Process Control and Servo Systems
Contents

PROCESS CONTROL SYSTEMS .......................................................................................................2
AUT 302102 Tank Model ................................................................. ..................................................4
AUT 302101 Car Model Speed Regulation ................................................................. ..................................4
AUT 302103 Regulator Module ................................................................. ..................................4
AUT 302201 PF1 Interface PID Future ................................................................. ..........................5
AUT 302202 PF2 Temperature Regulation ................................................................. ..........................5
AUT 302203 PF3 Speed Regulation ................................................................. ..........................5
AUT 302204 PF4 Signal Converter incl. Band Cable ................................................................. ..........................6
PRG 302200 PID-Future Programming Software ................................................................. ..........................6
AUT 302210 Sensor Set ................................................................. ..........................6
ELE 102000 Base Unit 2000 ................................................................. ..........................6

SERVO SYSTEMS .........................................................................................................................7
AUT 302500 Servo Baseplate with Linear Unit ................................................................. ..........................9
AUT 302502 DC Servo Motor without Gears ................................................................. ..........................9
AUT 302504 Flywheel ................................................................. ..........................9
AUT 302506 Generator Brake ................................................................. ..........................9
AUT 302508 SR1 Servo Regulator ................................................................. ..........................10
AUT 302510 SR2 Speed Regulation Module ................................................................. ..........................10
AUT 302514 Process Value Module ................................................................. ..........................10
AUT 302512 DC Servo Motor with Gears ................................................................. ..........................11
AUT 302516 SR3 Positioning Module ................................................................. ..........................11
AUT 302518 Stepper Motor ................................................................. ..........................11
AUT 302520 Stepper Motor Module SM1 ................................................................. ..........................12
AUT 302522 AC Servo Motor ................................................................. ..........................12
AUT 302524 AC Servo Amplifier ................................................................. ..........................12
PRG 302500 Programme Software Sigma Win ................................................................. ..........................12
SD 1664 Stepper Motor Training Unit ................................................................. ..........................13

ADVANCED CONTROL TECHNOLOGY ...........................................................................................14
AUT 300130 Autoportal - Advanced Control Technology ................................................................. ..........................14

Extracts from the broschyr Control Technology-Mechatronics ................................................................. ..........................16

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations.
PROCESS CONTROL SYSTEMS

Process control and measuring techniques is a modern educational packet containing technical literature and hardware. The system is developed and tested in a working environment in line with the demands of modern education. The program product PID-Future together with the interface (PF-1) and many different control components combine to give a package that can handle the most common control processes, together with the help of a computer.

The educational package includes technical information, exercises and experiments

Order Details

Equipment
ELE 102000 Base Unit 2000 (2 are required)
PRG 302200 PID-Future Program 8-user
AUT 302201 PF1 Regulator Interface incl.Cable
AUT 302202 PF2 Temperature Regulation
AUT 302203 PF3 Speed Regulation
AUT 302204 PF4 Signal Converter incl.Cable
AUT 302103 Regulator Module including Contact Module with Band Cable
AUT 302210 Sensor Set for Measuring Techn.
AUT 302101 Car Model for Speed Regulation
AUT 302102 Tank Model for Level and Flow

Technical Literature
BOK 302205 Control Techniques - Basic
Contents:
Control of the car model
Equipment installation
Temperature regulation
Speed regulation
Regulator models time constant
Measuring techniques
Examination of the tank model
Analogue regulator
Thermo element
Resistive temperature sensor
Light relay
Project work
BOK 302210 Control Techniques - Advanced
Contents:
Optimisation
Sluggishness
Proportional band
PI-Regulation
I-time effect on the control signal
PI-regulator
PI-optimation
Composite Regulation System
Forward connection
Quota regulation
Cascade regulation
Valves and Positioning tools
Service of valves with positioning tool
Assembling and disassembling the membrane
Communication
Project: Two capacity tank model

The program package consists of a PID regulator with which it is easy to adjust the different regulation parameters P, I and D and at the same time supervise the results. All of the Lab-Cards can be assembled on the Base Unit 2000. The equipment used in the experiments can also be used for Control Techniques (basic) and Control Techniques (advanced). The experiment book has clear instructions with 4-colour illustrations.
EXTRACT FROM THE LABORATORY EXERCISE BOOK (BASIC).

**Speed Regulation**

The aims of this experiment are to:

- Give practical experience in starting up a speed regulator.
- Practice the difference between control and regulation.
- Give knowledge of amplification factors effect on dynamic and stationary regulation changes.
- Give a general understanding of \( I \) time’s effect on the process. \( I \) time is explained in detail in the chapter-optimisation, in the Text Book.
- Connect PF3 and PF1 according to the diagram below.
- Start the regulation program and configure. See “Standard configuration of speed”. Change signal to 0-20mA.
- The motor speed is now approx. 3000rpm when the process value is 100%. This information is used when calculating rpm in future exercises.

**Equipment**

- ELE 102000 Base Unit 2000
- AUT 302201 PID Interface PF1
- AUT 302202 Temperature Regulation PF3
- Software: PID Future PC (Win 95/98 & XP)

There are two motors but one is used as a generator. It gives the signal that will be the process value in the system and functions in a similar fashion to a bicycle generator. The faster it is driven the higher the signal.

Before starting any experiments make sure that the components are functional and correctly connected. Set the regulator to the manual position and check that the speed can be changed using the mouse. In addition to hearing and seeing how the speed is affected, the actual value is directly affected by the speed.

**COMPOSITE REGULATION SYSTEM**

When a regulator is dependent on another e.g. when two liquids shall be mixed to a certain formula, known as quota regulation, the system is called a composite regulation system. This can also be the case when many actual values are connected together and the regulators counting unit takes account of all the incoming signals to calculate the size of the control signal.

a) What is the end product from the process?
b) What is the function of FT1?
c) Explain the function of FC1.

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations.
AUT 302102 Tank Model
The tank model can be used to regulate level and flow. It is connected via a band cable to the signal converter PF4 which is connected to the regulator interface PF1. The model consists of a container(tank) having a capacity of 1 liter, where the level is measured at 2 places by means of a pressure gauge. The level tank can be divided into max three volumes to create different flow levels in the process. There are four taps for draining off the water to create different loads. The flow to the tank is measured by a sensor on a turbine wheel. The pump motor is driven via a rectifier which regulates the speed of the pump.

General data:
Supply Voltage: 24V DC
Current: 5A
Dimension: 550 x 350 x 510 mm
Weight: 11.7 kg

AUT 302101 Car Model for Speed Controller
The Car Model for Speed Regulation is mounted on the Base Unit 2000. The model is connected to the Signal Converter PF4 which in turn is connected to the Regulator Interface PF1. Two Base Units 2000 are required. The Car Model keeps the speed constant under different loads (cruise control). The unit is equipped with a speed meter and a rotating wheel. It can be run manually or automatically. The Car Model AUT 302101 is seen mounted on the Base Unit 2000.

General data:
Dimension: 240 x 290 x 140 mm
Weight: 1 kg

AUT 302103 Regulator Module
The analogue regulator complete with contact module and band cable is connected to the Base Unit 2000. Setting of P, I and D is completed by trimming the potentiometer and setting the switches, instead of feeding in data via a PC.

General data:
Dimension: 240 x 140 x 30 mm
Weight: 0.3 kg
AUT 302201 PID Interface PF1

PF1 is to be mounted on the Base Unit 2000 and connected to a PC using the software PRG 203300 (See page 6). The PF1 has one analogue input, one analogue output, current or voltage loop, one PWM output, one output for control of the fan and two inputs for temperature sensors.

General data:
Input Signal: 0-20 mA
4-20 mA
0-1 V (diff.input)
Output Signal: 0-20 mA
4-20 mA
20-0 mA
Smart Temperature Transmitter
20-4 mA -30°C - +130°C
PWM.output: 1Hz
Dimension: 135 x 140 x 36 mm
Weight: 0.5 kg

AUT 302202 Temperature Module PF2

PF2 is a temperature regulation system including a heating chamber (oven) of approx. 50W, a temperature sensor and a fan for cooling. It is connected to and regulated by the PID Interface PF1.

General Data:
Heating Chamber: 50 W
Dimension: 145 x 140 x 105 mm
Weight: 0.5 kg

AUT 302203 Speed Regulation Module PF3

PF3 consists of a 12V DC motor which has a 12V DC generator as a load. The purpose is to regulate the speed of the motor. It is connected to the PID interface PF1.

General data:
Dimension: 150 x 140 x 60 mm
Weight: 1 kg

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations.
AUT 302204 Signal Converter PF4
Including Band Cable

PF4 is an interface for adapting signals from the PC based PID-Future to the Car Model and the Tank Model. It is connected to PF1. The Signal Converter is required to communicate between the PID Interface PF1 and the Car and Tank Models.

General data:
Dimension: 140 x 58 x 24 mm
Weight: 0.2 kg

PRG 302200 PID-Future Software

Programme software for measurement, control and regulation. Setting of the set points, P, I and D. Simulation of a sine wave formed process value. Parameters are shown in number form and graphical. The programme material is bought under licence for 8 users.

CD for PC Win 95/98 and XP.

ELE 102000 Base Unit 2000

The starting point of this laboratory system is Base Unit 2000, a control panel and PCB-holder. The Base Unit can be loaded with laboratory cards which have been carefully designed to suit each particular area of study. The Lab Cards are placed in slots and are automatically powered via a D-sub connector.

General Data:
Supply voltage: 220 - 240 V 50-60Hz 1-phase.
The unit has 6 outputs with following data:
Outputs 1-3: DC 12V / 3A with LED indication and fuse.
Outputs 4-6: AC 24V / 3A with LED indication and fuse.
Dimension: 370 x 180 x 75 mm.
Weight: 4 kg
Other supply voltages available on request.
This Servo Technique Set is an educational packet covering different types of servo motors and the associated electronics. The experiments are carried out on a servo baseplate containing fixtures for the different motors having ball bearing screws for positioning. The different motors used, are DC stepper motors, AC and DC servo motors with relevant controls. The control card is fitted to the Base Unit 2000. Servo motors are being used more and more in industry and are to a certain extent replacing both hydraulic and pneumatic. The Laboratory Exercise Book is easily understood with colour illustrations.

**Order Details**

**Equipment**

**Basic Requirements**
- ELE 102000 Base Unit 2000
- AUT 302500 Servo Baseplate

**DC Speed Servo**
- AUT 302502 DC Servo Motor without Gearing
- AUT 302504 Flywheel
- AUT 302506 Generator Brake
- AUT 302508 Servo Regulator SR1
- AUT 302510 Speed Module SR2

**DC Positioning Servo**
- AUT 302512 DC Servo Motor with Gearing
- AUT 302514 Process Value Potentiometer
- AUT 302516 Positioning Module SR3
- AUT 302508 Servo Regulator SR1
- AUT 302518 Stepper Motor
- AUT 302520 Stepper Motor Module SM1

**AC Servo**
- AUT 302522 AC Servo Motor 100 W, 3000 rpm
- AUT 302524 AC Servo Amplifier incl. SC-09
- PRG 302500 Program material Sigma WIN for Windows

*Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations.*
Programming software for the AC servo system.
To make it easier to programme and analyse the servo system a windows based software is used. Different systems can be tested, servo systems variables can be configured and the signal flow observed.

Servo programming software Sigma Win.
AUT 302500 Servo Baseplate with Linear Unit
The servo baseplate consists of a hard sprayed aluminium profile. On the baseplate a ball bearing supported axle is assembled. On the axle a disc graduated from 0 to 360 degrees is attached, also a code disc that controls an optical encoder with 500 pulses per rotation. At one end of the axle, different types of motor can be attached. A linear unit having a stroke length of 140mm is mounted on the baseplate. A millimeter scale showing 70-0-70 with an index on the travel carriage is also mounted on the baseplate. The unit rises by 1mm/revolution making it possible for good accuracy. The Linear Unit is equipped with a friction coupling.

General data:
Dimension: 420 x 240 x 100 mm
Weight: 5 kg

AUT 302502 DC Servo Motor without Gears
A DC servo motor for direct connection to a servo system. It is connected to the axle on the servo baseplate.

General data:
Nominal voltage: 12 V
Nominal torque: 10 Nmm
Nominal speed: 2850 rpm
Input power: 3.6 W

Dimension: 100 x 70 x 60 mm
Weight: 0.3 kg

AUT 302504 Flywheel
The Servo System 2000 is loaded by connecting a flywheel to the motor shaft by means of a shaft coupling. The flywheel weighs 0.3kg.

General data:
Dimension: 100 x 40 x 60 mm
Weight: 0.4 kg

AUT 302506 Generator Brake
For stepless adjustment of different loads, a generator brake is connected to the motor shaft. The brake action can be varied by means of a potentiometer.

General data:
Dimension: 110 x 90 x 60 mm.
Weight: 0.4 kg
AUT 302508 SR1 Servo Regulator
The servo regulator lab card is connected to the Base Unit 2000. It is used to regulate the DC servo. SR3 positioning module is used for positioning and SR2 speed module for control of speed.

General data:
Dimension: 290 x 140 x 45 mm.
Weight: 0.4 kg

AUT 302510 SR2 Speed Regulation Module
Used together with the SR1 Servo Regulation Module for speed control of the DC-Motor without gear. The SR2 Speed Regulation Module will be mounted on the SR1 Servo Regulator with two electrical connectors.

General data:
Dimension: 140 x 40 x 50 mm.
Weight: 0.1 kg

AUT 302514 Process Value Module
The process value module for the potentiometer, functions as an analogue positioning sensor. The moving parts follow the turn of the axle. The potentiometer has an operational angle of 360°. There is no stop and the potentiometer follows the axle changing the resistance continually.

General data:
Dimension: 160 x 60 x 60mm.
Weight: 0.1g

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations.
AUT 302512 DC Servo Motor with Gears

Used with the DC positioning servo. It is a 12V DC servo motor with built-in gears for reducing the speed to the baseplate axle.

General data:
- Voltage: 24 V
- Power: 4 W
- Off load speed: 5940 rpm
- Max load Current: 285 mA
- Max torque: 10.8 Nmm
- Dimension: 110 x 100 x 60 mm
- Weight: 0.3 kg

AUT 302518 Stepper Motor

The stepper motor is a brushless DC motor with a rotor that can rotate to selected positions. The motor can be made to move forwards or backwards and at different speeds with great accuracy by energising the motors different windings. The stepper motor is connected to the axle on the Servo Base Plate. It is regulated by the Stepper Motor Module SM1.

(See page 12)

General data:
- Dimension: 100 x 100 x 60 mm
- Weight: 0.7 kg

AUT 302516 SR3 Positioning Module

SR3 Positioning Module is an analogue positioning sensor which can be connected via a shaft coupling to the Servo Base Plate.

It includes a potentiometer which follows the torsion of the shaft. The potentiometer is single wound with an electrical angle of 360º. The potentiometer has no end stop, and it accompanies the shaft, continuously changing it’s resistance.

Positioning Module SR3 is mounted on the Servo Regulator SR1.

(See page 10)

General data:
- Dimension: 140 x 40 x 50 mm
- Weight: 0.1 kg

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations.
AUT 302520 Stepper Motor Module SM1

The stepper motor module SM1 is connected to the Base Unit 2000 for regulation of the stepper motor, which is mounted on the Servo Baseplate.

General data:
Dimension: 240 x 140 x 50 mm
Weight: 0.2 kg

AUT 302522 AC Servo Motor

The AC Servo Motor is mounted on the motor bracket with four quick release wing nuts. It is coupled to the shaft of the servo system. The servo motor is connected to the AC servo amplifier.

General data:
This AC Servo Motor has the following data:
Voltage: 200 V
Current: 0.89 A
Power: 100 W
Speed: 3000 rpm
Torque: 0.3 Nm

Dimension: 90 x 100 x 60 mm
Weight: 0.8 kg

AUT 302524 AC Servo Amplifier

The amplifier contains a control unit, flash memory and a power amplifier. From the control unit there are many switches for the control of the servo system. Connection to the PLC is at the back of the amplifier. The servo system can be programmed using a computer and then transferred to the flash memory in the amplifier.

General data:
Dimension: 290 x 260 x 170 mm
Weight: 5.3 kg

PRG 302500 Programme Software Sigma Win

Sigma Win is a software for programming AC servo’s. The software is Windows based.
SD 1664 Stepper Motor Training Unit

SD 1664 is a unit for training and teaching stepper motor applications. The stepper motor has many applications where it is very useful and economic but unfortunately it has a lot of "side effects" which are a problem.

SD 1664 teaches how to overcome problems like frequency resonance, loss of pulses and overshots.

### SD 1664 Specification

- Max pulse frequency 1200 Hz
- Max torque 160 Ncm
- Three modes
  1. Continues
  2. Count
  3. Single step
- Two types of drive systems, unipolar and bipolar. Both types of drives are used in CNC-machines, etc. The controller has several facilities such as on/off, half/full step and clockwise / counter clockwise rotation.

In continuous mode (1) the motor runs with a speed according to speedref potentiometer. The frequency can be measured at a testpoint.

In count mode (2) it is possible to preset number of revolutions, ramping times and maximum speed. In single step mode (3) the rotor rotates one step for each push on the push button.

The equipment includes:
- Control Unit
- Stepper Motor Module
- Two flywheels with different moment of inertia
- Comprehensive Laboratory Manual

**General Data**

<table>
<thead>
<tr>
<th>Control Unit</th>
<th>Stepper Motor Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension: 500 x 340 x 300 mm</td>
<td>300 x 190 x 120 mm</td>
</tr>
<tr>
<td>Weight: 12 kg</td>
<td>5 kg</td>
</tr>
</tbody>
</table>

Supply voltage: 220 - 240 V AC 50 - 60 Hz 1-phase

### SD 1664 Experiments

1. Torque characteristics / Speed
2. Pull in / pull out torque
3. Pull in / pull out rate
4. Holding torque
5. Max pull in rate
6. Max pull out rate
7. Max working torque
8. Start range
9. Slew range
10. Bipolar drive
11. Unipolar drive
AUT 300130 Autoportal provides a means of studying industrial automation techniques on the basis of PLC-controlled pneumatics. It has three axis consisting of two shuttle cylinders (X- and Y- axes) which can be positioned independently of each other, as required. The third axis is a double-acting cylinder (Z-axis) complete with a vacuum cup in which objects of different shapes and materials are collected, identified with a variety of transducers and sorted between different stations.

The Autoportal is mounted on a 750 x 960mm aluminium plate, which is grooved so as to facilitate adjustment and positioning of the different modules. The Autoportal includes a control and connection box which can be used for manual control or for connecting control systems (PLC).

The Autoportal is an excellent system for basics training, and can also be used for more advanced studies of control technology.

AUT 300130 Autoportal

Autoportal is an educational model for automation training. It measures and identifies different products (samples) which differ as follows: The products are either 30 mm or 25mm in height. They are either round Ø 50 mm or square having a side length of 50 mm. In addition they are either black or white and some of them have a metal covering. With the automation unit the student can learn how products are transported between the following stations.

- Magazine (store) for incoming products
- Measuring station for measuring height
- Station for detecting the product material
- Store for rejected products
- Store for selected products (3)
<table>
<thead>
<tr>
<th>General Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required number of I/O:s</td>
</tr>
<tr>
<td>Equipment:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Logic level:</td>
</tr>
<tr>
<td>Working pressure range:</td>
</tr>
<tr>
<td>Dimension:</td>
</tr>
<tr>
<td>Weight:</td>
</tr>
</tbody>
</table>

A PLC is required with the Autoportal.
A suitable PLC can be quoted on request.

**AUT 300135 AC Servo Package for Autoportal**

As a further enhancement of the Autoportal’s educational value, an optional servo-package has been developed which can also be retro-fitted to the Autoportal.

This servo package is intended for servo technology applications, enabling the student to position the X- and Y-axes of the Autoportal, with a high degree of accuracy. Using servo control of the axes, it is possible to run the system with the cylinders unpressurised or load the system with a back-pressure, for greater inertia and instability.

The system consists of two AC-servo motors having incremental transducers connected to two ball bearing screws. The main system is comprised of a PLC-system complete with positioning modules, servo amplifiers and an operators terminal for control and status indication.

**AUT 300150 Trolley for Autoportal**

The trolley for Autoportal is constructed from steel and has fixtures for the different units. The rubber wheels are lockable to keep the trolley stationary.

The trolley can be seen on page 14, under the Base-Plate.

<table>
<thead>
<tr>
<th>General Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension:</td>
</tr>
</tbody>
</table>

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations.
AUT 302005 Ball Selection Module

This module is used to select balls of different colour and material to two different stores. It includes store, collect position having a measurement fixture, two outputs positions and two stores. On the board there is magnetic detection, inductive sensor and micro switch. The Ball Selection Module gives the student more advanced training in pneumatics. From a storage area, the balls of metal and non-metallic materials are sent down to a sorting station. The arrival of the balls is detected by an optical sensor. The selection is made by a shuttle cylinder that carries the balls to the relevant container. A mini cylinder deposits the balls into the correct container. The Ball Selection Module is connected to the PLC board via the Terminal Block Module.

AU 5900 Mecha-Kit

Terco Mecha-Kit is a modular system for basic education in pneumatic and control techniques, known today as Mechatronics. The Kit consists of an aluminium base plate and a hard case, and a plastic box containing a number of different components within the field of Mechanics, Electronics, and Pneumatics. With the Kit the students can build a number of simple automatically controlled handling units where only the imagination of the students sets the limit. All electrical wiring and pneumatic circuitry work is done by the students. The combination of direct hands on training and almost unlimited possibilities, inspire the students and quickly increases their interest in this kind of engineering. Most of the handling units can be linked to a PLC unit for automated control. The units can be linked together and form a network and simulate a flexible manufacturing cell.

Yo - Yo Factory

The YO - YO factory is a flexible training system covering all aspects of automation. It consists of a number of stand-alone laboratory modules which together comprise a small-scale industrial manufacturing plant. The units can be operated independently using a Programmable Logic Controller (PLC) or as an on-line manufacturing plant with a fieldbus systems.

Each individual module is manufactured from extruded aluminium and is fitted on a specially designed trolley. The operating panel, power supply and the PLC are located under the top plate on an extractable drawer. The control system and the power supply are connected to the modules by two D-connectors. The modules are operated from a compressed air supply and each module has its own air filter and regulator. Modules can be easily linked together to form different combinations.
Terco Headoffice and factory outside Stockholm, Sweden.

TERCO AB • P.O. Box 5014 • SE-141 05 HUDINGE – STOCKHOLM • SWEDEN
Telephone: +46 8 506 855 00 • Telefax +46 8 506 855 01 • http://www.terco.se • e-mail export@terco.se