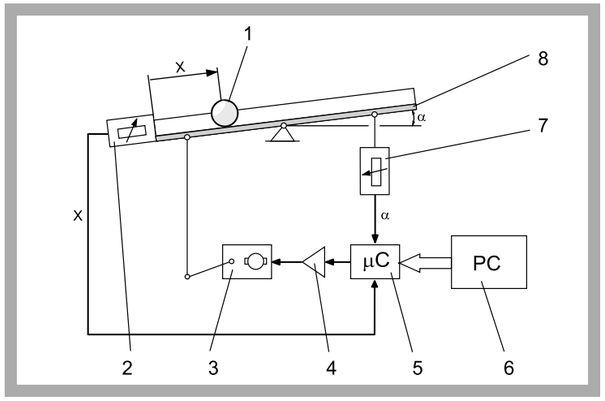
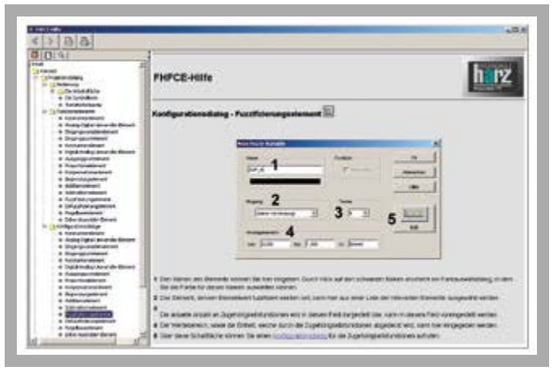
RT 121 Fuzzy Control: Ball-on-Beam



1 ball, 2 ball position sensor, 3 servo motor for beam drive, 4 amplifier, 5 microcontroller, 6 PC with development software, 7 beam inclination sensor, 8 beam

FSH-Shell development software: structure of a fuzzy control



FSH-Shell development software: help function

Specification

[1] introduction to fuzzy control and microcontroller technology
[2] ball-beam as mechanical single-variable system, SISO (Single Input - Single Output)
[3] switchable between fuzzy and manual mode
[4] servo motor for beam drive as actuator
[5] microcontroller with USB port as fuzzy controller
[6] FSH-Shell development software for design and optimisation of the fuzzy controller
[7] resistive measuring system with film potentiometer as ball position sensor
[8] potentiometer as beam inclination sensor
[9] part of the structured teaching concept: level 1 - basics

Technical Data

Beam, U-profile
- length: 500mm
- material: aluminium

Ball
-diameter: 25,4mm
- weight: 66g

Servo motor
- operating voltage: 5,0V
- actuation torque, interpolated: 206Ncm
- actuator velocity, interpolated: 0,18s/60°

Microcontroller
- 8bit microcontroller Zilog Z8Encore
- 12-fold ADC 8bit

Software: FSH-Shell, runs under Windows Vista or Windows 7

Film potentiometer
- resistance value: 12,5kΩ +/-30%
- electrical path: 500mm

Dimensions and Weight

LxWxH: 600x520x330mm
Weight: approx. 20kg

Required for Operation

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

Scope of Delivery

1 experimental unit
1 USB cable
1 FSH-Shell development software
1 set of instructional material

Order Details

080.12100 RT 121 Fuzzy Control: Ball-on-Beam

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RT 122 Fuzzy Control: Inverted Pendulum

* **Non-linear, one-dimensional single-variable system with two actuators**
* **Inverted pendulum with one input and two outputs**
* **Fast, real-time control using microcontroller**
* **Implementing fuzzy algorithms**
* **Microcontroller-based development process for process control systems**

Technical Description

This experimental unit forms part of a series of teaching systems developed in collaboration with the **Department of Automation and Information Technology at the Harz University of Applied Studies and Research**.

The unstable "inverted pendulum" system acts as a mechanical single-variable system. The upright position of the pendulum is adjusted by two independent propeller drives and should be achieved quickly and if possible without overshooting. A fuzzy control will be developed and optimised for this purpose.

The inclination of the pendulum is measured by a potentiometer. The sensor supplies a crisp signal to the fuzzy controller, where the signal is transformed into a fuzzy input value and inferenced before being transformed back into a crisp output value. This output value controls the actuators, two propeller drives.

The learning contents of the experimental unit RT 121 are extended by RT 122 that is more complex because of its two independent drives. Conducting the experiment makes high demands on the system optimisation, as the two independent drives have to be tuned.

The control algorithms are initially written and simulated in the user-friendly development software FSH-Shell and then compiled to generate microcontroller code. The control strategy can be optimised at a later date.

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

Learning Objectives / Experiments

- design of a fuzzy control for the unstable single-variable system: inverted pendulum (fundamentals from RT 121 are required)
- working with the development software FSH-Shell
- activating of two independent actuators that are coupled via the system
- mastering of non-linearities in the system: inverted pendulum
- mastering of non-linearities in the propeller drive
- optimisation of
  * fuzzification
  * rule base
  * defuzzification with respect to stability
  * velocity
  * control quality

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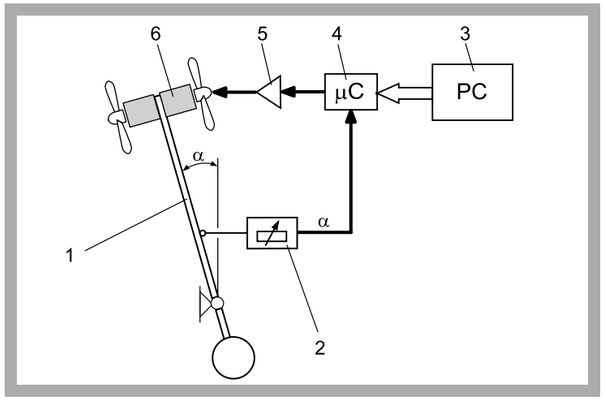
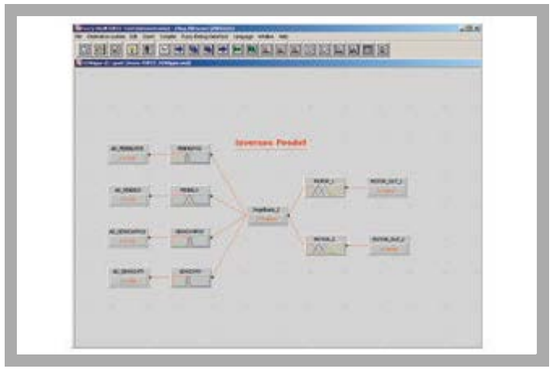
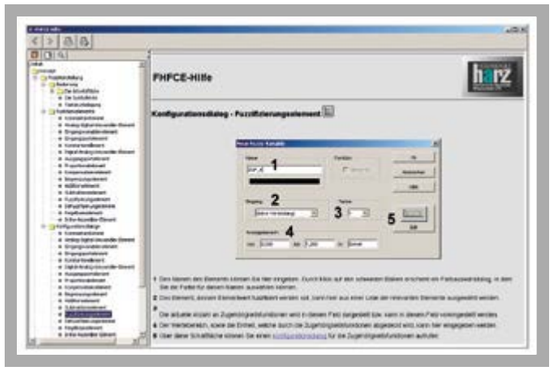
RT 122 Fuzzy Control: Inverted Pendulum



1 inverted pendulum, 2 pendulum inclination sensor, 3 PC with development software, 4 microcontroller, 5 amplifier, 6 drive motors with propellers



FSH-Shell development software: structure of a fuzzy control



FSH-Shell development software: help function

Specification

[1] design and optimise fuzzy control systems using microcontroller technology
[2] inverted pendulum as mechanical single-variable system, SIMO (Single Input - Multiple Outputs)
[3] 2 independent motors for propeller drive as actuators
[4] microcontroller with USB port as fuzzy controller
[5] FSH-Shell development software for designing and optimising the fuzzy controller
[6] rotary potentiometer as pendulum inclination sensor
[7] part of the structured learning concept: level 2a

Technical Data

Inverted pendulum
- length: 780mm
- counterweight: 1,89kg
2 drive motors: 7,2V / 23A
Microcontroller
- 8bit microcontroller Zilog Z8Encore
- 12-fold ADC 8bit
Software: FSH-Shell, runs under Windows Vista or Windows 7
Rotary potentiometer
- resistance value 5kΩ +/- 20%

Dimensions and Weight

LxWxH: 600x520x1200mm (with upright pendulum)
Weight: approx. 36kg

Required for Operation

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

Scope of Delivery

1 experimental unit
1 USB cable
1 FSH-Shell development software
1 set of instructional material

Order Details

080.12200	RT 122	Fuzzy Control: Inverted Pendulum

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RT 123 Fuzzy Control: Ball-on-Plate

*** Linear, two-dimensional multivariable system with two actuators**

*** Ball-plate model with two inputs and two outputs**

*** Fast, real-time control using microcontroller**

*** Implementing fuzzy algorithms**

*** Two fuzzy controllers with weak coupling**

*** Microcontroller-based development process for process control systems**

Technical Description

This experimental unit forms part of a series of teaching systems developed in collaboration with the **Department of Automation and Information Technology at the Harz University of Applied Studies and Research**.

A ball-plate model acts as a weakly-coupled mechanical multivariable system. A fuzzy control is used to move the ball to a specific position quickly and with as little movement of the plate as possible, even when the position of the ball is modified by external influences.

The position of the ball is measured without feedback using a touch panel and the crisp signals sent to the fuzzy controller, where the signals are transformed into fuzzy input values and inferenced before being transformed back into a crisp output value. Two servo motors act as actuators during this process. The inclination of the plate is modified by the movements of the respective motors; these movements are transferred to the plate by the drive rod.

The learning contents of RT 123 are based on the fundamentals of RT 121. The RT 123 is a multivariable system with two separate fuzzy controllers, which can also be coupled. Optimisation of the system by fine tuning the parameters will be looked at in a later exercise.

The control algorithms are initially written in the user-friendly development software FSH-Shell, simulated and then compiled to generate microcontroller code. The control strategy can be optimised at a later date.

A joystick can be used to control the system manually. This allows the degree of difficulty of the control process to be estimated very accurately.

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

Learning Objectives / Experiments

- design of a fuzzy control for a decoupled multivariable system (fundamentals from RT 121 are required)
- development of a model with two separate fuzzy controllers for each axis
- effect of the position and velocity of the ball on the control characteristic
- optimisation of control characteristic by additional coupling of the fuzzy controllers
- comparison of a fuzzy control with a manually controlled system

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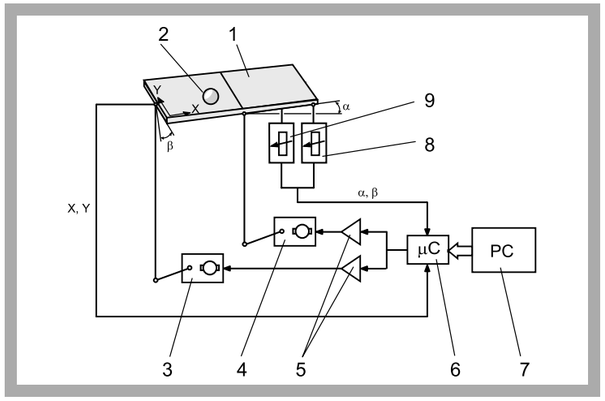
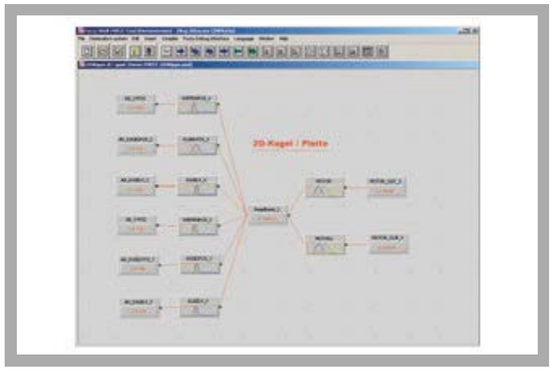
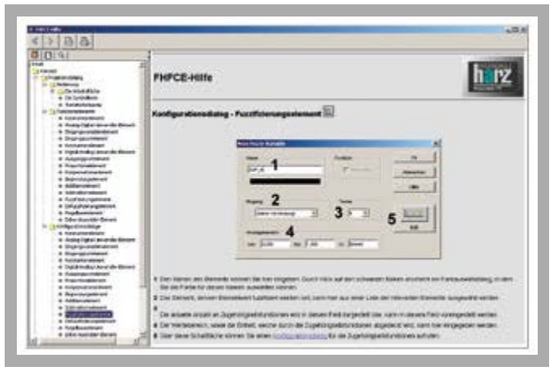
RT 123 Fuzzy Control: Ball-on-Plate



1 swivelling plate with touch panel to measure ball position, 2 ball, 3 swivel drive y-axis, 4 swivel drive x-axis, 5 amplifier, 6 microcontroller, 7 PC with development software, 8 plate inclination sensor y-axis, 9 plate inclination sensor x-axis



FSH-Shell development software: structure of a fuzzy control



FSH-Shell development software: help function

Specification

[1] develop parallel fuzzy controls using microcontroller technology
[2] two-axis ball-plate system as mechanical multivariable system, MIMO (Multiple Inputs - Multiple Outputs)
[3] switchable between fuzzy and manual mode
[4] 2 servo motors used as actuators to swivel the plate
[5] microcontroller with USB port as fuzzy controller
6] FSH-Shell development software for designing and optimising the fuzzy controller
[7] resistive analog touch panel as ball position sensor
[8] potentiometer as plate inclination sensor
[9] part of the structured learning concept: level 2b

Technical Data

Plate: LxW: 378x303mm
Ball
- diameter: 35mm
- weight: 174g

2 servo motors
- operating voltage: 5,0V
- actuation torque, interpolated: 206Ncm
- actuator velocity, interpolated: 0,18s/60°

Microcontroller
- 8bit microcontroller Zilog Z8Encore
- 12-fold ADC 8bit

Software: FSH-Shell, runs under Windows Vista or Windows 7

Touch panel
- operating voltage: 5,5V
- active area: 378,5x303mm

Dimensions and Weight

LxWxH: 600x520x300mm
Weight: approx. 24kg

Required for Operation

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

Scope of Delivery

1 experimental unit
1 USB cable
1 FSH-Shell development software
1 set of instructional material

Order Details

080.12300 RT 123 Fuzzy Control: Ball-on-Plate

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RT 124 Fuzzy Control: Carrier Vehicle with Inverted Pendulum

*** Non-linear, single-dimensional multivariable system with strong coupling**

*** Complex, mechanical system with two degrees of freedom**

*** Fast, real-time control using microcontroller**

*** Implementation of fuzzy algorithms**

*** Microcontroller-based development process for process control systems**

Technical Description

This experimental unit forms part of a series of teaching systems developed in collaboration with the **Department of Automation and Information Technology at the Harz University of Applied Studies and Research**.

A vehicle with an inverted rod pendulum acts as a mechanical multivariable system. A fuzzy control moves the rod pendulum to the centre position, where it is held in position, and at the same time controls the position of the vehicle.

A rotary encoder determines the position of the vehicle from the rotation of its wheels. A rotary potentiometer detects the inclination of the pendulum. These sensors supply crisp signals to the fuzzy controller, where the signals are transformed into fuzzy input values and inferenced before being transformed back into a crisp output value. This in turn activates an actuator, the drive motor on the vehicle. The control process is made more difficult by the fact that the vehicle can only move to a limited extent from its original position.

The RT 124 completes the learning contents from the RT 121 - RT 123 series. This experimental unit is very complex, as the controller has to activate an actuator using two input variables. The overall solution also has to be fine tuned properly.

The control algorithms are initially written and simulated in the user-friendly development software FSH-Shell and then compiled to generate microcontroller code. The control strategy can be optimised at a later date.

A joystick can be used to control the system manually. This allows the degree of difficulty of the control process to be estimated very accurately.

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

Learning Objectives / Experiments

- design of an demanding fuzzy control for an unstable, coupled multivariable system (fundamentals from the experiments with the units RT 121 - RT 123 are required)
- superposition of pendulum stabilisation and position control of the vehicle
- comparison of different controller structures
- optimisation of rule base
- development of a strategy to decide what to do in case of conflicting requirements
- demanding optimisation of control response

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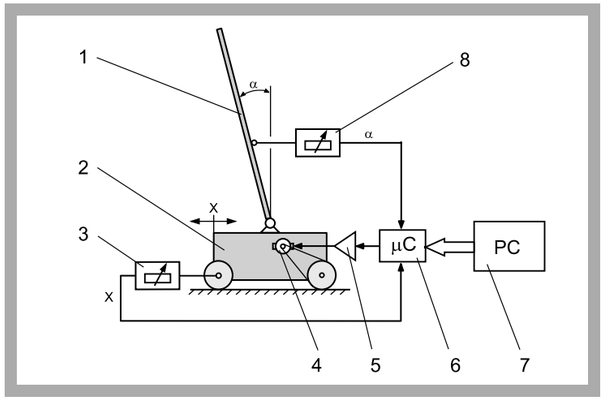
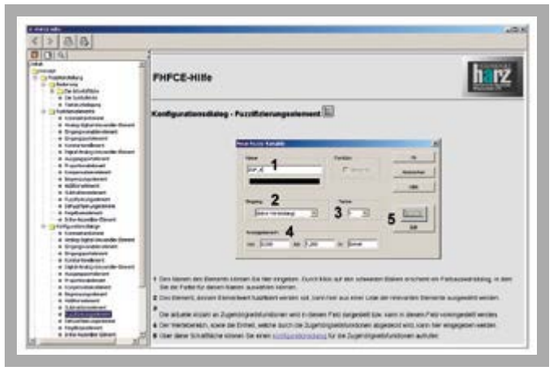
RT 124 Fuzzy Control: Carrier Vehicle with Inverted Pendulum



1 rod pendulum, 2 vehicle, 3 vehicle position sensor, 4 drive motor, 5 amplifier, 6 microcontroller, 7 PC with development system, 8 pendulum inclination sensor

FSH-Shell development software: structure of a fuzzy control



FSH-Shell development software: help function

Specification

[1] fine tuning of a fuzzy control system with strong coupling and use of microcontroller technology
[2] inverted rod pendulum with vehicle as mechanical multivariable system, MISO (Multiple Inputs - Single Output)
[3] switchable between fuzzy and manual mode
[4] motor to drive the vehicle as actuator
[5] microcontroller with USB port as fuzzy controller
6] FSH-Shell development software for designing and optimising the fuzzy controller
[7] rotary potentiometer as pendulum inclination sensor
[8] rotary encoder as vehicle position sensor
[9] permitted route of vehicle relative to starting position: adjustable
[10] part of the structured learning concept: level 3

Technical Data

Vehicle
- max. tensile force: 12N

Rod pendulum
- length: 990mm
- weight: 0,1kg

Drive motor: 12V

Microcontroller
- 8bit microcontroller Zilog Z8Encore
- 12-fold ADC 8bit

Software: FSH-Shell, runs under Windows Vista or Windows 7

Rotary potentiometer
- resistance value 5kΩ +/- 20%

Rotary encoder
- diameter of sensor wheel: D=40mm
- impulses per revolution: 50
- resolution: 2,51mm / impulse

Dimensions and Weight

LxWxH: 600x520x190mm (control unit)
Weight: approx. 20kg
LxWxH: 350x290x1080mm (vehicle)
Weight: approx. 2kg

Required for Operation

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

Scope of Delivery

1 experimental unit
1 USB cable
1 FSH-Shell development software
1 set of instructional material

Order Details

080.12400	RT 124	Fuzzy Control: Carrier Vehicle with Inverted Pendulum

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CONTACT

G.U.N.T.
Gerätebau GmbH

Hanskampring 15 - 17
D-22885 Barsbüttel
GERMANY

phone: +49 40 67 08 54 - 0
Fax: +49 40 67 08 54 - 42

web: www.gunt.de
e-mail: sales@gunt.de

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