Servo-systems and Process Control

The ERD 050 B Pack
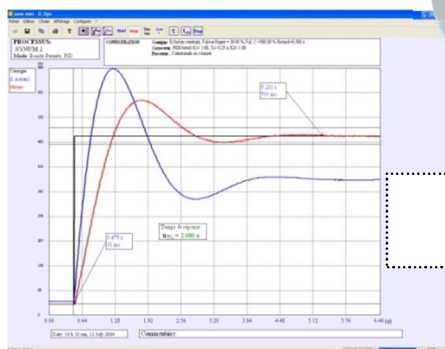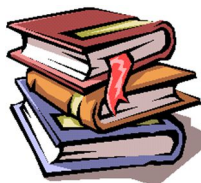
Electromechanical device
Ref. : ERD 050 000

D_IAPV PC Program
Ref. : ERD 050 100

Practical Work Manuals

INTRODUCTION TO SPEED & POSITION SERVOSYSTEMS

The ERD050B pack is a full **training system**, intended to The Servosystems experimental work.

It carries out a speed and position servosystem of a rotating mechanical load driven by DC motor. A graduated disk enables the display and location of angular motions.

It includes one electromechanical monitor (Ref. ERD 050 000), one software program (Ref. ERD 050 100), one technical file (Ref. ERD 050 010), several Manuals of Practicals (depending of the students level) and one set of accessories (Power Supply block, set of patching cords).

TOPICS

It enables the system behaviour analysis in many possible configurations, its characterization is the control synthesis according to the set specifications.

One Manual of Practicals deals with many topics: study of sensors,study of open loop, study of speed and position closed loop behaviour, according to the selected corrector and its adjustment, according to the type of control, of the mechanical load characteristics etc…

POSSIBLE CONFIGURATIONS

• **Selection of the structure :** open loop, speed closed loop, position closed loop,
• **Selection of the control signal :** constant step, ramp, trapezoid, sine, external control signal,
• **Selection of the corrector :** P/PI/PID
• **Selection of the input on which derivative action is applied :** on the error signal,on the measurement   (PID),
• **Selection of the driven mechanical load profile :** constant, according to the speed.

AREAS OF APPLICATIONS

- PROFESSIONAL TECHNICAL SCHOOLS,   - UNIVERSITIES
- TECNICAL COLLEGES

ERD 050 000 : SPEED & POSITION SERVOSYSTEM MONITOR

The ERD 050 000 electromechanical unit is built in a PVC box, to be set on a table.
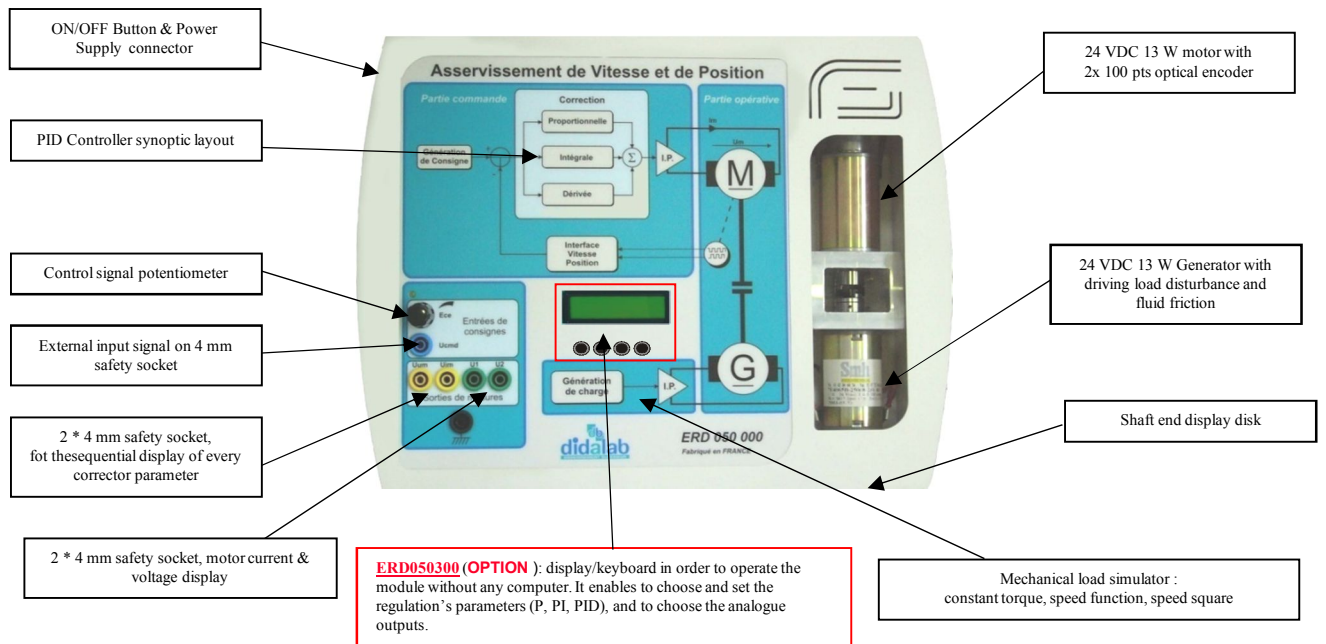
This box includes:

- ▸ 1 mechanical device with :
  - ▪ One 24 Vdc motor (characteristics are displayed there below)
  - ▪ One DC generator fitted to the motor by OLDHAM clutch, enabling the load generation
  - ▪ One graduated disk enables the display of the position and the behavior of the spinning device
- ▸ 1 high power level microprocessor control electronic board allows the system real-time control and communication to a PC Computer (USB link)
- ▸ 1 power electronic board enables the power interface for the motor supply, as well as the interface for the generator, simulating mechanical loads
- ▸ 2x 4-mm safety sockets, available on the front panel, enable the control signals sequential display
- ▸ 2x 4-mm safety sockets, available on the front panel, enable the motor current and voltage display
- ▸ 1x 4-mm safety sockets enables external control signal input
- ▸ 1 internal control signal adjustment button
- ▸ 1 ON / OFF power switch
- ▸ 1 light-emitting diode to display the voltage presence

The servo-control synoptic layout is silk-screened onto the front panel.
One transparent zone enables the internal view of the mechanical device.
The user can adjust the start position of the spinning actuator.
Powering is made by an external power supply (provided).

Label	
ON/OFF Button & Power Supply connector	
PID Controller synoptic layout	
Control signal potentiometer	
External input signal on 4 mm safety socket	
2 * 4 mm safety socket, fot thesequential display of every corrector parameter	
2 * 4 mm safety socket, motor current & voltage display	
ERD050300 (**OPTION**): display/keyboard in order to operate the module without any computer. It enables to choose and set the regulation's parameters (P, PI, PID), and to choose the analogue outputs.	
24 VDC 13 W motor with 2x 100 pts optical encoder	
24 VDC 13 W Generator with driving load disturbance and fluid friction	
Shaft end display disk	
Mechanical load simulator : constant torque, speed function, speed square	

MOTOR CHARACTERISTICS	Value	Units
Power Supply voltage	24	Vdc
rated current speed	4812	Rev./min
Permanent maximum current	700	mA
No-load current +/- 50%	140	mA
(No-load current / Rated current) ratio	20	%
Torque constant	42.4	mNm/A
Maximum efficiency	76.5	%
Maximum effective power	13.1	W

INCREMENTAL ENCODER
Two tracks in quadrature, 100 p/p/r
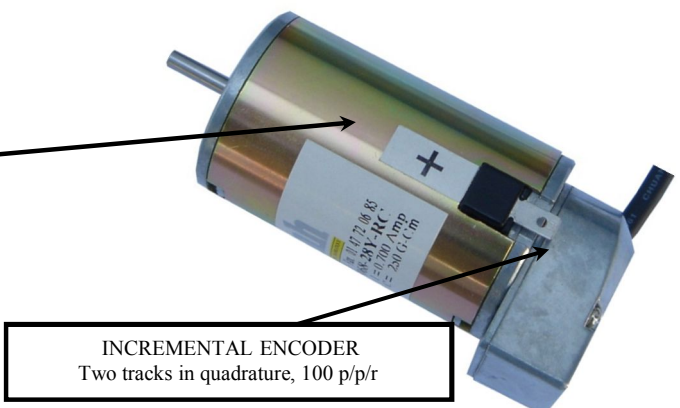
ERD 050 100 : D_IAPV SOFTWARE PROGRAM UNDER WINDOWS

D_IAPV, **D**MS Introduction to Speed and Position Servosystems program, operating under Windows 98, 2000, XP (Professional Editions) environment, it enables the control of the servosystem via USB link (RS232 on request).

It enables the User, through an ergonomic graphic interface, to configure the System:
- Selection of the System structure : speed or position open loop / closed loop,
- Selection of the control type and characteristic values : constant step, ramp, sine, trapezoid,
- Selection of the P, PI, PD, PID corrector and adjustments of the corrector parameters,
- Selection of the mechanical load profile (constant, in a.x or in $a.x^2$)
- Selection of acquisition and recording parameters,
- Selection of measurements units (degrees, radians, revolutions).

It also enables the experimental test campaign structure flow:
- request of the time response display of one (or several) characteristic value(s) :
  position, speed, acceleration, motor current, motor voltage, control signal, error, corrector output etc.
- modification of the time diagram scales (zoom in X, in Y)
- recording of the pending test configuration, comparison with the preceding tests.
- determination of Automatic characteristic values (time constant, response time at 5%, overflow amplitude etc.)

Speed control closed loop response, with automatic calculation of the reach time to the 5% zone.

Parameterization screen
Example of a speed servo system with PID corrector.
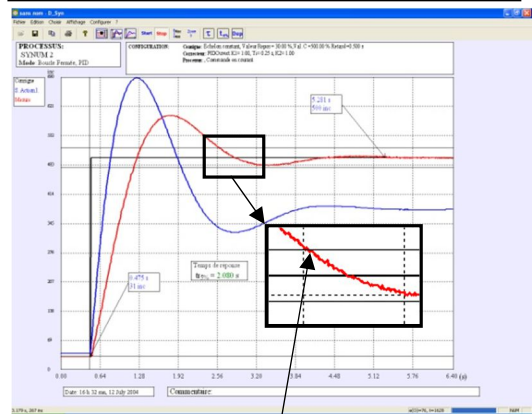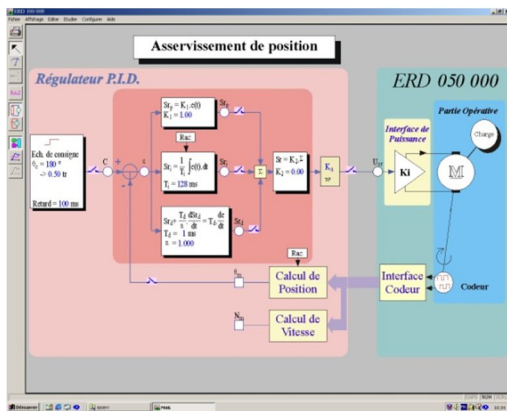
Automatic measurement of the response time at 5% on the feedback loop

Comparison of loops : Proportional & Proportional+Derivative closed loop position servo control.

Control signal
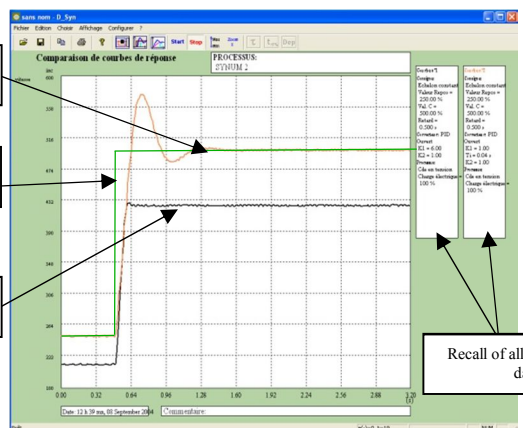
Measurement in P& D mode

Measurement in P mode

Comparison of loops : Proportional & Proportional+Integral closed loop speed servo control.
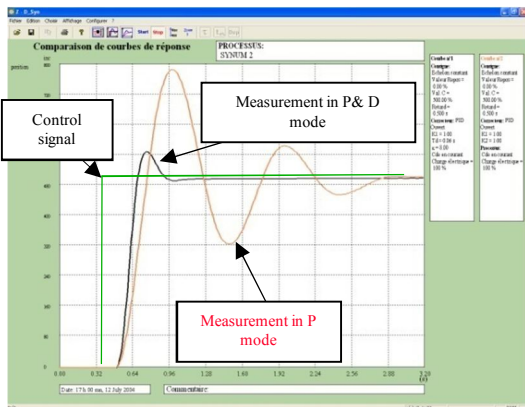
PI feedback loop, no static error

Control signal with delayed triggering

P feedback loop, important static error

Recall of all experiments data

Level 1 : (high school) ERD050031 Manual for Students (5 topics 30 pages) ERD050021 Manual for Teachers (with solutions) (32 pages)

Study in Open loop (Static transfer characteristics, constant step response, time constant restsponse time at 5 %, passing band) ; Study of Speed control (Closed Loop) (Proportional corrector, Integral corrector, static error, underscoring of the proportional band) ; Study of Position control (Closed Loop) (Proportional corrector, Derivative corrector, overflow amplitude (absolute / relative))

Level 2 : (technical college, licence) ERD050050 Manual for Students (10 topics 66 pages) ERD050040 Manual for Teachers (with solutions) (94 pages)

Study of sensors (structure, position / speed / acceleration, digital or analog outputs sensors); Identification in Open loop (Use of Laplace transform, 1st degree tansfer, response with constant step control, mechanical load profile, slowness coefficient, slimy friction); Predefined response in closed loop, then experimental check (speed control and position control) (transfer in closed loop, influence of the type of corrector, 2nd degree transfer …).

Level 3 : (university, engineer school) ERD050070 Manual for Students (6 topics 50 pages) ERD050060 Manual for Teachers (with solutions) (78 pages)

Numerical correction ; Experiment in Open loop (« Z » transfer); Predefined response in closed loop, then experimental check (speed control and position control) Prédétermination du comportement en boucle fermée en vitesse et vérification expérimentale(« Z » transfer in closed loop; stability degree, numerical integrator, …)

Accessories :

EGD 000 006 : « USB » patch cord
EGD 000 005 : 24 Vdc, 2.9 A Power supply

Standard configurations :

ERD 050 B : « STUDY OF ANAOLGIC AND NUMERICAL SPEED AND POSITION SERVOSYSTEMS» Basic Package including :

Reference	Description	Qty
ERD050000	DC motor speed and position control operating device	1
ERD050100	Cotrol program on computer (computer not supplied), P, PI, PID correction	1
ERD050031	Manual of Practicals (Student's Book), level 1 (High School),	1
ERD050021	Manual of Practicals (Teacher's Book), level 1 (High School),	1
ERD050050	Manual of Practicals (Student's Book), level 2 (technical college, licence), (in French for now)	1
ERD050040	Manual of Practicals (Teacher's Book), level 2 (technical college, licence), (in French for now)	1
ERD050010	Technical Files	1
ERD050500	Packing case	1
EGD000006	USB patch cord (to computer)	1
EGD000005	24 Vdc, 2.9 A Power supply	1

ERD 050 C: « STUDY OF ANAOLGIC AND NUMERICAL SPEED AND POSITION SERVOSYSTEMS» Complete Package including:

Reférence	Description	Qty
ERD 050 B	« STUDY OF ANAOLGIC AND NUMERICAL SPEED AND POSITION SERVOSYSTEMS» Basic Package	1
ERD050200	Optional software with numerical correction « Z » order 4, cascade control	1
ERD050060	Manual of Practicals (Student's book), level 3 (cascade control and numerical correction) (in French for now)	1
ERD050070	Manual of Practicals (Teacher's book), level 3 (cascade control and numerical correction) (in French for now)	1

Optional :

ERD 050 300 : display/keyboard in order to operate the module without any computer. It enables to choose and set the regulation's parameters (P, PI, PID), and to choose the analogue outputs.

Packing list :

1 package of 35 x 35 x 20 cm
Gross weight: 10 kg

Document non contractuel