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EQUIPMENT FOR ENGINEERING EDUCATION

FUNDAMENTALS OF CONTROL ENGINEERING

Simple, quickly understandable controlled system models with extensive software functions

Temperature - Level - Flow

Pressure - Speed - Position

THE SERIES PROVIDING AN EASY INTRODUCTION TO A COMPLEX SUBJECT

PLANNING & CONSULTING · TECHNICAL SERVICE · COMMISSIONING & TRAINING

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The Equipment Concept with Hardware/Software Integration (HSI)

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

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 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 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 060 Position Control
- Rotary encoder as displacement sensor
- Position control of a carriage by gear motor
- Two microswitches to shut down at end positions
The Software: Easy Operation with Selectable User Interfaces

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

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

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

Identification of a Real Controlled System and Adaptation of Controller Parameters

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

**Automatic identification of controlled system**
by inflectional tangent method

**Parameter setting of a PI controller**
- Calculation of gain and integral-action time from determined controlled system parameters
- Observation of control behaviour of this controller after reference variable step
  - Reference variable in black
  - Controlled variable in red
Simulation of Controlled Systems

The software features a simulation mode. This mode enables to also study controlled systems not covered by the real units. Real controlled systems usually have complex properties. The simulation mode enables elemental transfer functions to be entered and investigated. It is therefore possible to teach the fundamentals of control engineering in a simple way.

Features of the Simulation Mode

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

Editing of Step Responses by Filtering and Decimation

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

During recording of the step response a disturbance was repeatedly generated

The determined controlled system parameters characterise the disturbed controlled system

- Differentiation of the 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 controlled system parameters
The USB cable is removed from the RT 030 and connected to the RT 010. The green frame indicates the active unit. In the software window “unit selection”, a mouse-click is all it takes to switch from RT 030 to RT 010.

Now the RT 010 Level Control unit can be used.

The RT 030 Pressure Control unit is still running.

Easy Switching in between the Units of this Series

- ONE software for ALL units
- USB connection

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.