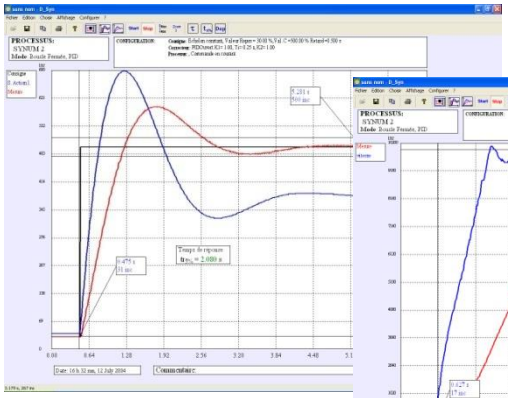
SERVO-SYSTEMS & PROCESS CONTROL

SYNUM 3 : ERD 100 B



Program under Windows

ref.: ERD 100100

Practical works manuals (with results)

ref.: ERD100041 & 061 & 081

Electromechanical module

ref.: ERD100000

SPEED/POSITION SERVO-SYSTEM

The ERD100B unit is a complete **training system** specifically designed for the **detailed study** of servo-systems. It shows the speed or position control by DC motor of a rotating mechanical load. It includes the electromechanical part ERD100000, the program ERD010100, accessories, and in option a program to implement rapid prototyping.

TRAINING PURPOSES

It allows the system behavior analysis in different possible configurations, its characterization and control synthesis according to the required specifications.

A complete **training manual** proposes many topics: study of transducers, characterization of a mechanical load, study of speed and/or position in open loop, study of speed and/or position in closed loop, selection and adjustment of the corrector, selection and adjustment of the control parameters etc…

POSSIBLE CONFIGURATIONS

- **Selection of the structure**: open loop, closed loop controlled in speed, closed loop controlled in position.
- **Selection of the control signal**: constant step, ramp, trapezoid, sine, external control.
- **Selection of the corrector**: P/PI/PID, 3rd order digital « Z » transform, ON/OFF, state feedback.
- **Selection of input on which the derivate action is applied**: on bias, on measurement (PID).
- **Selection of the driven mechanical load**: inertia, with or without friction (adjustable intensity), fluid, dry.
- **Selection of the motor power interface**: in current (torque), in voltage (speed).
- **Selection of the « system » different parameters**: sampling periods, transducer gain etc …

TRAINING IN

- Electrical engineering
- Mechanical engineering
- Physics
- Universities
- Vocational schools
- Military schools

ERD100000: ELECTROMECHANICAL MONITOR

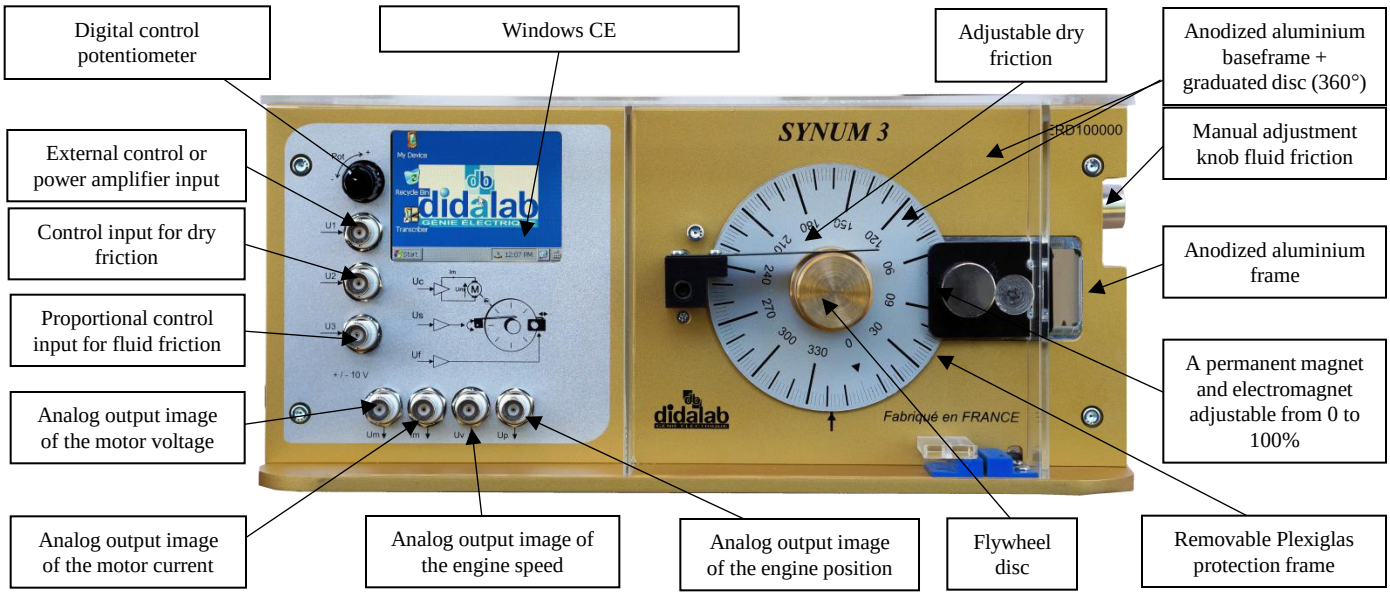
The ERD100000 electromechanical device is available on table-top anodized aluminium baseframe, with external power supply. It is proposed in 2 operating regimes:

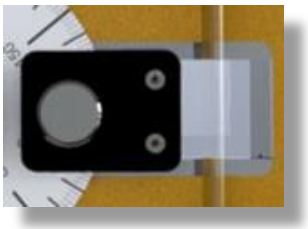
- Control with the software *D_Syn* (refer to the following pages), optional: rapid protoyping *D_Scil* (cf the documentation)
- Rapid prototyping using Matlab Simulink®, (interface board not supplied) ; in the latter case, the analog inputs enable to directly control the power interfaces, motor, fluid friction solenoid and dry friction motor.

It includes:

- 1 electronic board with a high-level of power microprocessor enabling the monitoring and control of the system in real-time and the communication with a PC *via* Ethernet link
- 1 power electronics board to carry out the power interfaces of the motor (current or voltage), the fluid friction control (electromagnet) and the dry friction control (gear motor)
- Measuring points are available in the front panel by BNC (speed/position images, motor voltage and current).
- 4 analog inputs
- 1 digital adjustment button for the external set value

DISPLAY OF THE FRONT PANEL





The fluid friction brake is a device composed of a powerful permanent magnet associated to an electromagnet, moving on a carriage.
This device is moving transversely, activated by a rack system activated by a button.
This device enables the use of both null fluid friction (carriage fully on the right), and initial fluid friction (magnet) fluid friction, on which another friction torque can be added on established rate (electromagnet).

The control motor is a high quality servomotor, using gold contact switching, ball bearings, and enabling to get practical works results, that can be **<u>modeled and repeated</u>**.

MOTOR CHARACTERISTICS	Value	Unit
Power supply	24	V_{DC}
Nominal current speed	4086	RPM
Max permanent current	662	mA
No-load current +/- 50%	14	mA
Idle I / nominal I	2.1	%
Constant torque	43.8	mNm/A
Max. efficiency	87	%
Max. effective power	19	W

INCREMENTAL ENCODER
Two tracks in quadrature, 500 steps per revolution

ERD100100 : PROGRAM UNDER WINDOWS

▪ It is operating under Windows environment and enables to drive the Synum 3 *via* Ethernet.

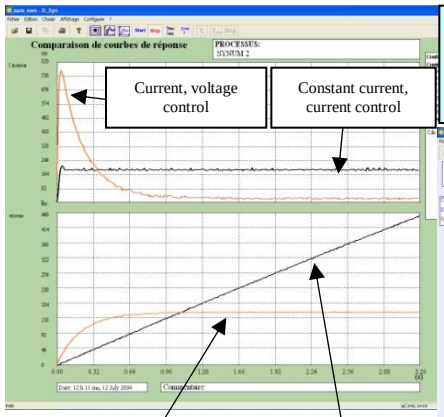
▪ Configuration of the system, via an ergonomic graphic interface:

- selection of the system structure: speed or position open/closed loop.
- selection of the control type, characteristic values: constant step, ramp, sine, trapezoid signals.
- selection of the corrector and its adjustments (P, PI, PID, Z corrector, On/Off, tacho-generator feedback)
- selection of the power interface type (current or voltage).
- selection of the fluid braking intensity and its trigger time.
- selection of the acquisition and recording parameters.
- selection of the measurements units.

It also enables the structured running of the experimental work:

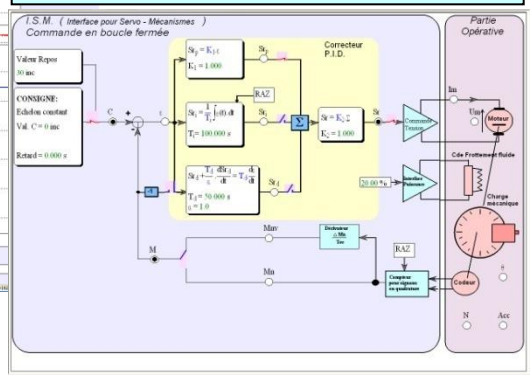
- request for the displaying of a time response of one (or several) characteristic parameter(s): position, speed, acceleration, motor current/voltage, control signal, overflow, corrector output etc…
- modification of the time diagram scales (zoom in X, or Y)
- recording of the running test, comparison with the previous tests
- determination of the automatic control characteristic values (time constants, 5% response time, overflow amplitude etc…)
- transfer of the result curves to be controlled by other processing software, such as MATLAB.

Comparison screen between OL responses in voltage control mode, and current mode, without friction disturbances.

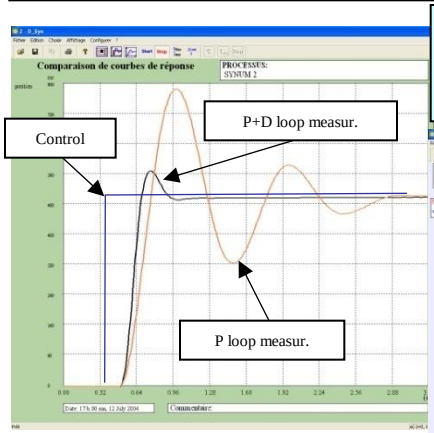


Response in closed loop speed control, with automatic calculation of the reaching time in the 5% zone.

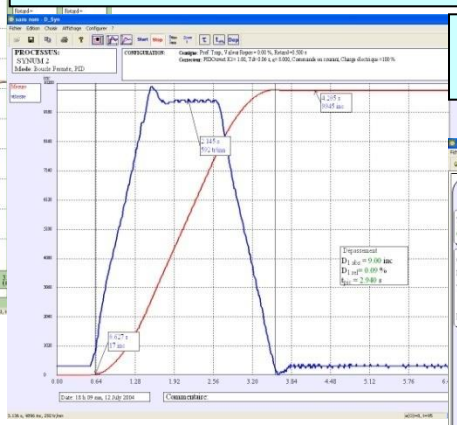
Parameter screen
Exemple of speed control by PID single loop corrector



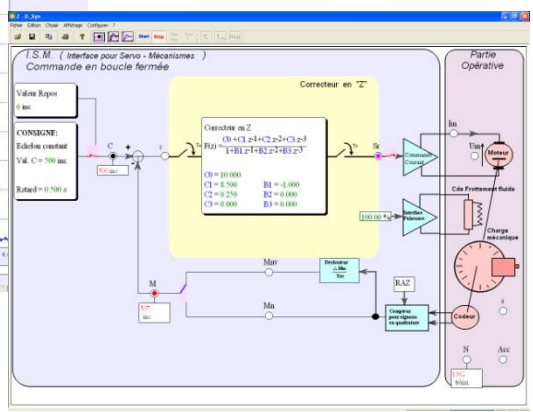
Comparison of curves : Proportional (P) and Proportional Derivate (PD) closed loop position controlled.



Closed loop position controlled **response** with trapezoid set value, speed and position curves



Parameter screen
Example of speed control by « Z » corrector



PRACTICAL WORKS MANUALS (WITH RESULTS):

ERD100 041/51 : **Practicals in linear control** (inhibited dry friction)
Study of the transducers: structure, position / speed / acceleration, digital or analog outputs transducers.
Study in open loop control: with current interface, and voltage interface:

- Experiments: static transfer characteristic, response to a constant level, a sinusoidal excitation.
- Management: open loop static gain, time constant, 5% response time, depending on the motor control mode, characterization of the mechanical load, transfer function, and block diagram implementation.

Study of a speed servo-control with P and PI corrector and eventually PID

- Experiments: response to a constant level, a ramp, a sinusoidal excitation, the influence of adjustment coefficients, influences the type of correction, proportional band highlighting.
- Management: closed loop static gain, 5% response time, stability degree, static error, following error, bandwidth, transfer function and block diagram implementation.

Study of a position servo-control with P and PD corrector

- Experiments: response to a constant level, a ramp, a sinusoidal excitation, the influence of adjustment coefficients, influences the correction type, proportional band highlighting.
- Management: closed loop static gain, 5% response time, stability degree, static error, following error, bandwidth, transfer function block diagram and block diagram implementation.

Fast prototyping

- With "***D_Scil***" development of a new corrector under *Scilab / Xcos* in the continuous domain, current controlled motor.
- With "***D_Scil***" development of a new corrector under *Scilab / Xcos* in the continuous domain, voltage controlled motor.

ERD 100 061/071: Practical works in the nonlinear domain
Study of a position servo-control of a mechanical load with a dry rub

- Experiments: static transfer characteristic, response to a constant level.
- Management: dead band, amplitude overruns, trajectory in the phase plane, duration of movement.

Study of a speed regulation corrector "On/Off" without/with threshold
Study of a position regulation corrector with "+ or –"

- Approximation of the 1st harmonic behavior and amplitudes of the oscillations in position

Study of a speed control with digital controller

- "Z" transfer function, stability study, the influence sampling, synthesis of digital controllers (P, P + I, by offsetting dominant pole ... etc), study and comparison of static and dynamic behavior.

Study of a position control with digital controller

- Transfer function "Z", study stability, digital synthesis correction (type P, P + D, by dominant pole compensation, stability margin, "Žďáň" method, etc…), study and comparison of static and dynamic behaviors depending on the experienced corrector.

Fast prototyping in the digital domain

- With "***D_Scil***" development of a new corrector in *Scilab / Xcos* in the digital domain.

ACCESSORIES :

EGD000010 : UTP/RJ45 lead
EGD000005 : 24 V_{DC}, 2.9 A power supply

Pack standard :

ERD100B-A : « STUDY OF DIGITAL & ANALOG SERVOSYSTEMS » package, including:

Reference	Designation	Qty
ERD100000	DC motor speed and position servo-control actuator	1
ERD100100	PC control program, ON/OFF, P, PI, PID corrector, 3rd order Z transform, state feedback,	1
ERD100041	Manual of practical (reports) in the continuous linear domain	1
ERD100051	Manual of practical (exercises subjects) in the continuous linear domain	1
ERD100061	Manual of practical (reports) in the digital domain	1
ERD100071	Manual of practical (exercise subjects) in the digital domain	1
EGD000010	2-m UTP/RJ45 lead	1
EGD000005	24 V_{DC}, 2.9 A power supply	1

ERD100S : "STUDY OF ANALOG AND DIGITAL AUTOMATIC CONTROLS & PROTOTYPING" simulation package including :

Reference	Designation	Qty
ERD100B	**« STUDY OF DIGITAL & ANALOG SERVOSYSTEMS » package**	**1**
ERD100801	**D_Scil,** Module for creating real-time correction in *Scilab / Xcos* applied to ERD100000 (see documentation)	1

PACKING :

Net: 350 x 160 x 135 mm, Weight: 4 kg
1 Case Gross dimensions: 40 x 30 x 50 cm
Gross Weight: 7 kg

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