



Linear Servos



Discovery screen showing a PID model

This range of servo control training equipment introduces the theory and practice of automatic control systems and allows investigation of open and closed loop analogue, digital, speed and position control.

Two systems available are:

- The 33 series introduces the principles of analogue and digital servo systems.
- The 150 series provides a more precise servo for quantitative measurements in dc, ac and hybrid systems.

Upgrade kits are available for both products to allow them to operate with **MATLAB®** software (see SFC3.2 for further information).

Analogue & Digital Servo Trainer 33-001-USB

DISCOVERY
software



The system comprises:

Mechanical Unit with input and output potentiometers, motor, tachogenerator, absolute and incremental encoder and on-board waveform generators.

Analogue Unit with four-input error amplifier. Optional additional time constant. Variable gain and velocity feedback. Single, two term or full PID control.

Digital Unit provides access to PC via a USB interface, has A/D and D/A converters, linear or PWM motor drive, LED display.

Discovery software supports both the analogue and digital units and allows assignment work to be carried out with on-screen theory, background, practicals and questions.

For the Digital unit, the software contains PC-based instrumentation, including a chart recorder. Supplied with power supply.

Curriculum Coverage

Analogue

- Operational amplifier characteristics
- Motor, tachogenerator and brake characteristics
- Simple control and speed systems
- Error channel and feedback polarity
- Influence of gain
- Velocity feedback
- System following error
- Unstable systems
- Speed control systems
- Introduction to 3-term control
- Applications of 3-term control
- Single amplifier control circuits
- Transient velocity feedback and derivative feedforward
- Transfer functions and frequency response principles
- Application of frequency response methods to the system

Digital

- A/D and D/A conversion
- Motor control
- Potentiometer position sensors
- Digital encoders
- Gray code encoder
- Incremental encoder
- Speed and directional encoding
- Position control using analogue sensor
- Position control using digital sensor
- Speed control using analogue sensor
- Speed control using digital sensor
- Position servo using P+D control
- Position servo using P+I control
- Position servo using PID control

Modular Servo System MS150

This system provides a linear quantitative control application for more advanced work.

It comprises individual units magnetically assembled on a baseplate.

The system is available as:

- **Complete dc/ac/hybrid system – MS150-3**
- **dc system – MS150**
- **ac system – MS150A**

Comprehensive assignment manuals are provided.

An add-on kit is available that converts the system to use **MATLAB®** software.



Speed and position control systems can be constructed. Allows investigation of how gain, damping, friction and inertia affect the system performance.

dc Modular Servo System MS150

This is the basic set from which the two variant systems are derived. The system comprises modules, leads, accessories and manuals. Practical work in book 1 is mainly qualitative and non-mathematical and covers the introduction to control systems. Further manuals introduce simple, differential equations and the operator “j”.

Curriculum Coverage

- Operational amplifiers
- Motor speed characteristics
- dc error channel
- Simple position control
- Closed-loop position control
- Simple speed control
- Deadband & step response
- Velocity feedback
- Analysis of simple position control with speed response
- Position response
- Closed loop frequency response
- Measurement of motor time constants
- Measurement of velocity error constant K_v
- Frequency & transient response
- Measurement of following error
- Stability considerations & the use of lead, lag & combined networks
- Tacho-generator feedback and its effects on system performance including acceleration feedback
- Linearisation of systems

ac Modular Servo System MS150A

This is available as a complete system or by adding extra modules to the dc system.

The MS150A is used in more specialised and advanced control applications and some detailed knowledge of ac carrier systems is required.

Curriculum Coverage

- Motor characteristics
- ac tacho-generator
- Motor speed control
- Characteristics of two-phase motors
- ac pre-amplifiers
- Position control systems
- Importance of phasing on torque and speed performance
- Compensation using the adjustable notch filter
- Notch filter design
- Frequency selective characteristics for the elimination of noise and harmonics
- Analysis of carrier systems
- Frequency transformation for compensator techniques
- Principles & measurement of compensation unit characteristics
- Instability
- Reduction in steady following error
- Effects of gain and damping
- Synchro link and the demodulator
- Closed loop systems

dc/ac & Hybrid Modular Servo System MS150-3

The addition of:

- **Simulated relay unit**
- **PID unit**
- **Sample & hold unit**
- **Differential synchro unit**

In addition to the subject areas covered by the MS150 and MS150A, the full system allows the following additional topics to be studied:

Curriculum Coverage

- Relay characteristics & relay operated systems
- Following characteristics of relay system
- Effect of backlash on the system
- Phase-plane analysis
- PID control loop characteristics
- Speed control
- Position control
- Following error
- Waveform sampling
- Sampled data servo control
- Simulated sampled data control
- Sampled data process control systems with appendices on transfer functions or hold circuits and the sampling theorem
- Differential synchros