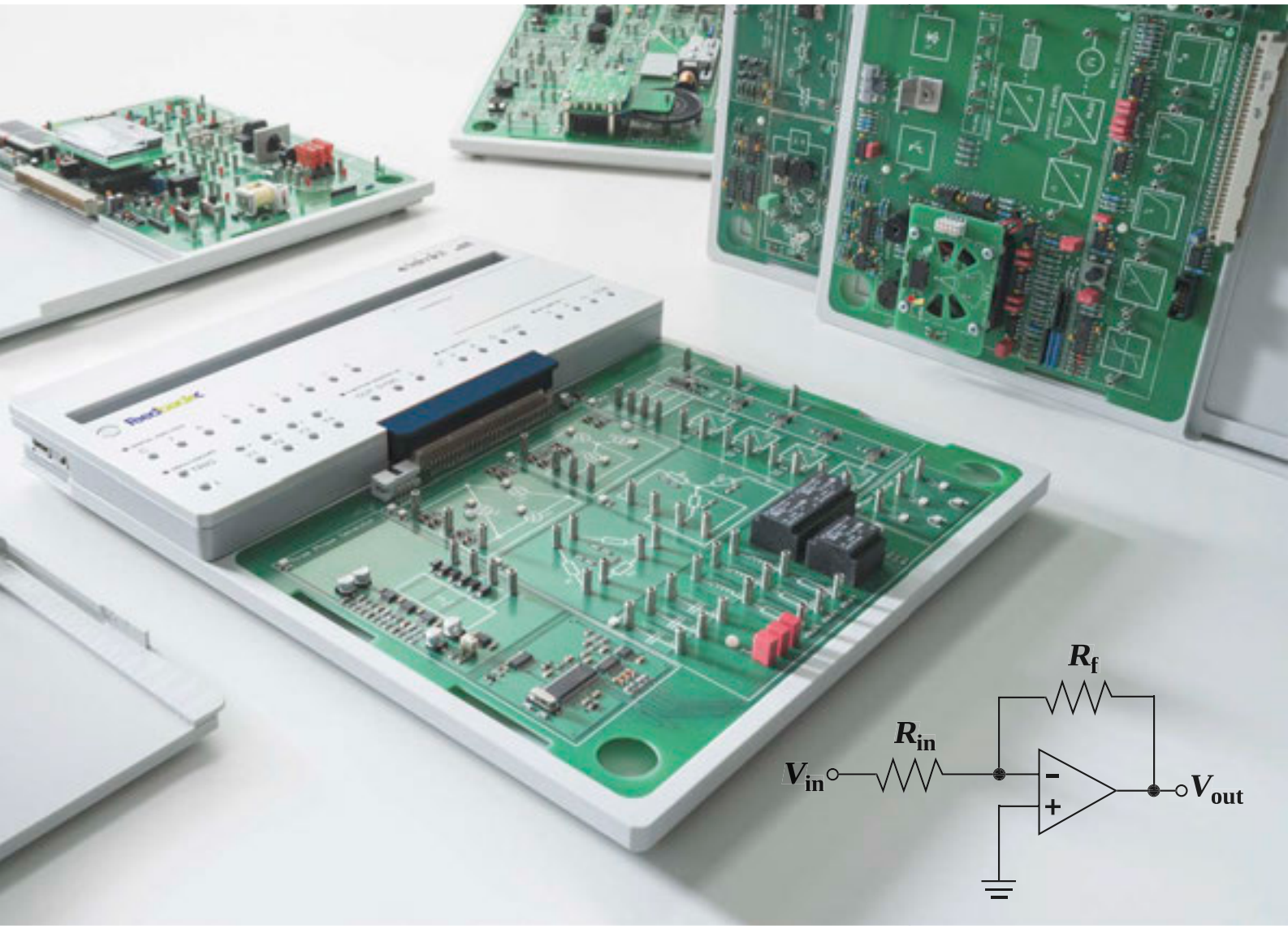
Feedback

Engineering Teaching Solutions

CATALOGUE 2016



- ELECTRICITY & ELECTRONICS
- TELECOMMUNICATIONS
- ELECTRICAL POWER & MACHINES
- CONTROL & INSTRUMENTATION
- PROCESS CONTROL
- REFRIGERATION & AIR-CONDITIONING
- PNEUMATICS & HYDRAULICS

LD DIDACTIC

Feedback

Engineering Teaching Solutions

WELCOME TO OUR CATALOGUE 2016!

WWW.FEEDBACK-INSTRUMENTS.COM

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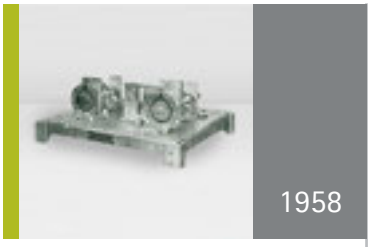
CONTENTS

TRADITION AND QUALITY

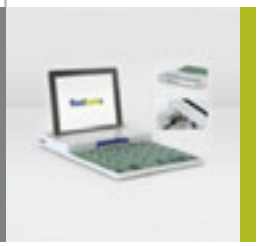
.... FOR MORE THAN 65 YEARS

FEEDBACK GROUP

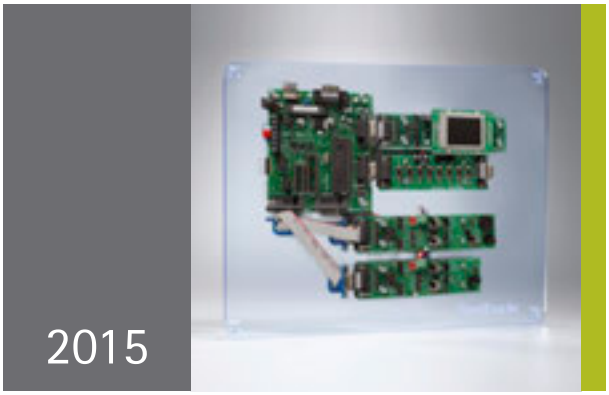

1958


1969


1985


2014

Feedback


2015

ABOUT FEEDBACK

Founded in 1958 by university academics specialising in engineering, the Feedback Group comprises Feedback Instruments Ltd, with headquarters in the south of England, and Feedback Incorporated in North Carolina USA. Manufacturing is in Germany, near to Cologne.

Feedback has been a key player, providing engineering teaching equipment to over 100 countries for more than half a century.

In 2012 Feedback became part of the LD Didactic Group and now combines the best of British innovative design and teaching material with German manufacturing excellence.

Many product designs originate from teaching institutions around the world so our reach is truly global.

FEEDBACK SERVICES

The Feedback range of high quality hardware is well supported by innovative software. Our services extend from the supply of single items, through to consultancy and the delivery of complete turn-key projects.

Our well founded reputation is based on a team with specialists in hardware and software design, production, marketing and sales.

2 YEAR WARRANTY AND AFTER-SALES SERVICE

Feedback catalogue products are supplied with a 2 year manufacturer's warranty, after-sales service being provided in the first instance by our in-Country agents in more than 80 Countries and North Carolina office for the US market supported by a dedicated service team based at our HQ in England.

We also provide an installation, commissioning and training service.

PRODUCT RANGES

Feedback is regarded as a premier supplier of high quality, competitively-priced, world class engineering teaching solutions. Many products are also supported by our unique Espial software.

The product range includes:

- **Electricity & Electronics**
- **Telecommunications**
- **Electrical Power & Machines**
- **Control Engineering & PLCs**
- **Process Control**
- **Refrigeration & Air-conditioning**
- **Pneumatics & Hydraulics**

WWW.FEEDBACK-INSTRUMENTS.COM

FEEDBACK TRAINING CENTRE

JUST AN HOUR FROM LONDON

The Feedback Training Centre (FTC) has examples of equipment from all Feedback product ranges and is based in our HQ in the South of England, just an hour from London.

You are most welcome to visit for an equipment demonstration or more in-depth training at any point pre- or post-order.

We are also offering a number of training courses, each lasting a day, which include some key subjects of interest to our customer base, including:

- PLCs
- MATLAB
- LABVIEW
- Process control in an industrial context
- Pneumatics & Hydraulics as used in industry

Details of the training courses will be posted on our website.

Whether it is for a formal training course, a product demonstration or a product training visit, you are most welcome at any time.

Thank you for your interest in Feedback – with a reputation built since 1958, you are in safe hands.

Leigh Baker
Managing Director
Feedback Group

3 COMPLEMENTARY ELEMENTS FORM 1 TEACHING SYSTEM

The **teknikit** learning environment combines experimentation with the advantages of interactive e-learning.

The new Console is the bridge between the experimental panel and the learning software. It contains all necessary measuring instruments and power supplies.

THE CONSOLE

- clearly labelled with a functional design
- interfaces to all PC systems
- precise and rapid measuring instruments and signal generators
- robust against electromagnetic interference
- simple and safe in the hands of students

NEW

teknikit

EXPERIMENT BOARD

- safe and clearly structured courses for every learning field of electrical engineering
- regular new courses on modern topics
- visible modules and realistic system components
- interactive course guidance with LEDs

INTERACTIVE TEACHING SOFTWARE

- clearly structured, simple operation
- easily understandable theoretical part
- all experiments performed under guidance with learning control tests
- multimedia support content with animations, videos, audio and real measuring instruments with virtual display

THE NEW CONSOLE

DESIGNED FOR TEACHERS AND TRAINERS

FOR TABLET, PC AND LAPTOP

No matter if and how your IT system changes tomorrow, the new Console fits into any modern infrastructure. Whether USB, WiFi or Ethernet, all interfaces are supported directly, and without adapters. Windows systems are supported natively, iOS and Android systems can be easily connected via RDP or VNC.

RUGGED CONSTRUCTION

Safety features for a long service life in the teaching laboratory:

- A blue security lock keeps the course board mechanically secure and if it is opened, the course board is switched off.
- To meet current regulations, 2 mm security cable can also be used.
- On the rear there is a slot for a Kensington lock so that your Console remains in the place where you need it.
- Course board frames made from high-quality material protect the PCB and the furniture against scratches and defects.
- The use of high-quality components.

ASSEMBLY AND DISASSEMBLY QUICK AND EASY

- The compact construction permits space-saving storage in a cupboard.
- Course boards can be connected to the new Console quickly.

HIGHER MOTIVATION AND GREATER LEARNING SUCCESS FOR STUDENTS

INTUITIVE LEARNING, FUNCTIONAL DESIGN

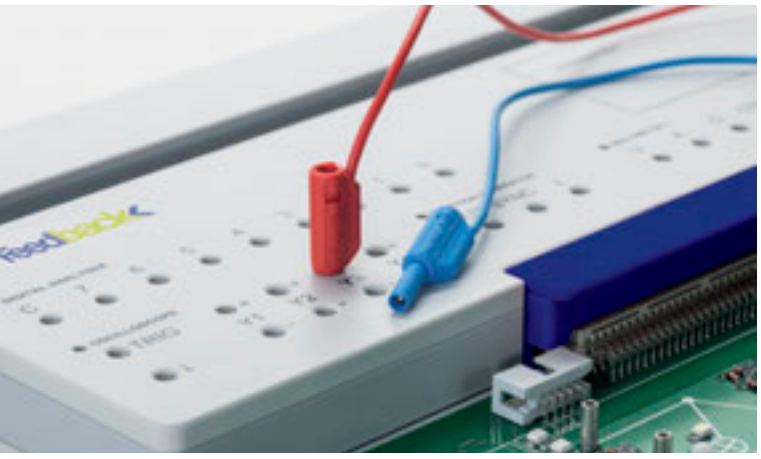
The Console has been designed to allow perfect learning ergometry:

- Complete and easily readable labelling.
- Multi-coloured activity indicators for measuring instruments.
- A luminous strip indicates to the instructor(s) whether a course is being actively carried out.
- All measuring instruments can be controlled directly by the software.

4 CHANNEL OSCILLOSCOPE

The integrated oscilloscope offers many advantages:

- Four differential inputs
- Measuring rate: 2 M-samples per channel
- Resolution: 12 bits per channel
- Memory depth: 4 K-samples per channel

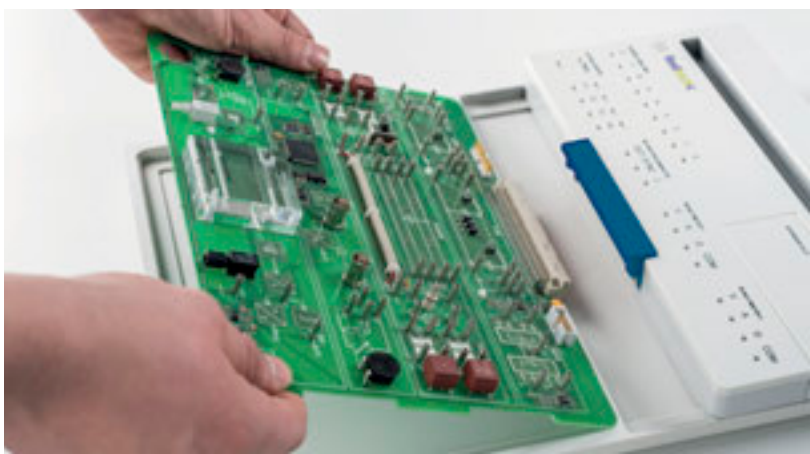


ACTIVE GUIDANCE

The relevant areas light up during the course of the experiment to guide the user through the experiment.

COMPATIBLE WITH ALL COURSE BOARDS

The course board frame acts as an "adapter" for all basic and advanced course boards. The frames can be purchased individually.



THE NEW CONSOLE

NEW FUNCTIONAL DESIGN

FOR TABLETS

Interfaces for many available models

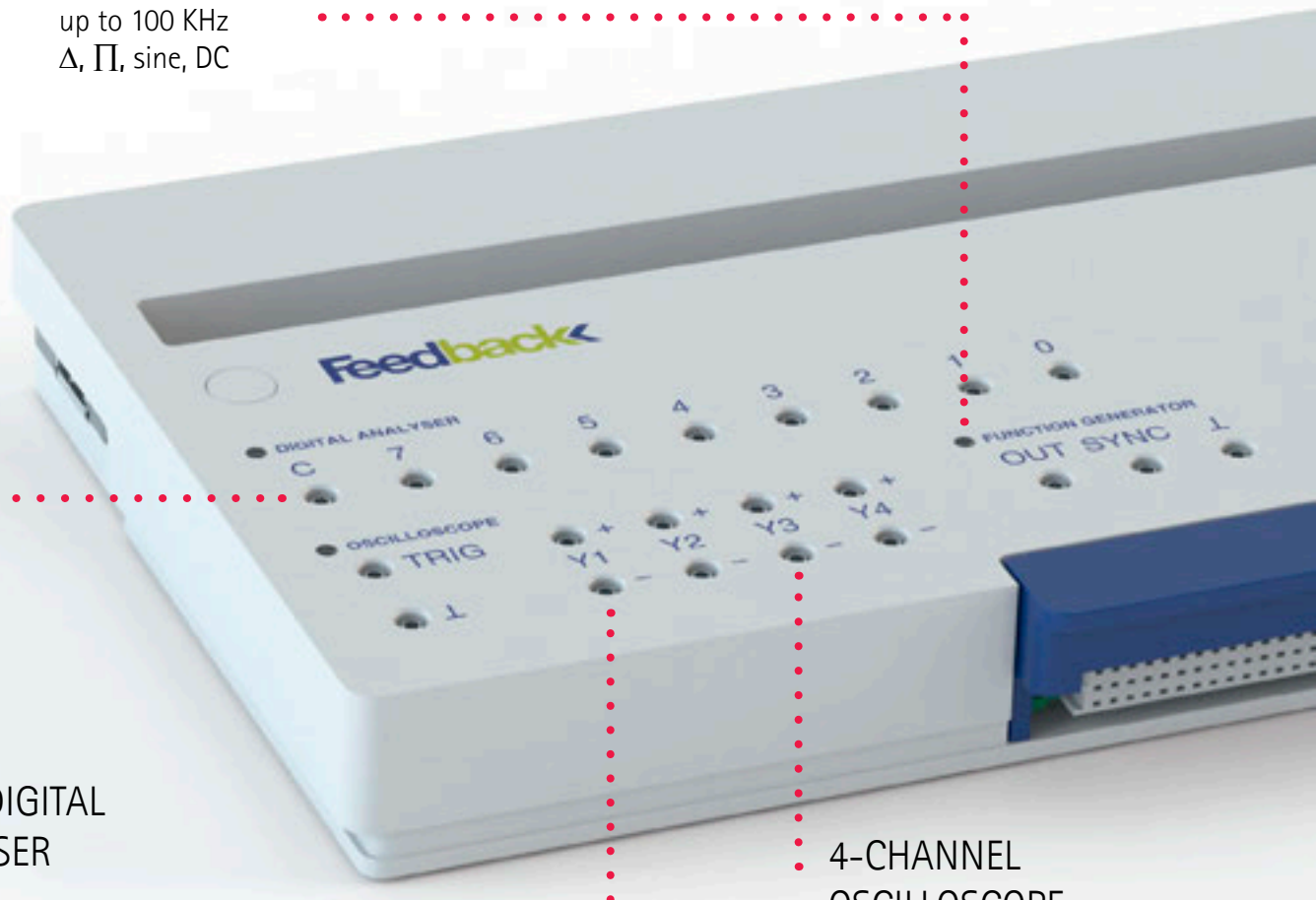
ANTI-THEFT PORT

using a Kensington lock

PC interface for controlling course boards (RJ45/USB/WLAN)

FUNCTION GENERATOR

up to 100 KHz
Δ, Π, sine, DC

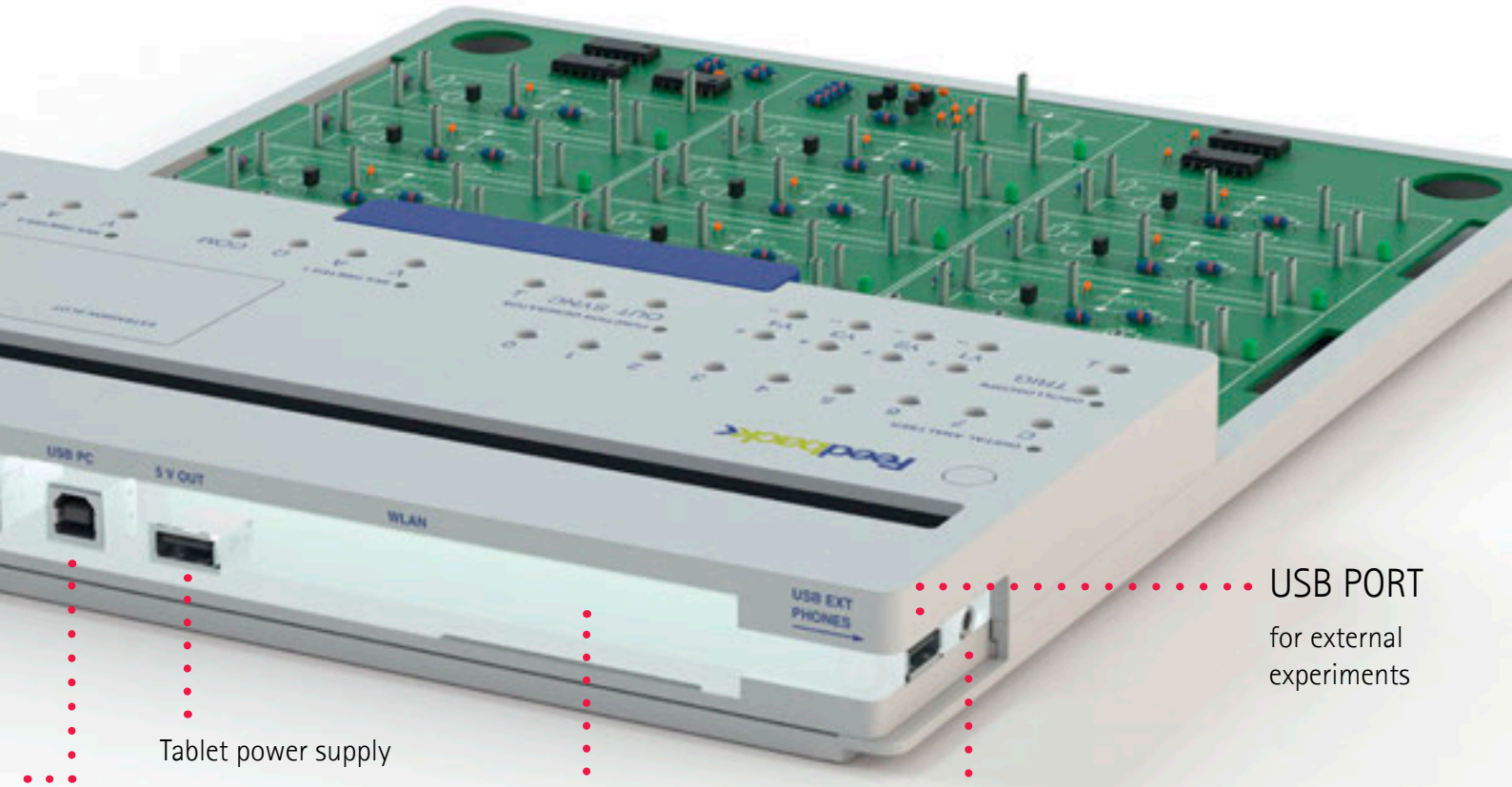


8-BIT DIGITAL ANALYSER

2 mm safety sockets

4-CHANNEL OSCILLOSCOPE

with differential inputs



Tablet power supply

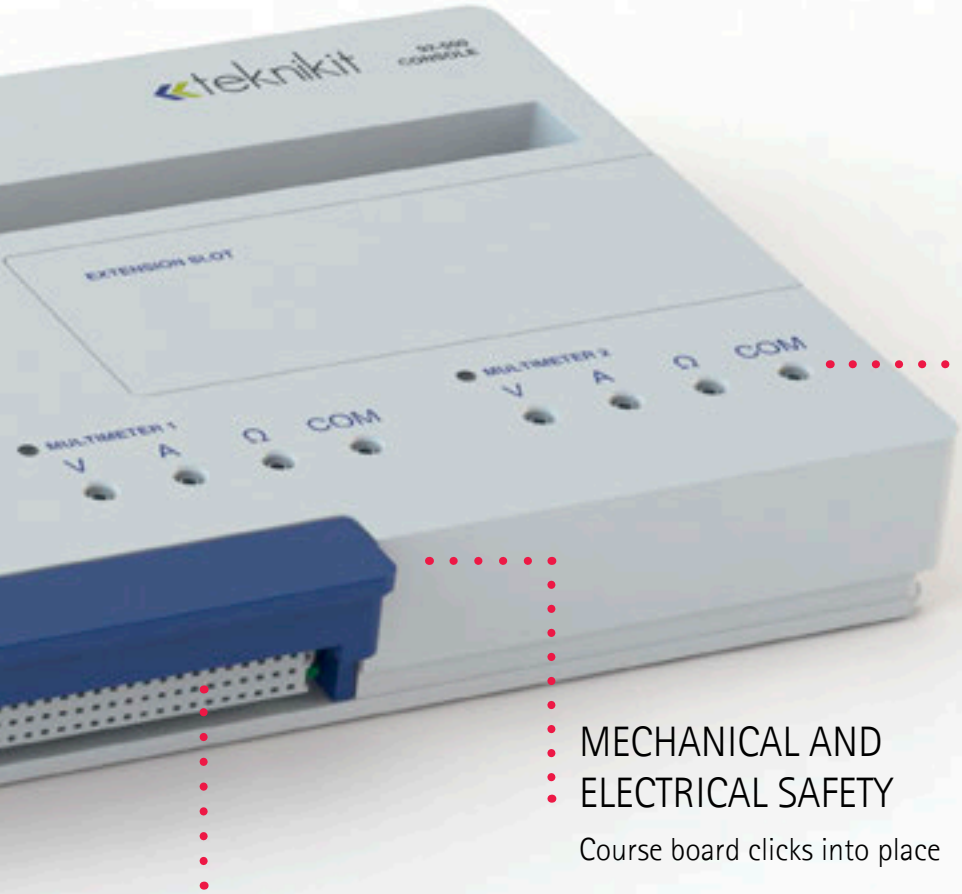
USB PORT

for external experiments

LUMINOUS STRIP

as a status indicator

One headphone socket each



2 x MULTIMETER

8 measurement ranges for current, voltage and resistance measurement

MECHANICAL AND ELECTRICAL SAFETY

Course board clicks into place

RASTER SLOT FOR EXPERIMENT BOARDS

compatible with **Teknikit**

teknikit

THE SOFTWARE

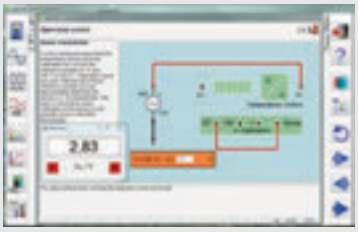
CHARACTERISTICS

- Compatible with Windows 7/8
- TEKNIKIT Console (92-500)
- Reliable and clearly presented courses for every field of learning in electrical engineering
- Frequent new courses on modern topics
- Visible modules and realistic system components
- Interactive course guidance with LEDs

TEKNIKIT STARTER

- Simple start of the courses regardless of the interface used (USB, LAN or WiFi)
- Automated recognition of courses
- Secure user logon for loading and saving the learning status

ADDITIONAL FEATURES



CONFIGURATOR

- For convenient user management, also for different learning groups
- With a comfortable integrated network management in the classroom by the teacher and the administrator

TEKNIKIT SUPERVISOR

- For assessment of learning progress by the teacher
- Integrated online and offline mode with classes, students and course view

TEKNIKIT COURSE SOFTWARE

- Updated course contents
- Operation concept suitable for tablets
- DEMO mode for all available courses, also without hardware

COURSES FOR EVERY LEVEL OF EDUCATION

UNIVERSITY LEVEL
suitable for practical work in fundamental principles, tutorials and for independent study

TECHNICIAN / COLLEGE LEVEL
suitable for project work and independent study

SCHOOLS LEVEL
suitable for demonstration and practical teaching

TEKNIKIT

92-500	Console

BASIC AND FUNDAMENTALS

14-106	DC TECHNOLOGY I
14-107	DC TECHNOLOGY II
14-108	AC TECHNOLOGY I
14-109	AC TECHNOLOGY II
14-110	ELECTRONIC COMPONENTS I
14-111	ELECTRONIC COMPONENTS II
14-112	DIGITAL TECHNOLOGY I
14-113	DIGITAL TECHNOLOGY II
14-114	THREE-PHASE TECHNOLOGY
14-115	SENSOR TECHNOLOGY
14-116	PHOTOVOLTAIC

APPLIED ELECTRICAL ENGINEERING

14-117	OPERATIONAL AMPLIFIER
14-118	CONTROL TECHNOLOGY I
14-119	CONTROL TECHNOLOGY II (extended course)
14-120	AUTOMATION- AND BUSTECHNOLOGY
14-121	POWER ELECTRONICS I
14-122	POWER ELECTRONICS II (extended course)
14-123	ELECTRICAL MACHINES I
14-124	ELECTRO PNEUMATICS
14-125	PNEUMATIC BOARD
14-126	PROTOBOARD II

AUTOMOTIVE ELECTRICITY / ELECTRONICS

14-127	AUTOMOTIVE ELECTRICS
14-128	AUTOMOTIVE SENSOR TECHNOLOGY
14-129	AUTOMOTIVE DATA BUSES
14-130	AUTOMOTIVE DIGITAL TECHNOLOGY I
14-131	AUTOMOTIVE DIGITAL TECHNOLOGY II

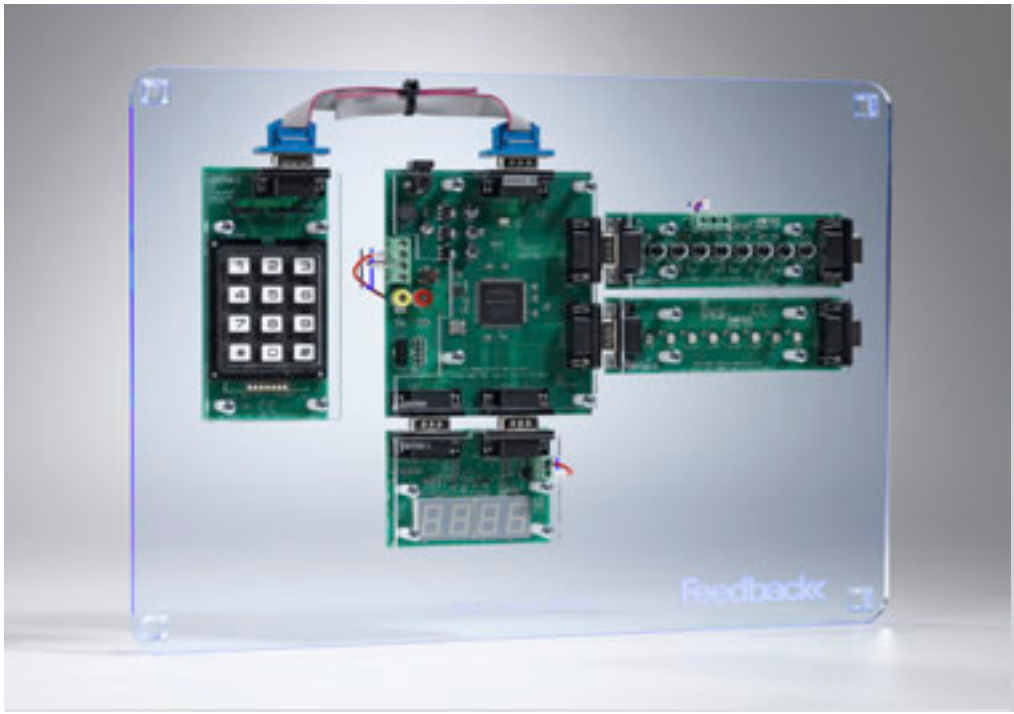
COMMUNICATION TECHNOLOGY

14-132	TRANSMISSION TECHNOLOGY TX433
14-133	RECEPTION TECHNOLOGY RX433
14-134	DIGITAL COMMUNICATION TECHNOLOGY
14-135	MODEM TECHNOLOGY
14-136	TELECOMMUNICATION LINES

Feedback

Engineering Teaching Solutions

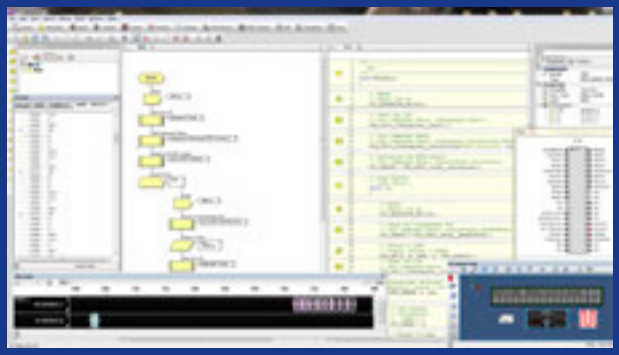
55-800 FPGA Trainer



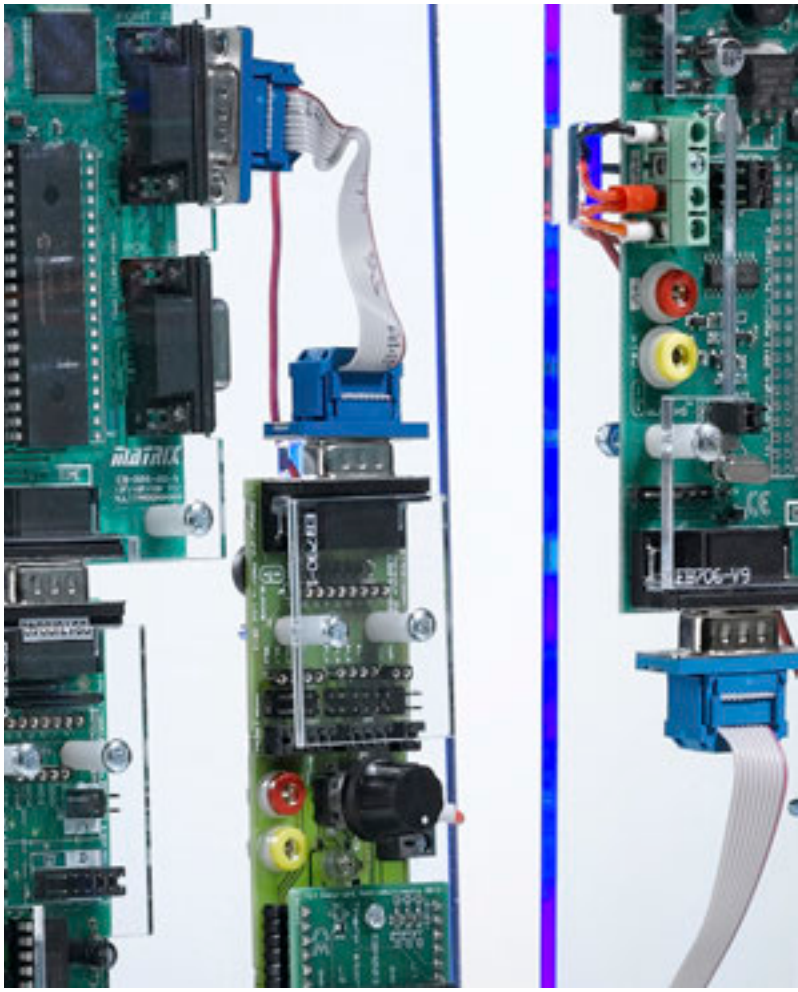
The Field-programmable Gate Array Trainer provides a platform for learning FPGA programming in either VHDL or Verilog. The trainer includes a FPGA development board, LED boards, switch boards, a dual 7-segment display board, a prototype board, serial D/A board and a power output board. The equipment is provided as a full working system.

FEATURES:

- Complete working system
- Includes all required experimental hardware, power supply and software
- 20 hours of lab time
- Comprehensive experiment manual



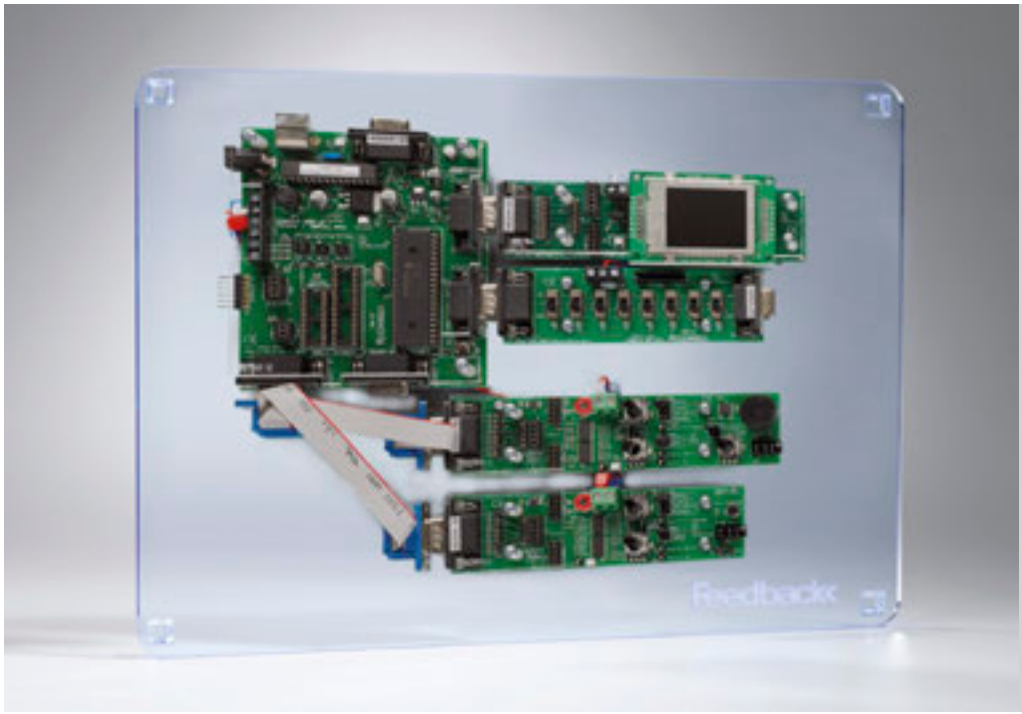
Detailed information is available in this catalogue in the telecommunications range.



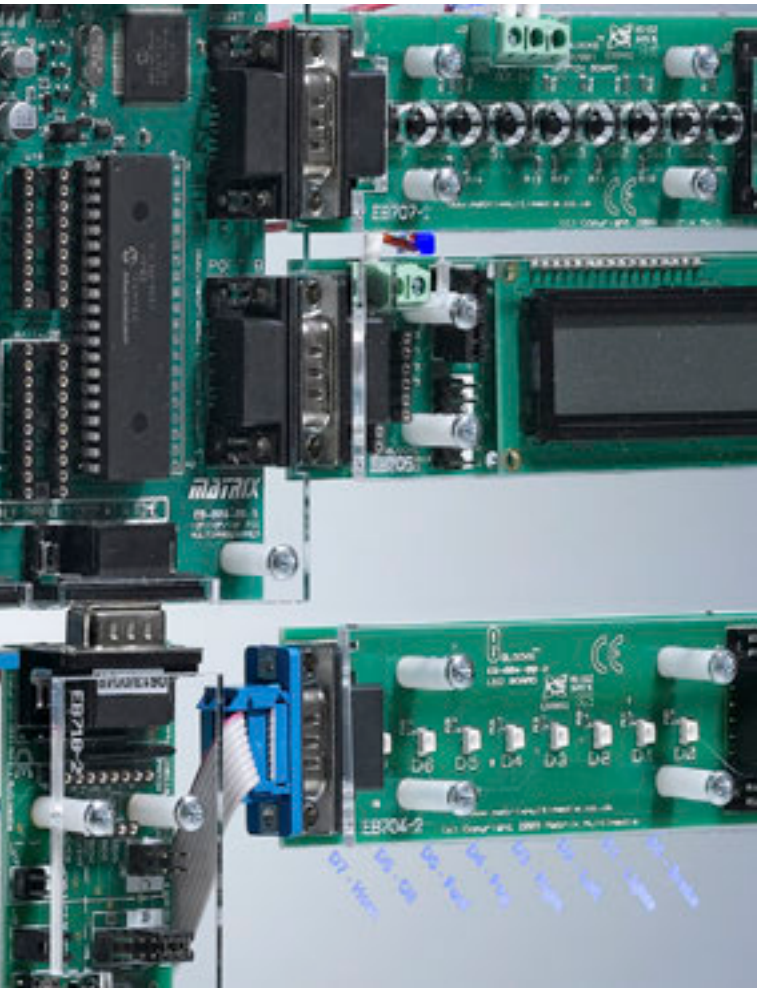
Engineering Teaching Solutions

Feedback

55-900 Audio DSP Trainer



This equipment enables students to carry out a number of practical exercises in audio DSP technology. Working through the exercises students build a good understanding of the various types of DSP operations.



FEATURES:

- Complete working system
- 7 different system developments
- Includes all required experimental hardware, power supply and software
- 20 hours of lab time
- Comprehensive experiment manual

Detailed information is available in this catalogue in the telecommunications range.

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

CONTROL ENGINEERING

PROCESS CONTROL

REFRIGERATION & AIR CONDITIONING

PNEUMATICS & HYDRAULICS

TEACHING SOFTWARE

TEACHING SOFTWARE

FEATURES

- Now includes Espial Tools
- Allows teachers & lecturers full edit facilities
- New content & additional assignments
- Free of charge online software updates
- Hands off for teachers, hand on for students
- Self-paced
- Unrestricted, open learning environment
- Practical demonstration of theory & concepts
- Interactive patching diagrams
- Real-time embedded instrumentation
- Automatic instrumentation configuration
- Data export for analysis
- USB connection to hardware
- Editing tools include laboratory architect, assignment builder, Winwiz & manual builder
- Compatible with 32-bit & 64-bit versions of Windows XP, Vista, Windows 7 & Windows 8
- Optional 93-410 Espial Course Manager

Espial Software Package

Espial is used extensively within the telecommunications, control and basic electronics ranges. It is therefore required for use with 12-300 series, 33-033, 53-004 (& 53-200 series), 57-200-USB, 38 series & PV75-100. The teaching content is provided within the software; this includes the underlying theory, written so that it does not make extensive use of mathematics. An important part of the content is to highlight the assignment learning objectives and to convey relevant background to the student. Consequently, the student is well prepared for the practical work using the hardware, and can put the results into perspective. Espial operates so that its appearance and the range of instrumentation depend on the context. So, for example, if the practical-work requires the use of complex instrumentation such a constellation or a phase meter, one is made available, whereas at lower levels of study it would not be provided. Test instruments are initialised with settings suitable for the required measurements, but students are often expected to change them during the practical work. The instruments have cursors to make measurements and their displays may be printed or exported for inclusion in laboratory reports. The 93-420 Espial Software Package now includes Espial Tools. This allows teachers and lecturers full edit facilities with the creation of new content and additional assignments. Laboratory Architect determines the range of assignments available to the students and to configure the look and feel of the Espial environment. Assignment Builder creates new or edits existing laboratory assignments and configures the test equipment. Content is edited using any HTML editor or Microsoft Word. Winwiz creates and edits work board „patching" diagrams. It also configures test equipment monitor points and „further information" points on the practical diagrams. Practical diagrams are edited by Microsoft Visio. (Visio is not supplied as part of Espial) Manual Builder creates a version of the content ready formatted for printing. Free of charge online software updates are included. An optional addition is 93-410 Espial Course Manager, although it is not necessary for equipment operation. The 93-410 creates complete courses containing assignments from any of the installed Espial products plus external resources such as documents, multimedia material, thrid party programs, web urls, or locations on local intranets. Includes Course Designer and Course Presenter.

Technical data:

- Dimensions & weight of a CD

93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	93-410	Espial Course Manager

FEATURES

- Electronic manual
- the same look and the same operation for all courses
- quick and easy installation
- Virtual lab (oscilloscope, multimeters, function generator etc.)
- Tools (printers, calculators, word processing, copy function for measurement results)
- Help
- Glossary
- Table of contents
- Switchable by pressing a button on other languages (German, French, etc.)
- Readings and texts can be used in your own documents
- Zoomable
- Free selectable chapters
- Status display (successfully processed, not processed)
- Evaluation of measurements and tasks
- Evaluation of the circuitry

DVD: Teknikit Software

Teknikit software package for Teknikit console (92-500).
Contains:

- All available Teknikit courses in all available languages
- Teknikit starter software
- Teknikit Konfigurator
- USB driver software for Teknikit console
- .NET 4.0
- Separate installation for the audio package in all available languages

For each Teknikit course there is an electronic, interactive instruction manual. The contents of the manual are dependent on the topic and are tailored to the hardware. The operation and function of the manuals are identical for all courses. The 32-bit user interface, into which the interactive manual, the virtual lab and the tools are integrated, also remains the same for all courses.

14-100	DVD: Teknikit Software

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

CONTROL ENGINEERING

PROCESS CONTROL

REFRIGERATION & AIR CONDITIONING

PNEUMATICS & HYDRAULICS

ELECTRICITY & ELECTRONICS

FEATURES

- 4-channel oscilloscope
- Digital multimeter (x2)
- Digital analyser
- Function generator
- Frequency counter
- Integrated USB interface for external measuring instruments
- USB charging socket for tablets
- Light strip & LEDs for status display
- 2 audio outputs enables 2 students to access the console simultaneously
- Interfaces: network interface 100 MBits RJ45, WiFi, USB
- Security lock for fastening the experiment boards
- Anti-theft protection (port for Kensington lock)

1.1 Teknikit

Teknikit Console

The console is a multifunctional, compact, measuring interface. It is used for the operation and power supply for the Teknikit multimedia experiment boards 14-106 to 14-136. The console is connected to the PC via a USB port, WiFi or Ethernet for the recording of measurements and for remote control of it's built-in functions. The console can be quickly attached to an experiment board via the experiment board carrier. It's clear and structured design results in easy operation.

The 92-500 comprises:

- Console (main unit)
- USB cable
- Ethernet cable
- d.c. power supply, 15 V, 6 A, 90 W

Technical data:

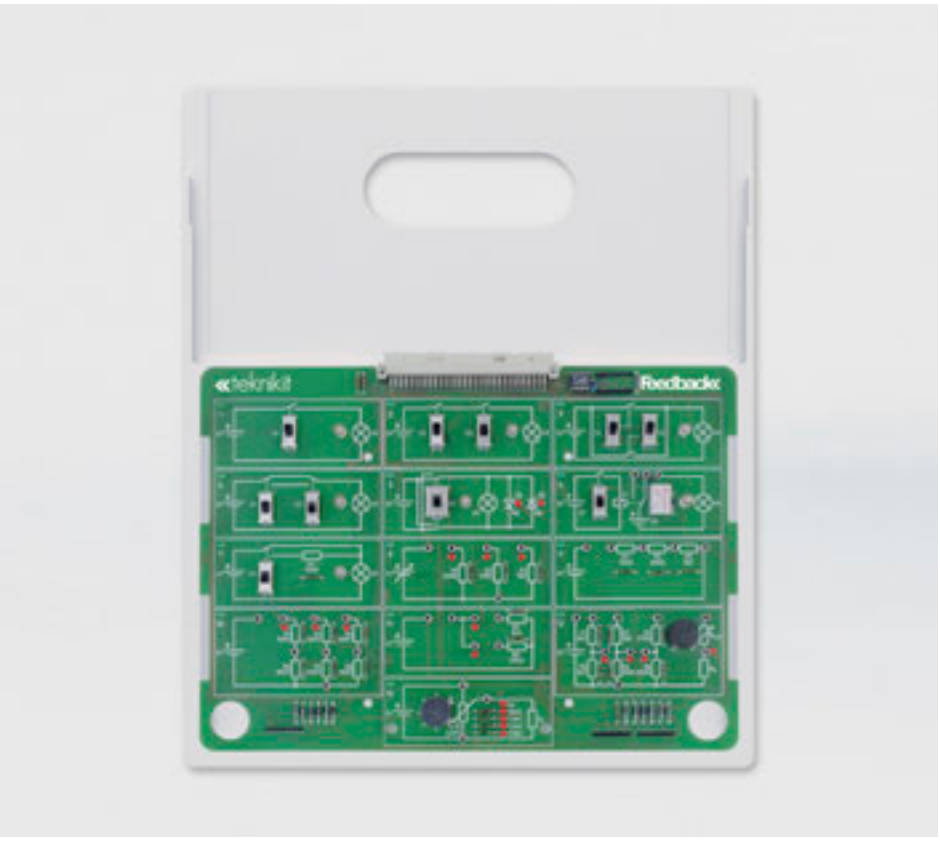
- Dimensions (net): width 295 mm x depth 155 mm (including connector) x height 35 mm (including connector in „up" position) - height 30 mm with connector in down position
- Weight (net): 0.75 kg

92-500	Teknikit Console

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)

PC running Windows Vista, 7, 8/8.1 32/64-bit required



FEATURES

Virtual Laboratory

- Oscilloscope
- Function generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

1.1.1 Basics & Fundamentals

d.c. Technology I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course in the fundamentals of direct current technology using 13 different circuits wired using 2 mm safety cables (14-101 Set of 2 mm Safety Cables, supplied separately), Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Circuits with switches
- Switches in series
- Switches in parallel
- Change-over switches
- Polarity reversing circuit
- Relays
- Conductivity
- Ohm's law
- Colour codes and IEC series
- Series-connected resistors
- Kirchhoff's law
- Voltage dividers
- Voltage dividers under load
- Wheatstone bridge

Technical data:

- Dimensions (net, board & carrier): width 295 mm x depth 355 mm x height 40 mm
- Weight: 0.6 kg

14-106	d.c. Technology I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

d.c. Technology II

Comprises an experiment board, housed within a carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course in the fundamentals of direct current technology using 11 different circuits wired using 2 mm safety cables (14-101 Set of Safety cables (2 mm), supplied separately). Characteristics can be recorded and the basic types of electrical circuit can be measured. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Incandescent lamp characteristics
- VDR characteristics
- Diode characteristics
- LDR characteristics
- NTC characteristics
- PTC characteristics
- Capacitors
- Capacitors connected in parallel
- Capacitors connected in series
- RC circuits
- Inductance
- Moving coil instrument
- Batteries
- 2 batteries connected in parallel
- 2 batteries connected in series

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-107	d.c. Technology II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

a.c. Technology I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course in the fundamentals of alternating current technology using 11 different circuits wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). This course covers the production of a.c. voltage, transformers and rectifier circuits. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Step voltage
- Continuous a.c. voltage
- Electronic generation of a.c. voltage
- Function generators & oscilloscopes
- Induction
- Principle of transformers
- Short-circuited transformers
- Transformers under load
- Transformer losses
- Diodes used as current valves
- M1 rectifiers
- M2 rectifiers
- B2 rectifiers
- Symmetrical output voltage

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-108	a.c. Technology I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

a.c. Technology II

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course in the fundamentals of alternating current technology using 11 different circuits wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm) supplied separately). This course covers the behavious of resistance, coil and capacitor in an a.c. circuit. Course content, experiment instructions and tasks are taught through course-specific software.

CURRICULUM COVERAGE

- Generating alternating voltages
- Key parameters of a.c. technology
- Ohmic resistance in an a.c. circuit
- Coils in an a.c. circuit
- Inductive reactance
- Series RL circuits
- Parallel RL circuits
- Capacitors in an a.c. circuit
- Capacitive reactance
- Series RC circuits
- Parallel RC circuits
- Series RLC circuits
- Parallel RLC circuits
- Series compensation
- Parallel compensation
- Voltage resonance
- Current resonance

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-109	a.c. Technology II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Electronic Components I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on Electronic Components using 12 different circuits wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). This course provides the behaviour of diodes and transistors. Course content, experiement instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Diode characteristics
- Characteristics of a Z diode
- Characteristics of an LED
- Diode branches in a transistor
- Input characteristics of the transistor
- Output characteristics of the transistor
- Control characteristics of the transistor
- Power dissipation of a transistor
- Characteristics of a phototransistor
- Darlington circuit
- Operating point of a transistor
- Transistor in a common emitter circuit
- Transistor in a common collector circuit
- Transistor in a common base circuit
- Transistors in timer circuits

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-110	Electronic Components I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Electronic Components II

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on electronic components using 12 different circuits wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). This course explains the behaviour of FETs, MOSFETs and IGBTs. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Design of the FET
- Transfer characteristics of the JFET
- Output characteristics family of a JFET
- JFET as a switch
- Characteristics of the MOSFET
- The MOSFET as a switch
- Characteristics of the IGBT
- The IGBT as a switch
- Characteristics of the DIAC
- Characteristics of the thyristor
- Thyristor in the d.c. circuit
- Phase angle control with a thyristor
- Characteristics of the TRIAC
- Phase angle control with a TRIAC

Technical data:

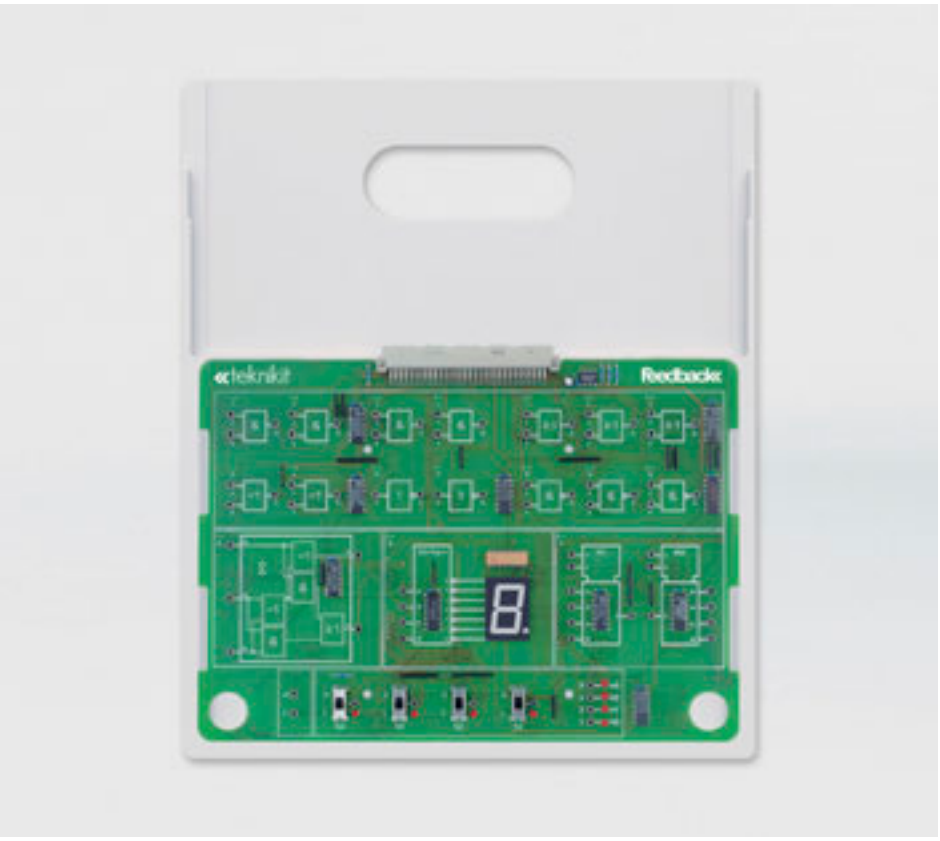
- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-111	Electronic Components II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console



FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Digital Technology I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the basics of digital technology (circuits) with numerous components and logic gates, experiments being wired by using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). The course examines the principles and laws in digital technology. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- TTL AND gates
- TTL OR gates
- TTL NOT gates (inverters)
- TTL XOR gates
- Boolean operations
- De Morgan's law
- TTL NAND gates
- Associative law
- Distributive law
- Karnaugh maps
- Coding
- Seven-segment displays
- Half-adders
- Full-adders
- Multiplexers/demultiplexers
- Fault simulation

Technical data:

- 4 x AND, 3 x OR, 2 x XOR, 2 x NOR, 3 x NAND
- Full adder
- 7 Segment display
- Multiplexers, Demultiplexers
- 4 command switches
- 2 sensors, 2 LEDs
- Dimensions (net, board & carrier):
  295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-112	Digital Technology I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Digital Technology II

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the basics of digital technology (switching networks) by forming various circuits wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). The course deals with the operation and use of flip-flops. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Flip-flops
- RS flip-flops
- RS flip-flops with clock input
- Monostable and astable multivibrators
- Schmitt triggers
- D flip-flops
- JK flip-flops
- JK master-slave flip-flops
- Frequency dividers
- Counters
- Shift registers
- Parallel-serial converters

Technical data:

- 2 x AND, 2 x NOR, 4 x NAND
- 2 Inverter
- 1 Schmitt trigger
- 1 7-segment display
- 4 JK flip-flop
- 1 Universal shift register
- 4 command switches,
- 2 sensors, 4 LEDs
- Dimensions (net, board & carrier):
  295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-113	Digital Technology II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Spectrum analyzer (FFT module)
- Frequency Counter
- Multimeters (x2)
- Function Generator
- Digital Memory Oscilloscope
- Multiplexer for recording 4 voltages and 4 currents

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Three-Phase Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course investigating the behaviour of a three-phase system, experiments being wired by 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Practical exercises show the generation of the rotary fields or the function of the transformer. Furthermore, passive components in different circuits are discussed. Coils, capacitors and resistors are analysed and evaluated in different circuits. An 8-channel oscilloscope enables the simultaneous measurement of all voltages and currents in the three-phase system. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Characteristics of a 3-phase system
- Representation of line diagrams & phase relationships
- Star- & delta circuits with different loads
- Measurement of phase & line voltage/current
- Ohmic load
- Symmetrical & unsymmetrical charges
- Measurement of power in the 3-phase system

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-114	Three-Phase Technology

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Frequency Counter
- Multimeter (x2)
- Function Generator
- Digital Memory Oscilloscope

Additional Functions

- Word Processing
- Printer
- Pocket calculator
- Free Experimentation
- Glossary

Sensor Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching the basics of the operation of sensors and measuring circuits, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Electronic circuits for temperature measurement
- Function and characteristics of different temperature sensors: Pt100, NTC, KTY & thermocouple
- Function and characteristics of pressure sensors
- Force measurements with strain gauges
- Force measurement with bending bar
- Displacement, angle & speed measurement
- Measurements with optical encoder
- Hall sensors

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-115	Sensor Technology

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser

Additional Functions

- Word Pocessing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Photovoltaics

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course investigating the structure and function of solar cells, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Animations and illustrations give a descriptive introduction to photovoltaic systems. On the basis of real experiments, the course describes the function of solar modules. The micro-controlled charge controller pursues the solar generator at the maximum power point. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Properties & function of a solar cell
- Properties & function of a solar module
- Different circuits of solar modules
- Solar characteristic
- Influence of temperature
- Influence of shadow
- Charge controller
- Solarcharger controller
- Photovoltaic systems
- Applications

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-116	Photovoltaics

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser
- FFT Spectrum Analyser
- Frequency Counter
- Bode Module

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

1.1.2 Applied Electrical Engineering

Operational Amplifier

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a course on operational amplifier circuits, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- The comparator
- Features of the operational amplifier
- Inverting op amp
- Noninverting op amp
- Fault simulation in inverting op amps
- Adder
- Integrator
- Differentiator
- Active filters
- Stabilised voltage source
- Stabilised current source
- Schmitt trigger
- Astable multivibrator
- Wien bridge oscillator
- Function generator

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-117	Operational Amplifier

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser
- Static Characteristic Plotter
- Step Response Plotter
- DDC Plotter
- Controller Design Calculator (for optimum controller parameters)

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Control Technology I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the fundamentals of automatic control technology, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software).

CURRICULUM COVERAGE

- Introduction
- Open-loop control
- Closed-loop control
- Analysis of controlled systems
- Controlled systems with/without compensation
- Controlled systems of a higher order
- Types of controllers
- P, I, PI, PID & PD control
- Automatic digital control
- Performance criteria for automatic controls
- Optimisation guidelines for PID controllers
- Automatic temperature control
- Automatic speed control
- Automatic light control
- Automatic control of systems without compensation
- Automatic control with discontinuous controllers
- Fault simulation

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-118	Control Technology I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter
- Digital Analyser
- Static Characteristics Plotter
- Step Response Plotter
- DDC Plotter
- Controller Design Calculator (for optimum controller parameters)

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Control Technology II

Supplementary course on the fundamentals of control technology including a dongle for use with, and requires, the Control Technology I board which in-turn requires the 92-500 Teknikit Console with 14-101 Set of Safety Cables (92-500 & 14-101 supplied separately).

CURRICULUM COVERAGE

- Introduction
- Stability of automatic control systems
- Controller design using the Ziegler/Nichols method
- Systems with lag time
- Limiting the manipulated variable
- Cascade control
- Introduction to frequency response
- Frequency response of single basic elements
- Frequency response of combined elements
- Controller design in the frequency domain
- Fuzzy control
- Adaptive control
- Experiments with external controlled systems

Technical data:

- Dimensions & weight: padded envelope

14-119	Control Technology II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	14-118	Control Technology I
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- PROFIBUS analyser
- PLC Control
- PLC Program
- Process In/Out

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Automation & Bus Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching the basics of a programmable logic controller (PLC) and showing it's networking capability including the use of sensors and actuatores by means of the PROFIBUS. With many examples, explanations and practical tasks, the base and mode of operation of the PLC and PROFIBUS are represented. Experiments are wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm) supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Basics and basic terms (IEC 1131) of the PLC
- Logic connections, times, counters, data processing & program editing
- Simple sensors & signal conditioning with analogue digital transformers & multiplexers
- Projecting of an automatisation system
- Programming & initiation of the PLC
- Data transfer structures & protocols
- Transfer & error analysis
- Connection of external components
- Link of PROFIBUS users (GSD)

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-120	Automation & Bus Technology

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser
- Characteristics Curve Plotter
- Converter analyser
- Converter Control Unit

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Power Electronics I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a course on various phase-commutated and self-commutated converter circuits, experiments being wired by using 2 mm safety cables (14-101 Set of safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Introduction
- Semiconductors in power electronics
- Wiring & triggering
- Switching processes & commutation
- Uncontrolled rectifier circuits
- Parameters for periodic signals
  Controlled line-commutated static converters
- M1C circuit
- M3C circuit
- B2C circuit
- B6C semi-controlled rectifiers

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-121	Power Electronics I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser
- Characteristics Curve Plotter
- Converter Analyser
- Converter Control Unit

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Power Electronics II

For use with the 14-121 Power Electronics I (required and supplied separately), this provides a supplementary course on power inverters, d.c. choppers, converters and drive technology, consisting of a dongle and a circuit board with the equivalent circuit of a three-phase induction machine including a rotating field indicator. A 92-500 Teknikit Console and 14-101 Set of Safety Cables (2 mm) are required, both supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Self-commutated converters (power inverters)
- Semiconductor switches & controllers (bi-directional static converters)
- Switches and controller for DC
- Converters
- Static converters in automatic control technology
- Static converters in drive technology

Technical data:

- Dimensions (net): 150 mm x 50 mm x 20 mm
- Weight (net): 0.5 kg

14-122	Power Electronics II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	14-121	Power Electronics I
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Multi-channel Oscilloscope
- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

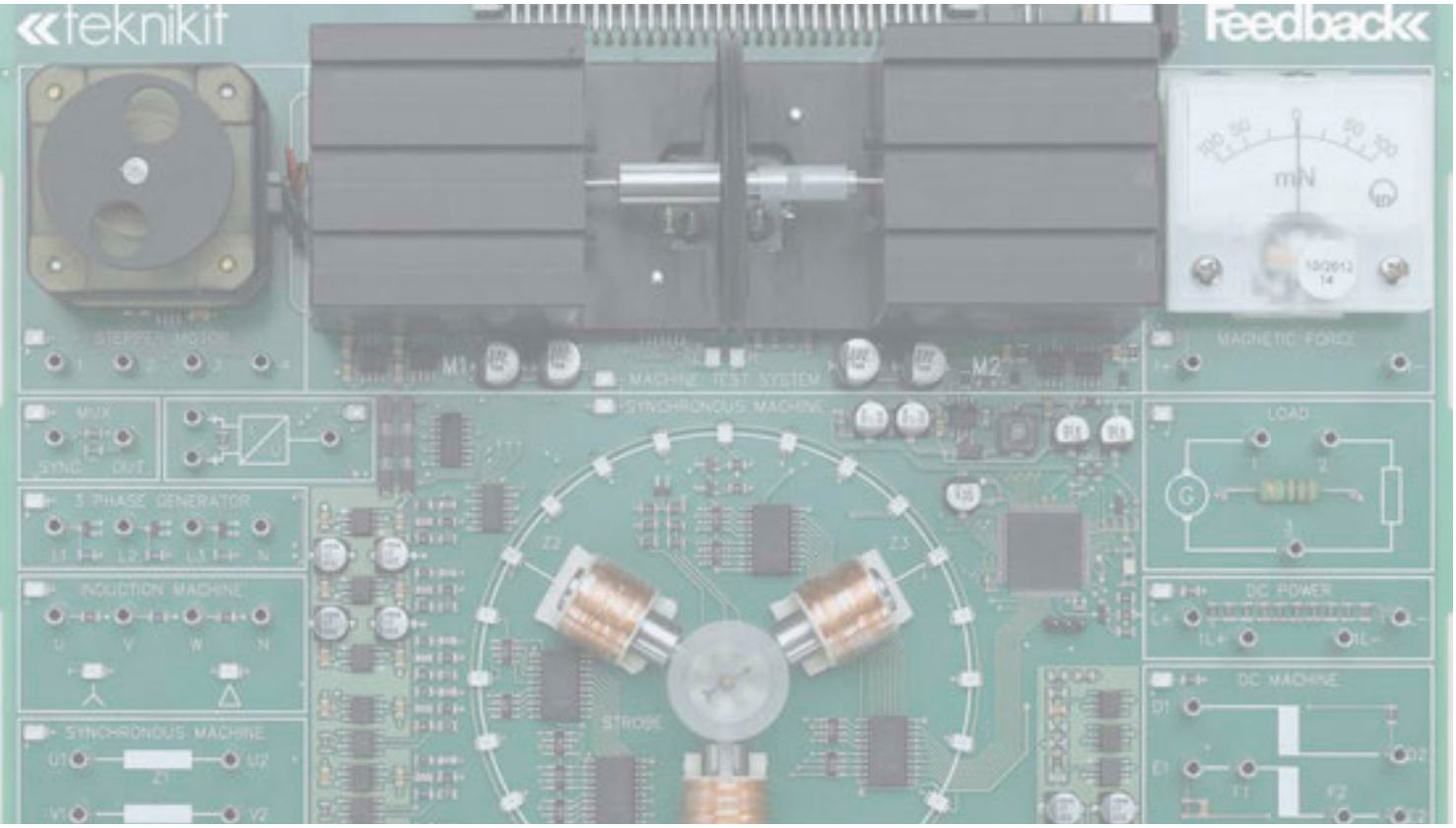
- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Electrical Machines I

Comprises an experiment board, housed in a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course concerning the connection methods and the recording of characteristics of electric motors and generators, experiments being wired by using 2 mm safety cables (14-101 Set of safety Cables (2 mm), supplied separately). With the integrated machine test system, a multitude of experiments can be carried out, for example the recording of torque, power and current-locus curves. Course content, experiment instructions and tasks are traught via course-specific software.

CURRICULUM COVERAGE

- Forces in a magnetic field
- Measurement of Lorentz force
- Drives
- Torque-speed characteristics
- Machine test system
- d.c. machines
- Speed and induced voltage with d.c. machines
- Torque and armature voltage with d.c. machines
- Torque and excitation voltage with d.c. machines
- d.c. machines with external excitation
- Reversible of direction
- Characteristics with variable armature voltage
- Characteristics with variable excitation voltage
- Shunt-wound d.c. machines
- Characteristics with variable operating voltage
- Series-wound d.c. machines
- Reversal of direction with d.c. machines
- Characteristics with variable operating voltage
- Generator operation of d.c. machines
- Drive and generator with a resistive load
- Power output of generator
- Rotating field (three-phase) machines
- Three-phase windings
- Rotating fields
- Direction of rotation with periodic swapping of phase conductors
- Direction of rotation when phase conductors are swapped
- Voltage and current in star (Y) circuits
- Voltage and current in delta circuits
- Resistance in stator winding
- Reactance of an a.c. winding
- Synchronous machines
- Equivalent circuit diagram for synchronous machines & how they are used
- Permanently excited synchronous machines
- Step operation of synchronous machines
- Determining rotor position in star configuration



- Determining rotor position in delta configuration
- Synchronous machine at variable speed (run-up)
- Speed measurement
- Speed setting using frequency converter
- Asynchronous machines
- Block and equivalent circuit diagrams for asynchronous machines
- Determination of slip
- Star-delta starting
- Measurement of torque and line currents during run-up
- Changing direction of asynchronous machines
- Recording of torque-speed characteristic for asynchronous machines
- Three-phase drives
- Changing speed of asynchronous machines
- How speed depends on slip
- How speed depends on stato rfrequency
- Stepper motors
- Full-step operation
- Half-step operation
- Changing the direction of a stepper motor

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-123	Electrical Machines I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

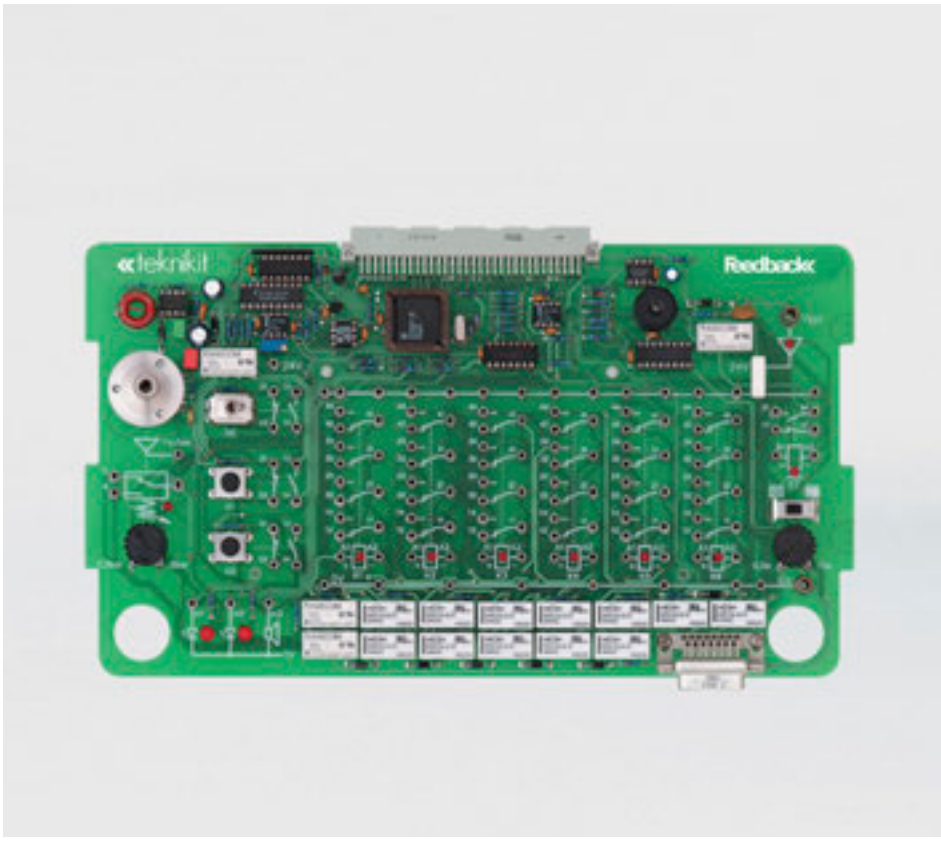
FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary



Electro-pneumatics

Comprises an experiment board, housed within a board carrier, for use in conjunction with, or powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on pneumatics and electro-pneumatics. In order to perform experiments, this board can either be connected with industry-standard valve technology or with the 14-125 Pneumatics Board (supplied separately) to perform all of the experiments. The wiring of the experiments is carried out over 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Basics of pneumatics/electro-pneumatics
- Pneumatic and electric circuit diagrams
- Pilot control of a single-acting cylinder
- Pilot control of a double-acting cylinder
- Holding element control
- Basic circuit with AND function
- Basic circuit with OR function
- Basic circuit with electric latching circuits
- Displacement-dependent control
- Time-dependent control, switch-on and switch-off time delay
- Pressure-dependent control
- Sequential controls

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-124	Electro-pneumatics

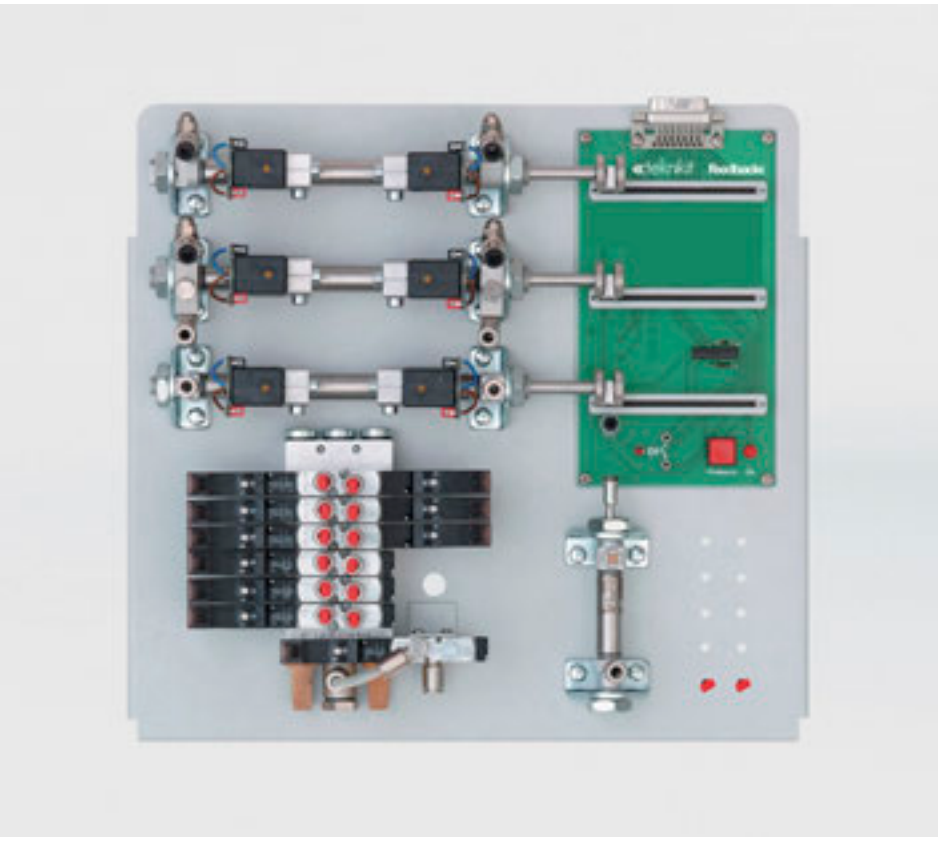
Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

Additionally recommended:

Qty	Cat.-No.	Name
1	14-125	Pneumatics Board

PC running Windows Vista, 7, 8/8.1, 32764-bit required per console



FEATURES

In addition to the Pneumatics Board itself, the 14-125 comprises:

- 1 x PU plastic hose 5 m long & 2.5 mm thick
- 6 x adaptor cables 2 mm on socket connectors
- 20 x blanking elements
- 10 x 2 mm cables in blue, 4 cm long
- 20 x 2 mm cables in blue, 15 cm long
- 12 x 2 mm cables in red/black, different lengths
- 1 x screwdriver
- A compressor is required which is supplied separately.

We recommend our 14-103 Low Noise Compressor.

Pneumatics Board

Selected by users of the 14-124 Electro-Pneumatics board as an optional, recommended item, this board will monitor the components with the integrated displacement sensors of the cylinders.

If you supply your own compressor with, the minimum requirements are:

- Connection power: 15 W
- Pressure: 500 kPa
- Feed rate: 2 litres per minute

Technical data:

- Dimensions (net, board & carrier): 200 mm width x 200 mm depth x 30 mm height
- Weight (net): 0.4 kg

14-125	Pneumatics Board

Additionally required:

Qty	Cat.-No.	Name
1	14-124	Electro-pneumatics

Additionally recommended:

Qty	Cat.-No.	Name
1	14-103	Low Noise Compressor

FEATURES

- 2 change-over switches for any desired connections
- 8 relay switchover contacts
- 8 digital outputs
- Relay and digital outputs can be switched using software

Protoboard II

Comprises an experiment board, housed within a board carrier, for use in conjuction with, and powered by, the 92-500 Teknikit Console (supplied separately), the Protoboard II expands the console into a development platform for electronic circuits. Any type of circuit with electronic components (not included) can be set up and tested on the breadboard with 1 mm contacts. The fixed voltage outputs and the function generator output are connected via 2 mm sockets and can be switched using slide switches. There are 2 change-over switches for any desired connections located on the prototyping board. Furthermore, standard European printed circuit boards can be connected using a 64-pin VG terminal strip. 8 relay switchover contacts are located on the VG terminal strip. 8 digital outputs can be tapped using the VG strip or via 2 mm sockets. The relay and digital outputs can be switched using software. The power supply, the multimeter and the function generator of the console can be operated without the PC.

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-126	Protoboard II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

1.1.3 Automotive

Automotive Electrics

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) and provides a practical course teaching the basics of automotive electrics/electronics, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Electricity in the vehicle: current - voltage - resistance
- Calculating with parameters: Ohm's law - Power
- Circuits
- Series and parallel circuits - forward slope resistances

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-127	Automotive Electrics

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Automotive Sensor Technology

Comprises and experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the advanced principles of automotive sensors, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). The course results in the comprehensive understanding of the electrical processes and events in vehicles. Measuring technology, troubleshooting and fault correction complete the learning content. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Components: switches, resistors, capacitors, diodes and Zener diodes, relays
- Schematics: reading vehicle schematics
- Sensors: inductive sensors, magnetic-field sensors
- Batteries and accumulators: Interconnecting cells, accumulator types
- Ignition: capacitors, relays, induction, ignition coil
- Generators and motors: rectification, three-phase generator, permanent magnet generator
- Transistors in the vehicle: transistor, checking transistors
- Monitoring features in vehicles, amplifier circuits, application circuits

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-128	Automotive Sensor Technology

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

- Comprehensive understanding of the connections in a vehicle
- troubleshooting and fault correction
- Comprehensive experiment manual

Automotive Data Buses

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the interconnected electronic systems in automotive technology, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables, supplied separately). The main aim of the equipment is to gain knowledge about bus systems and their application areas, the experiments here leading to a comprehensive understanding of the connections in a vehicle, including troubleshooting and fault correction. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Basics of the digital technology
- Bus systems: CAN & LIN
- Connection with external components feasible
- Measuring technology: physical signals, protocols, fault analysis
- Other applications and system components

Technical data:

- Dimensions (not, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-129	Automotive Data Buses

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

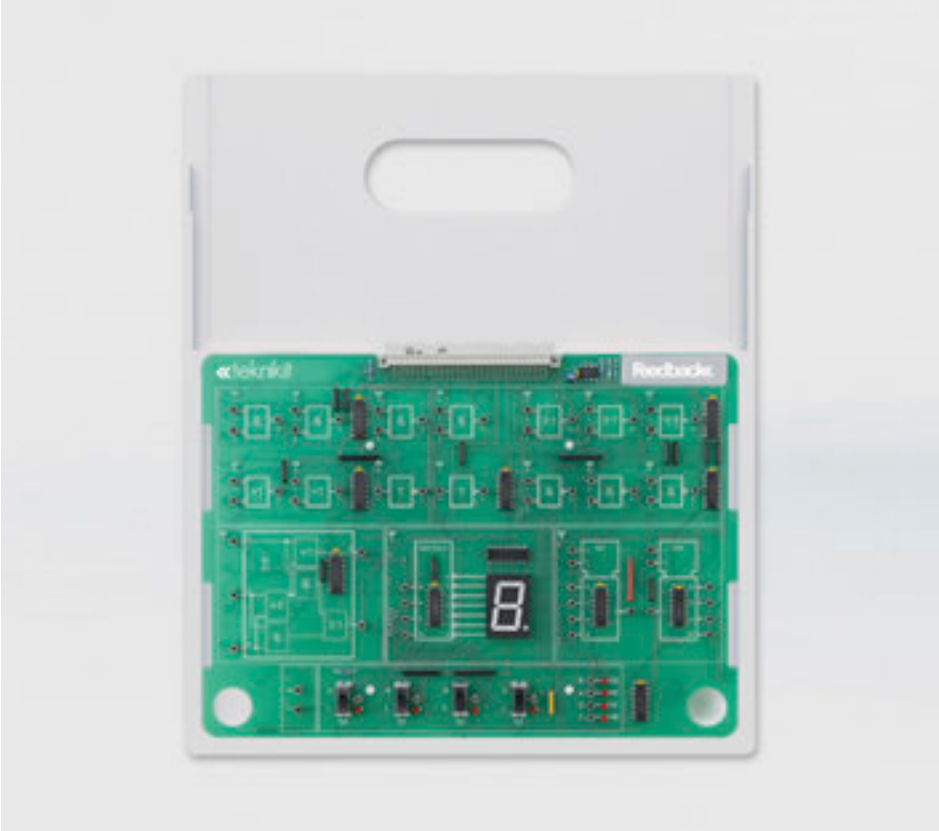
FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary



Automotive Digital Technology I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on switch algebra are dealt using logic links, experiments being wired by using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- TTL-AND
- TTL-OR
- TTL-NOT
- TTL-XOR
- TTL-NAND
- Boolean Operations
- Coding
- Multiplexer
- Fundamentals CAN Bus

Technical data:

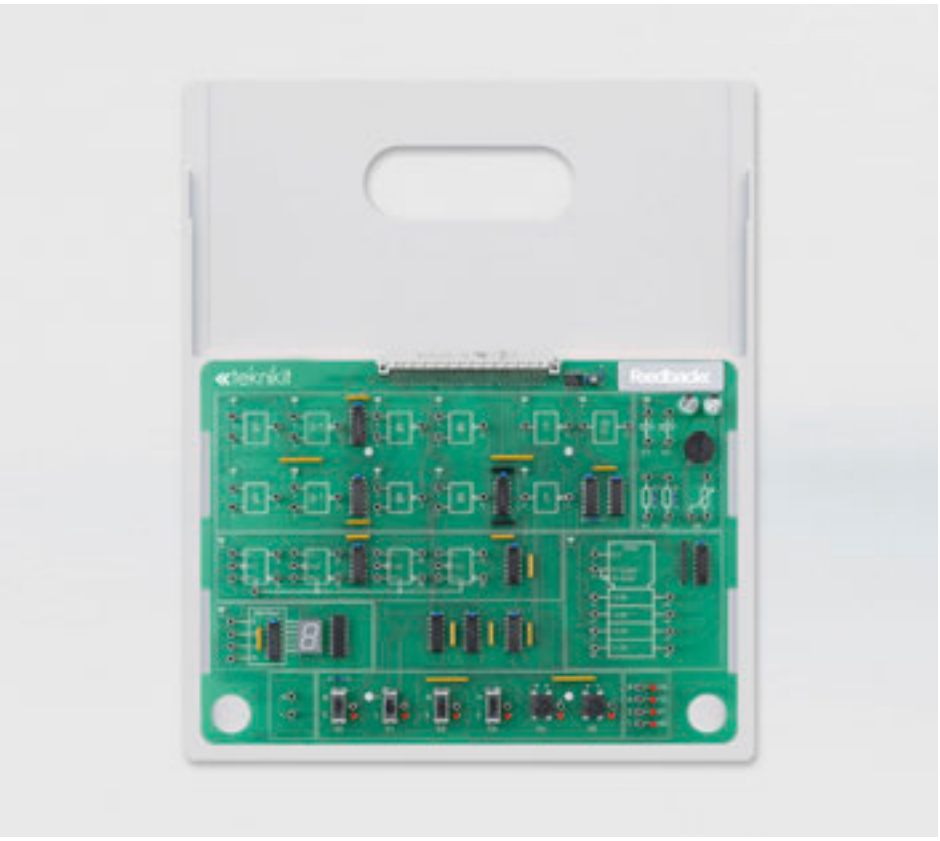
- 4 x AND, 3 x OR, 2 x XOR, 2 x NOR, 3 x NAND
- Full adder
- 7-segment display
- Multiplexer, Demultiplexer
- 4 command switch
- 2 sensors, 2 LEDs
- Dimensions (net, board & carrier):
  295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-130	Automotive Digital Technology I

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console



FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital analyser

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Automotive Digital Technology II

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course in digital technology for vehicle operations, the fundamentals of switch algebra are dealt with using logic links. Animations and interactions make the fundamentals of modern bus systems clear. The curriculum coverage is applied specifically to automotive technology as an application. Experiments are wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Flip-flop
- RS flip-flop
- JK flip-flop
- Shift register
- Counter
- Multivibrators
- Impulse diagram

Technical data:

- 2 x AND, 2 x NOR, 4 x NAND
- 2 x Inverter
- 1 x Schmitt trigger
- 1 x 7-segment display
- 4 x JK flip-flop
- 1 x Universal shift register
- 4 x Command switch,
- 2 x sensors, 4 LEDs
- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-131	Automotive Digital Technology II

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser
- Spectrum Analyser (FFT-module)
- Network Analyser with Bode module
- SWR Meter
- Frequency Counter
- Data Transfer Module

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

1.1.4 Communication Technology

Transmission Technology TX433

Comprises and experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the fundamentals and applications of radio transmission technology and analogue modulation technology, experiments being wired using 2 mm safety cables (14-101 Set of safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Introduction
- Measuring techniques, spectrum & network analysis
- Transmitter design
- Beats
- Double sideband AM
- Single sideband AM
- Frequency modulation
- Stereophonics & RDS
- Coding: shift-keying, ASK, FSK, PSK
- Matching
- Transmitting antenna
- SWR measurements
- Digital data
- Fault simulation

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-132	Transmission Technology TX433

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows 2000/XP/Vista, 7 or 8 (32-bit only) required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser
- Spectrum Analyser (FFT module)
- Network Analyser with Bode module
- Data Transfer Module

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Reception Technology RX433

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the fundamentals and applications of radio receiving technology and analogue de-modulation technology. The experiments are performed with the board of the transmitter and the receiver. The wiring of the experiments is carried out using 2 mm cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Receiver concepts
- Measurement techniques
- Sound equalising
- Radio receiver
- Stereo reproduction
- Applications of RDS, service features & information types
- Synchronous demodulation
- Envelope curve demodulation
- PLL
- De-emphasis
- Encoding
- Data security
- Fault simulation

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-133	Reception Technology RX433

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows 2000, XP, Vista, 7 or 8 (32-bit only) required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser
- Spectrum Analyser (FFT module)
- Frequency Counter

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Digital Communication Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on digital signal processing, experiments being wired using 2 mm cables (14-101 Set of safety Cables (2 mm), supplied separately). Attention is paid to the realisation and function of fibre optic transmission systems with emphasis on applications of PCM technology, for example the transmission of voice and signals with real telephones, sound cards and CD players. Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Characteristics of pulse carriers
- Generation of PAM
- PAM (natural)
- PAM (S&H)
- PAM spectrum
- Over sampling / under sampling
- Aliasing
- Shannon theorem
- Pulse code modulation (PCM)
- Quantisation linear & non-linear
- Compression / expansion
- Code errors
- Time division multiplexing (TDM)
- Sychronisation
- Quantisation noise
- Difference pulse code modulation (DPCM)
- Optical signal transmission
- Signal transmission by wire (coaxial line - two-wire line)
- Simplex / duplex communication

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-134	Digital Communication Technology

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboratory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser
- Spectrum Analyser (FFT module)
- Frequency Counter
- Data Transfer Module

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Modem Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the fundamentals and applications of shift keyed signals and modems, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Introduction
- Amplitude shift keying (ASK)
- Frequency shift keying (FSK)
- 2-phase shift keying (2PSK)
- 4-phase shift keying (4PSK)
- Difference phase coding
- Shift keyed signals in the time domain
- Shift keyed signals in the frequency domain
- Estimation of the bandwidth
- Modulation rate / data rate
- SNR & bandwidth
- Hardware of the modulators
- Hardware of the demodulators
- Carrier recovery & synchronisation of the demodulators
- Error correction
- Error detection
- Operational modes, simplex half duplex, full duplex
- NRZ line code
- Fault simulation

Technical data:

- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-135	Modem Technology

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console

FEATURES

Virtual Laboroatory

- Oscilloscope
- Function Generator
- Multimeter (x2)
- Digital Analyser
- FFT Spectrum Analyser
- Frequency Counter
- Bode Module

Additional Functions

- Word Processing
- Printer
- Pocket Calculator
- Free Experimentation
- Glossary

Telecommunication Lines

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Teknikit Console (supplied separately) teaching a practical course on the fundamentals and applications of various telecommunication line types, experiments being wired using 2 mm safety cables (14-101 Set of Safety Cables (2 mm), supplied separately). Course content, experiment instructions and tasks are taught via course-specific software.

CURRICULUM COVERAGE

- Frequency response of two wire lines
- Determination of characteristic wave impedance
- Measurement of near and far-end crosstalk
- Impulse behaviour of coaxial lines
- Mismatching
- Hybrid & phantom circuit
- Duplex transmission & remote supply Characteristic curves of LEDs in optical communications engineering
- Attenuation of fibre optic lines
- Measurement of optical power
- Coupling losses
- Bending losses

Technical data:

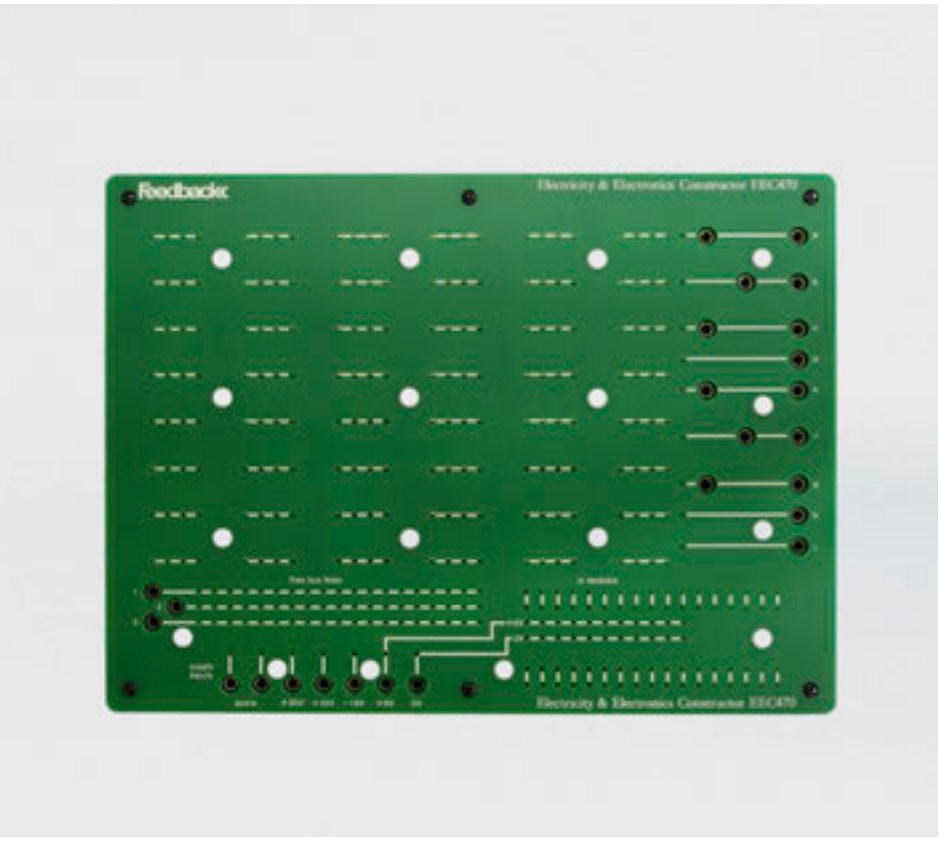
- Dimensions (net, board & carrier): 295 mm width x 355 mm depth x 40 mm height
- Weight (net): 0.6 kg

14-136	Telecommunication Lines

Additionally required:

Qty	Cat.-No.	Name
1	14-101	Set of Safety Cables (2 mm)
1	92-500	Teknikit Console

PC running Windows Vista, 7, 8/8.1, 32/64-bit required per console



FEATURES

- Modular, low cost system
- Rapid circuit construction
- Wide range of kits covering key subject areas
- Hands-on student assignments
- Simplifies the study of basic components and circuits
- Compact construction for easy use and storage
- Comprehensive theory & experimental manual

TECHNICAL DATA

- Power input d.c.: 0-20 V variable, 350 mA
- Power input a.c.: 5, 10, 15, 20, 25 V, 300 mA
- Dimensions (net): width 220 mm x depth 295 mm x height 25 mm
- Weight (net): 0.5 kg

1.2 EEC470 Series

Constructor Deck

The Electricity and Electronics Constructor EEC470 series is a structured practical training programme comprising an unpowered construction deck EEC470 and a set of educational kits. Each kit includes a comprehensive theory and experimental manual of student assignments and a selection of components, supplied in a conventional storage tray. EEC470 offers extremely versatile facilities for the rapid and easy-assembly of all types of circuit, with provision for discrete components, digital and analogue integrated circuits and high power devices mounted on carriers from 2-pin devices through to 16-pin integrated circuits. These carrier-mounted components are plugged into the deck's spring contact matrix to build the circuit to be investigated. The deck's layout allows swift and simple circuit construction and the high quality beryllium copper spring contacts have a self-cleaning action to ensure a long life of good electrical contact. The logical layout of the components aids comprehension of the theoretical principles involved.

EEC470	Constructor Deck

Additionally required:

Qty	Cat.-No.	Name
1	92-445	a.c./d.c. Power Supply

Additionally recommended:

Qty	Cat.-No.	Name
1	EEC470-001	Empty Component Carriers for EEC470
1	EEC471-2	Basic Electricity & Electronics
1	EEC473-4	Amplifiers & Electronic Circuit Applications
1	EEC475	Power Supply Design
1	EEC476	Electronic Control of Machines
1	EEC477	Opto-Electronics

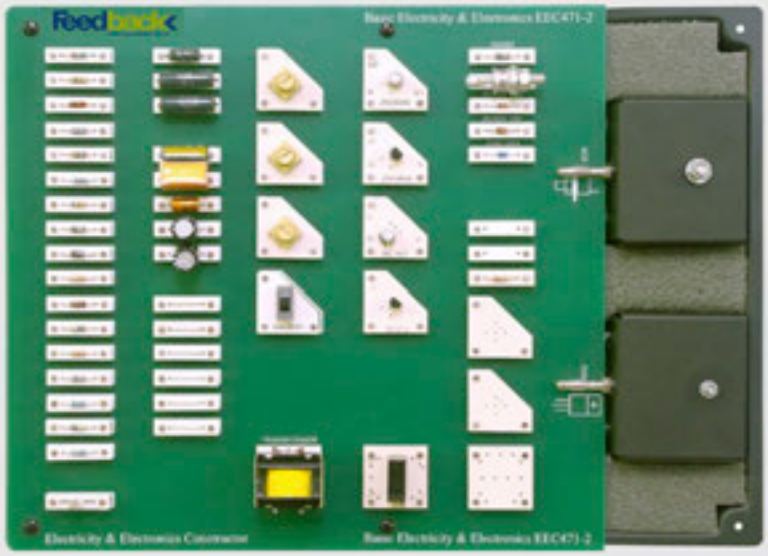
ELECTRICITY & ELECTRONICS
1.2 EEC470 SERIES

FEATURES

- Modular, low cost system
- Rapid circuit construction
- Wide range of kits covering key subject areas
- Hands-on student assignments
- Simplifies the study of basic components and circuits
- Compact construction for easy use and storage
- Comprehensive theory & experimental manual

TECHNICAL DATA:

- Dimensions (net): width 220 mm x depth 295 mm x height 25 mm
- Weight (net): 0.75 kg



Basic Electricity & Electronics

The Basic Electricity and Electronics kit EEC471-2 works in conjunction with the EEC470 Constructor Deck (supplied separately) and includes components mounted on carriers which are housed in a convenient storage tray with identification information. The kit introduces the student to the basic principles of electical theory and circuits, hence is supplied with a comprehensive theory and experimental manual including practical assignments. The combination of the EEC471-2 Basic Electricity & Electronics & EEC470 Constructor Deck (supplied separately) requires a 92-445 a.c./d.c. Power Supply (supplied separately) to provide a full working system.

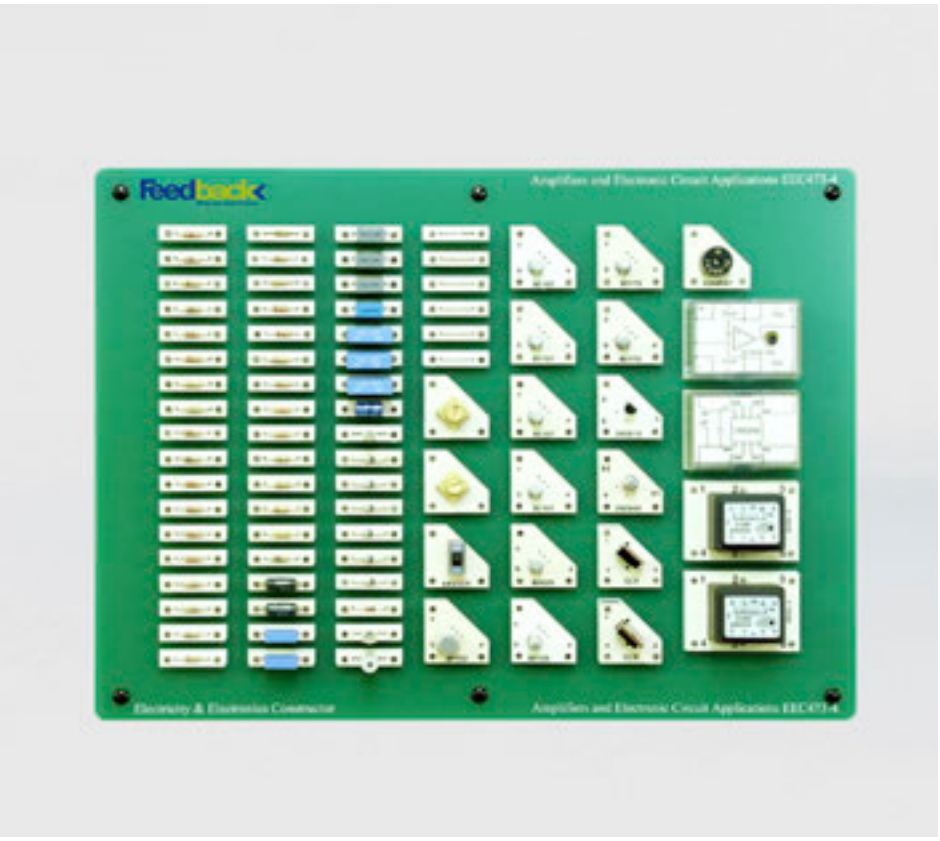
CURRICULUM COVERAGE

- Resistance
- Resistor networks
- Resistors in series & parallel
- Superposition theorem
- Thévenin's theorem
- Power
- Capacitance
- Capacitors in series & parallel
- Time constant
- Electromagnetic induction
- Inductance
- RMS value of an a.c. waveform
- Resistance in a.c. circuits
- Capacitance in a.c. circuits
- Inductance in a.c. circuits
- Capacitive & inductive reactance
- Series CR and LR circuits
- Impedance of a series CR Circuit
- Impedance of a series LR Circuit
- Impedance of a series LCR Circuit
- Parallel impedances
- Series resonance
- Power in a.c. circuits
- Parallel resonance
- The transformer
- The semiconductor diode
- Half-wave rectification
- Full-wave rectification
- The Zener diode
- Transistor familiarisation
- The common-emitter transistor circuit
- The Silicon controlled rectifier (SCR)
- The TRIAC
- Trigger devices - the DIAC & UJT
- The field effect transistor

EEC471-2	Basic Electricity & Electronics

Additionally required:

Qty	Cat.-No.	Name
1	92-445	a.c./d.c. Power Supply
1	EEC470	Constructor Deck



FEATURES

- Modular, low cost system
- Rapid circuit construction
- Wide range of kits covering key subject areas
- Hands-on student assignments
- Simplifies the study of basic components and circuits
- Compact construction for easy use and storage
- Comprehensive theory & experimental manual

TECHNICAL DATA:

- Dimensions (net): width 220 mm x depth 295 mm x height 45 mm
- Weight (net): 0.75 kg

Amplifiers & Electronic Circuit Applications

The Amplifiers & Electronic Circuit Applications kit EEC473-4 works in conjunction with the EEC470 Constructor Deck (supplied separately) and includes components mounted on carriers which are housed in a convenient storage tray with identification information. The kit introduces students to common semiconductor amplifier configurations, investigate their characteristics and provide an appreciation of their use. There is an comprehensive theory & experimental manual containing practical assignments. The combination of EEC473-4 Amplifiers & Electronic Circuit Applications and EEC470 Constructor Deck (supplied separately) requires a 92-445 a.c./d.c. Power Supply (supplied separately) to provide a full working system.

CURRICULUM COVERAGE

- Electronic amplifiers
- a.c. & d.c. gain
- Amplitude distortion
- Frequency & phase distortion
- Negative feedback
- Frequency response
- The a.c. amplifier
- The operational amplifier
- Push-pull amplifiers
- Passive attenuators
- Common-emitter amplifier
- Emitter follower
- Complementary push-pull amplifier
- Differential amplifier
- Operational amplifier
- Astable multivibrator
- Phase-shift oscillator
- Triangle-wave generator
- Unijunction pulse generator
- Bistable multivibrator
- Staircase generator
- Light-operated alarm
- Delay circuit
- Light-operated flasher
- Temperature-operated switch
- The Schmitt trigger
- Voltage regulator
- RTL NOT gate
- RTL OR & NOR gate
- DTL AND & NAND gate
- TTL NAND gate
- Exclusive-OR gate
- Set-reset flip-flop
- D-type flip-flop
- Clocked ste-reset flip-flop
- JK flip-flop

EEC473-4	Amplifiers & Electronic Circuit Applications

Additionally required:

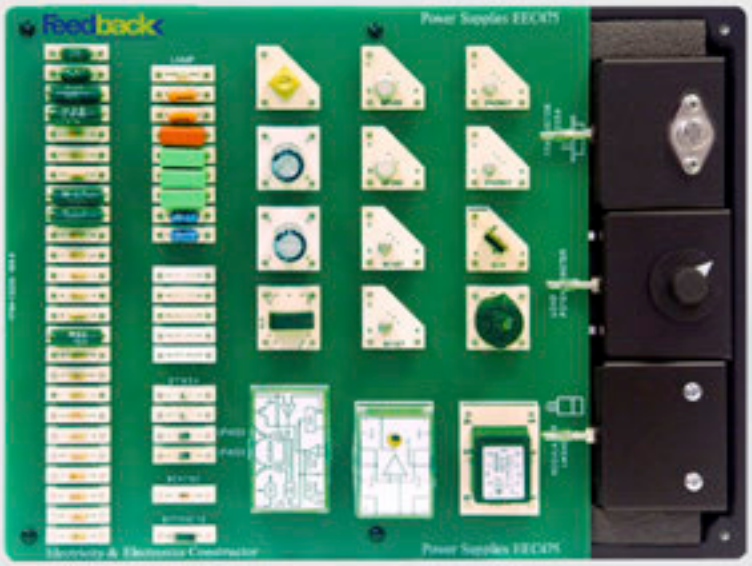
Qty	Cat.-No.	Name
1	92-445	a.c./d.c. Power Supply
1	EEC470	Constructor Deck

FEATURES

- Modular, low cost system
- Rapid circuit construction
- Wide range of kits covering key subject areas
- Hands-on student assignments
- Simplifies the study of basic components and circuits
- Compact construction for easy use and storage
- Comprehensive theory & experimental manual

TECHNICAL DATA:

- Dimensions (net): width 220 mm x depth 295 mm x height 45 mm
- Weight (net): 0.75 kg



Power Supply Design

The Power Supply Design kit EEC475 works in conjunction with the EEC470 Constructor Deck (supplied separately) and includes components mounted on carriers which are housed in a convenient storage tray with identification information. This kit shows the operation and basic design principles of various types of power supply. The student can make measurements of power supply performance, such as regulation, efficiency and current limit characteristics. The circuit operation can be studied from oscilloscope waveforms.

A comprehensive theory and experimentation manual, including 21 assignments, giving step-by-step instruction and patching diagrams is supplied. The combination of EEC475 Power Supply Design and the EEC470 Constructor Deck (supplied separately) requires a 92-445 a.c./d.c. Power Supply (supplied separately) to provide a full working system.

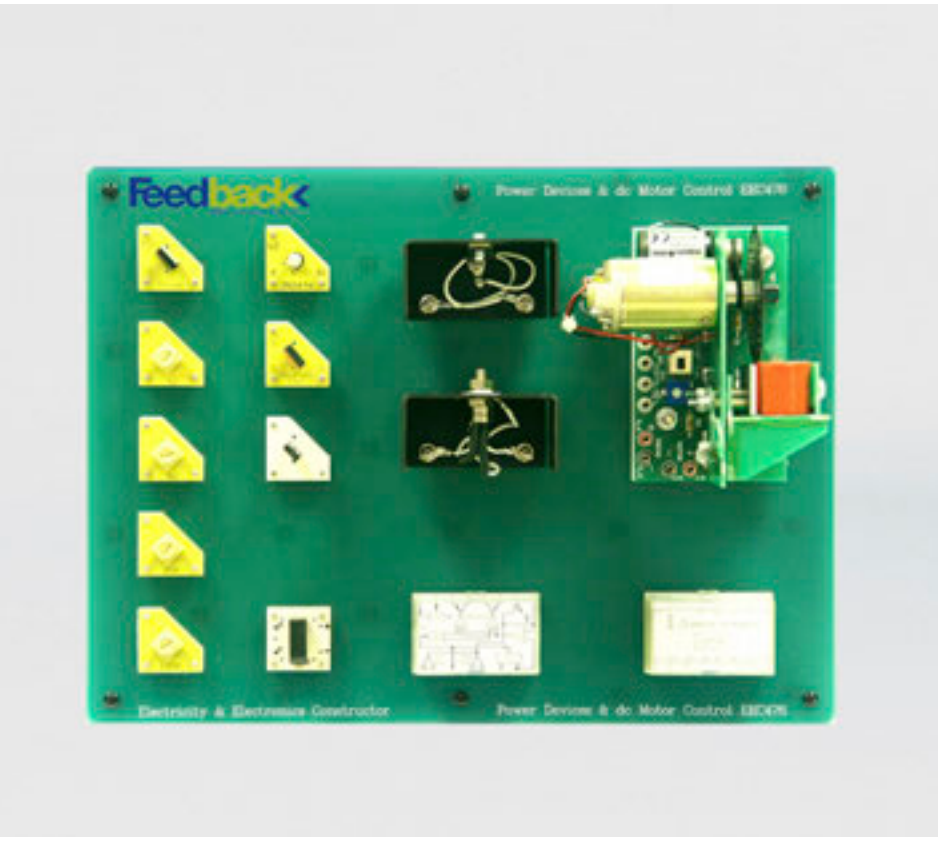
CURRICULUM COVERAGE

- Rectification - rectifier & transformer measurement of voltages
- Capacitive filters - voltage & current waveforms with or without reservoir capacitor, factors effecting ripple voltage
- Voltage doublers - half-wave & full-wave
- Simple voltage stabilisers - Zener diode stabiliser characteristics, measurement of Ro, regulation & efficiency
- Circuit protection - current limiting, current fold-back, over-voltage protection by „crowbar"
- Variable d.c. supplies - variation of regulated output, regulation measurement, performance of feedback regulator
- Integrated circuit voltage regulator - regulator operation, observation of thermal shutdown
- Inverters & converters
- Switch-mode regulator - observing a switching waveform, measurement, calculation of output voltage, efficiency, switching frequency

EEC475	Power Supply Design

Additionally required:

Qty	Cat.-No.	Name
1	92-445	a.c./d.c. Power Supply
1	EEC470	Constructor Deck



FEATURES

- Modular, low cost system
- Rapid circuit construction
- Wide range of kits covering key subject areas
- Hands-on student assignments
- Simplifies the study of basic components and circuits
- Compact construction for easy use and storage
- Comprehensive theory & experimental manual

TECHNICAL DATA:

- Dimensions (net): width 220 mm x depth 295 mm x height 45 mm
- Weight (net): 4.0 kg

Electronic Control of Machines

The EEC476 Electronic Control of Machines kit works in conjunction with the EEC470 Constructor Deck (supplied separately). This kit shows the operation of various types of machine control circuit. It comprises two boards, one of which carries a universal machine which may be controlled by a.c. or d.c. voltages. The content of the comprehensive theory and experimental manual is aimed at giving a practical understanding of machine control using a non-mathematic approach to the subject. The kit introduces the student to device characteristics and d.c. motor control methods, including PWM motor control. The hardware includes a d.c. motor module with optical incremental encoder and eddy current brake. The combination of EEC476 Electronic Control of Machines and EEC470 Constructor Deck (supplied separately) requires a 92-445 a.c./d.c. Power Supply (supplied separately) to provide a full working system.

CURRICULUM COVERAGE

- Characteristics & operation of the power MOSFET
- Silicon controlled rectifier (SCR) d.c. characteristics, forward & reverse
- The unijunction transistor - Zener diode stabiliser characteristics, UJT switching action, UJT relaxation oscillator, phase controlled UJT oscillator
- SCR circuits with resistive and complex loads - phase angle control, phase-control of inductive load, effect of the flywheel diode
- Characteristics of the TRIAC - blocking characteristic, positive & negative
- Speed measurement methods - incremental encoder calibration, tachogenerator calibration procedure
- Frequency to voltage conversion - electronic tachogenerator calibration
- Phase angle control of a d.c. motor - speed control of a d.c. motor, speed & torque of a d.c. motor
- Feedback control of a d.c. motor - linearity of speed control, speed-torque characteristic
- Pulse width modulation - pulse width control of power on-load
- Pulse width modulation control of a d.c. motor - PWM control of a d.c. motor, closed-loop PWM control of a d.c. motor

EEC476	Electronic Control of Machines

Additionally required:

Qty	Cat.-No.	Name
1	92-445	a.c./d.c. Power Supply
1	EEC470	Constructor Deck

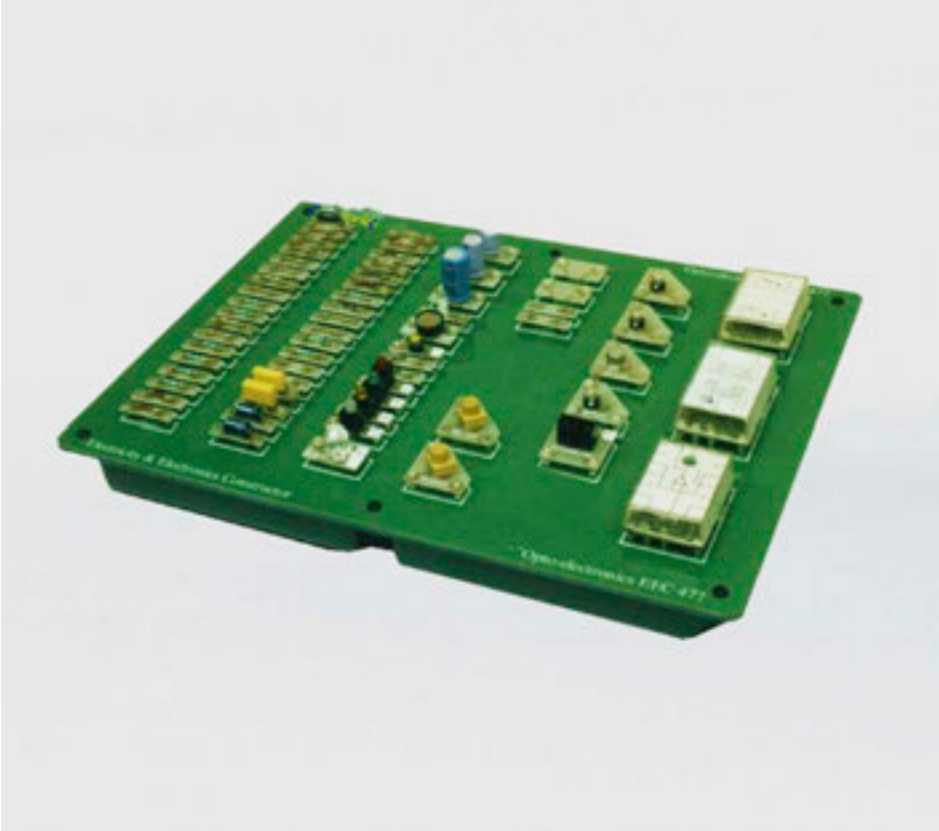
ELECTRICITY & ELECTRONICS
1.2 EEC470 SERIES

FEATURES

- Modular, low cost system
- Rapid circuit construction
- Wide range of kits covering key subject areas
- Hands-on student assignments
- Simplifies the study of basic components and circuits
- Compact construction for easy use and storage
- Comprehensive theory & experimental manual

TECHNICAL DATA:

- Dimensions (net): width 220 mm x depth 295 mm x height 45 mm
- Weight (net): 0.75 kg

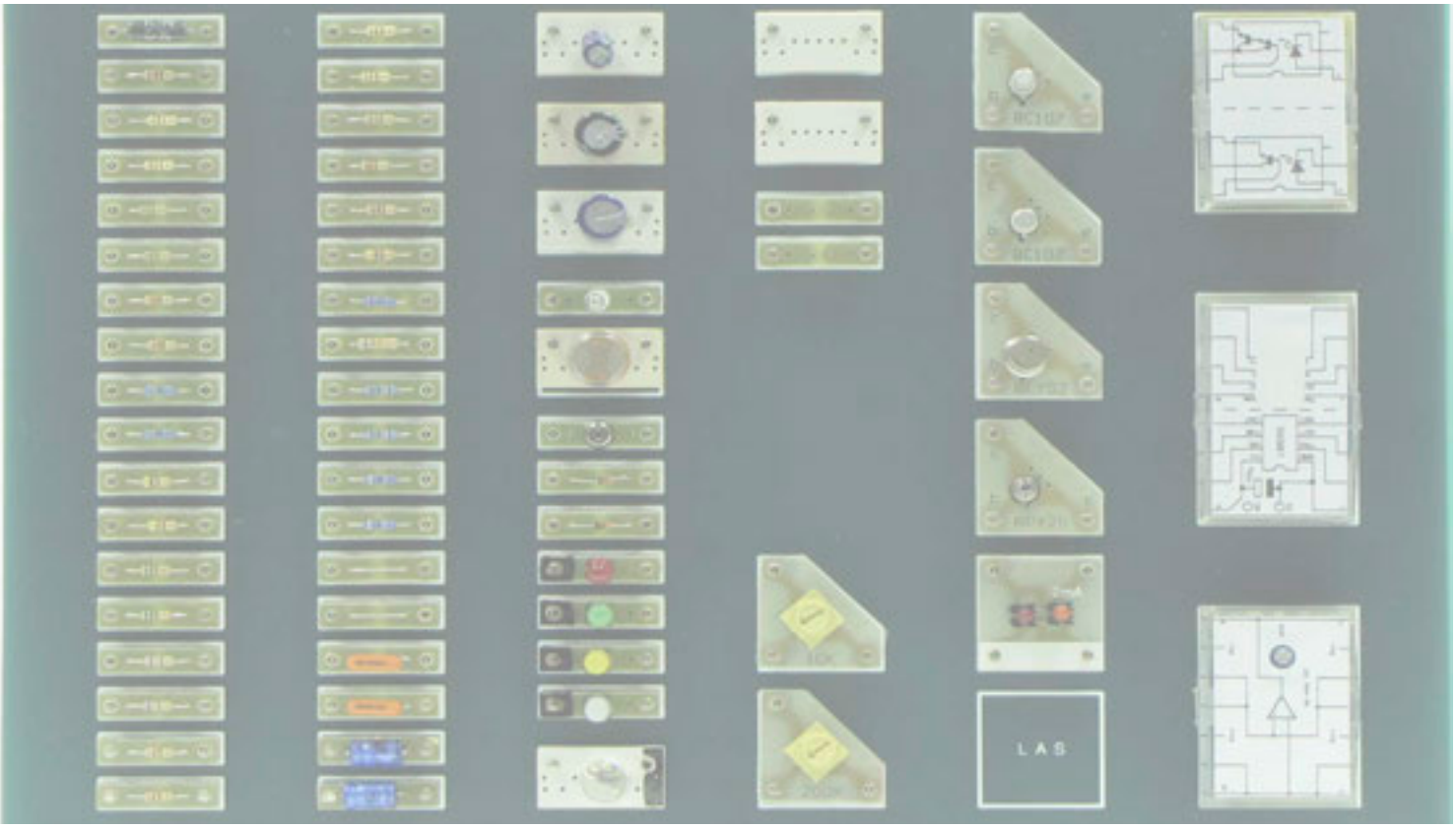


Opto-Electronics

The EEC477 Opto-Electronics kit operates in conjuction with the EEC470 Constructor Deck (supplied separately) and includes components mounted on carriers which are housed in a convenient storage tray with identification information. This kit of opto-electronic components introduces the student to the characteristics of various optical devices like light emitting diodes (LEDs), light dependent resistors (LDRs) and photodiodes. Included in the kit is a comprehensive theory and experimental manual with practical assignments. The combination of EEC477 Opto-Electronics and EEC470 Constructor Deck (supplied separately) requires a 92-445 a.c./d.c. Power Supply to provide a full working system.

CURRICULUM COVERAGE

- Characteristics of a LED - multi-colour & sensitive types
- Series & parallel connected LEDs - a.c. supply for LEDs
- Flasher circuits - two colour flasher
- Filament lamp characteristics - dynamic behaviour
- Photo-detection circuits - photo resistor, photo diodes, photo transistor
- Diode & transistor opto-couplers
- Application circuits - light activated switch with an operation amplifier, light activated switch with two transistors



Technical data:

- Dimensions (net): width 220 mm x depth 295 mm x height 45 mm
- Weight (net): 0.75 kg

EEC477	Opto-Electronics

Additionally required:

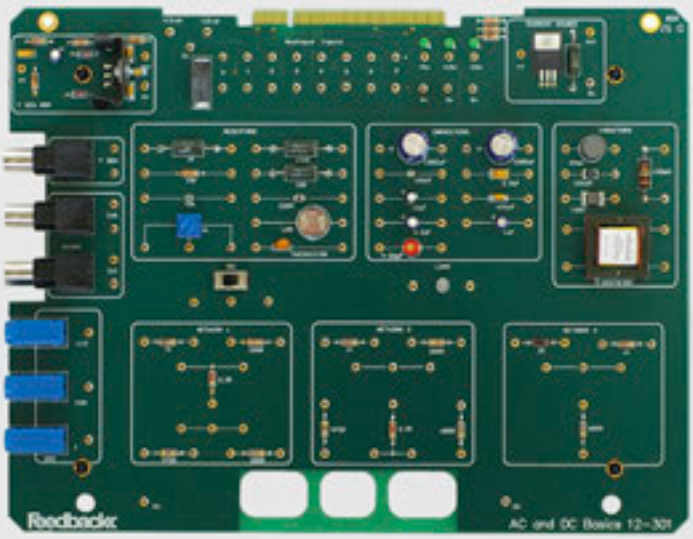
Qty	Cat.-No.	Name
1	92-445	a.c./d.c. Power Supply
1	EEC470	Constructor Deck

FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg



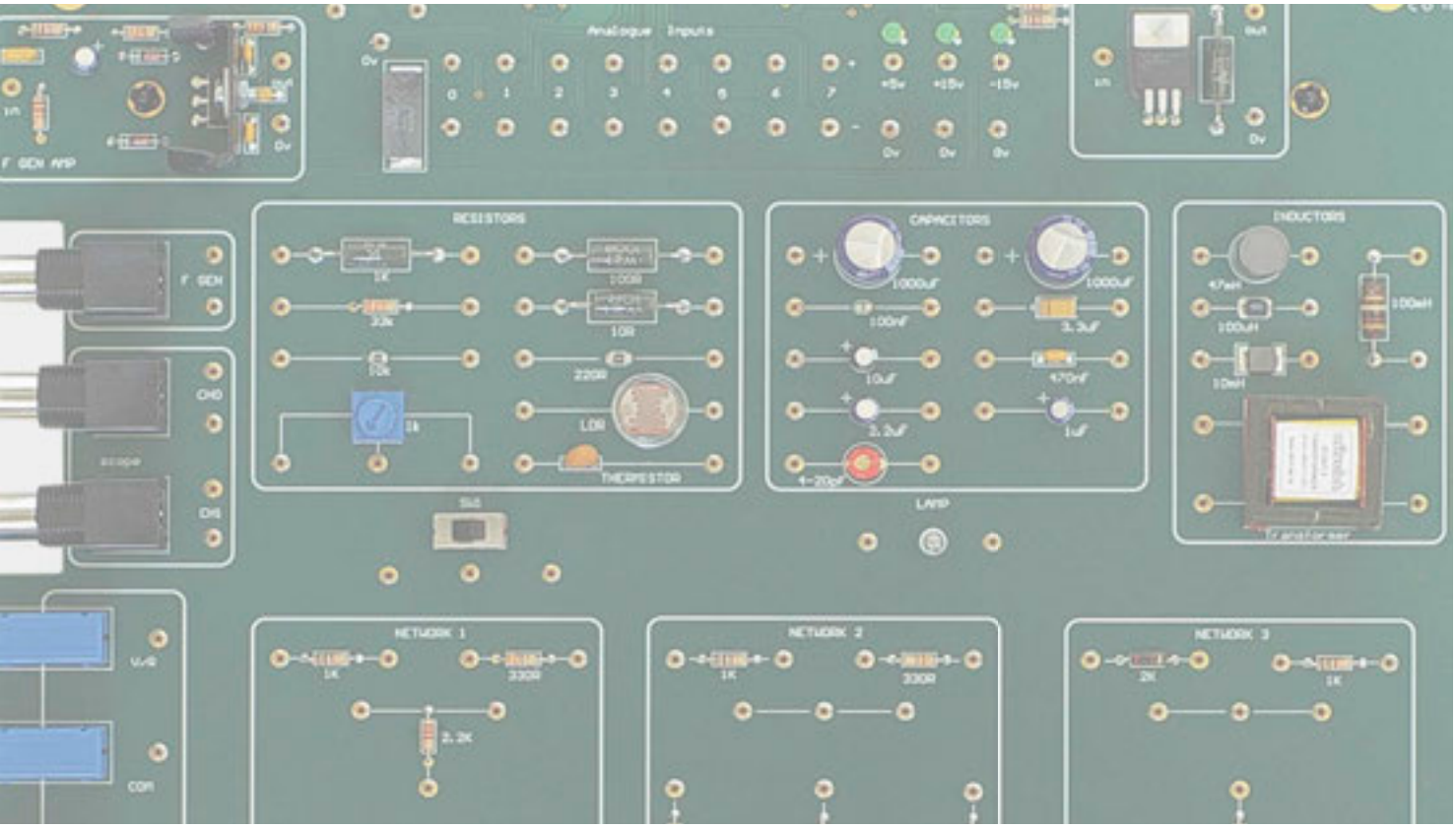
1.3 12-300 Series

a.c. & d.c. Basics

The 12-301 board provides an introduction to electronics and electrical principles using pre-constructed circuit elements that may be connected in different ways to perform a series of assignments. The board connects to the NI ELVIS II/II+ console (supplied separately) which provides power and signal acquisition. Teaching material and pc-based instrumentation are delivered by Feedback's own ESPIAL software (93-420 supplied separately), which teaches the student the necessary theory in order to complete the practical experiments. On-screen instructions guide the student through the set-up of the boards and the on-screen instrumentation enables students to record their results. There is the potential to edit assignments or create completely new teaching material.

CURRICULUM COVERAGE

- Introduction to electronics
- Conductors & insulators
- Resistance and Ohm's Law: resistor types, values, colour code identification
- Relationship between resistance current & voltage
- Ohm's Law
- Resistor Networks: series & parallel connection of resistors
- Application of Kirchoff's Law applied to resistors in a circuit
- Multiple voltage sources in a network
- Superposition
- Thevenin's theorem
- Norton's theorem
- Star-Delta transformation
- Capacitors: capacitor types, values, ratings & identification
- Advantages and disadvantages of different capacitor types
- The behaviour of a capacitor under d.c. conditions
- Series & parallel connection of capacitors
- Time constants
- Power: Power dissipated in resistor networks
- Electromagnetic induction
- Electromagnetic induction in a transformer
- Inductance: Inductor types, values, ratings & identification
- The behaviour of an inductor under d.c. conditions
- Series and parallel connection of inductors



- Time constants
- A.C. Signals: The properties of a.c. waveforms
- Power producing properties of a.c. waveforms & the relationship to d.c. signals
- The relationship between voltage and current in an a.c. circuit with R, L and C components
- Capacitor impedance over a range of frequencies
- Inductor impedance over a range of frequencies

Technical data:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg

12-301	a.c. & d.c. Basics

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

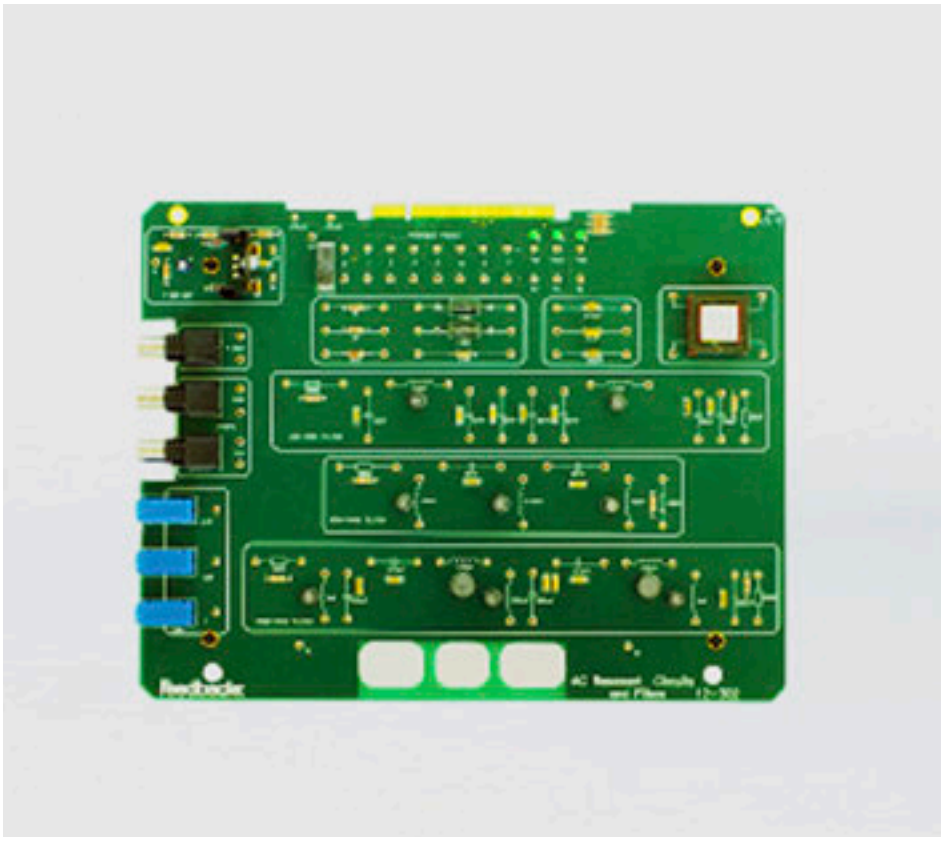
*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.

FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg



a.c. Resonant Circuits & Filters

The 12-302 board introduces the concept of electrical impedance and teaches students how passive components behave under a.c. conditions. This is a natural progression from the 12-301 d.c. & a.c. Basics board. The behaviour of resistive and reactive components is studied under a.c. conditions along with the associated phase lead and lag. This effect can be observed using the on-screen oscilloscope and phase-scope provided by ESPIAL software (93-420 supplied separately). The student can then measure the power dissipated in a.c. circuits using their results, which can be saved for future reference. Resonance in a.c. circuits is then covered, with emphasis on the student being able to set up the experiment and to then observe its response using the on-screen instrumentation. Results can be saved for future analysis and presentation. Filters are then introduced using passive components and the method of recording the frequency response using Bode and Nyquist formats is demonstrated. The NI ELVIS II/II+ console is required (supplied separately).

CURRICULUM COVERAGE

- Introduction to a.c. resonant circuits & filters
- Amplitude & phase shift in a CR circuit
- Amplitude & phase shift in a LR circuit
- Impedance of a series CR circuit with a.c. applied
- Impedance of a series LR circuit with a.c. applied
- Impedance of a series LCR circuit with a.c. applied
- Impedance of parallel connect components with an a.c. signal applied
- Power dissipated by components with a.c. applied
- Resonance of an LCR series circuit
- Resonance in parallel LC circuits
- Resonance in parallel LCR circuits
- Resonance in parallel L (+R) C circuits
- 1st, 2nd, 3rd & 5th order low pass filters
- 5th order high pass filter
- 5th order band pass filter

12-302	a.c. Resonant Circuits & Filters

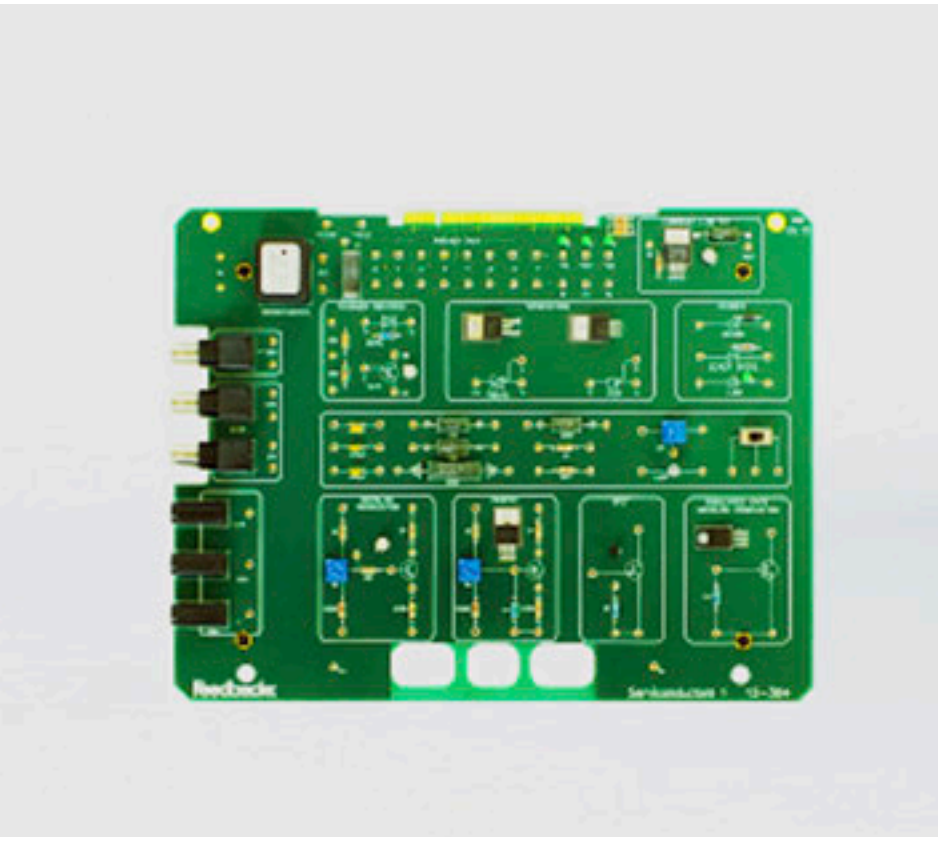
Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.



FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg

12-303 Magnetic Devices

The 12-303 board teaches how electro-magnetic components work and what their applications are. This follows on from the fundamentals introduced in the electromagnetic induction section on board 12-301. The board enables students to learn by hands-on and using pre-constructed circuit elements that may be connected in different ways to perform a series of assignments. The principles of operation of the most common electro-magnetic components are covered by taking a hands-on approach and the student is then able to perform practical tests using ESPIAL software (93-420 supplied separately). Transformers are covered in detail, with practical experiments relating to the efficiency, phase shift and turns ratio. The use of the transformer to convert the impedance of a load is also demonstrated. The concept of d.c. motors and generators are demonstrated by an experiment designed to see the effect on the generating motor has on the driving motor. The student also learns how to calculate the efficiency of a generator by measuring the power in and power out. An ELVIS II/II+ console is required (supplied separately).

CURRICULUM COVERAGE

- The properties of a magnetic field & electromagnetism
- Transformers - voltage ratio, efficiency, impedance & transformation, BH loop
- Relays - off/on change over, latching, operating relay as a buzzer, relay coil pulls current
- Reed relay operation
- Hall-effect device
- Motor - d.c. applied in both directions, amplitude effect, voltage from second motor, loading the generator, efficiency of power in and power out of generator

12-303	12-303 Magnetic Devices

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.

FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg

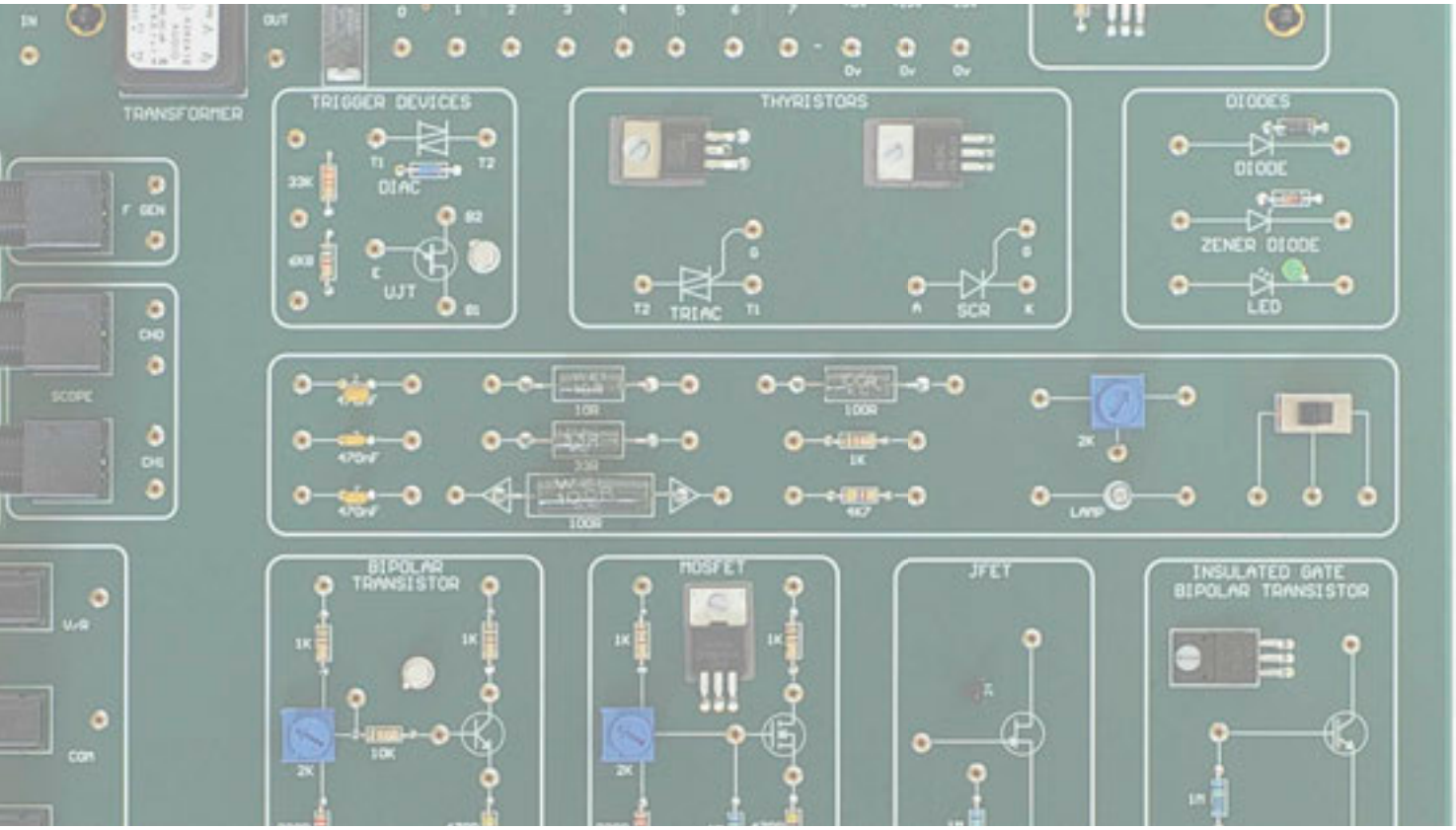
Semiconductors 1

The 12-304 board introduces semiconductors devices and how they function. The student learns the fundamentals of the p-n junction and how its characteristics make the operation of a diode possible. The transistor is able to be tested using the on-screen instrumentation, allowing the student to measure and record the key characteristics of the bipolar junction transistor and the field effect transistor. The principle of operation of the p-n junction is fundamental to the understanding of semiconductor electronic components and the 12-304 covers the basics through to modern field effect transistors. Transistor characteristics are studied with the opportunity for the student to measure the input, output and transfer characteristic using the on-screen instrumentation.

This leads onto the calculation of the a.c. current gain, or hFE, of the transistor. The need for biasing is explained, such that the transistor is able to be used with a.c. signals and the effect of applying signals to different terminals of the transistor is investigated. Teaching material and pc-based instrumentation are delivered by Feedback's own ESPIAL software (93-420 supplied separately), which teaches the student the necessary theory in order to complete the practical experiments. On-screen instructions guide the student through the set-up of the boards and the use of the on-screen instrumentation enables students to observe parameters in real time and to record their results.

CURRICULUM COVERAGE

- The Semiconductor Diode - recognition of diode types, determining diode polarity, electrical characteristics of a diode
- Zener diodes & Light Emitting Diodes (LEDs)
- Transistor characteristics - recognition & identification of types of transistor, input and output characteristics, common emitter, common collector & common base circuits
- MOSFET characteristics - field-effect transistor familiarisation, enhancement mode MOSFET input & output characteristics
- JFET - input & output charactistics, gate capacitance
- FET Circuits - MOSFET with a signal applied to the gate & extracted at the drain, MOSFET with a signal applied to the gate and extracted from the source, MOSFET with a signal applied to the source and extracted from the drain
- Insulated gate bipolar transistors
- Silicon controlled rectifiers - triggering the SCR
- TRIACs - characteristics & triggering
- DIACs and unijunction transistors



Technical data:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg

12-304	Semiconductors 1

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

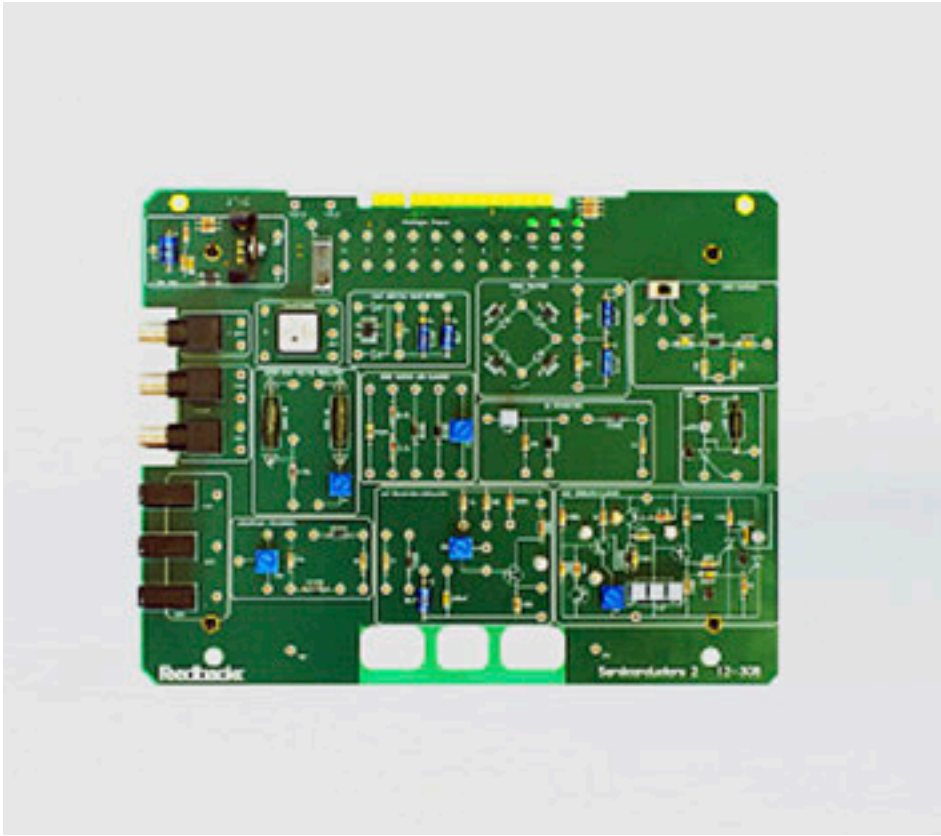
*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.

FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg



Semiconductors 2

The 12-305 board builds on the semiconductors fundamentals covered on the 12-304 board to demonstrate key applications of semi-conductor devices. In particular it covers how the diode may be used to rectify an a.c. signal and it's importance as a device for clipping an a.c. signal. Amongst the many other components studied the Zener diode and its use as a voltage regulator in a power supply is investigated. The principle of rectification of a.c. to d.c. is covered in detail allowing the student to study half-wave and full-wave rectification using the on-screen oscilloscope provided by Feedback's own ESPIAL software (93-420 supplied separately). Smoothing of rectified signals is investigated by measuring the effect of applying a capacitor across the load. The student can construct a light dimming circuit using a unijunction transistor and utilise silicon controlled rectifiers (SCRs) for power control applications. An ELVIS II/II+ console is required (supplied separately).

CURRICULUM COVERAGE

- Diodes - back EMF protection, clipping, clamping, switches, voltage multipliers, d.c. restoration, log conversion
- Half-wave rectification - recognise half-wave rectifier waveforms
- Full-wave rectification - advantages of full-wave over half-wave rectification, two diode full-wave rectification, full-wave bridge rectification, smoothing capacitors
- The Zener Diode - voltage regulation circuits, clipping, over-voltage protection

12-305	Semiconductors 2

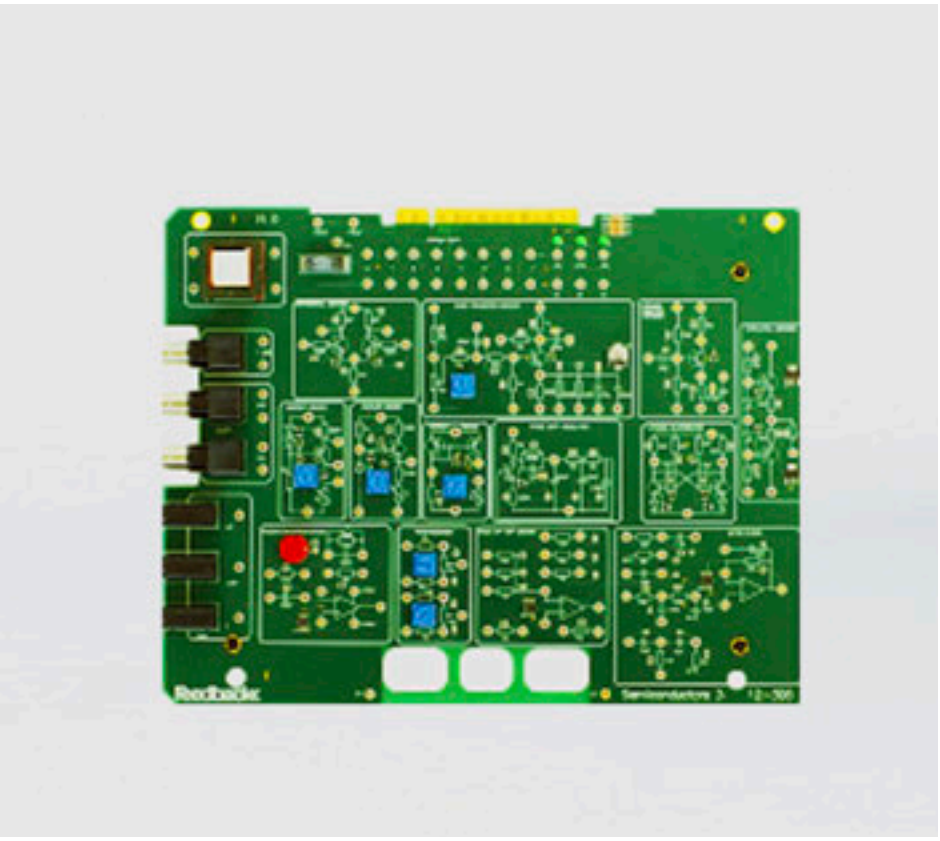
Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.



FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg

Semiconductors 3

The 12-306 board features comprehensive courseware on operational amplifiers, active filters and more advanced transistor applications. Operational amplifiers are introduced so that the student can appreciate the ideal versus non-ideal behaviour and how basic circuits are constructed. The use of the operational amplifier to perform mathematical operations and it's use as an oscillator are also covered. The on-screen oscilloscope and function generator are used extensively throughout the experiments using Feedback's own ESPIAL software (93-420 supplied separately). The board enables students to explore how the transistor is used to perform amplification in multiple configurations. The principles of biasing, gain and feedback are introduced such that transistor circuits can be designed using parameters to accurately define performance. The most common operational amplifier circuits - such as the inverting amplifier, non-inverting amplifier and voltage follower - are able to be constructed and tested by the student. A comprehensive introduction to active filters highlight the benefits over passive filters and this is illustrated by testing examples of first and second order high- and low-pass filters. An ELVIS II/II+ console is required (supplied separately).

CURRICULUM COVERAGE

- Thyristors & trigger devices and how they are used, phase shifters & power control (light dimmer)
- Transistors
- Biasing - fixed biase, collector biased, emitter resistor (temperature compensation), switches
- Gain
- Distortion
- Feedback - positive & negative
- Sources - voltage, current, current mirror
- Differential amplifiers
- Power amplifiers - classes A, B, C & D, push-pull amplifiers
- Muti-stage amplifiers
- Oscillators
- Operational amplifiers
- Basic op-amp circuits - inverting amplifier, non-inverting amplifier, voltage followers
- Mathematical operations 1 - summing amplifier, differential input op-amps
- Mathematical operations 2 - integrators, differentiators
- Comparators
- Schmitt triggers
- Active filters - 1st & 2nd order high-pass & low-pass, band-pass & all-pass (phase shifts)

12-306	Semiconductors 3

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

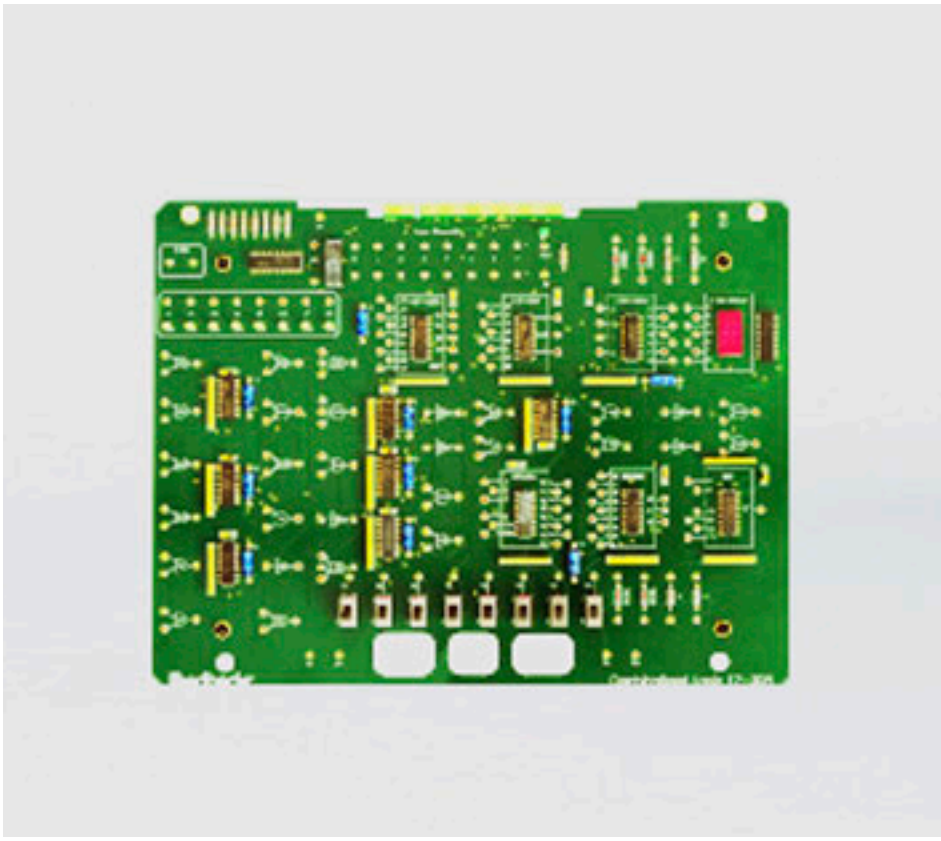
*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.

FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg



Basic Logic Circuits

The 12-307 board provides an introduction to basic logic gates and circuits using pre-constructed circuit elements that may be connected in different ways to perform the assignments. The board connects to the NI ELVIS II/II+ console (supplied separately) which provide power and signal acquisition. The 12-307 is designed to give students a thorough introduction into digital electronics by teaching the different technologies behind logic gate design. Students will require knowledge of the fundamentals of analogue electronics from using other boards in the Feedback 12-300 series. The student is introduced to a variety of digital technologies from elementary Resistor-Diode-Logic (RTL), Transistor-Transistor-Logic (TTL) and CMOS. The fundamentals of transistor operation are covered, along with application specific topics such as propagation delays, logic levels and interfacing between difference logic families. ESPIAL sofware is also required (93-420 supplied separately).

CURRICULUM COVERAGE

- Familiarisation
- Digital electronics
- Logic gates
- Diode logic
- Transistor characteristics
- Resistor-transistor logic (RTL)
- Diode-transistor logic (DTL)
- Transistor-transistor logic (TTL)
- TTL output circuits
- MOSFET characteristics
- CMOS logic circuits
- TTL & CMOS logic 1
- TTL & CMOS logic 2
- Interfacing TTL & CMOS logic
- Emitter coupled logic

12-307	Basic Logic Circuits

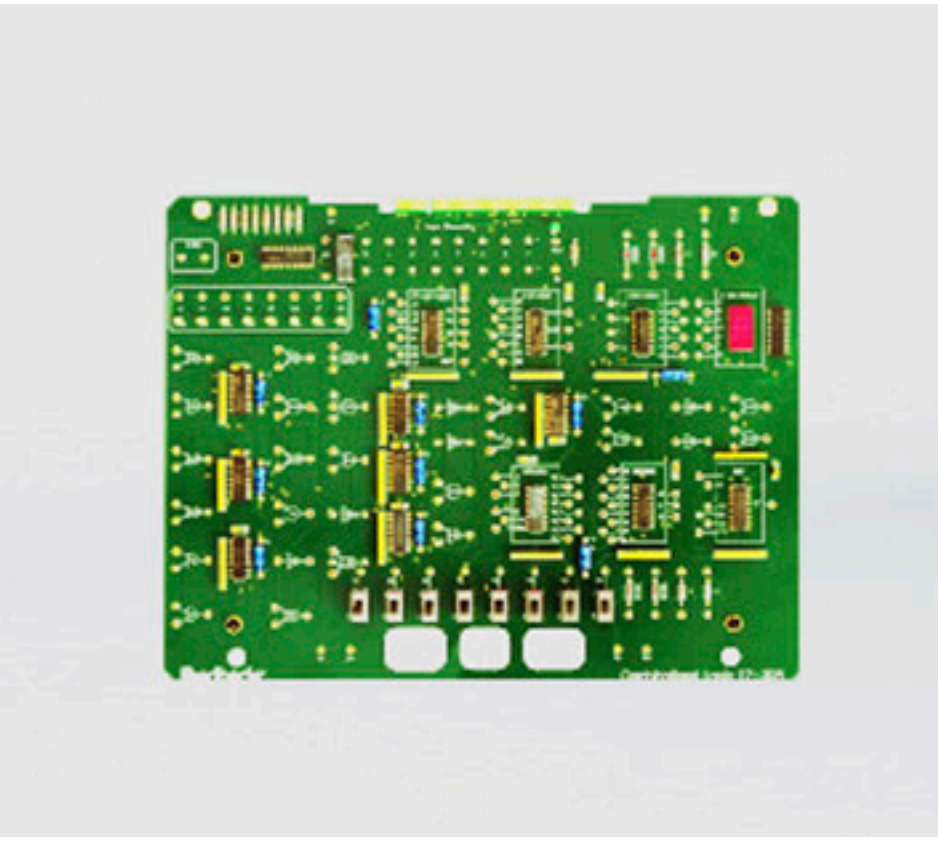
Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.



FEATURES

- Suitable for a wide range of electricity & electronic courses
- Hands-on practical work
- PC-based instrumentation delivered by ESPIAL Software (93-420 supplied separately)
- Pre-constructed circuit for rapid configuation using cables
- Comprehensive experiment manual
- Uses NI Elvis console (supplied separately)

TECHNICAL DATA:

- Dimensions (net): width 280 mm x depth 215 mm x height 20 mm
- Weight (net): 0.5 kg

Combinational Logic

The 12-308 board provides an introduction to combinational digital logic systems using pre-constructed circuit elements that may be connected in different ways to perform the assignments. Combinational Logic describes the branch of electronics in which the output of a given digital network is always a predetermined function of the input. These circuits are implemented with devices called logic gates which perform the operations of Boolean algebra, which enable basic arithmetic operations to be carried out. The student is introduced to combining logic gates together and learns how to manipulate Boolean algebra expressions. This leads onto techniques for reducing logic gate count for a given circuit using Karnaugh mapping and De Morgan's theorem. The board is used in conjunction with the ELVIS II/II+ console and 93-420 ESPIAL software (both supplied separately).

CURRICULUM COVERAGE

- Logic gates - NOT, AND, NAND, OR & NOR, working with logic gates, substituting logic gates, Boolean algebra
- Further Boolean algebra
- De Morgan's theorem - sum & products
- Minterms & maxterms
- Karnaugh mapping - two variables, there variables, more than three variables
- Binary addition - half adder, full adder, multi-digit numbers, binary subtraction
- Equivalence & non-equivalence - binary number equality & inequality
- Magnitude comparators - one bit & four bit
- Binary coded decimal encoders / decoders - 8 to 3 line priority binary coded decimal (BCD) encoder, 2 to 4 line BCD decoder, 3 to 8 line (BCD) decoder

12-308	Combinational Logic

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additional:

- A PC with Windows Vista, Windows 7 or 8, 32bit or 64bit or higher with USB interface
- NI ELVIS II/II+ Console* is required (supplied separately)

*The Elvis console is not available from Feedback. Please contact your local National Instruments agent.

FEATURES

- Now includes Espial Tools
- Allows teachers & lecturers full edit facilities
- New content & additional assignments
- Free of charge online software updates
- Hands off for teachers, hand on for students
- Self-paced
- Unrestricted, open learning environment
- Practical demonstration of theory & concepts
- Interactive patching diagrams
- Real-time embedded instrumentation
- Automatic instrumentation configuration
- Data export for analysis
- USB connection to hardware
- Editing tools include laboratory architect, assignment builder, Winwiz & manual builder
- Compatible with 32 bit & 64 bit versions of Windows XP, Vista, Windows 7 & Windows 8
- Optional 93-410 Espial Course Manager

Espial Software Package

Espial is used extensively within the telecommunications, control and basic electronics ranges. It is therefore required for use with 12-300 series, 33-033, 53-004 (& 53-200 series), 57-200-USB, 38 series & PV75-100.

The teaching content is provided within the software; this includes the underlying theory, written so that it does not make extensive use of mathematics. An important part of the content is to highlight the assignment learning objectives and to convey relevant background to the student. Consequently, the student is well prepared for the practical work using the hardware, and can put the results into perspective. Espial operates so that its appearance and the range of instrumentation depend on the context. So, for example, if the practical-work requires the use of complex instrumentation such a constellation or a phase meter, one is made available, whereas at lower levels of study it would not be provided. Test instruments are initialised with settings suitable for the required measurements, but students are often expected to change them during the practical work. The instruments have cursors to make measurements and their displays may be printed or exported for inclusion in laboratory reports.

The 93-420 Espial Software Package now includes Espial Tools. This allows teachers and lecturers full edit facilities with the creation of new content and additional assignments. Laboratory Architect determines the range of assignments available to the students and to configure the look and feel of the Espial environment. Assignment Builder creates new or edits existing laboratory assignments and configures the test equipment. Content is edited using any HTML editor or Microsoft Word. Winwiz creates and edits work board „patching" diagrams. It also configures test equipment monitor points and „further information" points on the practical diagrams. Practical diagrams are edited by Microsoft Visio. (Visio is not supplied as part of Espial) Manual Builder creates a version of the content ready formatted for printing. Free of charge online software updates are included. An optional addition is 93-410 Espial Course Manager, although it is not necessary for equipment operation. The 93-410 creates complete courses containing assignments from any of the installed Espial products plus external resources such as documents, multimedia material, thrid party programs, web urls, or locations on local intranets. Includes Course Designer and Course Presenter.

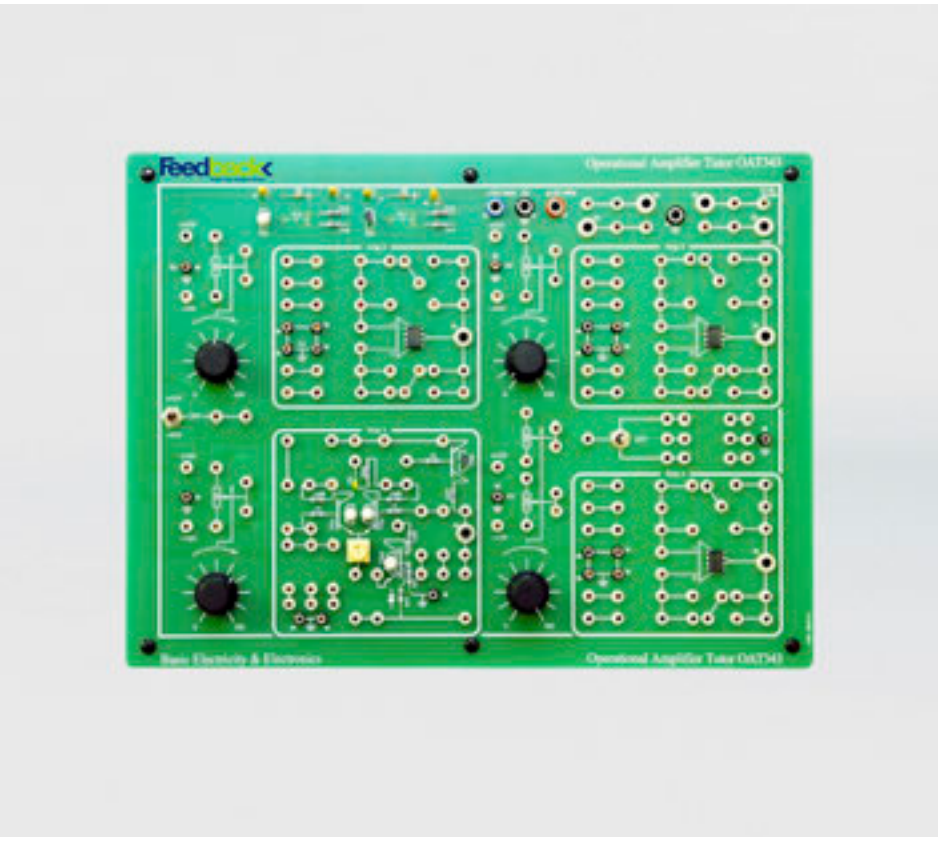
Technical data:

- Dimensions & weight of a CD

93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	93-410	Espial Course Manager



FEATURES

- Open-board construction
- 4 operational amplifiers
- Selection of resistive & capactive components
- On-board potentiometers
- Comprehensive experimental manual with interconnecting leads

1.4 Pre-mounted Trainers

Operational Amplifier Tutor

The OAT343 is an open board style Operational Amplifier Tutor. It features four operational amplifiers, one of which is constructed with discrete components, enabling work to be carried out on the internal make up of an Op Amp. A front panel mimic diagram showing elements and circuitry. The Tutor is supplied with all interconnecting leads and a comprehensive theory and experimental manual with practical assignments. The OAT343 Operational Amplifier Tutor requires a d.c. Power Supply for a full working system. The 01-100 d.c. Power Supply (or similar) is required.

CURRICULUM COVERAGE

- Op-amp feedback requirements
- Input offset voltage
- Slew rate
- Frequency response
- Operational amplifier characteristics
- Inverting & non-inverting modes
- Open-loop voltage gain
- Common mode rejection ratio (CMRR)
- Sign changer or inverter
- Scale changer
- Adder or summing amplifier
- d.c. voltage follower
- Differential d.c. amplifier
- Analogue integration & differentiation
- Linear & non-linear oscillators

Technical data:

- Power Outputs: 4 sets of 0 V, ±10 V sockets
- Power requirements: 0 V, ±15 V d.c. regulated at 200 mA
- Dimensions (net): width 295 mm x depth 220 mm x height 45 mm
- Weight (net): 1.8 kg

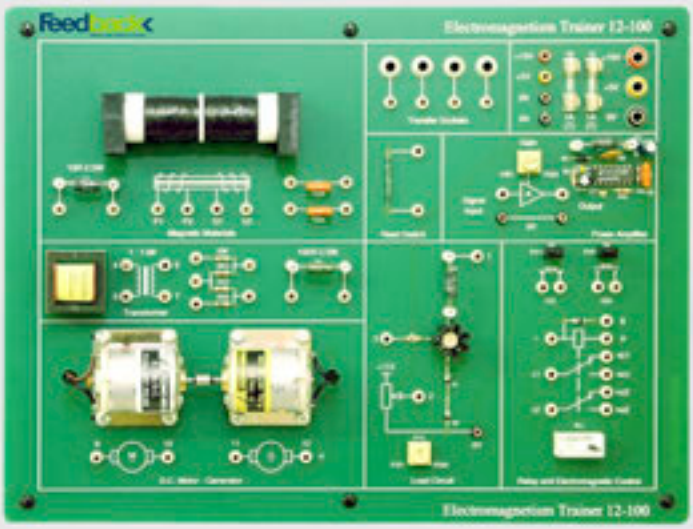
OAT343	Operational Amplifier Tutor

Additionally required:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A

FEATURES

- Glass fibre laminate PCB
- Principles of electromagnetic components
- Components have a simple mimic printed on the board
- Comprehensive experiment manual



Electromagnetism Trainer

The 12-100 Electromagnetism Trainer provides an introduction to the application of electromagnetic fields through the use of various components and materials. A comprehensive theory and experimental manual is included, containing practical assignments address the importance topics in electromagnetism. A d.c. power suppy is required to provide a full working system, so we recommend our 01-100 d.c. Power Supply (supplied separately).

CURRICULUM COVERAGE

- RMS value of an a.c. waveform
- Power at a.c.
- Electromagnetic induction
- Inductance
- Inductive circuit at a.c.
- Inductive reactance
- Series resonance
- Parallel resonance
- The transformer
- Magnetic circuits & materials
- Magnetic reed switches
- Relays
- Latched relay motor control
- d.c. motor characteristics
- d.c. generator

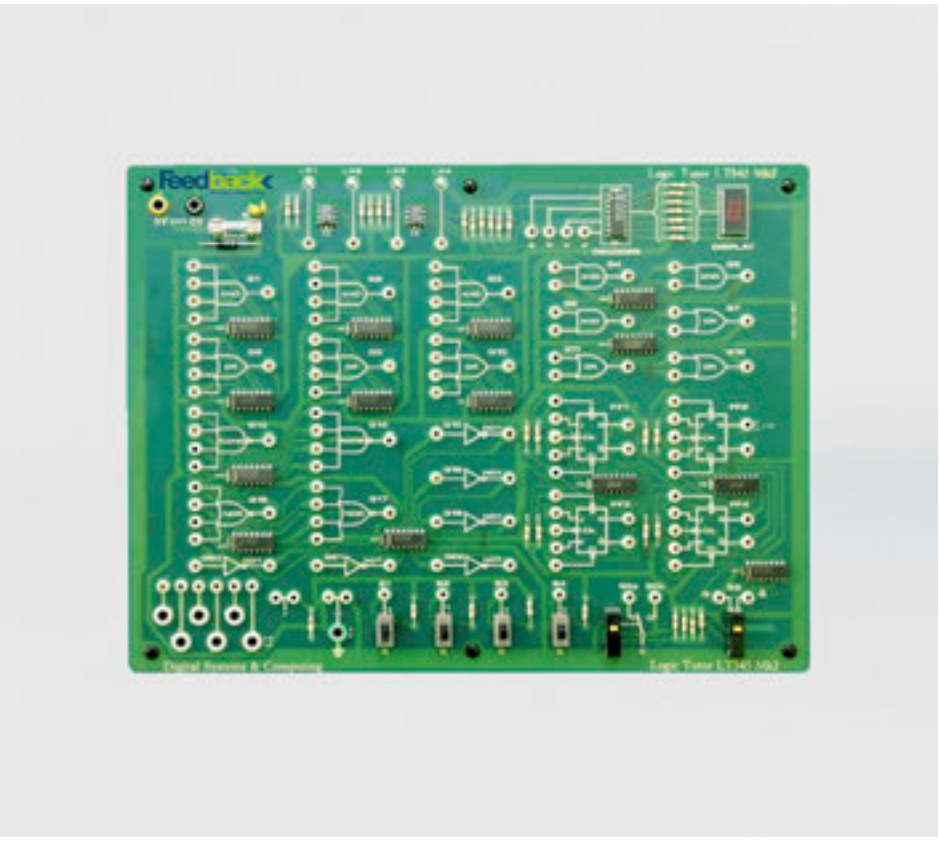
Technical data:

- Dimensions (net): width 295 mm x depth 220 mm x height 60 mm
- Weight (net): 0.75 kg

12-100	Electromagnetism Trainer

Additionally required:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A



FEATURES

- Wide range of combinational & sequential logic studies
- All inputs & displays provided
- Reliable & Robust
- Comprehensive experiment manual

Logic Tutor

The Logic Tutor LT345 MK2 is ideal for introducing logic tuition into a syllabus on a small budget. It is a compact and easy-to-use board for studies of digital techniques and principles. It is supplied with a comprehensive teaching manual which takes the student from the simplest logic operations, up to the applications of counters, shift registers and numeric displays. For ease of interconnection and understanding, all necessary inputs and logic indicators are built-in and all logic elements are shown in mimic diagram form on the panel. Unlike many other logic tutors, there are no confusing cross references to integrated circuit data sheets. The integrated circuits are permanently fitted, which avoids the potential student damage and contact problems normally associated with the breadboard type of tutor employing loose ICs and sockets. The equipment is robust and fully protected electrically and mechanically and supplied with a comprehensive theory and experimental manual including 13 assignments. The Logic Tutor requires a d.c. power supply, so we recommend the 01-100 d.c. Power Supply (supplied separately).

CURRICULUM COVERAGE

- Binary numbers
- Logic operations
- Combinational logic
- Karnaugh maps
- The simple latch
- Clocked flip-flops
- The JK flip-flop
- Equivalence
- Non-equivalence & other circuits
- Binary addition
- Registers
- Synchronous counters
- Asynchronous counters
- Codes & code converters
- 7-segment display

Technical data:

- Dimensions (net): width 295 mm x depth 220 mm x height 45 mm
- Weight (net): 0.25 kg

LT345MK2	Logic Tutor

Additionally required:

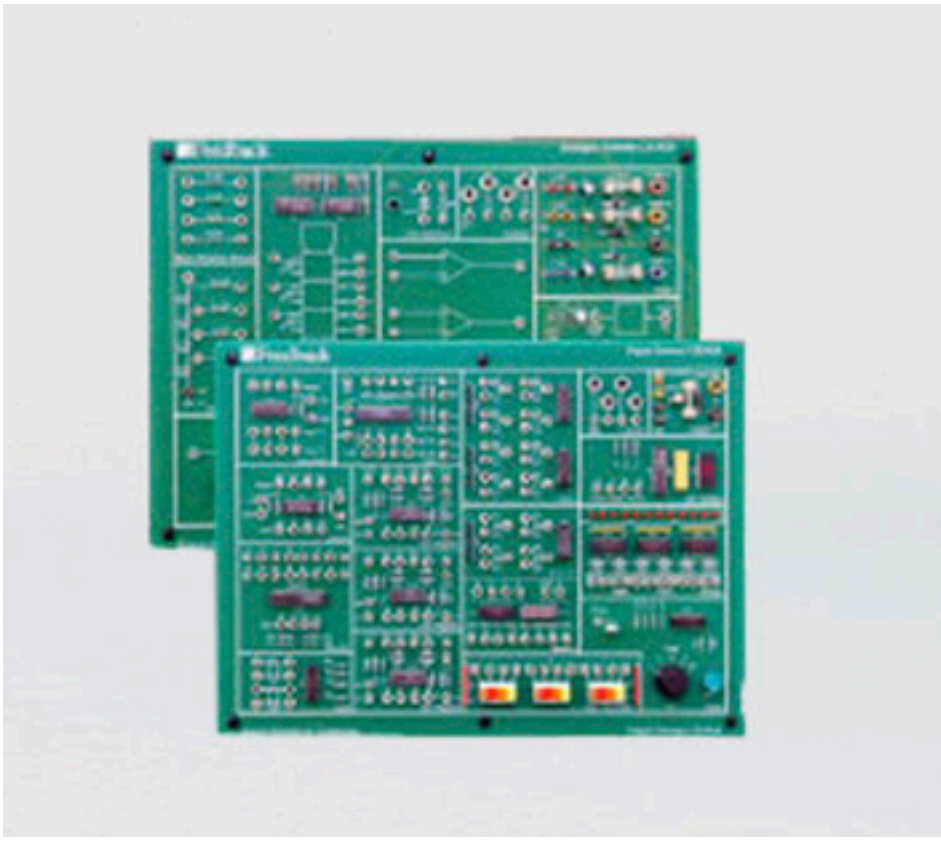
Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A

FEATURES

- Open board circuit construction with PCB mimic
- CK342 includes 2 boards, 1 digital and 1 analogue
- Medium scale integration
- Electronic devices
- A-D/D-A principles
- Comprehensive experiment manual included

TECHNICAL DATA:

- Dimensions (net): width 372 mm x depth 260 mm x height 83 mm
- Weight (net): 1.8 kg



Analogue & Digital Trainer

For students to understand the connection between simple logic circuits and microprocessor systems, they need an appreciation of medium scale integration devices. The CK342 Analogue & Digital Trainer provides students with the experience of many of the popular electronic systems building blocks. It allows the investigation of individual elements and then shows the effect of connecting them together in different configurations. The system comprises two modules, the CK342A Digital Systems Trainer and CK342B Analogue Systems Trainer. The CK342A introduces analogue to digital and digital to analogue conversion from basic principles. The CK342B extends the coverage of the CK342A by teaching analogue to digital and digital to analogue conversion as applied to digital systems used to control analogue devices. As more digital systems are used to control analogue devices. The CK342A can operate independently, whereas the CK342B requires a CK342A to be operational. The CK342A requires a d.c. power supply, so we recommend our 01-100 d.c. Power Supply (supplied separately). Hence, the complete systems are: CK342A + 01-100 or CK342A + CK342B + 01-100.

CURRICULUM COVERAGE

Digital Systems Trainer CK342A

- Registers
- Counters
- The arithmetic unit ALU
- Addition 7 subtraction
- Data storage & retrieval
- Fetching an instruction and it's operand

Analogue Systems Trainer CK342B

- D to A conversion DAC
- DAC using analogue switch
- DAC based on R-2R network
- Monolithic DAC
- A to D conversion ADC
- Integrating ADC
- Sample & hold

Scope of delivery:

Qty	Cat.-No.	Name
1	CK342A	Digital Systems Trainer
1	CK342B	Analogue Systems Trainer

CK342	Analogue & Digital Trainer

Additionally required:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A

FEATURES

Inputs

- Optical fibre receiver
- 8-bit digital switch bank
- Numerical keypad
- Optical speed & position sensor
- Temperature sensor
- Slide potentiometer
- External analogue input
- Comprehensive experiment manual

Outputs

- Optical fibre transmitter
- d.c. motor
- 8 LEDs
- Heater
- 2 dual segment displays
- Analogue output
- Speaker

1.5 Microprocessor Trainers & Applications

Microprocessor Applications Board

This is a highly versatile board, compatible with all our micro trainer hardware or a PC. It is ideal for teaching the basics of micro-processor programming and applications such as decision making, D/A and A/D conversion, open and closed-loop control, delay loops, sub-routines & event counting. It covers the techniques of micro control of fibre optics, keyboard entry, digital sound production, d.c. motors control, infra-red sensing, heating & cooling & visual displays. It is required for use with a range of microprocessors, micro-controllers and programmable logic modules including 24-102, 24-104, 24-121, 24-131, 24-141, 24-160, 24-161, 24-170, 24-171, 28-107 & 28-122. It is included within the 25-151-2.

CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Inputting & outputting data
- Subroutines & delays
- Digital to Analogue conversion
- Analogue to Digital conversion
- Successive approximation
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Control of a d.c. motor
- d.c. motor speed control
- d.c. motor speed control with IR sensor
- Temperature control
- Fibre optic link

Technical data:

- Dimensions (net): width 340 mm x depth 238 mm x height 108 mm
- Weight (net): 1.0 kg

24-200	Microprocessor Applications Board

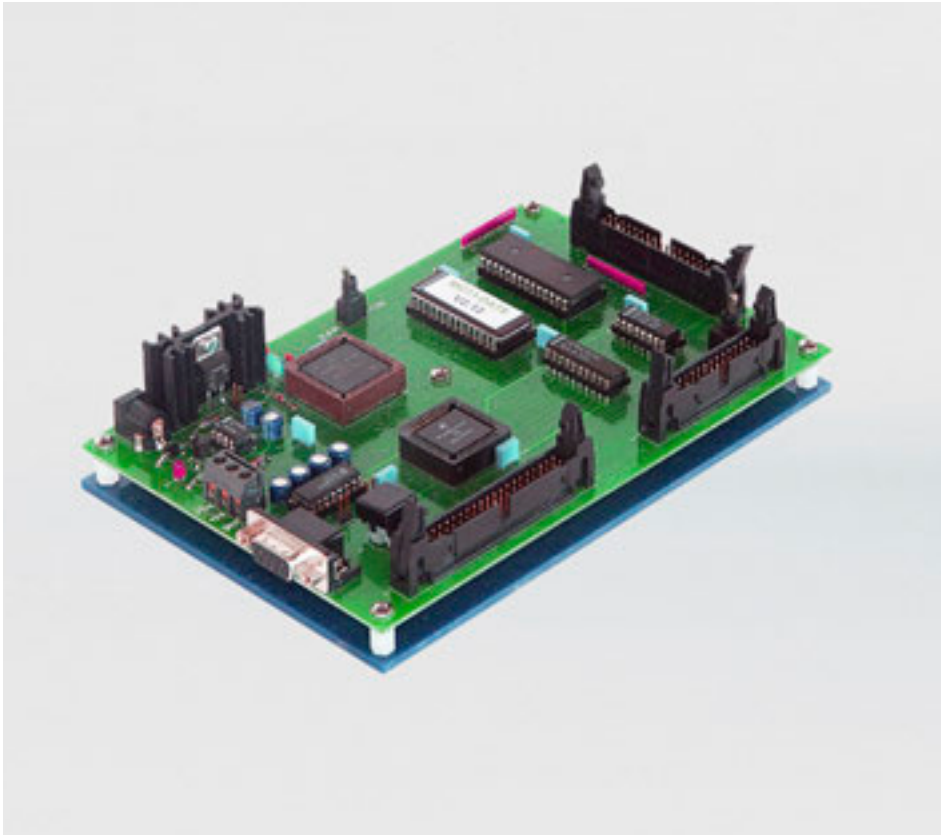
- Compatible with various boards in the range, see 24-102, 24-104, 24-121, 24-131, 24-141, 24-160, 24-161, 24-170, 24-171, 28-107, 28-122. Included in 25-151-2.

FEATURES

- 2MHz MCU
- 256 bytes RAM
- RS232 serial communications
- Two input/output ports
- 8k monitor program-ROM
- Hardware reste button
- Register contents can be viewed & modified
- Debugging facility
- Hexadecimal number handling
- Compatible from WIN95 to Windows 8
- Comprehensive experiment manual

TECHNICAL DATA:

- Dimensions (net): width 285 mm x depth 243 mm x height 100 mm
- Weight (net): 1.0 kg



68HC11 Microcontroller Trainer

The 24-102 is a comprehensive single board computer, based on the Motorola MC68HC11 microcontroller unit (MCU). The unit may be used as a development system and training aid or can be used as a stand-alone controller or computer. For simple applications, a ROM-resident monitor allows user programs to be quickly assembled on a line-by-line basis, then run and debugged. More sophisticated programs may be assembled (or compiled) on the host PC using cross-development software. A comprehensive user manual is supplied together with a cable adaptor to connect to the 24-200 Applications Board (supplied separately). Optional cross assembler software packages available (supplied separately) are 24-904 (single user licence), 24-904-05 (5 user licence), 24-904-10 (10 user licence), 24-904-15 (15 user licence) and 24-904-20 (20 user licence).

CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Inputting & outputting data
- Subroutines & delays
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Successive Approximation ADC
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Controlling the DC motor
- DC motor speed control
- DC motor control using IR sensor
- Temperature control
- Fibre optic link
- Stepper motor
- LCD

24-102	68HC11 Microcontroller Trainer

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Additionally recommended:

Qty	Cat.-No.	Name
1	24-904	68HC11 Cross Assembler software
1	24-904-05	68HC11 Cross Assembler software (5 user licence)
1	24-904-10	68HC11 Cross Assembler software (10 user licence)
1	24-904-15	68HC11 Cross Assembler software (15 user licence)
1	24-904-20	68HC11 Cross Assembler software (20 user licence)

Windows PC with WIN95 or higher required (compatible from WIN95 to Windows 8)

FEATURES

- Operates up to 33MHz
- 64k bytes of Flash memory
- 1k x 8-bit RAM
- Programmable UART serial port
- 32 programmable I/O lines
- Full debug facilities
- Single step facility
- Memory view / alter facility
- On-screen help
- Trace facility
- Compatible from WIN95 to Windows 8
- Comprehensive experiment manual

TECHNICAL DATA:

- Dimensions (net): width 285 mm x depth 243 mm x height 100 mm
- Weight (net): 1.0 kg

8051 Microcontroller Development & Training System

This trainer is supplied with the ATMEL T89C51RD2 chip fitted. This chip features FLASH memory, EEPROM and internal RAM. A versatile Windows-based real-time monitor communicates with a PC via the built-in serial port. The monitor includes a line assembler and disassembler, facilities to set break point and single step. It also has the facility to examine and change memory contents. An experimental manual is provided. The 24-200 Applications Board is required to satisfy all experimental requirements (supplied separately). Optional cross assembler packages available (supplied separately) are 24-946 (single user licence), 24-946-05 (5 user licence), 24-946-10 (10 user licence), 24-946-15 (15 user licence) and 24-946-20 (20 user licence).

CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Inputting & outputting data
- Subroutines & delays
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Successive approximation ADC
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Controlling the DC motor
- DC motor speed control
- DC motor using IR sensor
- Temperature control
- Fibre optic link
- Stepper motor (option)
- LCD (option)

24-104	8051 Microcontroller Development & Training System

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Additionally recommended:

Qty	Cat.-No.	Name
1	24-201	Stepper Motor Module
1	24-202	Liquid Crystal Display Module
1	24-946	8051 Cross Assembler Software
1	24-946-05	8051 Cross Assembler Software (5 user licence)
1	24-946-10	8051 Cross Assembler Software (10 user licence)
1	24-946-15	8051 Cross Assembler Software (15 user licence)
1	24-946-20	8051 Cross Assembler Software (20 user licence)

Windows PC with WIN95 or higher required (compatible from WIN95 to Windows 8)

FEATURES

- 1.79MHz processor speed
- RS232 serial communications
- I/O lines on IDC connectors
- 8k static RAM
- 8k EPROM based monitor
- Interrupt control of peripherals
- Line-by-line assembler
- Single step facility
- Compatible from WIN95 to Windows 8
- Comprehensive experiment manual included

Z80 Microprocessor Trainer

This is a comprehensive computer board based on the Z80 microprocessor which can be used as a development system for Z80 assembler or machine code programes, the EPROM based monitor providing a user interface to any standard PC via one of it's serial ports. Line-by-line assembler programs to be entered and disassembled and powerful monitor facilities then enable programs to be easily debugged. Monitor's totally integrated environment gives direct access to the users' cross-development software. On board static RAM and EPROM are provided, and auxiliary memory sockets allow for the fitting of additional RAM and EPROM/EEPROM chips. Using the EEPROM programming routines provided by the monitor, the board is an excellent target for many stand-alone applications. An experimental manual is provided. The equipment requires the 24-200 Applications Board for the full range of experiments (supplied separately). Optional cross assembler software packages available (supplied separately) are the 24-922 single user licence, 24-922-05 (5 user licence), 24-922-10 (10 user licence), 24-922-15 (15 user licence) and 24-922-20 (20 user licence).

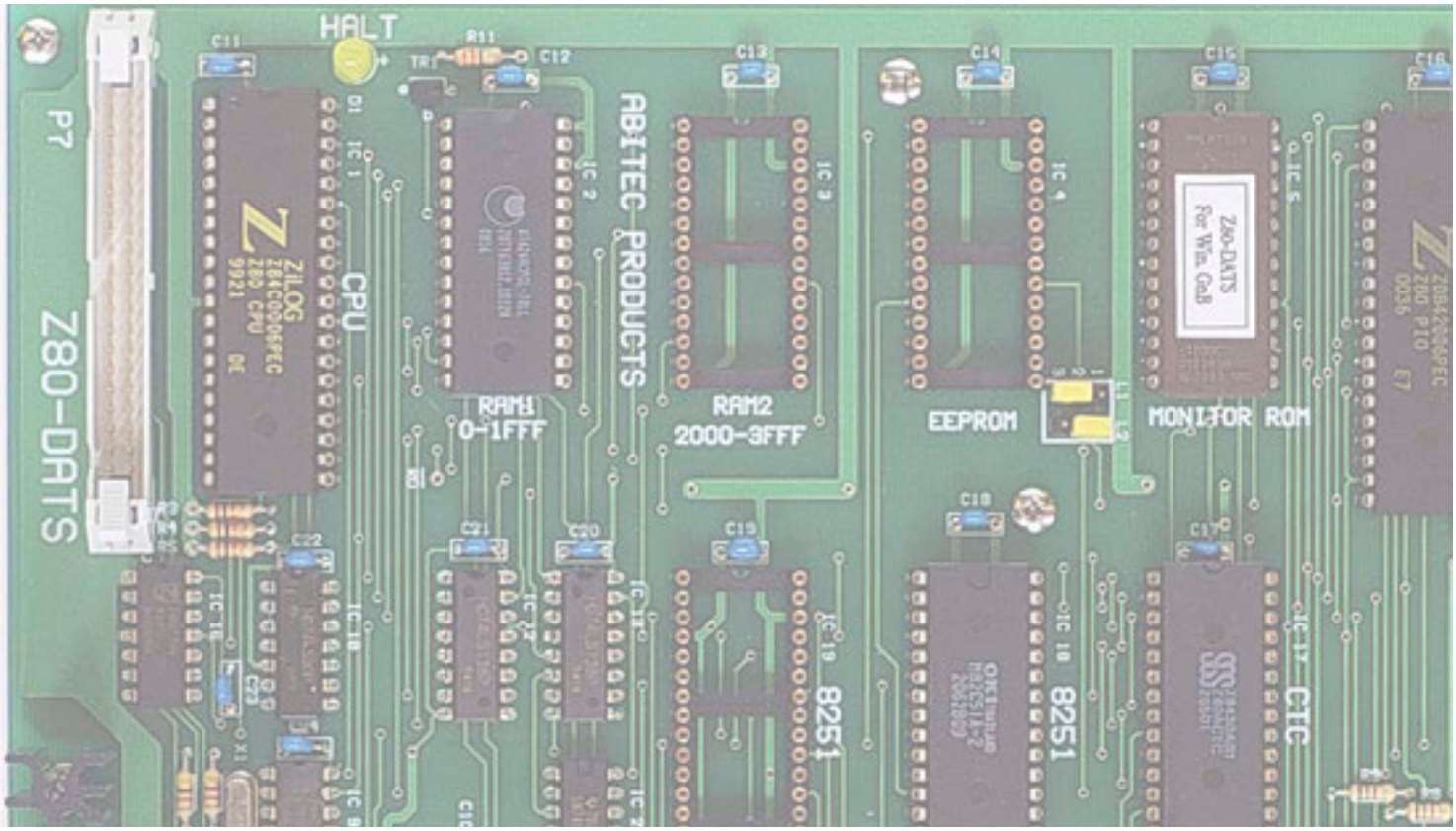
CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Inputting & outputting data
- Subroutines & delays
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Successive approximation ADC
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Controlling the DC motor
- DC motor speed control
- DC motor speed control using IR sensor
- Temperature control
- Fibre optic link
- Stepper motor
- LCD

Technical data:

- Dimensions (net): width 340 mm x depth 238 mm x height 108 mm
- Weight (net): 1.0 kg

24-121	Z80 Microprocessor Trainer



Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Additionally recommended:

Qty	Cat.-No.	Name
1	24-922	Z80 Cross Assembler Software
1	24-922-05	Z80 Cross Assembler Software (5 user licence)
1	24-922-10	Z80 Cross Assembler Software (10 user licence)
1	24-922-15	Z80 Cross Assembler Software (15 user licence)
1	24-922-20	Z80 Cross Assembler Software (20 user licence)

Windows PC running WIN98 or higher required (compatible from WIN95 to Windows 8)

FEATURES

- 4.9 MHz processor speed
- RS232 serial communication
- 2 x 16-bit programmable I/O ports
- 8 levels of interrupts
- On-board hardware reset
- Windows monitor software
- Examine / alter memory & register
- Single step function
- Memory block display
- Port in/out display function
- Compatible from WIN95 to Windows 8
- Comprehensive experiment manual included

8086 Microprocessor Development & Training System

The 24-131 is a general purpose unit that simplifies the teaching of the 8086 CPU and it's commonly used peripherals. The 8086 16-bit microprocessor and a set of associated peripheral devices are fitted to this computer board and it is supplied complete with an on-board EPROM based complete monitor. Driven from a PC serial port, this product is compatible with the 8086 assembler software 24-945 which is available as single user licence, 5 user, 10 user, 15 user and 20 user with the product codes respectively 24-945, 24-945-05, 24-945-10, 24-945-15 and 24-945-20. An experimental manual is provided along with a suitable d.c. power supply.

The 24-200 Applications Board is required (supplied separately) to enable the full range of experimentation described in the manual. Assembler code programs can be entered into the integral LINE-by-LINE assembler, disassembled and debugged with the powerful monitor facilities. LINE-assembled programs can also be saved and reloaded, when required. Both register and memory contents can be displayed on the screen in their own windows and a watch window enables specific selected memory locations to be monitored.

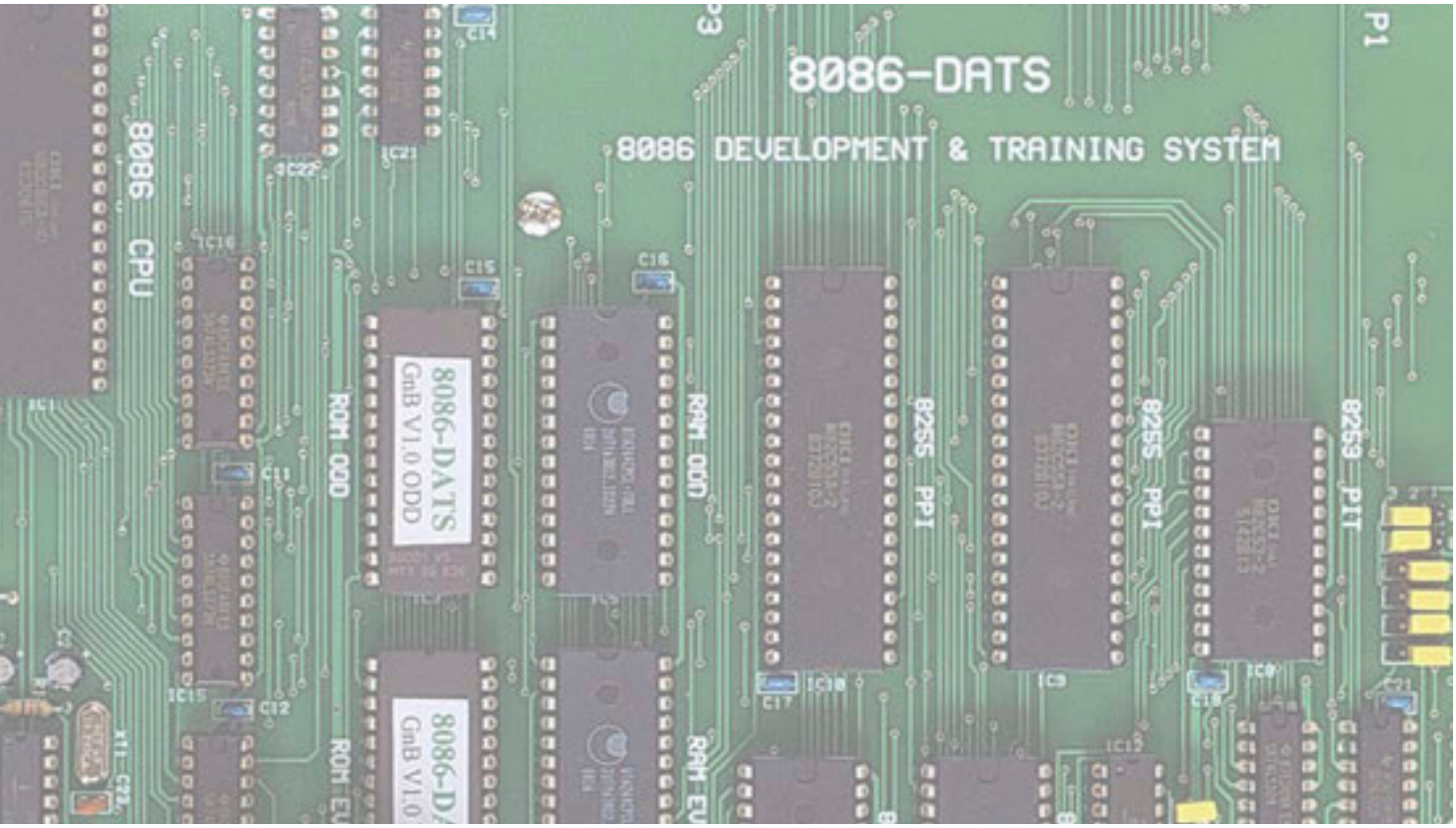
CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Inputting & outputting data
- Subroutines & delays
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Successive approximation ADC
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Controlling the DC motor
- DC motor speed control
- Temperature control
- Fibre optic link
- Stepper motor (option)
- LCD (option)

Technical data:

- Dimensions (net): width 340 mm x depth 238 mm x height 108 mm
- Weight (net): 1.0 kg

24-131	8086 Microprocessor Development & Training System



Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Additionally recommended:

Qty	Cat.-No.	Name
1	24-201	Stepper Motor Module
1	24-202	Liquid Crystal Display Module
1	24-945	8086 Cross Assembler Software
1	24-945-05	8086 Cross Assembler Software (5 user licence)
1	24-945-10	8086 Cross Assembler Software (10 user licence)
1	24-945-15	8086 Cross Assembler Software (15 user licence)
1	24-945-20	8086 Cross Assembler Software (20 user licence)

Windows PC running WIN98 or higher required (compatible from WIN95 to Windows 8)

FEATURES

- 8 MHz processor
- 64k bytes of RAM & ROM
- 16-bit wide data bus
- 16-bit bases accessible
- RAM & ROM expandable
- EPROM based monitor
- LINE-by-LINE assembler
- Registers inspected / modified
- View each step with trace function
- Standard uploading format
- Compatible from WIN95 to Windows 8
- Comprehensive experiment manual included

68000 Microprocessor Trainer

Based on the MC68000 16-bit microprocessor, this is a complete computer suitable for many stand-alone applications, especially for real-time control, where power and speed are important. It is supplied with comprehensive EPROM based monitor, LINE-by-LINE assembler programs and PC compatible communications software. This trainer is a versatile design and evaluation tool for education and training purposes, with full access given to data and address buses, enabling logic analysers and other diagnostic equipment to be connected for demonstration and debugging. On-board 16-bit wide static RAM and EPROM are provided with expansion facilities and extensive serial and parallel I/O hardware. A serial cable and suitable power supply are supplied with the trainer, as is an experimental manual. The 24-200 Applications Board (supplied separately) is required to enjoy the range of experiments covered in the manual. Various packages of cross assembler software are available (supplied separately) with product codes 24-944 (single user licence), 24-944-05 (5 user licence), 24-944-10 (10 user licence), 24-944-15 (15 user licence) and 24-944-20 (20 user licence).

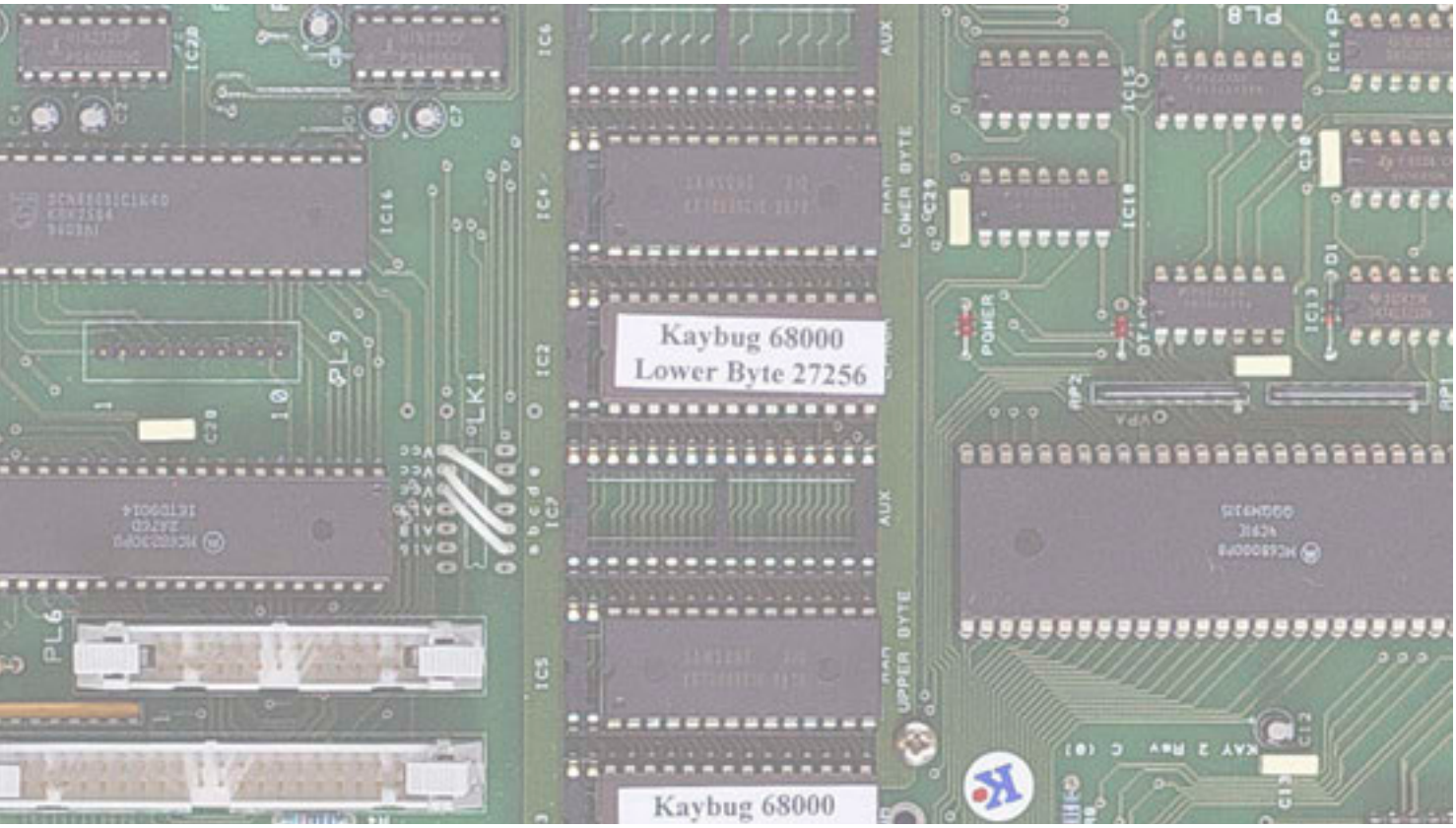
CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Inputting & outputting data
- Subroutines & delays
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Successive approximation ADC
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Controlling the DC motor
- DC motor speed control
- DC motor speed control using IR sensor
- Temperature control
- Fibre optic link
- Stepper motor (option)
- LCD (option)

Technical data:

- Dimensions (net): width 340 mm x depth 238 mm x height 108 mm
- Weight (net): 1.0 kg

24-141	68000 Microprocessor Trainer



Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Additionally recommended:

Qty	Cat.-No.	Name
1	24-201	Stepper Motor Module
1	24-202	Liquid Crystal Display Module
1	24-944	68000 Cross Assembler Software
1	24-944-05	68000 Cross Assembler Software (5 user licence)
1	24-944-10	68000 Cross Assembler Software (10 user licence)
1	24-944-15	68000 Cross Assembler Software (15 user licence)
1	24-944-20	68000 Cross Assembler Software (20 user licence)

Windows PC running WIN95 or higher (compatible from WIN95 to Windows 8)

FEATURES

- „In System" programmable device
- Uses LATTICE Synario starter software
- Programmable using PC parallel port
- Input / output connector provided for external applications
- Compatible from WIN95 to Windows 8
- Comprehensive experiment manual included

Programmable Logic Development & Training System

This trainer provides a low cost introduction to „in system" programmable logic device (PLD) programming and application. Using a proprietary level, PLD development software, programs can be developed on a PC. By connecting the hardware to the parallel port of a PC, programs can be downloaded into an „in system programmable" (ISP) device. The device can be repeatably re-programmed without removal from the hardware. A complete system comprises the hardware, the LATTICE Starter software (also supplied) and the 24-200 Application Board (supplied separately). An experimental manual is provided.

CURRICULUM COVERAGE

- Simple logic gates
- 2 to 4 line encoder
- Gray to binary encoder
- Binary coded decimal to 7 segment decoder
- Arithmetic circuits
- Synchronous binary counter
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Controlling the DC motor
- Shift registers (using the fibre optic link)

Technical data:

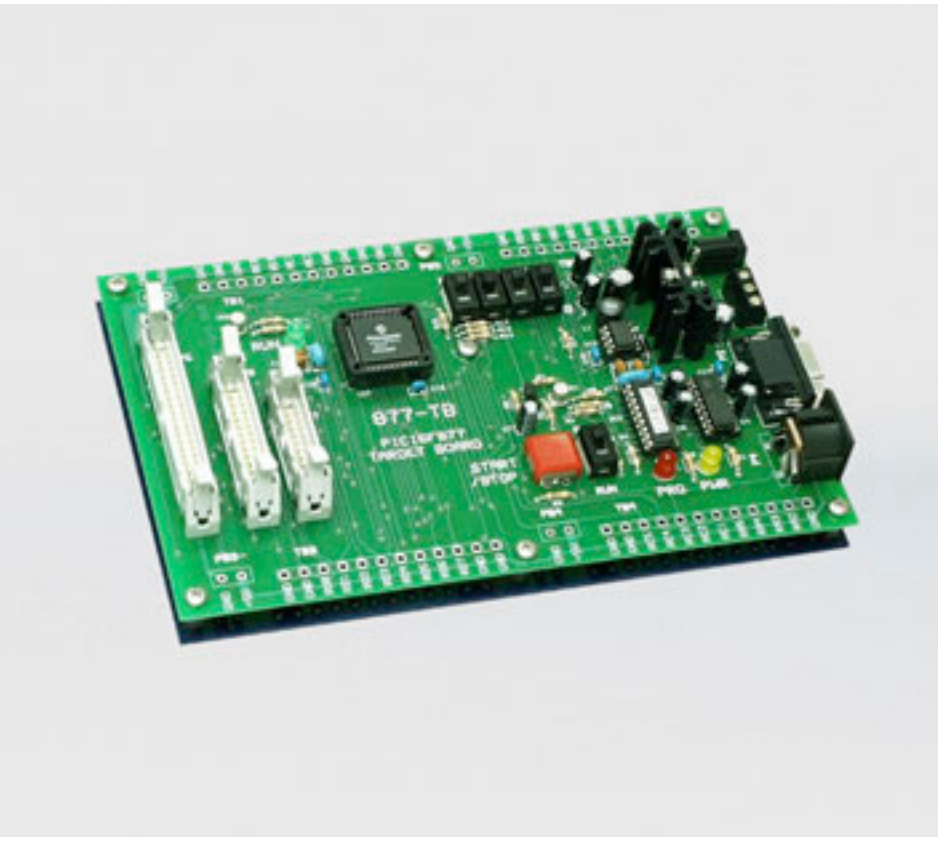
- Dimensions (net): width 285 mm x depth 243 mm x height 100 mm
- Weight (net): 1.0 kg

28-107	Programmable Logic Development & Training System

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Windows PC running WIN95 or higher required (compatible from WIN95 to Windows 8)



FEATURES

- 10MHz controller speed
- RS232 serial communications
- 8k (14-bit) Flash program memory
- 8 x 10-bit analogue input channels
- In-circuit bugging
- MPLAB PC programs sent direct to PIC device
- Source code viewable when loaded for programming
- Compatible from WIN95 to Windows 8
- Comprehensive experiment manual included

PIC Development & Training System

Programmable Interface Controllers (PICs) area family of low cost Reduction Instruction Set Computer (RISC) microcontrollers that are powerful and easy to use. The 28-122 is based on the versatile microchip PIC16F877 CMOS FLASH device in a 44-pin PLC and has in-circuit bugging. It can be used for various applications as a target board for educational purposes. It can also be used as a stand-alone via a serial port to a PC, allowing easy downloads of control code, developed using Microschips MPLAB software or high level language development software. The system is capable of running at clock speeds of 20MHz or above. These devices are based on the Harvard architecture of separate program and data storage areas and are self-contained systems providing on-chip RAM or FLASH RAM (program area) and I/O. The 28-122 comprises the board with a suitable power supply and connection cables, software on CD and experimental manual. The 24-200 Applications Board (supplied separately) is required to provide the full range of experiments in the manual.

CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Inputting & outputting data
- Subroutines & delays
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Successive approximation ADC
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Controlling the DC motor
- DC motor speed control
- DC motor control using IR sensor
- Temperature control
- Fibre optic link
- Stepper motor
- LCD

Technical data:

- Dimensions (net): width 285 mm x depth 243 mm x height 100 mm
- Weight (net): 1.0 kg

28-122	PIC Development & Training System

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Windows PC running WIN95 or higher required (compatible WIN95 to Windows 8)

FEATURES

- ARM7S 32/16-bit microcontroller
- Debug hardware & software
- Full access to controller ports
- USB or RS232 serial port connectivity
- 8 channels of 10-bit ADC
- Advanced interrupt controller
- Development & testing of ARM7 programs
- d.c. power supply included
- Comprehensive experiment manual included

ARM7S Microcontroller Development & Training System

This trainer is based on the Atmel range of microcontrollers with high performance 32-bit RISC architecture and high density 16-bit instruction set with real-time emulation and embedded trace support, which combine microcontroller with embedded high-speed flash memory. Designed for educational and training purposes this training system provides the opportunity to learn about this range of microcontrollers and the development of programs applied to a wide range of applications including 24-200 Applications Board (supplied separately) which is required to fully utilise the experimental capability of the board. The 24-160 that comprises the ARM7S target board, ‚C' development software, JTAG debug hardware to plug into the target board, d.c. power supply and experimental manual.

CURRICULUM COVERAGE

- Switch & Jumper operation
- Connectors
- Tutorial

Technical data:

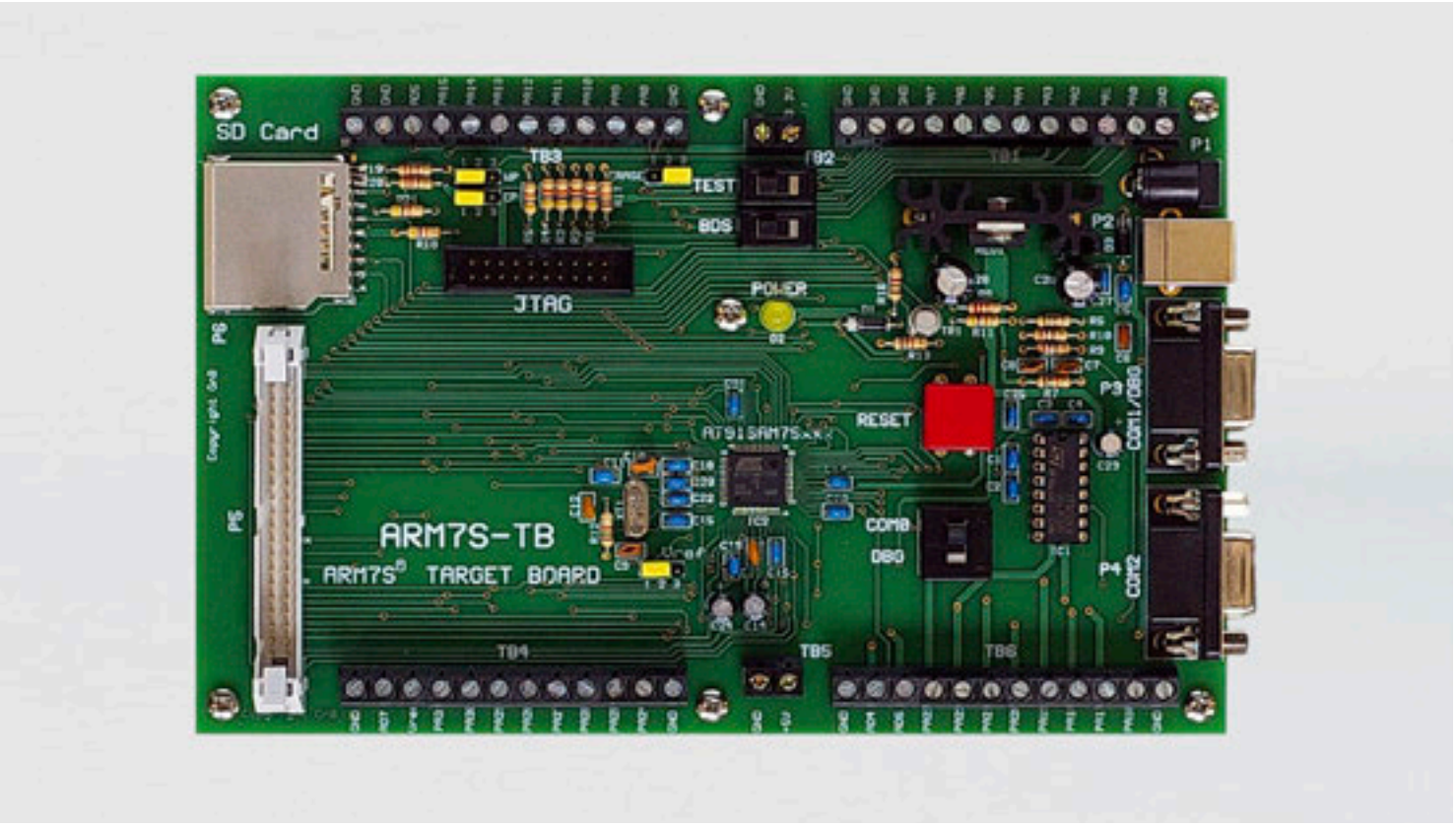
- Dimensions (net): width 285 mm x depth 243 mm x height 100 mm
- Weight (net): 1.0 kg

24-160	ARM7S Microcontroller Development & Training System

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Windows PC running WIN2000 or higher



ARM7S Microcontroller Development Board

This trainer is based on the Atmel range of microcontrollers with high performance 32-bit architecture and high density 16-bit instruction set with real-time emulation and embedded trace support, which combine Microcontroller with embedded high-speed flash memory. Designed for educational and training purposes this training system provides the opportunity to learn about this range of microcontrollers and the development of programs applied to a wide range of applications including 24-200 Applications Board (supplied separately) which is required to fully utilise the experimental capability of the board. The 24-161 comprises the ARM7S target board, d.c. power supply and experimental manual.

CURRICULUM COVERAGE

- Switch & jumper operation
- Connectors
- Tutorial

Technical data:

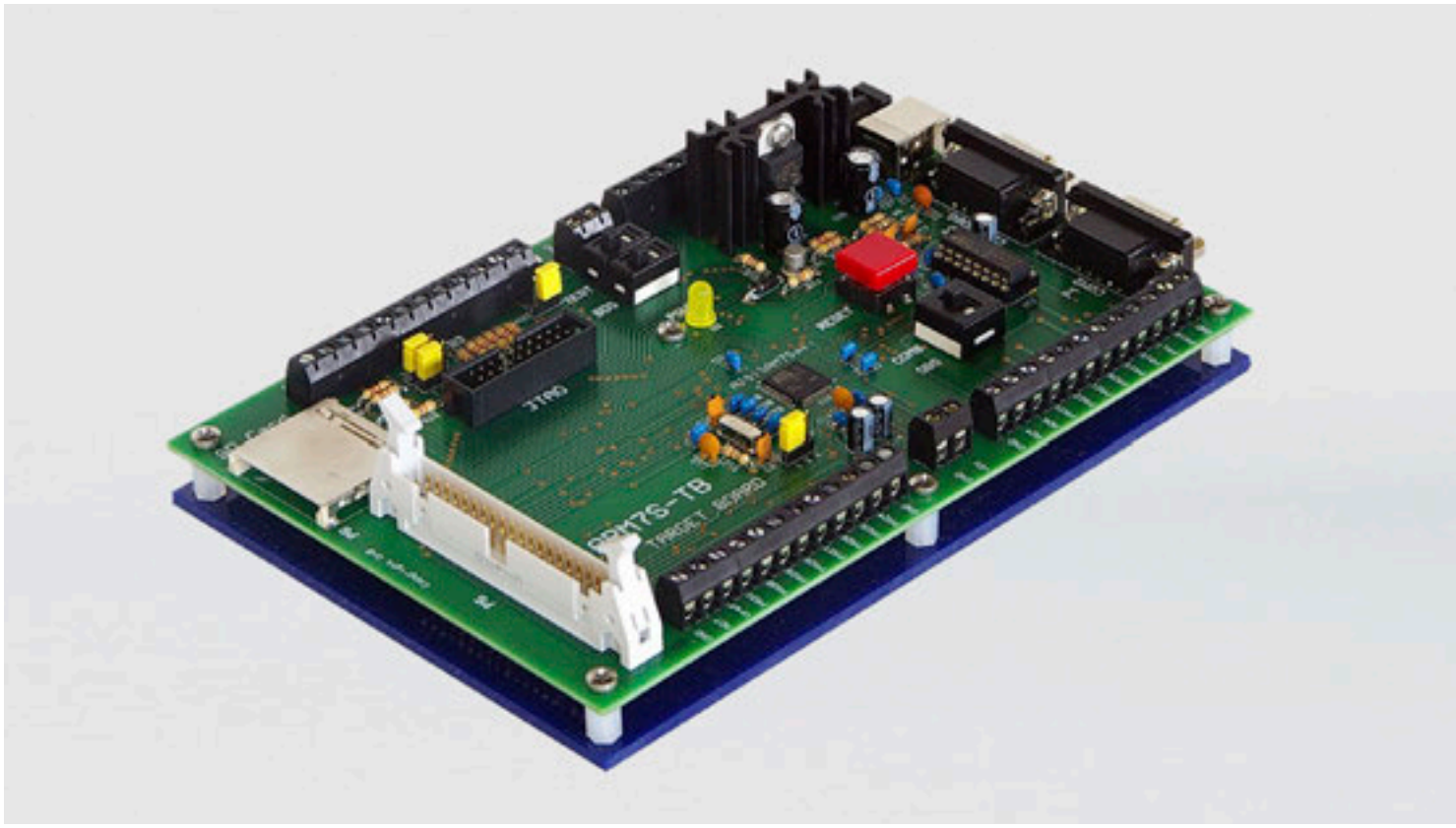
- Dimensions (net): width 285 mm x depth 243 mm x height 100 mm
- Weight (net): 1.0 kg

24-161	ARM7S Microcontroller Development Board

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Windows PC running WIN2000 or higher



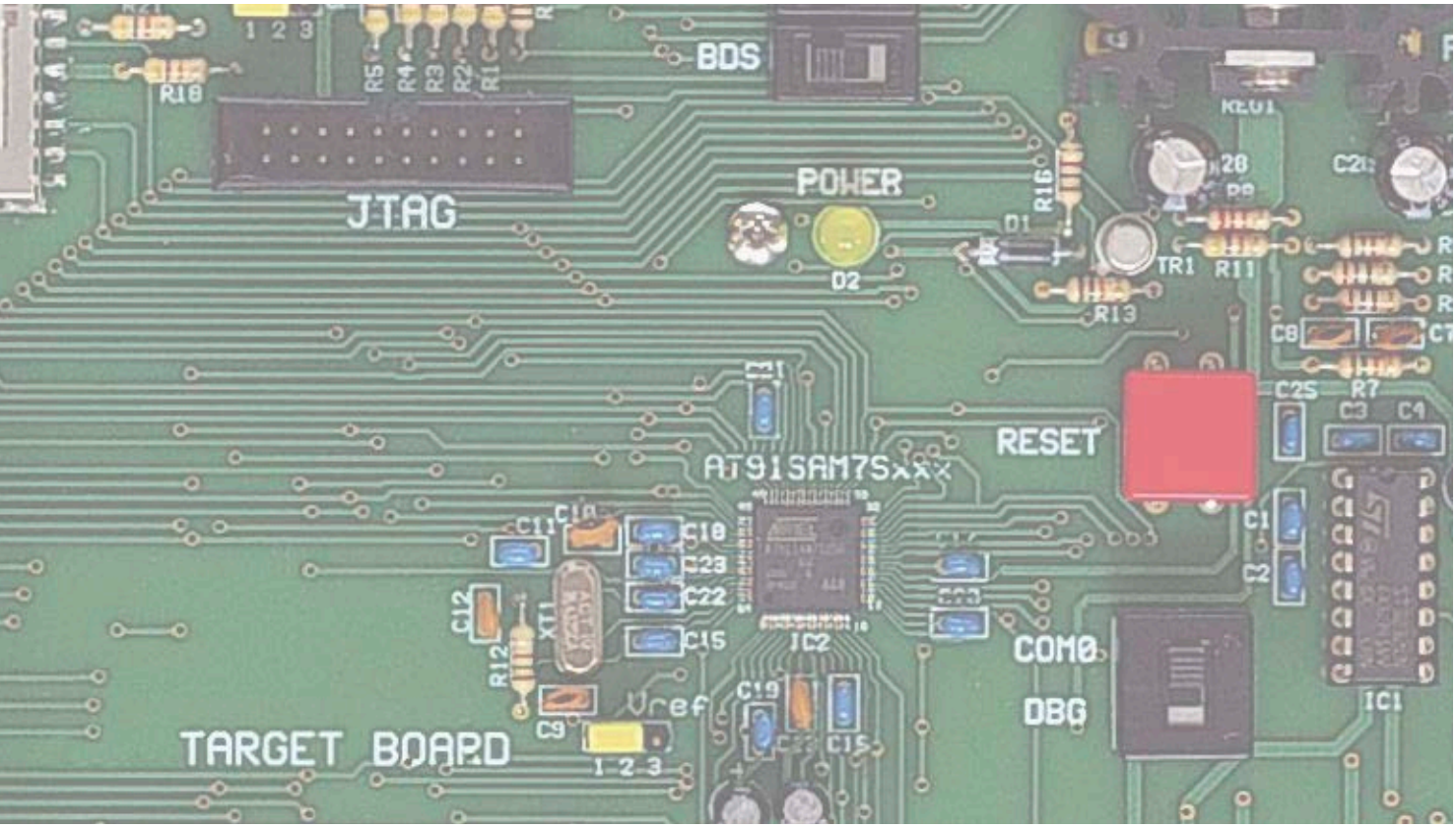
ARM3S Cortex Microcontroller Development & Training System

This trainer features the latest ARM processor technology with a comprehensive software development suite which uses the C++ programming language. ARM processors are now the favoured microcontroller for mobile devices, and have been adopted in literally thousands of embedded mobile devices, from PDAs, smartphones, data collection terminals to mobile music players. Designed for educational and training purposes but also ideal for industrial development applications, the ARM3S target board is directly compatible with the existing Feedback 24-200 Applications Board (supplied separately) which is required to fully utilise the range of experimentation available on the board.

In common with the other products in the Feedback micro range, the system consists of an open board mounted on a durable acrylic base and comes complete with all ancillaries. The Crossware Jaguar USB JTAG interface is designed to facilitate on-chip ARM debugging. It connects to the standard 20-pin ARM JTAG connector, allowing the source-level debugger to drive the on-chip ARM embedded debug logic.

The Feedback 24-170 consists of the ARM3S-TB target board fitted with the powerful Atmel AT91SAM3S4B256 „In System Programmable" device, together with the Crossware® ARM3S Software Development Suite complete with Jaguar™ JTAG interface. The AT91SAM3S4B256 is a high performance microcontroller with 128K bytes of downloadable non-volatile FLASH Memory and 32K bytes of SRAM. Designed for educational and training purposes but also ideal for industrial development applications, the ARM3S-TB target board is directly compatible with the Feedback 24-200.

The ARM3S Development Suite includes an advanced optimizing C compiler, Code Creation Wizards, source level instruction and peripheral simulator extendable to simulate complete target systems, source level debugger and the Crossware „Jaguar" JTAG to USB debugger interface. Software downloading to the target is achieved by plugging the Jaguar into the JTAG connector on the ARM3S-TB and into a suitable USB port on the host PC. Programs are developed in „C" or „C++", debugged and then compiled before downloading. Program download can also be achieved via the, 9 way D type, serial port connection or the on board USB port.



Technical data:

- Dimensions (net): width 285 mm x depth 243 mm x height 100 mm
- Weight: 1.0 kg

24-170	ARM3S Cortex Microcontroller Development & Training System

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Windows PC running WIN2000, XP or higher

FEATURES

- AT91SAM3S4B256 Atmel Cortex™ - M3 microcontroller
- Parallel capture mode
- Memory protection unit
- 128KB of in-System re-programmable downloadable FLASH memory
- 32KB SRAM
- 10 channels of ADC
- 2 channel of 12-bit DAC
- USB 2.0 full speed device port
- 2 Enhanced USARTs
- SPI, SSC & TWI
- High-speed multimedia card interface
- SD memory card interface
- In system programmable (ISP) downloaded via RS232, USB or JTAG connections
- All controller connections accessed via an IDC connector for external processor bus examination
- 2 programmable UART serial port (via external 9 way D type connector) buffered by line receiver/driver
- On-board low-dropout voltage and reset generation. Generates +3.3 V from a +5 V supply

ARM3S Cortex Microcontroller Development Board

This comprises a high performance controller with 128k bytes of downloadable non-volatile FLASH memory and 32k bytes of SRAM. It is designed for educational purposes, but also ideal for industrial development applications and is compatible with the 24-200 Applications Board which is required.

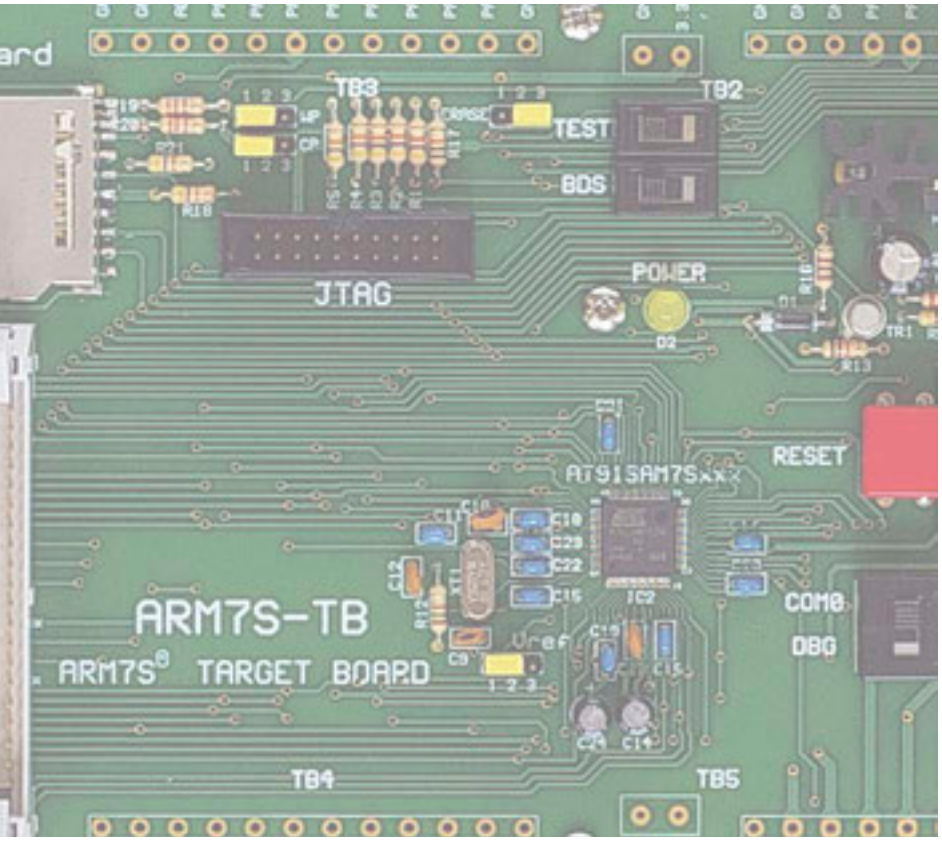
CURRICULUM COVERAGE

- Outputting data
- Inputting data
- Subroutines & delays
- Digital to Analogue conversion (DAC)
- Analogue to Digital conversion (ADC)
- Successive approximation ADC
- Seven segment display
- Multiplexing seven segment display
- Scanning the keypad
- Controlling the d.c. motor
- d.c. motor control using IR sensor
- Temperature control
- Fibre optic link
- Stepper motor (option)
- LCD (option)

Technical data:

- Dimensions (net): width 285 mm x depth 120 mm x height 50 mm
- Weight (net): 0.6 kg

24-171	ARM3S Cortex Microcontroller Development Board



FEATURES

- Powered from a simple unregulated 8 to 13 V d.c. applied to 2.1 mm connector (centre positive)
- 4 channel 16-bit PWM
- Up to 47 multiplexed programmable input/ output lines accessible via IDC headers (3 lines allocated for in service programming)
- Screw terminal block option to access the I/O lines
- Input / output connections compatible with a range of applications products (via 40 way header)
- Nested vectored interrupt controller (256 level priority)
- 6 x 3 channel 16-bit programmable counter timer
- 12-bit Programmable watchdog timer (WDT) providing reset and interrupt signals
- 3 programmable external clock signals
- Hardware reset signal push button
- Can be powered via the USB connector
- Power supply, cables, communication software & technical manual (on CDROM) included

Additionally required:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

Additionally recommended:

Qty	Cat.-No.	Name
1	24-201	Stepper Motor Module
1	24-202	Liquid Crystal Display Module

PC with WIN2000, XP or higher

FEATURES

- Includes 24-200 Applications Board
- Wide range of components available
- d.c. motor with speed & position sensor
- Numerical keypad
- Temperature sensor
- Resistive slide potentiometer
- Optical fibre transmitter & receiver
- 2 x dual seven segment display
- Electrical heater
- Audi speaker
- Comprehensive experiment manual included

PC Applications Training System

The PC Applications Training System demonstrates the use of a PC as a means of controlling an external application (24-200) via a USB port. Supplied as part of the system is a digital I/O adaptor board that connects between the 24-200 Applications Board and a USB to 24 I/O board, both supplied. This connects the 24-200 to the PC USB port. The options of the 24-201 Stepper Motor and 24-202 Liquid Crystal Display (both supplied separately) are available to plug into the 24-200 Applications Board (included). The 24-205 digital I/O package, consisting the DIO-ADP1 adaptor and Digital I/O USB module) may be purchased separately if you already have the 24-200.

Technical data:

- Dimensions (net): width 340 mm x depth 238 mm x height 108 mm
- Weight (net): 1.0 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	24-200	Microprocessor Applications Board

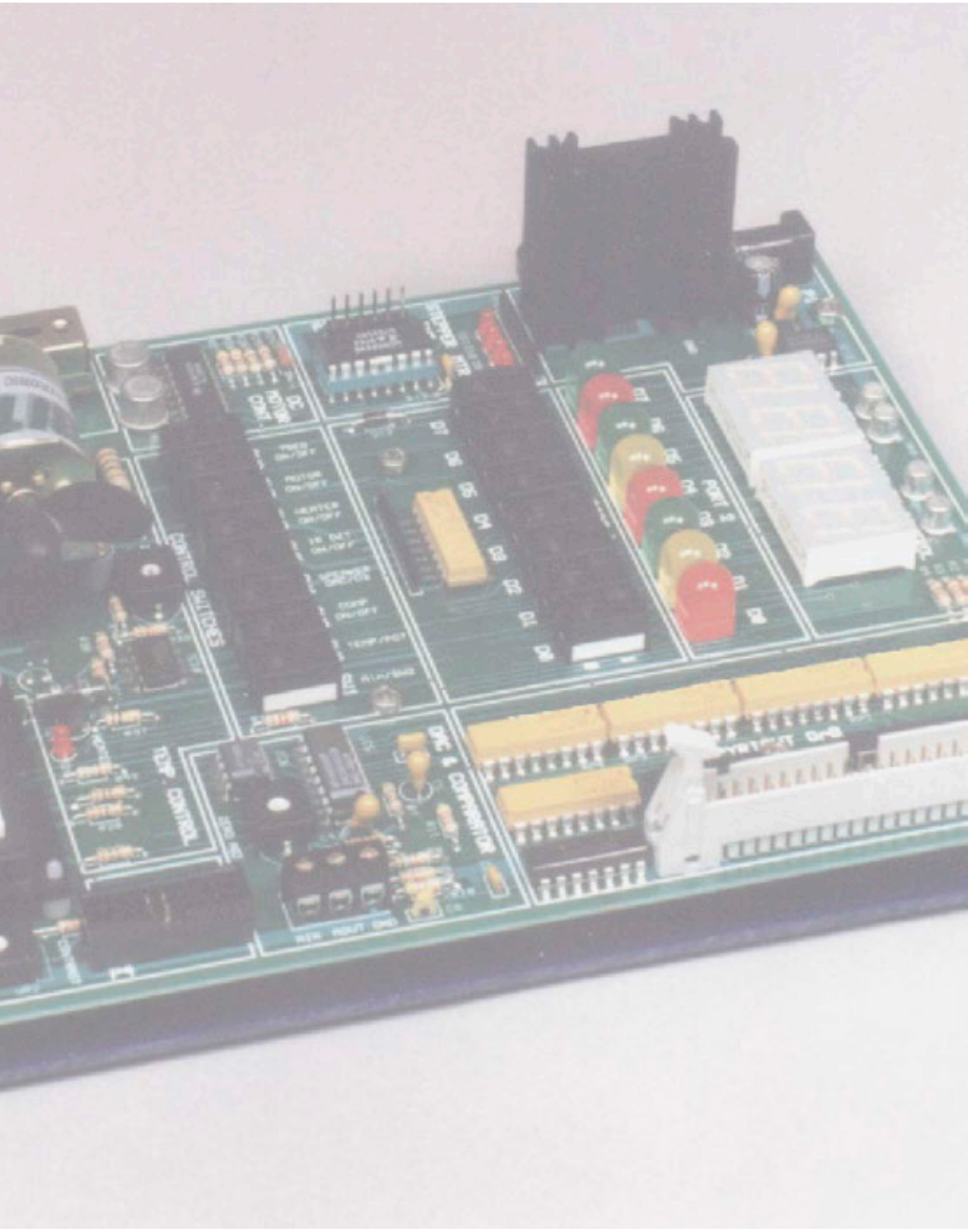
25-151-2	PC Applications Training System

Additionally recommended:

Qty	Cat.-No.	Name
1	24-201	Stepper Motor Module
1	24-202	Liquid Crystal Display Module
1	24-205*	USB to I/O module plus adaptor board for 24-200.

* alternative

PC with WIN2000 or higher


CONTROL SWITCHES
PORT A
PORT B
PORT C
PORT D

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

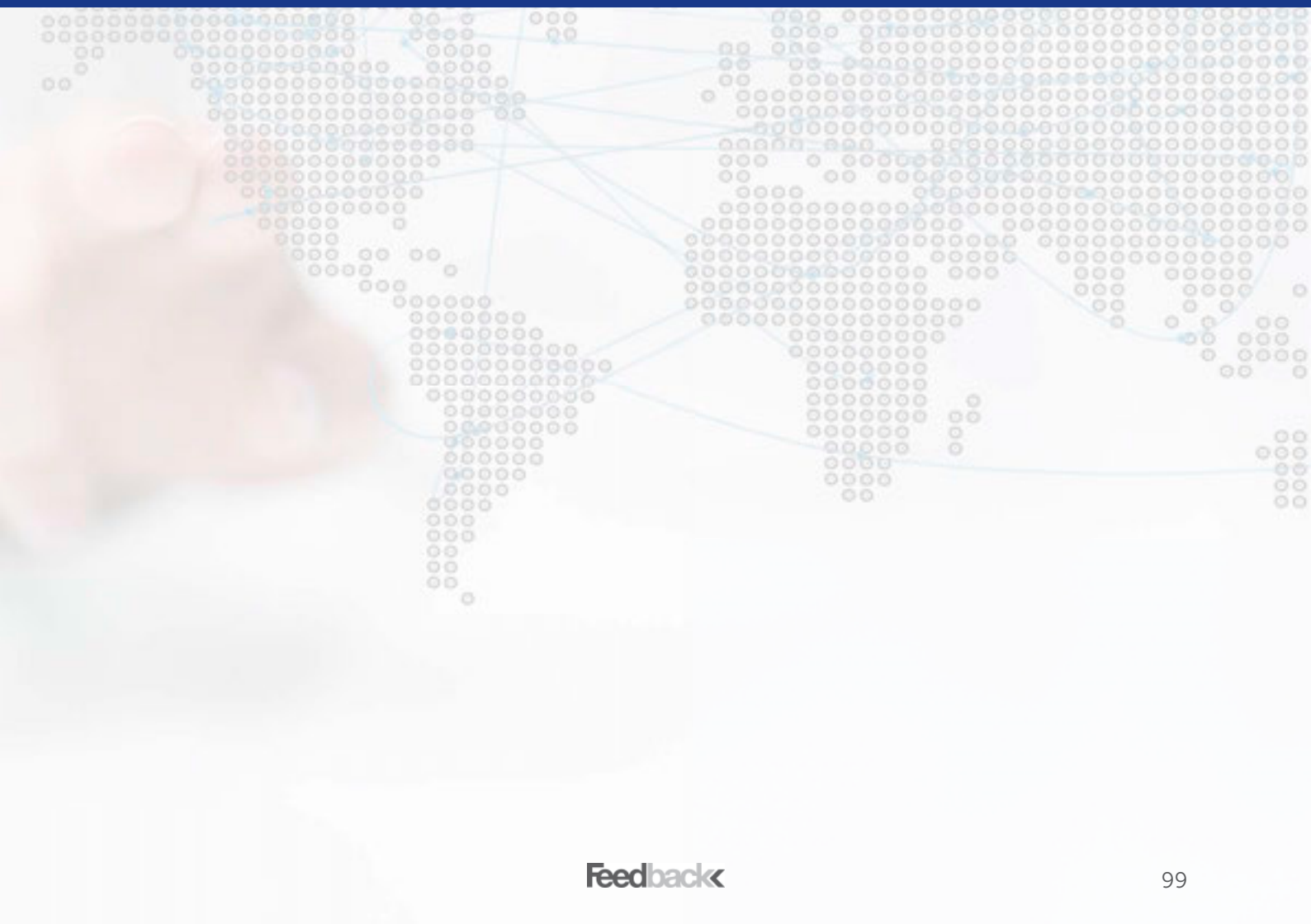
CONTROL ENGINEERING

PROCESS CONTROL

REFRIGERATION & AIR CONDITIONING

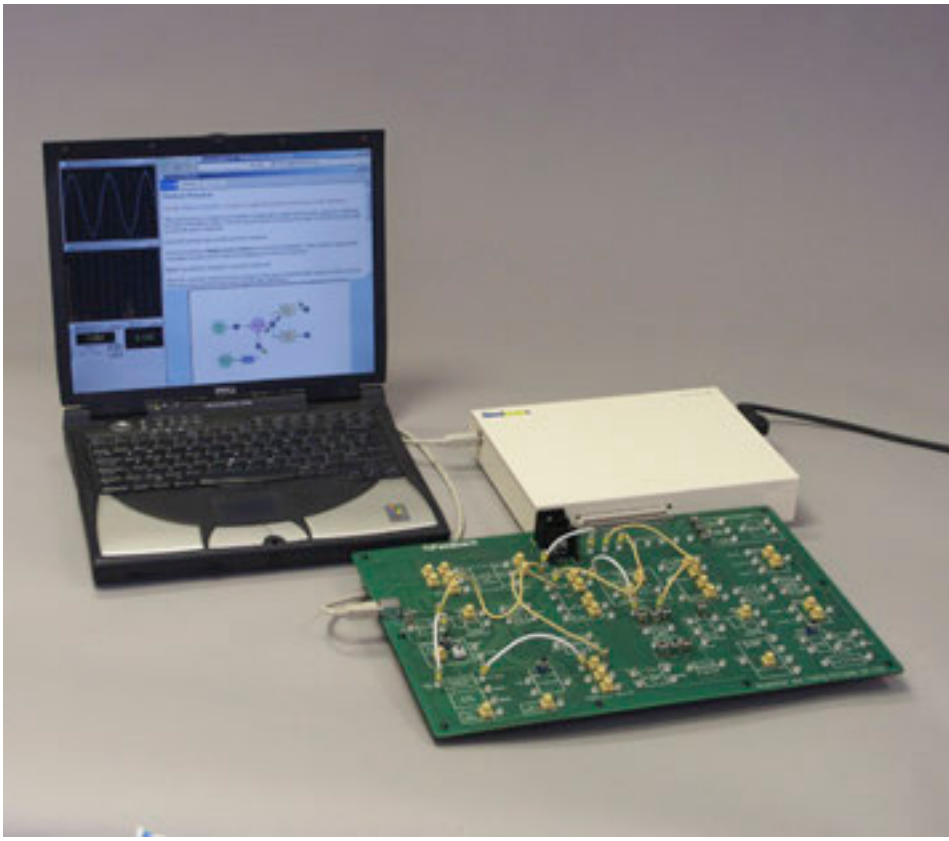
PNEUMATICS & HYDRAULICS

TELECOMMUNICATIONS



FEATURES

- Cost-effective, complete system
- Used for technician & undergraduate teaching
- Comprehensive set of laboratory assignments
- Modern modulation principles & practice
- Integrated hardware & software environment
- On-screen background, theory & practical instructions (93-420 Espial Sofware Package required)
- Espial provides embedded instrumentation including a constellation meter
- Quantitative measurements of fundamental circuit properties
- Uses a gain phase analyzer
- No costly additional instruments required
- Comprehensive experiment manual included
- 3 workboards included



2.1 Analogue & Digital Communications

Analogue & Digital Telecommunications Workstation

The 53-004 Analogue & Digital Telecommunications Workstation comprises:

53-210 Amplifier & Oscillators Workboard

- Allows the construction of various amplifiers, oscillators & signal sources
- Principles of RC, LC & crystal oscillators
- Feedback
- Loop gain
- Amplitude stabilisation
- Oscillation
- Distortion
- Frequency stability
- Nyquist & Bode Plots

53-220 Tuned Circuits & Filters Workboard

- Principles of passive filters
- RC & LC tuned circuits
- Q loading
- Low-pass crystal filters
- Active filters
- Tuned amplifiers
- Automtic gain control (AGC)

52-230 Modulation & Coding Workboard

- Principles & operation, and practical implementation, of modern modulation systems required for both analogue & digital communication systems

92-203 USB Real-time Access Terminal (RAT)

- A/D converter
- Sampling signals on workbaords at rate 10 to 100MHz
- Power supply

This package contains all the necessary power supplies. The 93-420 Espial Software Package is required (supplied separately). The complete system forms a comprehensive modern telecommunications course with a close integration for the hardware workboards with PC-based instruction software providing students with a rich learning environment while providing a cost-effective solution for telecommunications teaching at a practial level. Each experiment is configured by patching together circuit blocks on the boards. The patching is shown sequentially through the software. The workboards connect to a PC via the 92-203 RAT which provides an a/d converter and all necessary power supplies.

CURRICULUM COVERAGE

53-210 Amplifiers & Oscillators Workboard

- Voltage amplifier
- Current input amplifer
- Controlled gain amplifier
- Oscillation criteria
- Wien bridge oscillator
- Tuned amplifier
- LC oscillator
- Crystal oscillator
- Oscillator stability & buffering
- Multivibrator
- Tuned power amplifier

53-220 Tuned Circuits & Filters Workboard

- Tuned circuits
- Coupled tuned circuits
- Crystal filters
- Ceramic bandpass filter
- Audio op-amp filters
- LC low-pass filters
- LC high-pass filters
- Butterworth filters
- Chebyshev filters
- High-order filters

53-230 Modulation & Coding Workboard

- Signals in the time & frequency domais
- Sampling & time division multiplexing (TDM)
- Amplitude modulation (AM)
- AM with suppressed carrier
- SSB generation with an IQ modulator
- Amplitude shift keying (ASK)
- Frequency modulation (FM)
- FM with IQ modulator
- Frequency shift keying (FSK)
- Phase modulation (PM)
- Phase shift keying (PSK)
- Multi-state phase shift keying
- Quadrature amplitude modulation (QAM)
- Uncoded binary data formats
- Bi-phase data format
- Alternate mark inversion
- Word synchronisation

Technical data:

- Dimensions (packed): width 610 mm x depth 570 mm x height 410 mm
- Weight: gross 13.3 kg, net 8 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	53-210	Amplifiers & Oscillators Workboard
1	53-220	Tuned Circuit & Filters Workboard
1	53-230	Modulation & Coding Workboard
1	92-203	USB Real-time Access Terminal (RAT)

53-004	Analogue & Digital Telecommunications Workstation

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

PC with Windows XP or higher, 32-bit or 64-bit or higher with USB interface

FEATURES

- Now includes Espial Tools
- Allows teachers & lecturers full edit facilities
- New content & additional assignments
- Free of charge online software updates
- Hands off for teachers, hand on for students
- Self-paced
- Unrestricted, open learning environment
- Practical demonstration of theory & concepts
- Interactive patching diagrams
- Real-time embedded instrumentation
- Automatic instrumentation con-figuration
- Data export for analysis
- USB connection to hardware
- Editing tools include laboratory architect, assignment builder, Winwiz & manual builder
- Compatible with 32-bit &-64 bit versions of Windows XP, Vista, Windows 7 & Windows 8
- Optional 93-410 Espial Course Manager

Espial Software Package

Espial is used extensively within the telecommunications, control and basic electronics ranges. It is therefore required for use with 12-300 series, 33-033, 53-004 (& 53-200 series), 57-200-USB, 38 series & PV75-100. The teaching content is provided within the software; this includes the underlying theory, written so that it does not make extensive use of mathematics. An important part of the content is to highlight the assignment learning objectives and to convey relevant background to the student. Consequently, the student is well prepared for the practical work using the hardware, and can put the results into perspective. Espial operates so that its appearance and the range of instrumentation depend on the context. So, for example, if the practical-work requires the use of complex instrumentation such a constellation or a phase meter, one is made available, whereas at lower levels of study it would not be provided. Test instruments are initialised with settings suitable for the required measurements, but students are often expected to change them during the practical work. The instruments have cursors to make measurements and their displays may be printed or exported for inclusion in laboratory reports. The 93-420 Espial Software Package now includes Espial Tools. This allows teachers and lecturers full edit facilities with the creation of new content and additional assignments. Laboratory Architect determines the range of assignments available to the students and to configure the look and feel of the Espial environment. Assignment Builder creates new or edits existing laboratory assignments and configures the test equipment. Content is edited using any HTML editor or Microsoft Word. Winwiz creates and edits work board „patching" diagrams. It also configures test equipment monitor points and „further information" points on the practical diagrams. Practical diagrams are edited by Microsoft Visio. (Visio is not supplied as part of Espial) Manual Builder creates a version of the content ready formatted for printing. Free of charge online software updates are included. An optional addition is 93-410 Espial Course Manager, although it is not necessary for equipment operation. The 93-410 creates complete courses containing assignments from any of the installed Espial products plus external resources such as documents, multimedia material, thrid party programs, web urls, or locations on local intranets. Includes Course Designer and Course Presenter.

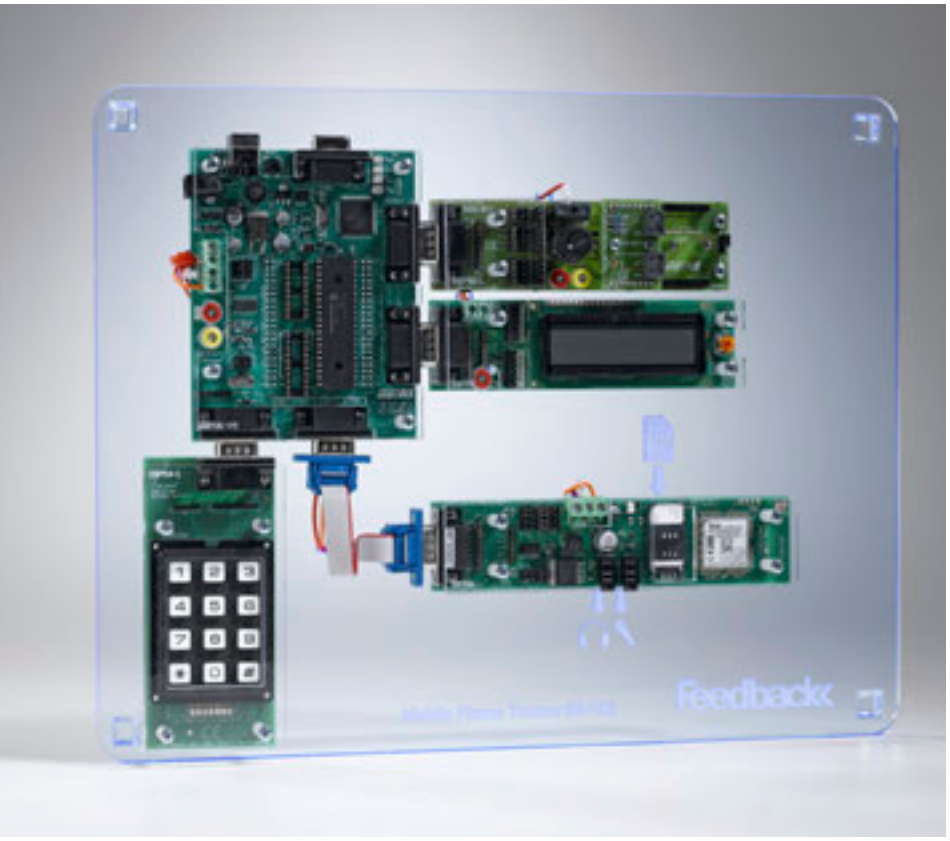
Technical data:

- Dimensions & weight of a CD

93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	93-410	Espial Course Manager



FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual cluded

2.2 Modern digital Communications

Mobile Phone Trainer

The mobile phone trainer provides a complete course in developing communication systems covering the subject areas of communication systems, the AT commend protocol and communications strategies. A full working system is provided including experimental hardware with power supply, software & experimental manual.

CURRICULUM COVERAGE

Programming

- General programming of systems including LCD & keypad
- RS232 protocol & programming
- String construction & deconstruction in communications
- The use of state machines in controlling electronic systems

Communications

- RS232 communications & handshaking protocols
- ASCII representation of characters in messages
- AT command structure & command protocols used in telecommunications
- Sending & receiving test messages in mobile phone systems
- Modem control & messaging

Technical data:

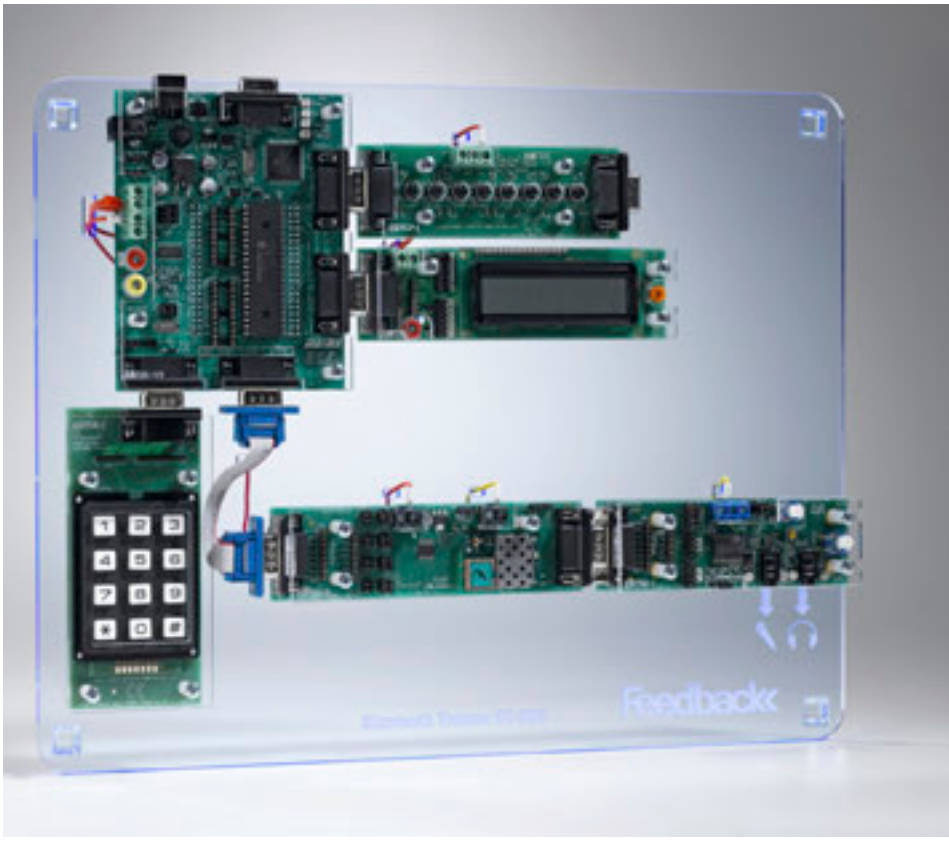
- Dimensions (net): width 350 mm x depth 265 mm x height 40 mm
- Weight (net): 1.0 kg

55-100	Mobile Phone Trainer

PC with Windows XP or higher & 32/64-bit-OS required

FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual included



Bluetooth Trainer

The Bluetooth Trainer provides a complete course including investigations into the Bluetooth standard using high level macros. Students use the hardware, software and curriculum to investigate the various Bluetooth protocols and functions including the serial protocol (SPP), local area protocol (LAP) and the headset protocol (HPP). A full working system is provided including experimental hardware including power supply, software and experimental manual.

CURRICULUM COVERAGE

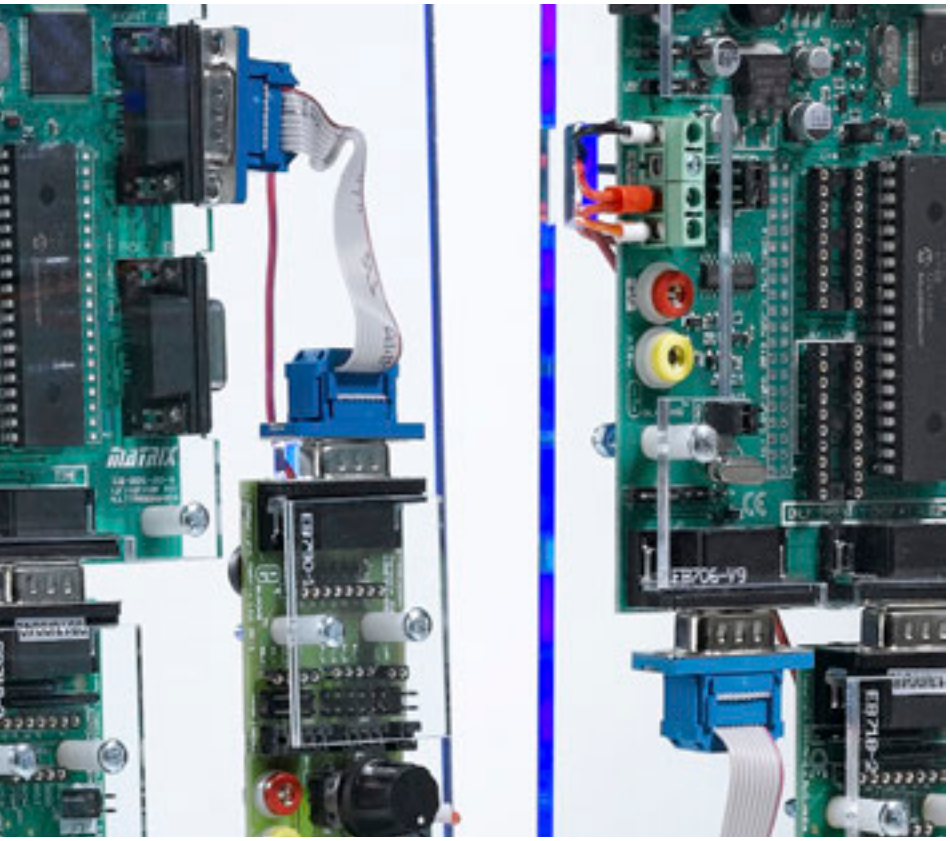
- Data communication between microcontroller & Bluetooth modules
- AT command structure & programming strategy in AT controlled systems
- Bluetooth visibility
- Device discovery, pass keys & addresses
- Responses - sequence flow & error checking
- Connecting & pairing
- Data communication
- Using Bluetooth for control applications
- Audio & implementation of the audio gateway
- Headset & telephone profiles

Technical data:

- Dimensions (net): 350 mm width x 265 mm depth x 40 mm height
- Weight (net): 1.0 kg

55-200	Bluetooth Trainer

PC with Windows XP or higher & 32/64-bit OS required



FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual included

Zigbee Trainer

The Zigbee Trainer provides a complete course in developing wireless area networks based on the Zigbee standard. It gives students who are familiar with microcontrollers an understanding of the programming techniques involved in developing Zigbee wireless communication systems. A Zigbee packet analyser is included in the solution, along with four fully working Zigbee nodes. The product comprises a full working system of experimental hardware including power supply, software and experimental manual.

CURRICULUM COVERAGE

- Zigbee protocols
- Message transmission, reception & networks
- Zigbee principles
- Topologies & components
- Development of microcontroller based systems
- Moulding the network
- Adding nodes
- Expanding the network
- Reducing power consumption
- Dynamic networks
- Message routing
- Data-logging gateways
- Complete modular fire & burglar/intruder alarm
- Improving network security

Technical data:

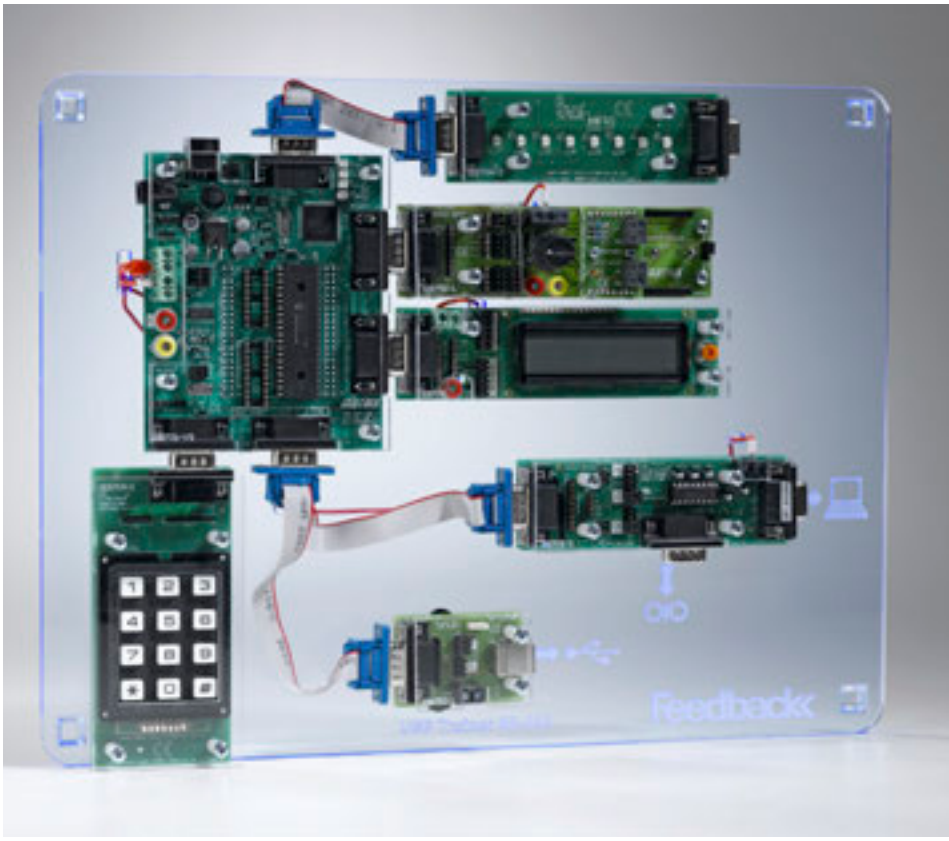
- Dimensions (net): 350 mm width x 265 mm depth x 40 mm height
- Weight (net): 1.0 kg

55-300	Zigbee Trainer

PC with Windows XP or higher & 32/64-bit OS required

FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual included



USB Trainer

The USB Trainer enables practical exercises in USB technology. Students learn about USB through eight different systems: mouse, joystick, temperature logger, USB terminal, USB to RS232 converter, basic slave, storage scope and oscilloscope with variable trigger. By working through these exercises, students build an understanding of the various types of USB system including human interface devices, communications devices and slave devices. A full working package is provided including experimental hardware, power supply, software & experimental manual (PC required separately).

CURRICULUM COVERAGE

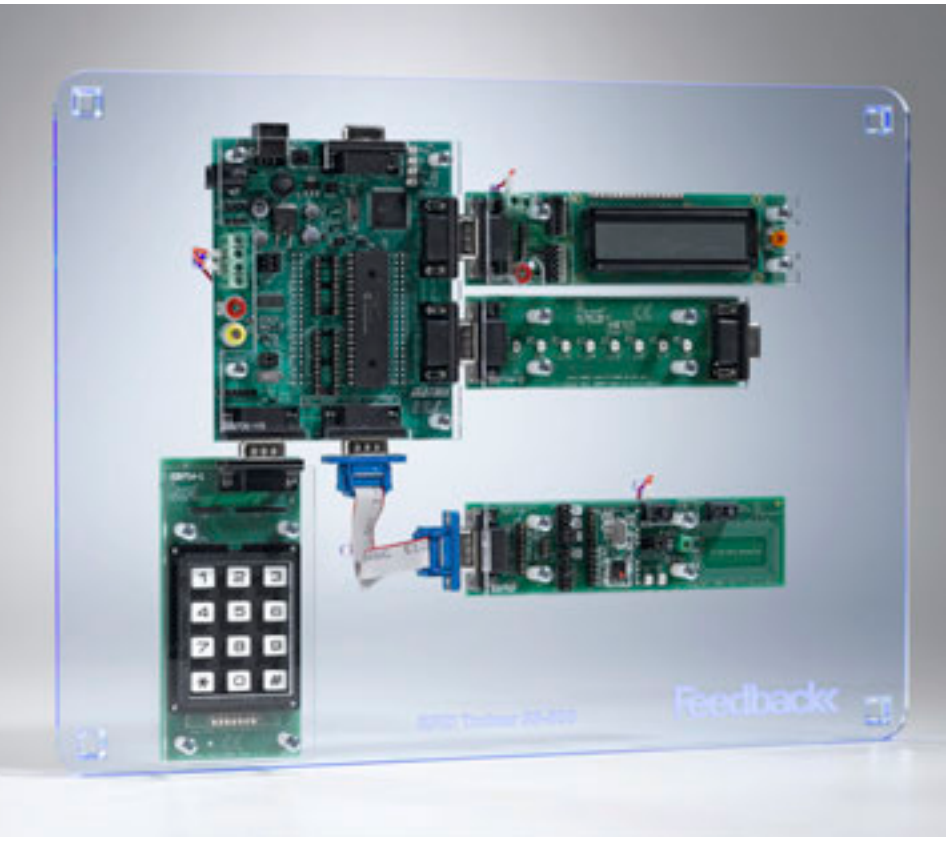
- USB protocol & packet structure
- Devices, descriptors & configuration
- USB HID, serial & slave protocols
- Development of microcontroller-based systems using USB technology
- HID mouse
- HID keyboard
- HID datalogger
- HID USB terminal
- HID RS232
- Storage & triggered scope

Technical data:

- Dimensions (net): 350 mm width x 265 mm depth x 40 mm height
- Weight (net): 1.0 kg

55-400	USB Trainer

PC with Windows XP or higher & 32/64-bit OS required



FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual included

RFID Trainer

The RFID Trainer provides a complete course in developing RFID systems. It gives students who are familiar with microcontrollers an understanding of the programming involved in developing RFID systems. An RFID board and four RFID tags embedded into credit cards are included. This hardware enables students to learn about reading and writing transponder data in both I-code and Mirfare mode. The package included the experimental hardware, power supply, cables, software and experimental manual.

CURRICULUM COVERAGE

- RFID systems & applications
- Configuring RFID readers
- Commands & syntax used in reading & writing data to & from RFID cards
- Communication with both Mirfare & I-code systems
- Development of microcontroller based systems using transponder unique ID, reading transponder data, writing transponder data & value format

Technical data:

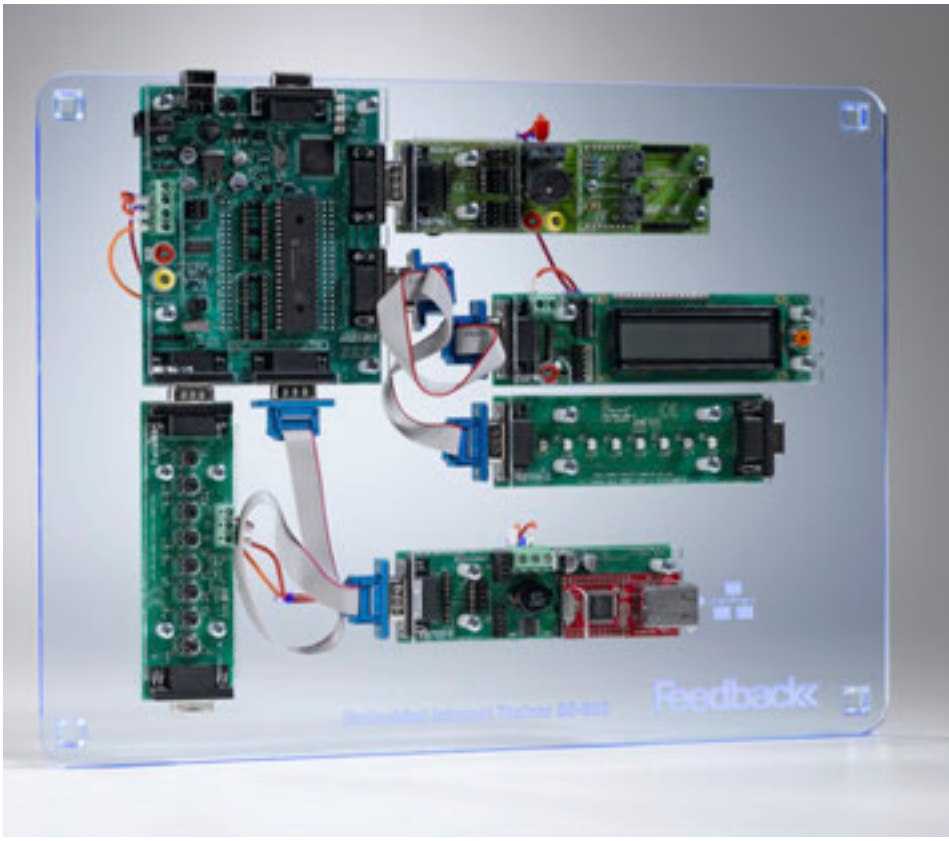
- Dimensions (net): 350 mm width x 265 mm depth x 40 mm height
- Weight (net): 1.0 kg

55-500	RFID Trainer

PC with Windows XP or higher & 32/64-bit OS required

FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual included



Embedded Internet Trainer

The Embedded Internet Trainer provides students with a full understanding for modern digital communications protocols and the development of embedded internet-based products. The package includes all experiment hardware, power supply, connection cables, software and experimental manual.

CURRICULUM COVERAGE

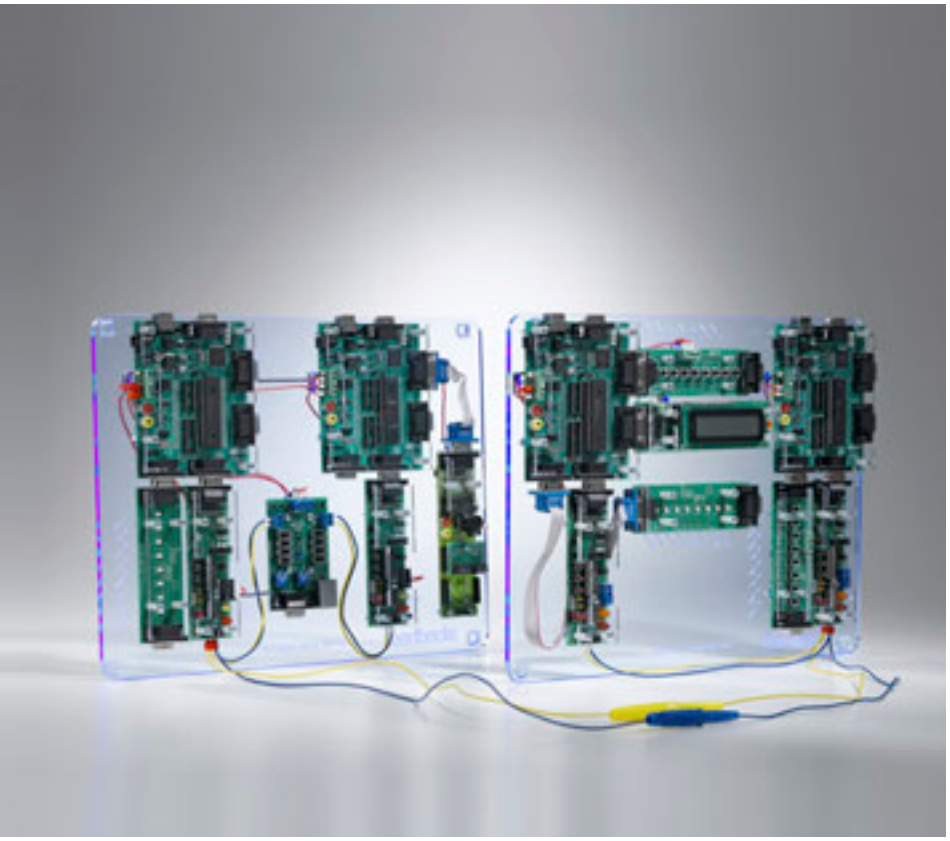
- OSI models & layers
- Ethernet, DLC, MAC, ARP, TCP, IP, UDP, ICMP, HTTP & POP3 protocols
- MAC packet structure & message creation using microcontrollers
- Communication strategy & information flow
- Packet injectors & debuggers
- ARP scanning
- Ping
- Time & date message using UDP
- Sending HTML using HTTP protocol
- Receiving HTML
- Sending an email using SMTP protocol
- Custom messaging using UDP
- A firewall application

Technical data:

- Dimensions (net): 350 mm width x 265 mm depth x 40 mm height
- Weight (net): 1.0 kg

55-600	Embedded Internet Trainer

PC with Windows XP or higher & 32/64-bit OS required



FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual included

CAN bus Trainer

The CAN Bus Trainer provides a course which includes the development and investigation of systems that use the CAN bus protocol. Four fully programmable CAN modes are included in the solution, along with circuit boards which mimic the functions of indicator lamps, switches and sensors. The package includes all experimental hardware required, power supply, connection cables, software and experimental manual. A CAN bus analyser and message generator are also included.

CURRICULUM COVERAGE

- CAN technology, wiring, topology & networks
- CAN message structure & physical layer transmission
- Understanding CAN bus protocols
- Using buffers in CAN systems
- Using CAN transmit & receive messages
- Errors in CAN systems
- Programming techniques in CAN systems
- Masks & filters in CAN systems
- Higher level protocols
- Development of complete CAN systems based on microcontrollers

Technical data:

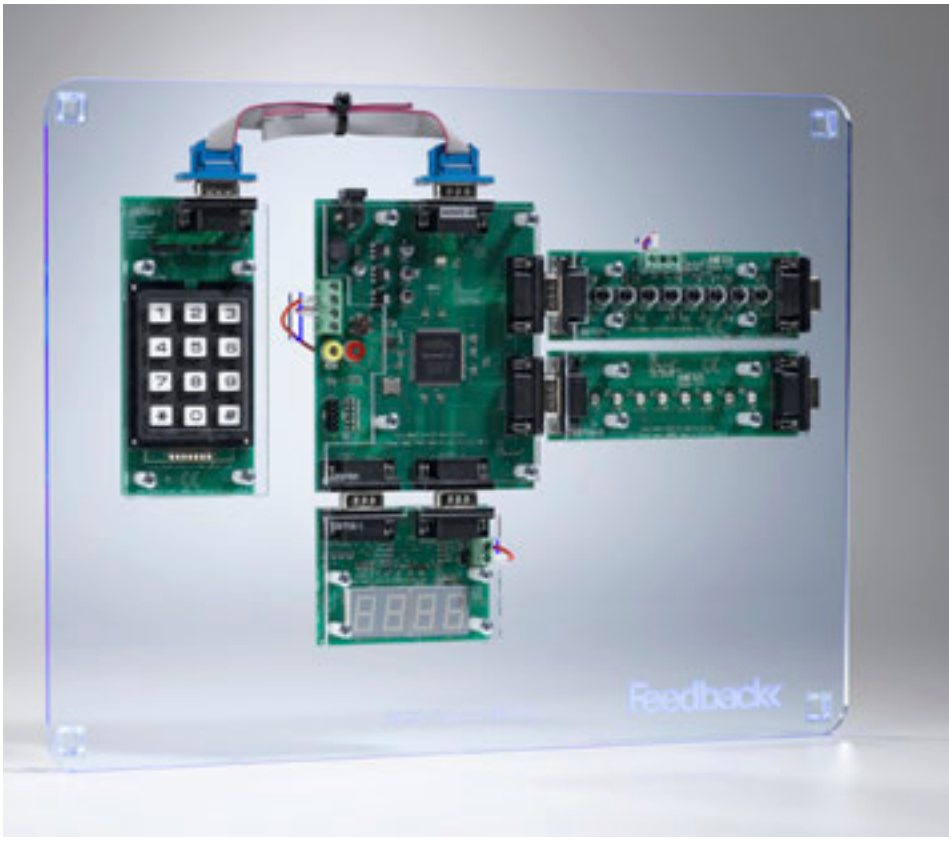
- Dimensions (net): 2 x boards, each 350 mm width x 265 mm depth x 40 mm height
- Weight (net): 1.0 kg

55-700	CAN bus Trainer

PC with Windows XP or higher & 32/64-bit OS required

FEATURES

- Complete working system
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experimental manual included



FPGA Trainer

The Field-programmable Gate Array Trainer provides a platform for learning FPGA programming in either VHDL or Verilog. The trainer includes a FPGA development board, LED boards, switch boards, a dual 7-segment display board, a prototype board, serial D/A board and a power output board. The equipment is provided as a full working system.

CURRICULUM COVERAGE

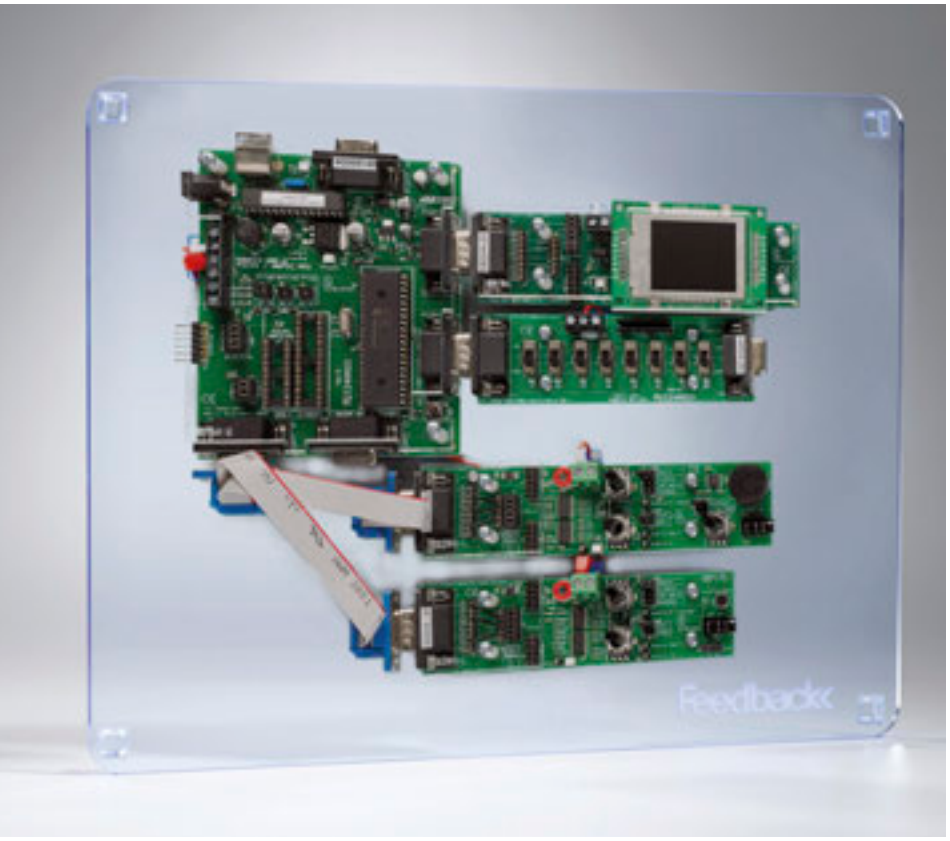
- PLD technology
- Getting to know QUARTUS II
- Descriptor languages
- Combination logic using HDL
- Combination logic assignment
- Sequential logic
- Modulo-sixty counter

Technical data:

- Dimensions (net): width 350mm x depth 265mm x height 40mm
- Weight (net): 1.0 kg

55-800	FPGA Trainer

PC with Windows XP or higher & 32/64-bit OS required



FEATURES

- Complete working system
- 7 different system developments
- Includes all required experimental hardware, power supply & software
- 20 hours of lab time
- Comprehensive experiment manual included

Audio DSP Trainer

This equipment enables students to carry out a number of practical exercises in audio DSP technology. Students learn about DSP by utilising 7 different system developments:

- Audio pass-through
- Echo effect
- Reverb effect
- Sine wave generator
- Waveform generator
- Low-pass filter
- High-pass filter

Working through the exercises students build a good understanding of the various types of DSP operation including:

- Inputs
- Outputs
- Sum
- Level
- Filter
- Delay

The solution can also be used for teaching microcontroller programming in a highly motivating context. It is also useful for teaching the specifics of Audio DSP development and has many outcomes, detailed below.

CURRICULUM COVERAGE

Programming outcomes:

- General programming of systems including graphical LCD, I/O
- SPI protocol and programming
- Timer Interrupts used to control sampling rates
- The use of state machines in controlling electronic systems

Communications outcomes:

- SPI communications and protocols
- Splitting and combining data bytes
- DSP functionality and methods of operation

Technical data:

- Dimensions (net): width 350 mm x depth 265 mm x height 40 mm
- Weight (net): 1.0 kg

55-900	Audio DSP Trainer

PC with Windows XP or higher & 32/64-bit OS required

FEATURES

- Unique integration of hardware & software
- Simulates, models & tests real antennas
- Hardware modelling between 1200 & 1800 MHz
- PC measurement and results
- Rapid graphic display of antenna characteristics
- Bench-top operation
- Low, safe power output
- 2 expert textbooks included
- Comprehensive experiment manual included

2.3 Antenna Trainers

AntennaLab

The AntennaLab is an integrated package of hardware and software for teaching and demonstrating common antenna configurations at all levels of study. It can also be used as a design tool by those engaged in research and development of antenna systems. AntennaLab is operated in conjunction with a PC and the whole system can easily be accommodated on a standard laboratory bench. The equipment comprises two towers, approximately 1 metre high, one of which contains a low-power generator controlled by a frequency synthesizer, and a motor/shaft encoder assembly to rotate the antenna under test. The antenna being investigated is mounted on a small platform on top of this tower. The „receiver" tower contains a receiver controlled by a frequency synthesizer and produces a d.c. output representing the received signal intensity. A broad-band array of log periodic antennas is mounted on this tower and is not changed in normal use. The receiver and generator synthesizers are synchronised, the two tower assemblies being linked by a five-metre multiway cable carrying both power and data. The „generator" tower is linked to the microcomputer. A selection of components is supplied with the system to enable most of the common antenna types to be constructed. The measurements are controlled, and the results plotted by the microcomputer. The unique and powerful software provides the test interface & provides high quality graphical displays. There are no user adjustments required on the equipment itself, although it is necessary to connect up the required RF configuration for specific measurements. The results are quantitative and, within the limits of environmental factors, agree with theory.

Espial Software Environment

AntennaLab requires the associated 93-420 Espial Software (supplied separately) to perform the assignments. An upgrade from previous versions of the product 57-100 or AMS506 to USB are possible using the 57-202 AntennaLab Upgrade kit (enquire before ordering). Introductory information about AntennaLab's approach to the subject is followed by details of the available application windows:

- Signal strength monitor
- Signal strength vs angle graph windows (2D Cartesian or polar, 3D polar)
- Signal strength vs frequency graph window
- Return loss vs frequency graph window. Additional guidance is given on the installation of the hardware and the formatting and configuration of the graphing applications.
- Manuals supplied: AntennaLab comes complete with all hardware, measurement software, simulation software, 57-200 Operator's Manual, Student's and Tutor's Workbooks, Simulation Software Manual and two reference textbooks.

CURRICULUM COVERAGE

- Familiarisation
- The dipole in free space
- Effects of the surroundings
- Dual sources
- Gain
- Directivity & aperture
- Ground reflections
- The monopole
- Phased monopoles
- Resonance
- Impedance & standing waves
- Return loss & VSWR measurements
- Parasitic elements
- Multi-element parasitic arrays
- Stacked & bayed arrays
- The log periodic antenna
- The horn antenna
- The dish antenna
- Projects

Technical data:

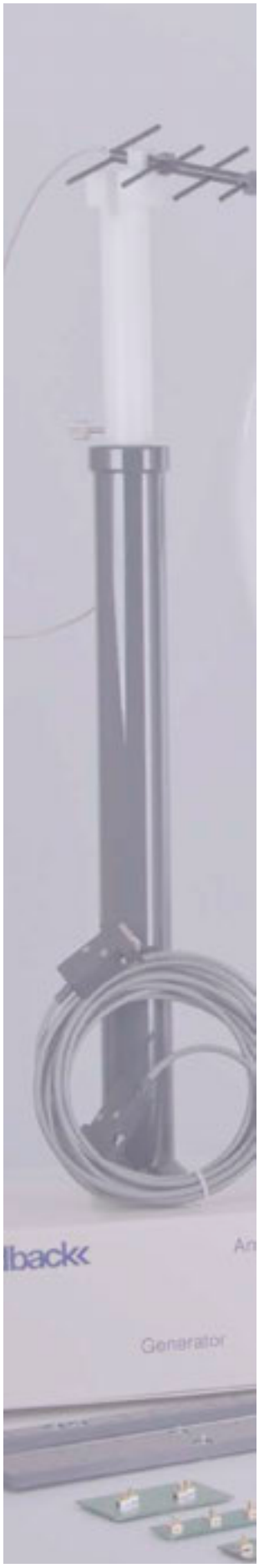
- Operating frequency 1200 - 1800 MHz
- Smallest frequency step 1 MHz
- Transmitter power, maximum 10 mW, normal 1 mW
- Receiver bandwidth 6 MHz
- Receiver dynamic range 70 dB
- Receiver output precision 8-bit
- Transmitter and Receiver terminal impedance 50 ohms
- Receiver linearity ±1 dB
- Maximum frequency step rate 25 per second
- Transmitter frequency accuracy ±100 kHz
- Maximum antenna rotation speed 90 degrees/second
- Antenna position resolution 1 degree
- Receiver input for 1dB compression 5 mW
- Transmitter output power variation over full frequency range 2 dB
- Transmitter mismatch capability = Infinite
- RF connection system SMB
- Normal receiving antenna 4 x 5 element log periodic
- Height of antenna towers 1 metre
- Tower spacing 2 to 5 metres
- Computer connection USB
- Dimensions: width 860 mm x depth 760 mm x height 960 mm
- Weight: gross 35 kg, net 30 kg

57-200-USB	AntennaLab

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

PC running Windows XP or higher, 32-bit or 64-bit with USB interface



FEATURES

- Now includes Espial Tools
- Allows teachers & lecturers full edit facilities
- New content & additional assignments
- Free of charge online software updates
- Hands off for teachers, hand on for students
- Self-paced
- Unrestricted, open learning environment
- Practical demonstration of theory & concepts
- Interactive patching diagrams
- Real-time embedded instrumentation
- Automatic instrumentation configuration
- Data export for analysis
- USB connection to hardware
- Editing tools include laboratory architect, assignment builder, Winwiz & manual builder
- Compatible with 32-bit & 64-bit versions of Windows XP, Vista, Windows 7 & Windows 8
- Optional 93-410 Espial Course Manager

Espial Software Package

Espial is used extensively within the telecommunications, control and basic electronics ranges. It is therefore required for use with 12-300 series, 33-033, 53-004 (& 53-200 series), 57-200-USB, 38 series & PV75-100. The teaching content is provided within the software; this includes the underlying theory, written so that it does not make extensive use of mathematics. An important part of the content is to highlight the assignment learning objectives and to convey relevant background to the student. Consequently, the student is well prepared for the practical work using the hardware, and can put the results into perspective. Espial operates so that its appearance and the range of instrumentation depend on the context. So, for example, if the practical-work requires the use of complex instrumentation such a constellation or a phase meter, one is made available, whereas at lower levels of study it would not be provided. Test instruments are initialised with settings suitable for the required measurements, but students are often expected to change them during the practical work. The instruments have cursors to make measurements and their displays may be printed or exported for inclusion in laboratory reports. The 93-420 Espial Software Package now includes Espial Tools. This allows teachers and lecturers full edit facilities with the creation of new content and additional assignments. Laboratory Architect determines the range of assignments available to the students and to configure the look and feel of the Espial environment. Assignment Builder creates new or edits existing laboratory assignments and configures the test equipment. Content is edited using any HTML editor or Microsoft Word. Winwiz creates and edits work board „patching" diagrams. It also configures test equipment monitor points and „further information" points on the practical diagrams. Practical diagrams are edited by Microsoft Visio. (Visio is not supplied as part of Espial) Manual Builder creates a version of the content ready formatted for printing. Free of charge online software updates are included. An optional addition is 93-410 Espial Course Manager, although it is not necessary for equipment operation. The 93-410 creates complete courses containing assignments from any of the installed Espial products plus external resources such as documents, multimedia material, thrid party programs, web urls, or locations on local intranets. Includes Course Designer and Course Presenter.

Technical data:

- Dimensions & weight of a CD

93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	93-410	Espial Course Manager

FEATURES

- Fully operational antennas
- Vivid displays of antenna characteristics
- Convenient size for demonstrations
- Versatile & easy to assemble
- Complex concepts made easy
- Reconciles theory & practice

The ASD512 comprises:

- RF Generator Unit
- Antenna Ground Plane (also the storage case)
- Antenna
- Detectors (2 off)
- Comprehensive theory & experiment manual

Antenna System Demonstrator

The ASD512 is a fully operational Antenna System Demonstrator, working at a frequency of 167.2MHz, giving a half-wave element of approximately 90 cm. It has been designed to provide an ideal classroom demonstrator. The system is provided with a kit of parts allowing many types of antenna to be constructed, making the system versatile as a demonstrator of both antenna principles and practice. The system has two hand-held detectors that show relative magnitudes of voltage and current fields around the antenna, and the field strength of the antenna. Practical demonstrations are described in the accompanying manuals, illustrating the principles involved and introducing the student to the various basic concepts of most types of antennas in common use.

CURRICULUM COVERAGE

- Basic theory of radiation
- Radiating & non-radiating systems
- Feeders
- Radiation resistance
- Drive point impedance & ground resistance
- Physical & electrical length
- Directional antennas & radiation patterns
- Parasitic arrays & antenna gain
- Antenna with folded elements
- Slot radiators
- 3-dimensional polar diagrams
- Loop antenna

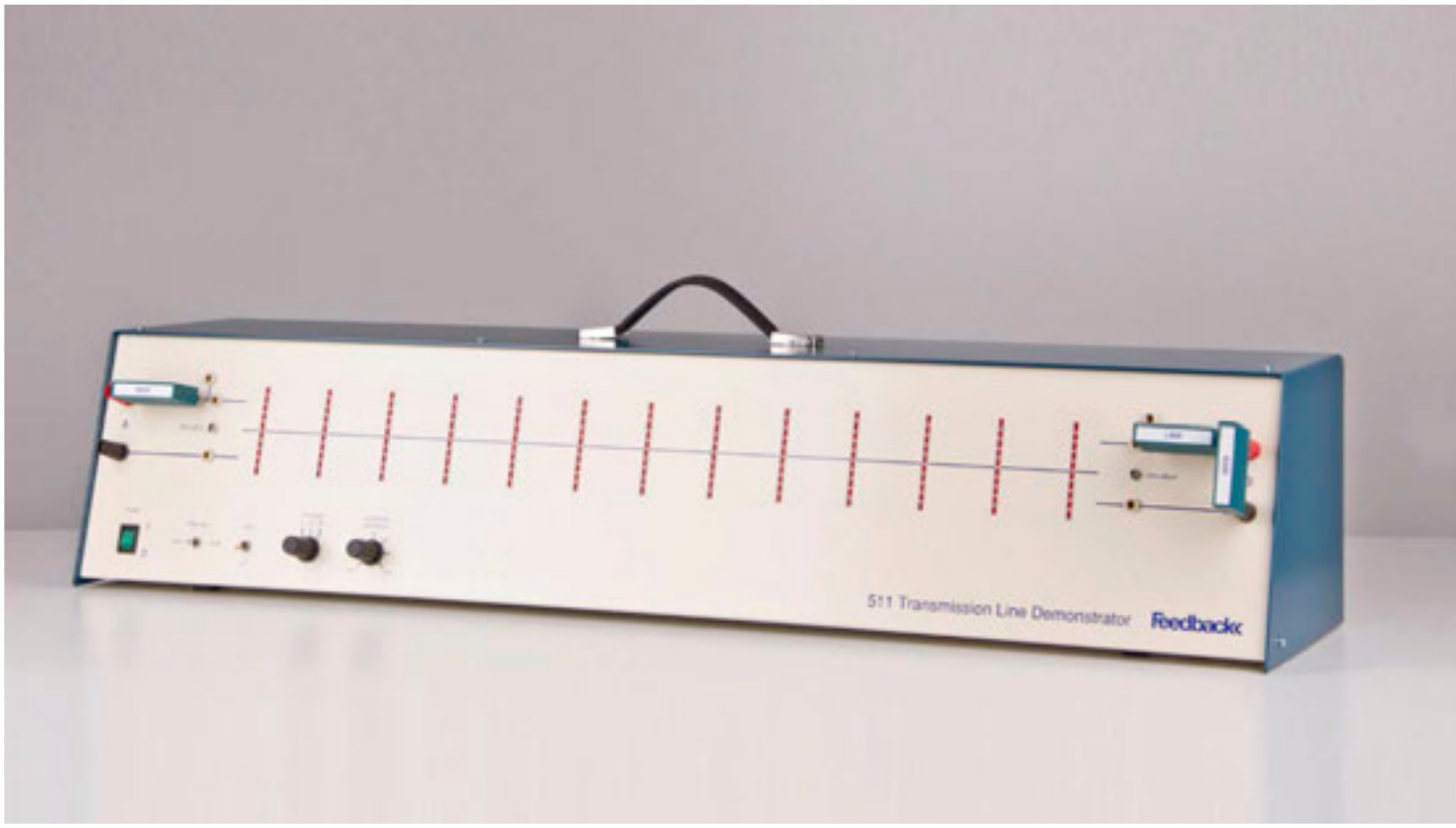
Technical data:

- Transmitter - the equipment emits an unmodulated carrier at field strength not exceeding 0.5 Volt/metre at 30 metres
- Frequency 167.2 MHz ±50 kHz. Power 0 - 5 Watts output
- Ambient temperature 0° to +50°C
- Metering Forward / Reverse Power 0 - 10 Watts
- Detector charge - two outputs charging at 60 mA for 5 V. The transmitter can be amplitude modulated if required by miniature jack
- Dimensions: width 1160 mm x depth 855 mm x height 127 mm
- Weight: 18.2 kg

Scope of delivery:

- R F Generator Unit
- Antenna Ground Plane (also the storage case)
- Antenna
- Detectors (2 off)
- Comprehensive theory & experiment manual

ASD512	Antenna System Demonstrator



2.4 Transmission Lines Trainer

Transmission Line Demonstrator

The TLD511 Transmission Line Demonstrator visually clarifies transmission line concepts by graphically displaying, at low frequency, the characteristics of a transmission line. For students of communications engineering, the TLD511 provides an ideal demonstration of line characteristics and wave motion. Demonstrating these characteristics has been a problem in the past because of the high transmission speeds involved. Now, by using a simulated line, the TLD511 displays at low frequencies the high frequency characteristics of a transmission line so that students can easily observe them and the operator can also readily adjust them. The line is completely symmetrical so that either end may be regarded as the input or output. Although primarily designed to illustrate features common to electrical lines operating at power audio and radio frequencies, the TLD511 can also be used to teaching other subjects, such as acoustics. LED columns indicate positive and negative voltage at 13 positions. The VPG608 Variable Phase Generator (supplied separately) is required for full functionality.

CURRICULUM COVERAGE

- Propogation of a wave front
- Propogation of a sine wave
- Effect of wavelength
- Attentuation & dispersion
- Terminations
- Reflection, standing waves & characteristic impedance
- Partial reflections, standing waves & superposition of incident & reflected waves
- Resonance & the effect of attenuation

FEATURES

- Large, bright LED display, 13 columns
- Built-in step function process
- Variable simulated line length
- Manual hold facility
- Comprehensive theory & experiment manual

Technical data:

- Propagation time - Switch 0.25, 0.5, 2s at zero attenuation, representing line lengths L, 2L, 8L respectively
- A centre-stable 2-way switch applies a signal to either end of the line
- Line impedance 600Ω
- Plug-in terminations: Short-circuit link (2) 600Ω 200Ω 1.8kΩ 50Ω 100kΩ 100µF nominal (reversible electrolytic)
- Power supply 100 -125 V/ 200 - 250 V 50/60 Hz. Fuse rating 315 mA
- Dimensions: 813 mm width x 203 mm depth x 178 mm height
- Weight: 4.0 kg

TLD511	Transmission Line Demonstrator

Additionally recommended:

Qty	Cat.-No.	Name
1	VPG608	Variable Phase Generator

2.5 Microwave & Microstrip Trainers

Complete Microstrip Trainer

This trainer uses high precision components to allow students to investigate microstrip technology principles. The complete Microstrip System, MST532-1, needs no special test equipment as it includes a digital multimeter and dual d.c. power supply. A CD manual is provided (paper manual on request) containing detailed background material, theory and structured assignments. The precision components (18 passive & 3 active) are packaged in nickel-plated enclosures and are interconnected using industry-standard SMA couplings.

MST532 components included:

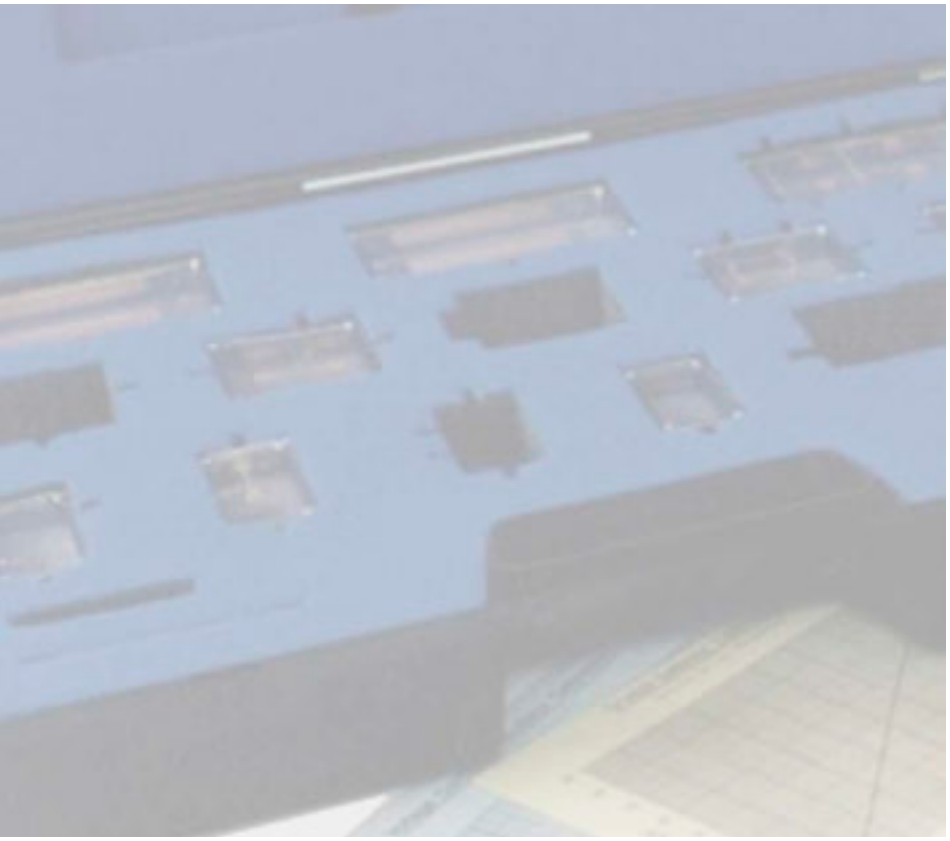
- Microwave source (VCO)
- Low-pass filter (LPF)
- Wilkinson power divider (PD)
- Ring resonator (RR)
- Three-port circulator (CIR)
- MMIC amplifier (AMP)
- Patch antenna (ANT)
- SMA coaxial connector (PPC)
- 50 ohm coaxial termination (MT)
- 20 dB attentuator (ATT)
- Directional coupler (DC)
- Matched load (ML)
- Rate-race hybrid coupler (RRH)
- Unknown load & shunt stub (ZT)
- PIN dioade modulator (PIN)
- d.c. biasing unit (BL)
- Crystal detector (D)
- Coaxial short-circuit termination (SC)
- Coaxial open-circuit termination (OC)
- SMA plug - BNC jack adaptor (ADR)

Purchasing Options

- MST532-1 Complete Microstrip Trainer (includes MST532 Microstrip Trainer, MX553 Digital Multimeter & AX502 Power Supply), or
- MST532 Microstrip Trainer (if you already have an appropriate digital mutimeter & power supply to form an MST532-1), or
- 56-001 MIDE Microstrip System Complete (MST532-1 plus the 56-901 MIDE Design Software), or
- 56-100 MIDE Microstrip System (includes MST532 Microstrip Trainer & 56-901 MIDE Design Software)

CURRICULUM COVERAGE

- Power source & detector action
- Action of a 3-Port circulator
- Insertion loss measurement on a low-pass filter



FEATURES

- Comprehensive theory & experimental manual
- Latest microwave technology
- 2.4 to 3.4GHz VCO
- 2 to 4GHz PIN diode modulator
- Safe low power output
- Components identified with inscribed reference number
- Supplied in protective case

- Measurement of return loss
- Reflection coefficient & VSWR of a filter
- Microstrip & commercial matched loads
- Matched investigations: reflection coefficient of unknown resistive load & it's matching by transformer & shunt stub
- Properties of a power divider and rat-race coupler
- Effective dielectric constant / line loss measurement with a ring resonator
- d.c. biasing & MMIC amplifier investigations
- PIN diode modulator investigations
- Microwave radio link & antenna investigations

Technical data:

- Dimensions (in protective case): 520 mm width x 380 mm depth x 180 mm height
- Weight: gross 5.3 kg, net 4.8 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	AX502	Power Supply (2 x 30V at 2.5A)
1	MST532	Microstrip Trainer
1	MX553	Digital Multimeter Benchtop

MST532-1	Complete Microstrip Trainer

Additionally recommended:

Qty	Cat.-No.	Name
1	56-901	MIDE Design Software

PC running Windows XP or higher required if the 56-001 or 56-100 are purchased (they include the MIDE Design Software 56-901), a PC is not required for the purchase of MST532 or MST532-1 (where 56-901 is not included)

FEATURES

- Stand-alone, complete sytem
- Robust stands for antennas
- Modulated 10.425GHz solid-state DRO source
- Components identided by inscribed reference number
- Comprehensive experiment manual included

Microwave Trainer

The Microwave Trainer has been designed to enable students to investigate the principles of microwave transmission systems, such as those used in radar and communication links. It is a precision made, bench-top microwave system that uses standard type WG16 (WR90) waveguide components to illustrate the essential elements in this field of study. The equipment has a selection of waveguide components and an electronic supply console which contains the power supply for a modulated, solid-state Dielectric Resonance Oscillator (DRO) X-band microwave source, a demodulation circuit and a meter which monitors the detector output. The trainer is supplied in a dedicated, protective, carrying case, is completely self-contained and provides the means to allow students to carry-out realistic practical work at extremely low cost per workstation. It is suitable for use in courses ranging from technician studies to degree level. A comprehensive manual containing extensive microwave theory and a progressive series of assignments is supplied with the trainer.

Purchasing Options

- 56-200 Microwave Trainer, or
- 56-002 MIDE Microwave Trainer (56-200 plus the 56-901 MIDE Design Software)

CURRICULUM COVERAGE

- Introduction to microwave wave guide bench
- Measurement of (a) source frequency & (b) guide wavelength
- Measurement of voltage standing wave ratio (VSWR)
- Measurement of diode detector law
- Measurement of impedance & impedance matching
- Measurement of radiation diagram of a horn antenna
- Use of directional couplers in power transmission & reflection measurement
- Series, shunt and hybrid tee waveguide junctions
- Waveguide-to-coaxial transformers

Technical data:

- Power Supply: 120 - 230 V, 50/60 Hz
- Modulator bandwidth: 10 kHz min
- Oscillator power supply: + 18 V
- Frequency: 10.425 GHz
- Output Power: 10 mW min
- Dimensions (in protective case): width 518 mm x depth 370 mm x height 121 mm
- Weight: gross 9.1 kg, net 8.85 kg

56-200	Microwave Trainer

Additionally recommended:

Qty	Cat.-No.	Name
1	56-901	MIDE Design Software

PC with Windows XP or higher required if 56-901 purchased, but not required for 56-200 alone

FEATURES

- Fibre-optic measuring techniques
- Demonstrates standard properties of visible & infra-red light
- Analogue & digital data transmission
- Self-contained training package including comprehensive theory & experiment manual

2.6 Fibre Optics Trainers

Fibre Optics Trainer

This Fibre-Optics range of equipment provides the means to investigate various aspects of fibre-optic technology and it's use in transmitting analogue and digital data, with particular reference to Telecommunications. The EFO1101 comprises a transmitter, a receiver, two lengths of fibre-optic cable and various electrical connectors and accessories. These are supplied in a specially designed carrying case. The manual, together with the associated textbook on Communications Systems, offers a large amount of relevant theory, supported by a range of practical assignments. Power is provided by an internal battery (supplied) or you can use an external power supply (9 V or 15 V) (not supplied). EFO1102 Fiber Optics Power Meter (supplied separately) is an accurate, versatile and low-cost unit for measuring optical power levels at terminated optical cables. An easy-to-read pointer scales gives readings in both dBm and microwatts.

CURRICULUM COVERAGE

- Properties of visible light
- Properties of infra-red radiation
- Transmission of high quality analogue & digital data over fibre-optic fibres
- Coverting various light sources, including mains lighting, torch light & infra-red
- Construction of an alarm system
- Differences between analogue & digital techniques
- Measurement of the optical absorption or reflection properties of various materials
- Testing analogue & digital optical receivers & transmitters

Technical data:

- Dimensions (packed): width 530 mm x depth 400 mm x height 140 mm
- Weight: gross 4.7 kgs, net 4.5 kgs

EFO1101	Fibre Optics Trainer

Additionally recommended:

Qty	Cat.-No.	Name
1	EFO1102	Fibre Optics Power Meter
1	EFO1105	Fibre Optics Monitor

FEATURES

- Demonstrates integrated voice / data communication link
- TDM & digital communication principles
- Demonstration & measurement of multimode fibre characteristics
- Individual LED, LASER, PD & APD modules
- Experimental OTDR
- Plastic & glass fibre links
- PCBs for link construction
- Light source with variable power output
- Power meter calibrated at 650 & 850, 1300 & 1550 nm
- Comprehensive theory & experiment manual

Optical Fibre System

The OFS IVi provides comprehensive training to students and all levels of scientific and technical personnel on fibre optic devices and digital communication systems with the primary intention of teaching fibre-optic device characteristics, principles of fibre-optics & digital communications, fibre-optic equipment & digital and analogue fibre-optic links.

CURRICULUM COVERAGE

- Plastic-fibre characteristics
- Glass-fibre characteristics
- Laser diode module
- Avalanche photodiode module
- LED module
- PIN photodiode module
- OTDR & fibre event module
- Digital communication concepts
- Fibre-optic link design

Technical data:

- Dimensions (packed): 810 mm x 570 mm x 370 mm (x2)
  plus 330 mm x 340 mm x 170 mm (x3)
  plus 505 mm x 425 mm x 225 mm (x9)
  plus 370 mm x 280 mm x 250 mm (x7)
  plus 591 mm x 477 mm x 274 mm (x4)
- Weight (total packed): 139 kgs

OFS IVI	Optical Fibre System

FEATURES

- 11 useable 64 Kbps channels
- User-definable frame marker
- 2 on-board digitised voice channels
- An 8-bit data channel & several user-expansion channels
- Demonstrates fully operational integrated voice / data fibre-optic communication link
- RS232C communications module, optional
- Time division multiplexing of voice, data & user-defined data streams
- Modular design enables configuration with user-defined modules
- Wide scope of experimentation
- Complete kit
- Comprehensive theory & experiment manual

TECHNICAL DATA:

- Dimensions (net): 870 mm width x 570 mm depth x 370 mm height
- Weight (net): 10 kg

Optical Fibre Trainer

The Optical Fibre Communications Trainer is a powerful, versatile, experimental kit teaching voice and data communications using fibre-optics. It is ideally suited for students of electrical / electronic engineering and physics, as well as practicing engineers and for companies and organisations working in the area of fibre-optic communications. The trainer provides experience in working with optical fibres and demonstrates the principles of optical communications. The OFT also teaches the principles of time division multiplexing, since optic-optic communication systems mostly use time division multiplexing in order to exploit the large bandwidth available. It supports a wide variety of experiments involving the multiplexing of voice and data signals and transmitting them using optical fibres. Experiments can be performed using two OFTs, which will allow simultaneous full-duplex communication between the two or on its own in loop-back mode. Most experiments require an oscilloscope (preferably multi-channel) and a function generator. Some of the experiments also involve designing and bread-boarding of simple digital circuits. The OFT-RS232C Communications Module is optional and demonstrates computer communications over fibre (supplied separately).

CURRICULUM COVERAGE

Fibre Optics Experiments

- Fibre optic analogue links
- Digital link
- Losses in optical fibre
- Effect of EMI interference
- Numerical aperture measurement

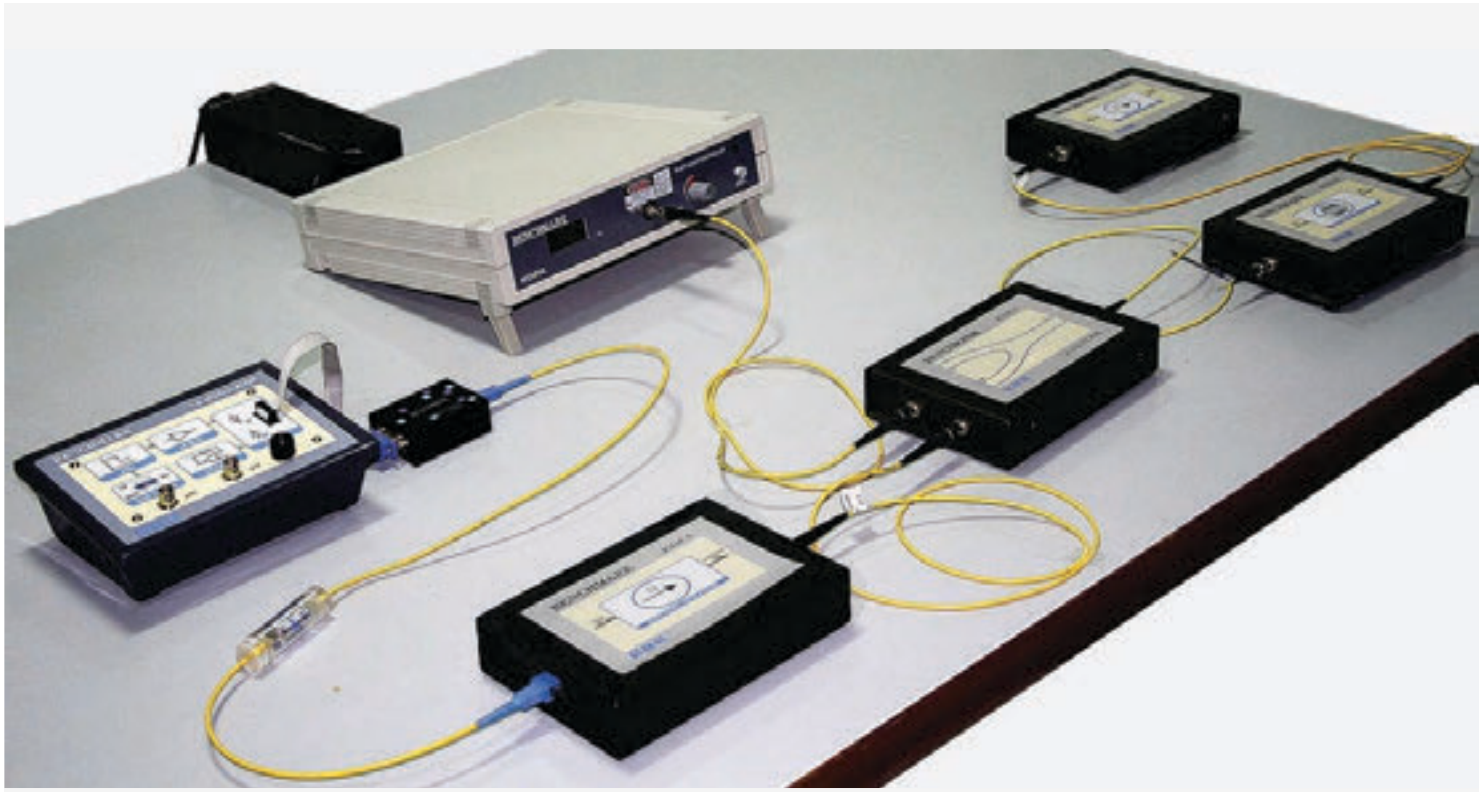
Multiplexing and Digital Comms

- Time division multiplexing
- Framing in time division multiplexing
- Voice coding - A-law
- Pulse Broadening in fibre-optic communications
- Interfacing 8, 64, 256 kbs synchronous channels
- Asynchronous channel interfacing using oversampling & bit stuffing

OFT	Optical Fibre Trainer

Additionally recommended:

Qty	Cat.-No.	Name
1	OFTRS	232C Communications Module



EDFA Training System

Erbium Doped Fibre Amplifier (EDFA) is an optical amplifier that amplifies optical signals sufficiently to cover several tens of kilometers without any need for conventional repeaters. As it works in the same optical domain, it avoids the need for several stages of signal conversion with their associated problems. Consequently, EDFA finds extensive use in the fibre backbone. This training system shows the building blocks of a typical EDFA as well as their characteristics. All the blocks can be configured in different modes of operation, such as co-directional and counter-directional operations. This modular approach also facilitates study of individual block characteristics wherever possible.

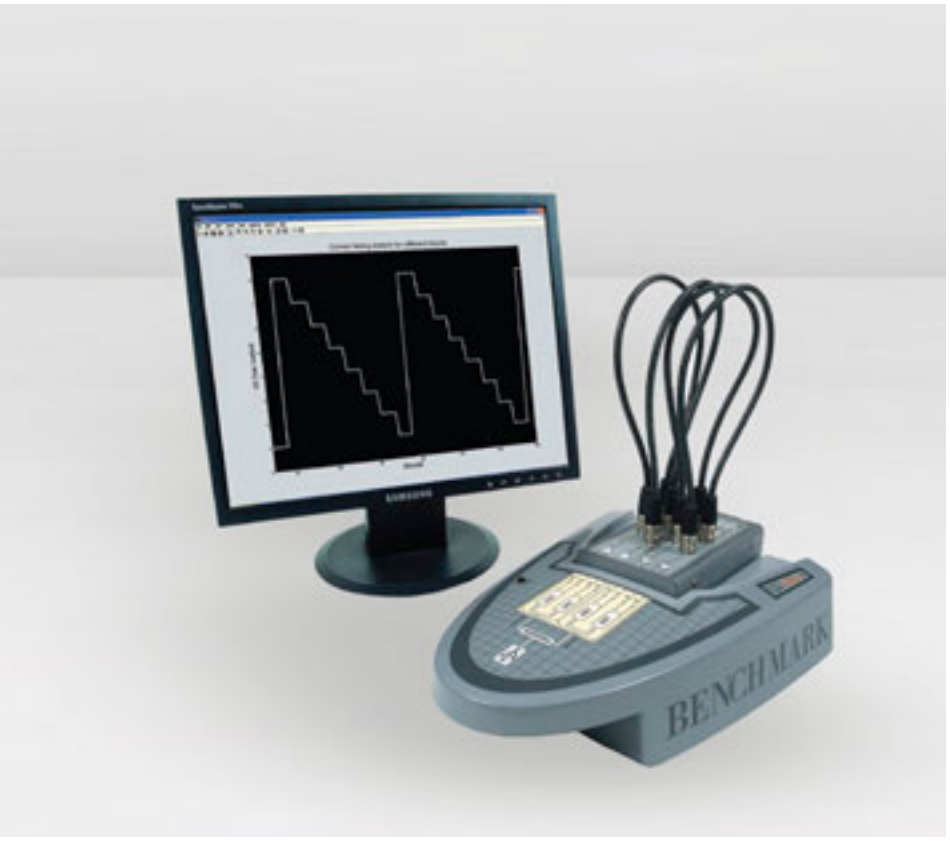
CURRICULUM COVERAGE

- Understanding EDFA - operating principles
- Understanding the EDFA building blocks
- Characteristics of EDFA
- Study of the pump lazer 980 nm
- Study of the signal DFB lazer 1550 nm
- Causes of EDFA gain
- Setting up a fibre-optic link using EDFA
- Fibre ring lazer
- Noise figure measurement

Technical data:

- Dimensions (packed): 810 mm x 570 mm x 370 mm
- Weight (packed): 10 kgs

ETS	EDFA Training System



FEATURES

- Modern communication systems
- Interface with MATLAB (MATLAB not supplied)
- Comprehensive theory & experiment manual

PROJECTS

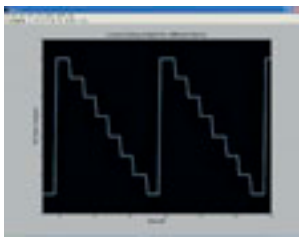
- A simple software designed radio (SDR)
- Transmission & reception at various frequencies
- FM reception radio
- Spectrum analysis
- Reception of local GSM broadcast channel
- Channel coder / decoder
- Access WiCOMM-T platform remotely
- V.32 modem
- Frequency hopping spread (FHSS)
- Discrete multi-tone (DMT) modem

Wireless Digital Communications Training System

The WiCOMM-T is the ultimate wireless digital communication training platform and is the actual implementation of modern digital communication systems with a direct interface to MATLAB (not supplied) through the high-speed USB port of a PC. The system studies complete digital communication system concepts, which includes digital modulation techniques, baseband equalization, filtering concepts and the basics of CDMA, GSM etc.

CURRICULUM COVERAGE

- Baseband digital communication link
- Quadrature modulation schemes
- Adaptive equalization techniques
- GSM
- Basics of DS-CDMA
- Basics of OFDM



Technical data:

- Dimensions (packed): 810 mm x 570 mm x 370 mm
- Weight (packed): 17 kgs

Scope of delivery:

- BU: Base Unit IFX70MHz
- 70 MHz IF Module WiCOMM-T
- PS: Power Supply
- WiCOMM-T SW: Experiment Software
- WiCOMM-T MAN: Manual

WICOMM-T	Wireless Digital Communications Training System

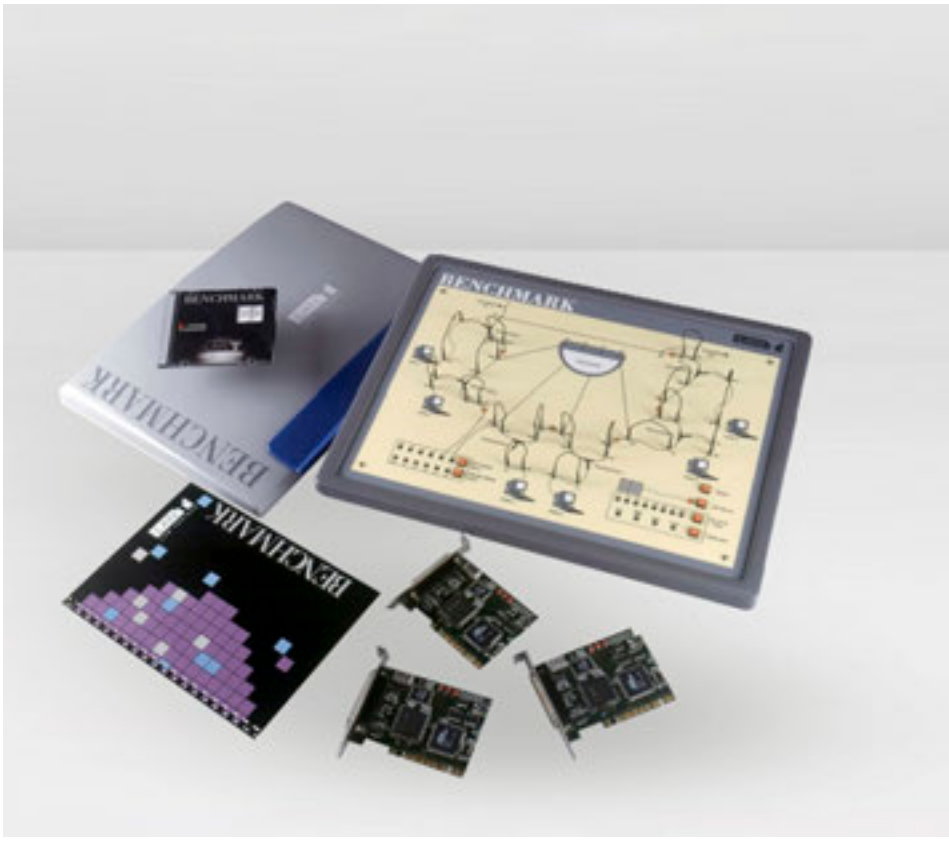
Additionally required and recommended:

- Windows PC required, Pentium 4 or higher with high-speed USB port (USB 2.0) and at least 512 MB RAM (1GB RAM preferred), Windows 2000 SP4, Windows XP SP2 up to Windows 8
- MATLAB 7.5 (R2007b) or higher version required with signal processing, communication & instrument control tool boxes for each system
- Spectrum Analyser required (not supplied)

RFX2.4GHz module option (not supplied) - 2 x WICOMM-T required to be operational

FEATURES

- User configurable data rates 8, 16, 32, 64, 128, 256, 512 Kbps, 1 Mbps
- Generation of bit errors and frame errors between nodes
- Variable network size - up to 6 nodes with each NEU
- Emulation of 2 nodes by each PC
- Experimentation using the software provided
- Programming experiments using a library
- Menu-driven user interface to experiments
- Comprehensive theory & experiment manual



Local Area Network Trainer

LAN-T exposes users to networking concepts at the physical, MAC, network and transport layers through a carefully designed series of experiments. The LAN-T is a hardware and software based product. Emulation of nodes, topologies, etc., are implemented in a combination of hardware, firmware and software to emulate a real network environment. All the network layers can be implemented in the software. This arrangement gives more freedom to try out various protocols and layers in the network and study their behaviour. With a single trainer and 2-3 PCs, users can obtain hands-on experience with a wide variety of different network topologies and protocols, including all the popular ones such as CSMA/CD (Ethernet) and token passing (Arcnet, Token Ring).

The LAN-T comprises:

- Network Emulator Unit (NEU)
- Network Interface Units (NIU)
- Experiment software
- Comprehensive theory & experiment manual

CURRICULUM COVERAGE

- Behaviour of various network protocols
- Packet transmission
- MAC layer
- BUS topology
- RING topology
- DLL
- Network layer, study of routing protocols
- Distance vector routing
- Link state routing
- Application layer, TCP connection
- Serial / parallel port networking
- Data security in computer networks
- STAR topology

Technical data:

- Dimensions (packed): 810 mm x 570 mm x 370 mm
- Weight (packed): 18 kgs

LAN-T	Local Area Network Trainer

Additionally required:

- 2 or 3 PCs required, Windows Pentium or higher, one PCI slot required, 512 MB RAM, up to Windows 7 (32-bit)

Visual C++ compiler V6.0 or higher required for programming, modifying and development

FEATURES

- Single trainer for network security & cryptography
- Security threats & attacks
- Central control unit to emulate real-life
- Variable network size - up to 7 nodes in each network (trusted & black)
- Comprehansive theory & experiment manual

Network & Data Security Training System

The i-SECURIT is a complete network system that is isolated from any external network. Instead it is connected to a local „Trusted Network" and a „Black Network". The Central Control Unit (CCU) runs the network services, administration and control methods. The Black Network users attempt to compromise the services by different attacks, such as Intrusions, Password Cracking, and Denial of Service. The trusted network users simultaneously work on and are trained to deploy suitable counter measures to keep network services running properly. The system covers a large gamut of network security threats and its users can obtain hands-on experience with a wide variety of network security issues and cryptography methods. The course design allows the learner to read about a concept, witness a demonstration and then actually practice its execution. This meets the study flow of beginners as well as industry professionals. With a single i-SECURIT you can connect up to 15 PCs, with one slot reserved for the network administrator and can start working with as little as two or three PCs.

CURRICULUM COVERAGE

- Network security fundamentals
- Security basics
- Ethics & legality
- Network & system threats
- Web vulnerabilities
- Malware
- Network identification
- Cryptography
- Web serices using cryptography techniques

Technical data:

- Power input: 220V AC, 50Hz
- Dimensions (packed): width 660 mm x depth 460 mm x height 425 mm
- Weight (packed): 24 kgs

I-SECURIT	Network & Data Security Training System

Additionally required:

- Minimum set-up: 3 PCs required comprising 2 x Windows PCs plus 1 x Linux with FTP server
- Full set-up: 14 PCs required comprising 7 x Windows PCs plus 1 x Linux with FTP server plux 6 x Windows / Linux machines
- Windows OS: Windows 2000 with SP4 or Windows XP with SP2 required
- Linux OS: Redhat Linux ver 7.3 or ver 9.0

Network System Lab

Traditionally, teaching in computer networks or LAN / WAN subjects is orientated towards signal transmission methods or network architecture and protocols study in both electronics & communication and computer science engineering streams. The NETSys-T, however, helps to realise end-to-end network service in a lab environment diffusing boundaries between voice and data, wired and wireless, LAN and WAN, etc. This teaching equipment provides a network architecture and protocols study focusing on switching techniques (circuit switching, packet switching, data/multimedia content streaming) queuing models (throughput, delay, blocking, burstiness) and computer networks (protocols, algorithms). The system facilitates emulating a real world computer network within a lab including backbone realization using IP routers, wired LAN realization using HUB, Layer 2 & Layer 3 switches, Firewall and wireless LAN realization using Access points. All working 24/7 and following various technologies such as Ethernet, WLAN, E1/T1, DSL, SDH, FDDI, ATM, etc, and ensuring the required data is exchanged seemlessly. Understanding how all the network systemns work is the experience available here for students.

CURRICULUM COVERAGE

- Shared & switched bandwidth utilization in LANs using HUB & switches
- LAN realization using layer 2 (L2) switches & demonstrate key aspects of Ethernet protocol
- VLAN realization using layer 3 (L3) & L2 switches & demonstrate inter-VLAN routing
- Routing protocols (RIP, OSPF)
- Network access control in a LAN / WAN network using L3 switcher & router
- Network security realization using firewall & intrusion detection systems (IDS)
- Radio survey of WLAN design
- WLAN realization & through-put measurement

Technical data:

- Dimensions (packed): 710 mm x 600 mm x 430 mm
- Weight (packed): 45 kgs

NETSYS-T	Network System Lab

Additionally required:

- 5 off Windows/Linux PCs plus 1 Linux PC plus 1 off Windows laptop required (minimum 512MB RAM per system + 100Mbps fast Ethernet Network Interface)
- Windows 7, 32-bit and 64-bit required

FEATURES

- Receive operating at 500 - 1600 kHz (MW) & 3 - 4 MHz (SW)
- One fixed generator frequency in each band
- Transmission medium may be coaxial cable or very limited range on-air
- Transmission power very low, less than 10 mW
- Extensive use of monitor points for tracing
- Switched faults on both generator & receiver
- 2 boards, 1 the generator, 1 the receiver
- Comprehensive experiment manual included

2.7 Radio Trainers

AM Radio Systems Trainer

The AM Radio Systems Trainer comprises a pair of open-boards; the AM2961A, an AM/DSB/SSB generator and the AM2961B, an AM/DSB/SSB receiver. The AM circuits operate within the AM broadcast band and the DSB/SSB circuits operate within the 80 Meter „ham band". The generator output is only a few milliwatts, so the range of transmission is extremely limited and no licence is required. The receiver has an integral antenna, but may also be used, with the addition of an external antenna, to receive normal broadcast and amateur signals. The principles and techniques of AM with full carrier, double-sideband suppressed carrier and single side-band suppressed carrier transmission and reception can be easily investigated. Switched faults may be introduced on both generator and receiver units. On the receiver, fault options include disabling of mixers, local oscillators, audio amplifier and beat frequency. Other faults include fast/slow and min/max gain AGC faults. Switches on the generator disable audio source, AGC of audio source, MW local oscillator and modulator, SW carrier oscillator, modulator, SW mixer and SW local oscillator.

CURRICULUM COVERAGE

- Familiarisation & on-air reception
- Principles of AM radio signal generation & reception
- Amplitude modulation & frequency changing
- Envelope detection & automatic gain control
- Double-sideband transmission & reception
- Single-sideband transmission & reception

Technical data:

- Dimensions (each of the 2 boards): width 296 mm x depth 220 mm x height 45 mm
- Weight (each of the 2 boards): 1.1 kg

AM2961	AM Radio Systems Trainer

Additionally required:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A

FEATURES

- Stereo transmission & reception
- Extensive use of monitor points for signal tracing
- Switched faults on both generator & receiver
- Built-in microphones & speakers, plus stereo headphones
- Low transmission power, less than 10 mW
- 2 boards, 1 generator, 1 receiver
- Comprehensive experiment manual included

FM Stereo Radio System Trainer

The FM Stereo Radio System Trainer receiver circuits operate over a range of 88 - 108 MHz and the generator provides a fixed output frequency of 100 MHz with a 19 kHz pilot tone. The generator output is only a few milliwatts, so the range of transmission is extremely limited and no licence is required. The receiver operates on an IF frequency of 10.7 MHz in stereo or mono mode and may also be used with an external antenna to receive normal broadcast and amateur signals. Switched faults may be introduced on both generator and receiver units. On the receiver, fault options include Multiplex, Pilot tone and Mute errors; power for tuner, audio and demodulator, forces tuning volts to zero and high-gain AFC loops locking to a signal. Switches on the generator create left/right signal, VCO supply, modulated subcarrier, baseband, 19 kHz pilot tone, 38 kHz oscillator and phase shift fault options.

CURRICULUM COVERAGE

- Principles of FM radio generation & reception
- Frequency modulation
- Basic FM reception
- Stereo transmission
- Stereo reception
- Simulated faults

Technical data:

- Dimensions (each of 2 boards): width 296 mm x depth 220 mm x height 45 mm
- Weight (each of 2 boards): 1.1 kg

FM2962	FM Stereo Radio System Trainer

Additionally required:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A

The Feedback Training Centre (FTC) has examples of equipment from all of our product ranges and is based in our HQ in the South of England, just an hour from London.

You are most welcome to visit for an equipment demonstration or more in-depth training at any point pre- or post-order.

We are also offering a number of training courses, each lasting a day, which include some key subjects of interest to our customer base, including:

- PLCs
- MATLAB
- LABVIEW
- Process control in an industrial context
- Pneumatics & Hydraulics as used in industry

Details of the training courses will be posted on our website.

Whether it is for a formal training course, a product demonstration or a product training visit, you are most welcome at any time.

Thank you for your interest in Feedback – with a reputation built since 1958, you are in safe hands.

Leigh Baker
Managing Director
Feedback Group

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

CONTROL ENGINEERING

PROCESS CONTROL

REFRIGERATION & AIR CONDITIONING

PNEUMATICS & HYDRAULICS

ELECTRICAL POWER & MACHINES

FEATURES

- Low cost entry level
- System can be enhanced over time when budgets become available
- Industrial-style d.c., single & three phase machines
- Conventional & virtual instruments available
- Supplied with comprehensive torque / speed measurement system
- High level of electrical & mechanical safety
- Quick & easy machine coupling
- Multi-output d.c., single & three phase protected supply
- 230 V or 120 V versions available
- Comprehensive experiment manual

TECHNICAL DATA:

- Dimensions (packed): width 1250 mm x depth 850 mm x height 1000 mm
- Weight: gross 130 kgs, net 110 kgs

3.1 Electrical Machines Core System

Electrical Machines Core System

The 60-070 core system, available in a 230 V or 120 V version, provides a versatile but cost-effective introduction to the study of Electrical Power and Machines which can be enhanced at any time by adding modules. Safety has been paramount to protect both the user and the equipment, hence 4 mm safety sockets are used throughout for interconnections and guards are provided to cover rotating components. All machines and motors are nominally rated at 250 W and are bench mounted and provide characteristics more typical of large machines. All other modules including power supplies, loads and measuring instruments are available separately and are mounted in a rigid insulating frame into which they can be easily inserted or removed. A detailed manual providing both theory and experimental procedures is provided in hard copy and electronic formats to help the student to gain a working understanding of the subjects listed. The complete systems are available with virtual or conventional instrumentation.

The 60-070-230 (230 V version) core system comprises:

- 60-105 Universal power supply
- 63-120 d.c. compound wound machine
- 64-110 Single phase induction motor - capacitor start/induction run
- 64-501 Three phase induction motor - squirrel cage, dual voltage
- 67-142 Switched three phase resistance load
- 67-505 Swinging field dynamometer
- 68-445 Machine testing system
- 68-703 Shaft coupling 12 mm to 12 mm with key
- 68-800 Standard set of patch leads
- 91-200 System frame
- 91-270 Machine guards

The 60-070-120 (120 V version) comprises the sames as the 230 V version, as described above, plus the 03-100 Auto-transformer.

CURRICULUM COVERAGE

d.c. motors & generators

- d.c. shunt motor
- d.c. series motor
- d.c. compound motor
- d.c. separately excited motor
- d.c. shunt generator
- d.c. compound generator
- d.c. separately excited generator

a.c. motors

- Single phase induction motor - capacitor start/induction run
- Starting requirements

- Effect of start capacitor
- Effect of capacitor output on output characteristics
- Torque / speed
- Efficiency characteristics

Three phase a.c. motors

- Three phase squirrel cage induction motor
- Star connected motor voltages & currents
- Delta connected motor voltages & currents
- Torque / speed
- Efficiency characteristics

Optional additional packages available (see datasheet for details) to increase the capability of the 60-070 core system in both 230 V & 120 V versions (supplied separately):

- 60-070-DM Dissectible Machines
- 60-070-ECT Electrical Circuits
- 60-070-EM Electrical Machines
- 60-070-EP Electrical Principles
- 60-070-SMC Synchronous Machine
- 60-070-SUM Series Universal Motor
- 60-070-TFM Transformers
- 60-070-ASC a.c. Motor Speed Control
- 60-070-DSC d.c. Motor Speed Control
- 60-070-CI1 Conventional Instrumentation 1
- 60-070-CI2 Conventional Instrumentation 2
- 60-070-VIP Multi-Channel Power Sensor (68-600)
- 60-070-EMC Electromagneitc Motor Control

Virtual Instrumentation upgrade

If you previously purchased a core system that included the 68-500, 67-502 & 68-441, you can upgrade to the new 68-600 Multi-Channel Power Sensor with vectorscope by purchasing the following package:

- 68-600 Multi-Channel Power Sensor
- 67-502 Swinging Field Dynamometer
- 68-445 Machines Testing System

Scope of delivery:

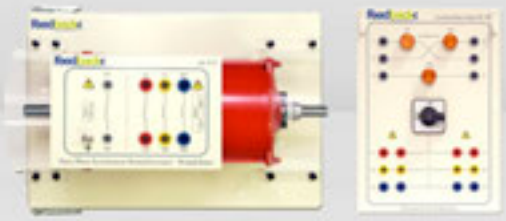
Qty	Cat.-No.	Name
1	60-105-230	Universal Power Supply - 230V
1	63-120-230	d.c. Compound Wound Machine
1	64-110-230	Single Phase Induction Motor - Capacitor Start / Induction Run
1	64-501-230	Three Phase Induction Motor - Squirrel cage, Dual Voltage
1	67-142-230	Switched Three Phase Resistive Load
1	67-505	Swinging Field Dynamometer
1	68-445	Machine Testing System
1	68-703	Shaft Coupling 12mm to 12mm with key
1	68-800	Standard Set of Patch Leads
1	91-200	System Frame
1	91-270	Machine Guards

60-070-230	Electrical Machines Core System

Additionally recommended:

Qty	Cat.-No.	Name
1	60-070-ASC-230	a.c. Motor Speed Control
1	60-070-CI1	Conventional Instruments 1
1	60-070-CI2	Conventional instrumentation 2
1	60-070-DM-230	Dissectible Machine
1	60-070-DSC-230	d.c. Motor Speed Control
1	60-070-ECT-230	Electrical Circuits
1	60-070-EM-230	Electrical Machines
1	60-070-EP-230	Electrical Principles
1	60-070-SMC-230	Synchronous Machine
1	60-070-SUM-230	Series Universal Motor
1	60-070-TFM-230	Transformers
1	60-070-VIP	Virtual Instrumentation Package

various options described above



60-070-SMC

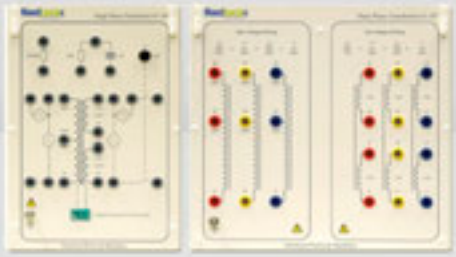
60-070-SUM

60-070-CI1

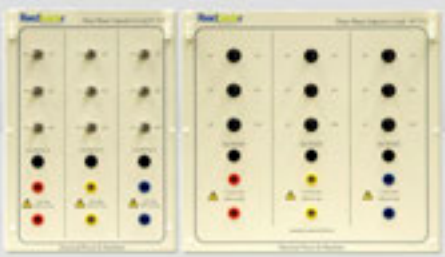
60-070-CI2

60-070-VIP

60-070-EMC



60-070-TFM

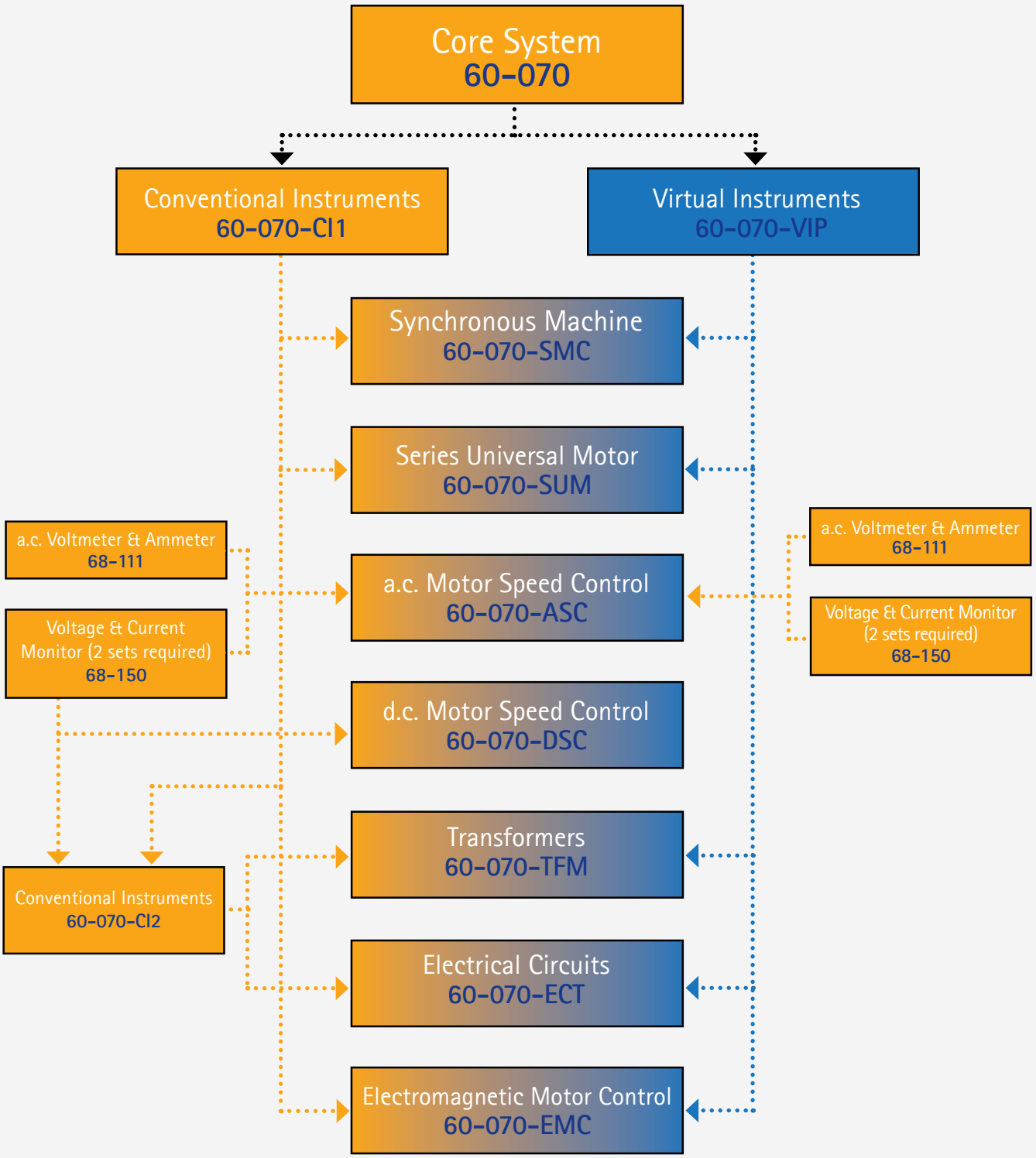


60-070-ECT

60-070-DSC

60-070-ASC

RANGE STRUCTURE



FEATURES

- Excellent Espial software & compact hardware package
- Real-time waveform of voltage and current
- Organised such that traces may be overlaid for comparative purposes
- Three D vector display of voltage and current showing both amplitude and phase
- Spectral data & derived functions in graphical form
- Numerical data displayed, such as frequency
- Data from different displays can be viewed concurrently
- All instrumentation has built-in facilities for accurate parameter extraction & display export to stored images
- Comprehensive experiment manual

Multi-Channel Power Sensor

The 68-600 comprises a hardware & software package used to capture signals for analysis and display using the integrated instrumentation in Espial and is part of the 60-070 electrical machines range. It provides numerical, waveform, spectral and vector plots of both direct measurements, such as voltage and current as well as derived functions such as relative phase and power factor. This is available for both single phase and three phase systems.

In order to have clean and stable measurements extensive use is made of digital signal processing, in particular where signals have significant harmonic content or where unavoidable noise is present. It is also possible to examine the parameters associated with individual harmonics. This is of interest in the analysis of non-linear loads and their contribution to system losses. The direct measurements comprise three voltage and three current channels, each with their own reference so there is complete connection flexibility. Preconfigured displays are available that mean common measurements can be achieved quickly and simply.

The Working System
The 68-600 Multi-Channel Power Sensor is regarded as a functional replacement of the previous product 68-500-2-USB Multi-Channel I/O Unit and can directly replace it when used solely for data acquisition purposes.

However, due to the technology enhancement, the 68-600 is not compatible with the existing 68-500-2-USB, 67-502 Swinging Field Dynamometer & 68-441-2 Torque & Speed Control panel, in which case a complete upgrade is formed by combining 3 new products, with a special price for purchasing the package:

- 68-600 Multi-Channel Power Sensor
- 67-505 Swinging Field Dynamometer
- 68-445 Machine Testing System

When operated in conjunction with the 67-505 and the 68-445, data may be taken from both systems at the same time and hence plots such as torque against power factor may be created.

Technical data:

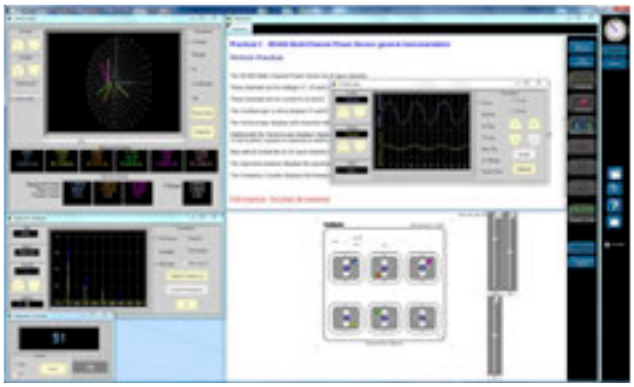
- Number of voltage channels: 3
- Voltage input resistance >10 k ohms
- Number of current channels: 3
- Maximum differential peak voltage 600 volts, 320 volts with respect to local ground
- Maximum current: 14 amps
- Current input resistance <0.5 ohms
- Computer Interface: USB2
- Maximum sampling rate: 512 kHz
- Maximum sample length: 1024
- Resolution: 12 bits

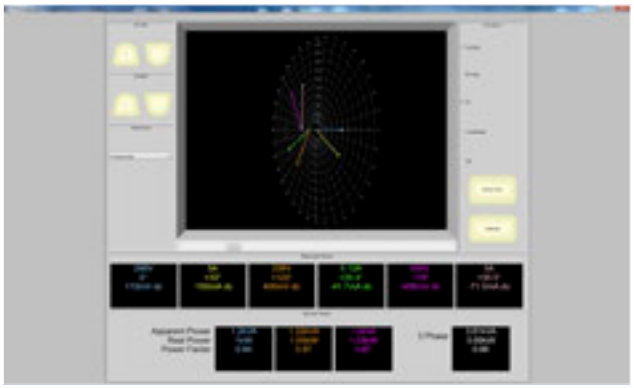
Scope of delivery:

- Hardware panel
- Software in Espial
- Connecting cables

68-600	Multi-Channel Power Sensor

PC running Windows XP or higher, 32-bit or 64-bit with USB interface required

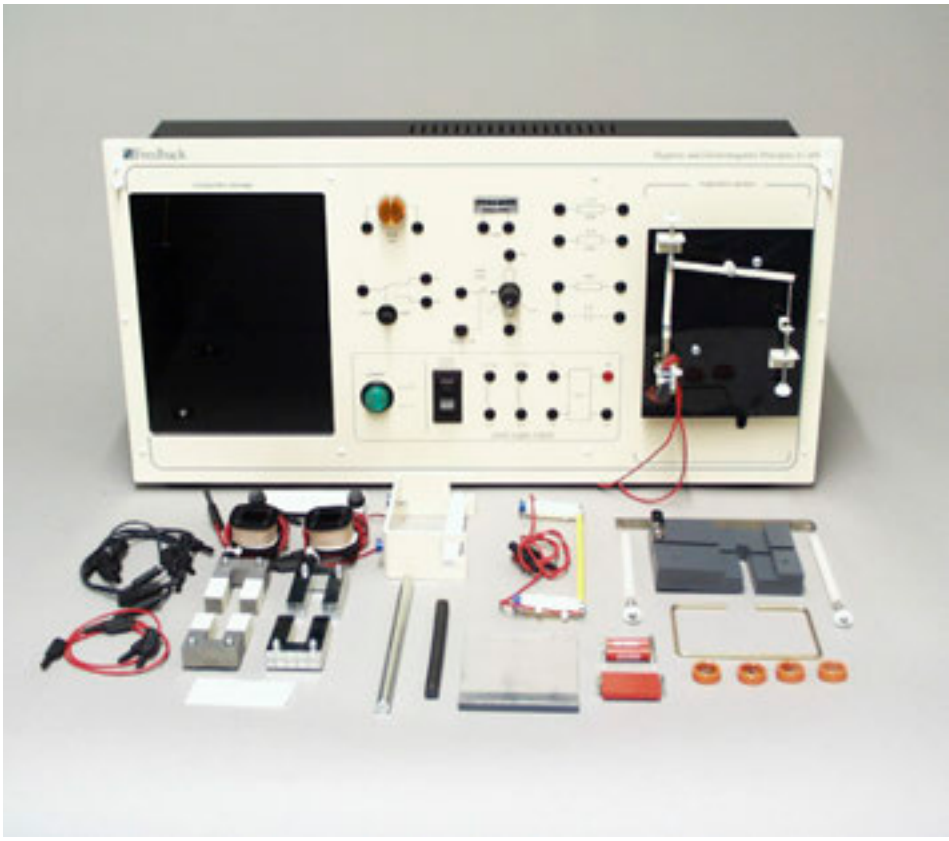




FEATURES

Magnetic and electromagnetic components provided are:

- Bar magnets
- Wound coils
- Iron and ferrite cores
- Fixed and moving conductors
- Compasses
- D.C. Solenoid
- Comprehensive experiment manual



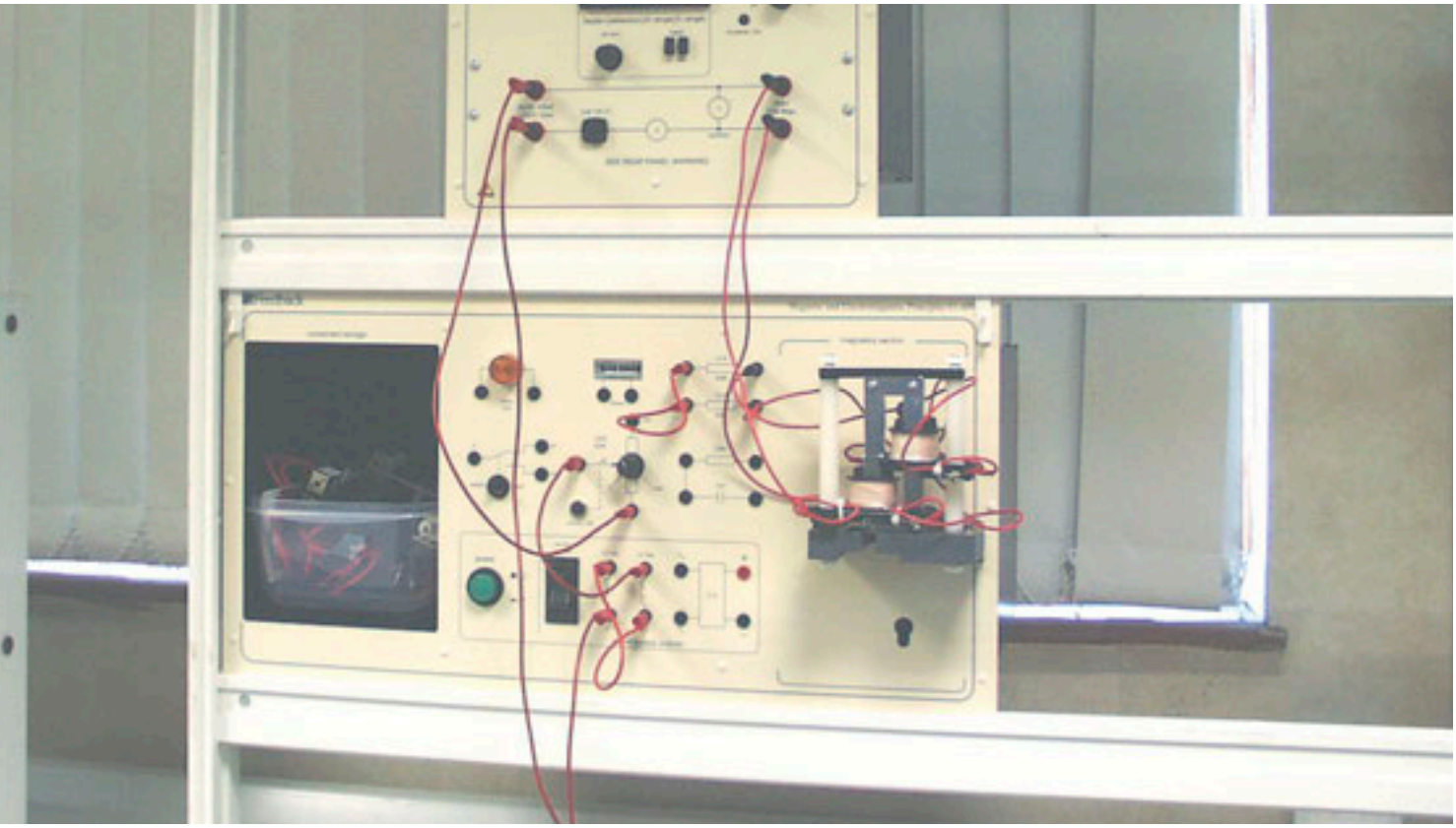
3.2 Magnetics/Electromagnetics

Magnetic & Electromagnetic Principles Trainer

This bench-mounted system comprises a series of magnetic and electromagnetic components together with an electrodynamic wattmeter which allows the investigation of a wide range of magnetic and electromagnetic principles.

CURRICULUM COVERAGE

- Direction of magnetic fields
- Forces of attraction between two magnets
- Magnetic field due to an electric current
- Forces between a conductor carrying current & a magnetic field
- Magnetic field of a solenoid
- Magnetic pull in force of a solenoid
- Electromagnetic induction
- Mutual inductance
- Transformer action
- Voltage / turns relationship
- Current / turns relationship
- Transformer construction & materials
- Primary & secondary power of a transformer circuit
- No load losses
- Core-loss loop - high loss core, low loss core & low loss core with added gap
- Series & Parallel connections
- Transformer on load
- Magnetic saturation
- The current transformer



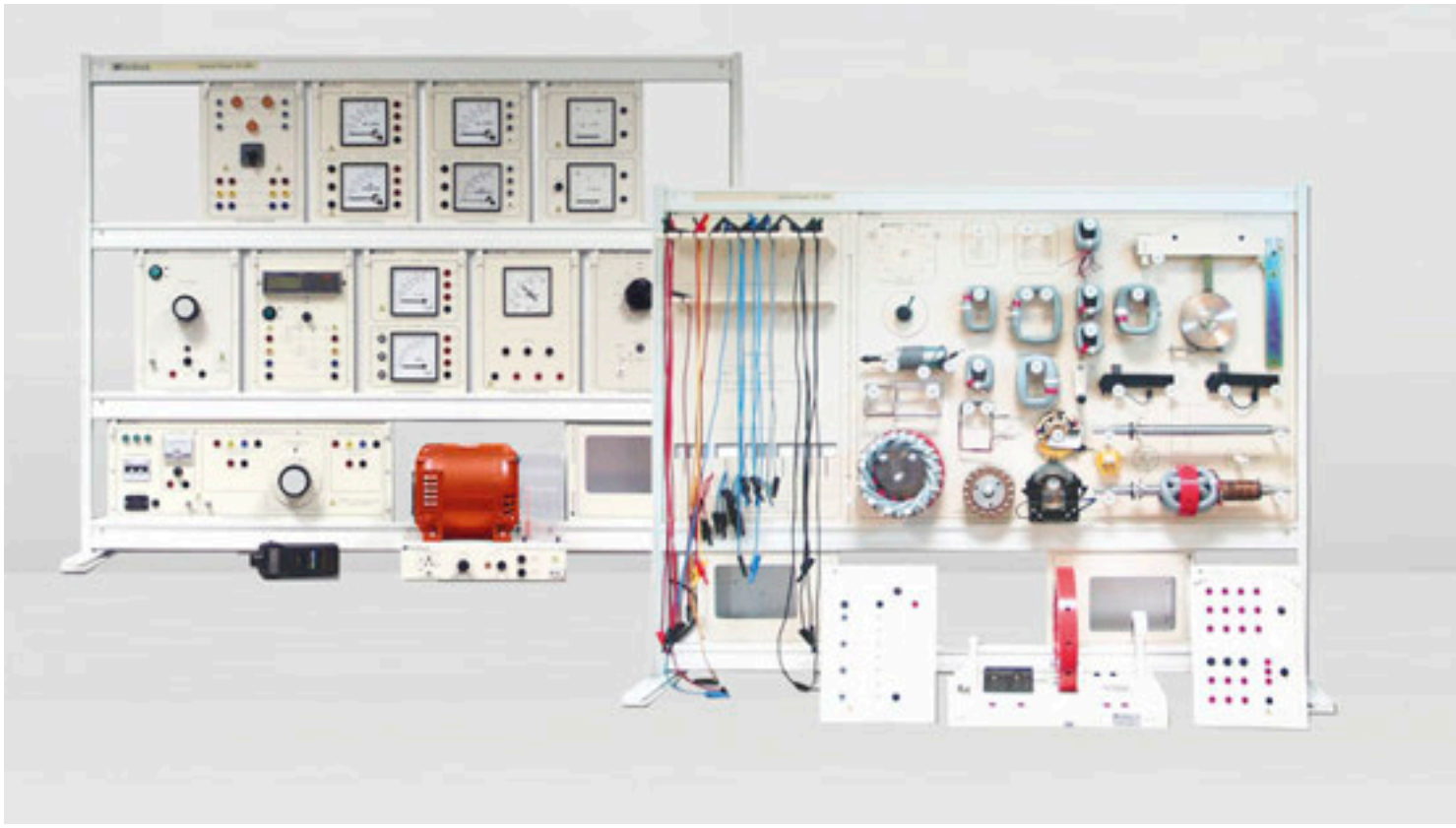
Technical data:

- Dimensions (packed): width 760 mm x depth 420 mm x height 900 mm
- Weight: gross 19 kgs, net 16 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	61-400	Electromagnetic & Magnetic
1	68-200	a.c./d.c. Electronic Wattmeter 1000V 10A
1	91-207	PACK OF 4 FEET

61-022	Magnetic & Electromagnetic Principles Trainer



3.3 Dissectible Machines System

Complete Dissectible Machines System

This trainer provides all the components to perform the full range of student assignments using the Dissectible Machine which enables construction and investigation of different machine assemblies. The System is used to study a wide range of topics, from the principles of magnetic circuits and electrical machine theory through to three phase synchronous machines. The bench-top free-standing frames divide the equipment into two distinct areas. One frame specifically holds all the component parts of the Dissectible Machine on an inventory control panel that also includes connecting lead storage and component storage for couplings. The second frame houses the workstation. It consists of a wide range of a.c. and d.c. meters, resistive and capacitive loads and power supplies. The system provides a hands-on approach to the understanding of electrical machines principles.

System Components

- Baseplate
- Frame ring
- Shaft
- Coupling
- Fixed & removable bearing housings
- Wound stator
- Squirrel cage rotor
- Hand crank
- Centrifugal switch
- Brush holders & brushes
- Commutator / slip rings
- Interpoles
- Armature poles & hub
- Field poles
- Armature, field & interpole coils
- Compound field coils
- Tools & hardware

CURRICULUM COVERAGE

- Elementary a.c. & d.c. generators
- d.c. series motor & generator
- d.c. shunt motor & generator
- d.c. compound motor & generator
- d.c. separately excited generator
- Single phase a.c. induction motor, squirrel cage, 2 pole & 4 pole
- Single phase a.c. series universal motor
- Single phase a.c. repulsion motor
- Single phase a.c. synchronous motor/ generator, 2 pole & 4 pole
- Single phase a.c. generator, rotating field
- Single phase a.c. generator, rotating armature
- Three phase a.c. induction motor, squirrel cage, 2 pole & 4 pole
- Three phase a.c. synchronous motor, 2 pole
- Three phase a.c. synchronous generator, 2 pole
- a.c. brushless generator
- Stepper motors
- Shaded pole induction motor
- Split field series motor
- Dynamic braking of a d.c. motor
- Power factor correction of a.c. motors
- Sychronisation
- Synchronous motor characteristics
- Pole-changing induction motor
- d.c. shunt motor faults
- 4 pole induction motor faults

Technical data:

- Three phase supply input of 400 - 415 V a.c. from a five wire system required
- Total power requirement is 6 kVA
- Dimensions (carton 1): 1240 mm x 860 mm x 1430 mm
- Weight (carton1): 144 kg
- Dimensions (carton 2): 940 mm x 680 mm x 1350 mm
- Weight (carton 2): 21 kg

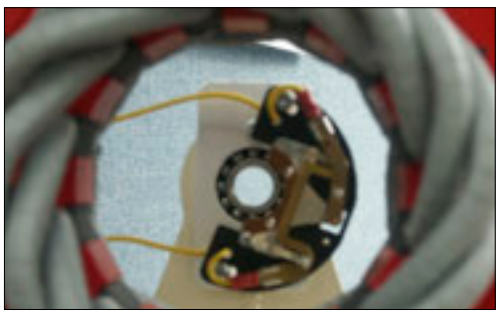
Scope of delivery:

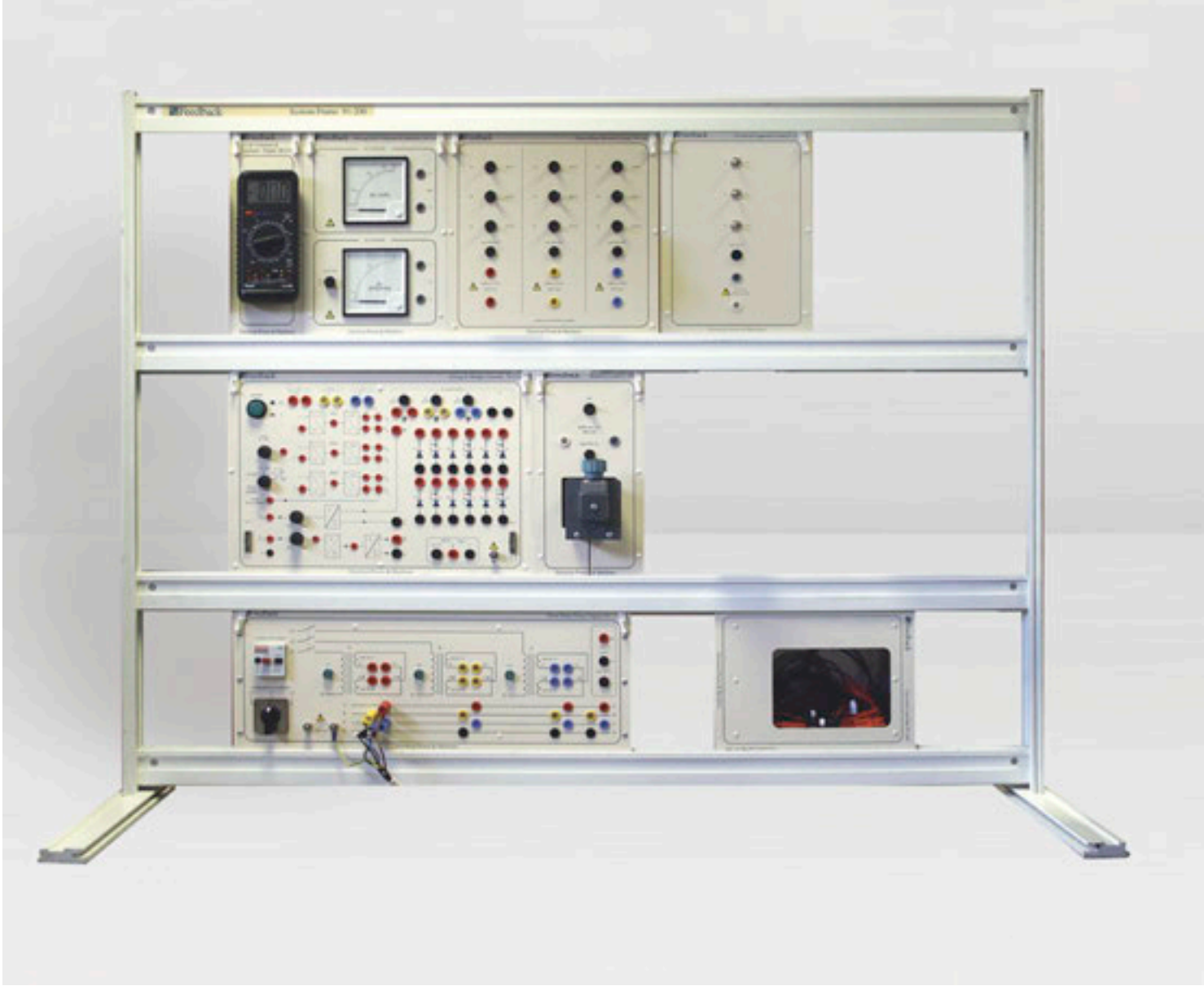
Qty	Cat.-No.	Name
1	60-105-230	Universal Power Supply - 230V
1	60-121-230	Variable ac/dc Supply 230V5A
1	62-100	Dissectible Machines Tutor, basic components
1	62-101	Dissectible Machines Storage
1	62-102	Rotatable Brush Gear
1	63-501-230	Variable Speed Drive 230V
1	65-130	Control Switches
1	67-113	Variable Resistance 200ohm 3A
1	67-190	Resistor/Capacitor Unit
1	67-470	Friction (Prony) Brake
1	68-100	Electronic Single & 3 Phase Measurements
2	68-110	d.c. Voltmeter & Ammeter
1	68-113	d.c. Milliammeter Centre Zero - P
1	68-117	Rectifier Voltmeter & Ammeter
1	68-120-230	Synchronising Lamps
1	68-121	a.c. Voltmeter & Frequency Meter
1	68-470	Digital Optical/Contact Tachometer
1	68-800	Standard Set of Patch Leads
2	91-200	System Frame
4	91-240	Universal Bin
1	91-245	Lead Storage Panel

62-005-230	Complete Dissectible Machines System

FEATURES

- Complete training system comprising 2 panels
- First panel is to display & store components
- Second panel is the workstation (running & testing machines)
- More than 50 types of machine can be assembled
- Choice of conventional or virtual instruments
- Comprehensive theory & experimental manual, fully developed course curriculum
- Thorough construction & testing of electrical machines
- Machines construction from component parts
- Magnetic principles to three phase machines
- Conventional instrumentation pointer type & digital meters
- d.c. single phase & three phase motors & generators
- Protected supplies, meters & connecting leads
- Safety earthing system
- Easy benchtop installation
- Portable machine & system components





3.4 Power Electronics

Thyristor Control Principles

This trainer comprises a firing and bridges panel, a three phase supply panel, electrical loads and instrumentation to enable the study of the principles and operation of single and three phase thyristor circuits. It begins with the principles of uncontrolled rectification and simple control using thyristors, progressing through single and three phase controlled recification and their associated firing circuits. The characteristics of the various thyristor circuits are studied in conjunction with inductive, capacitive and resistive loads. Available in 230 V or 120 V versions.

CURRICULUM COVERAGE

- Uncontrolled rectification circuits - single phase half and full wave, three phase half and full wave, d.c. levels
- Fully controlled rectification circuits - single phase half / full wave, three phase half wave
- Half controlled rectification circuits - single phase & three phase
- a.c. control - single phase & three phase
- Basic firing circuits - firing circuit requirements
- Advanced firing circuits - thyristor phasing, multipulse firing circuits single & three phase

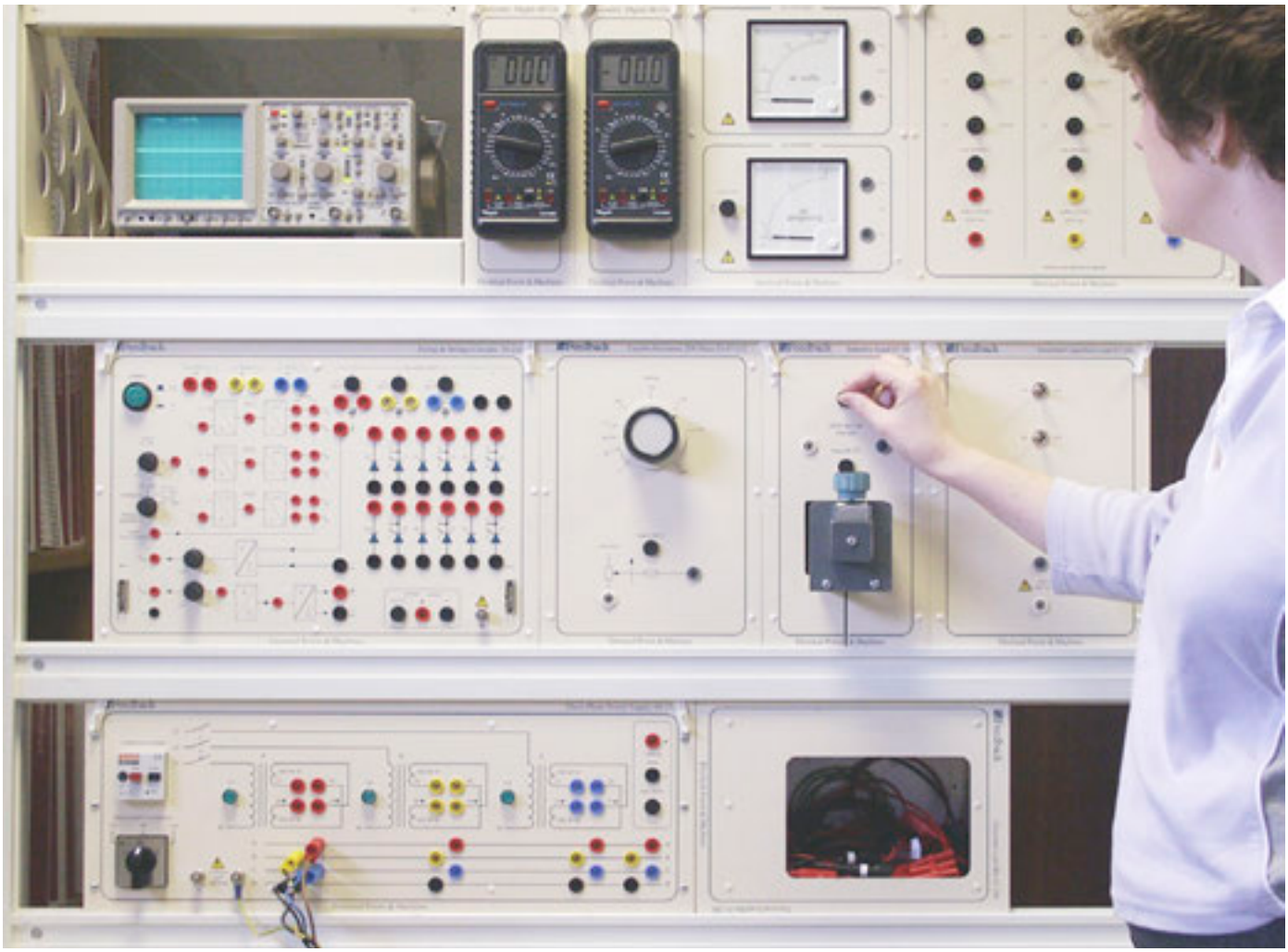
Technical data:

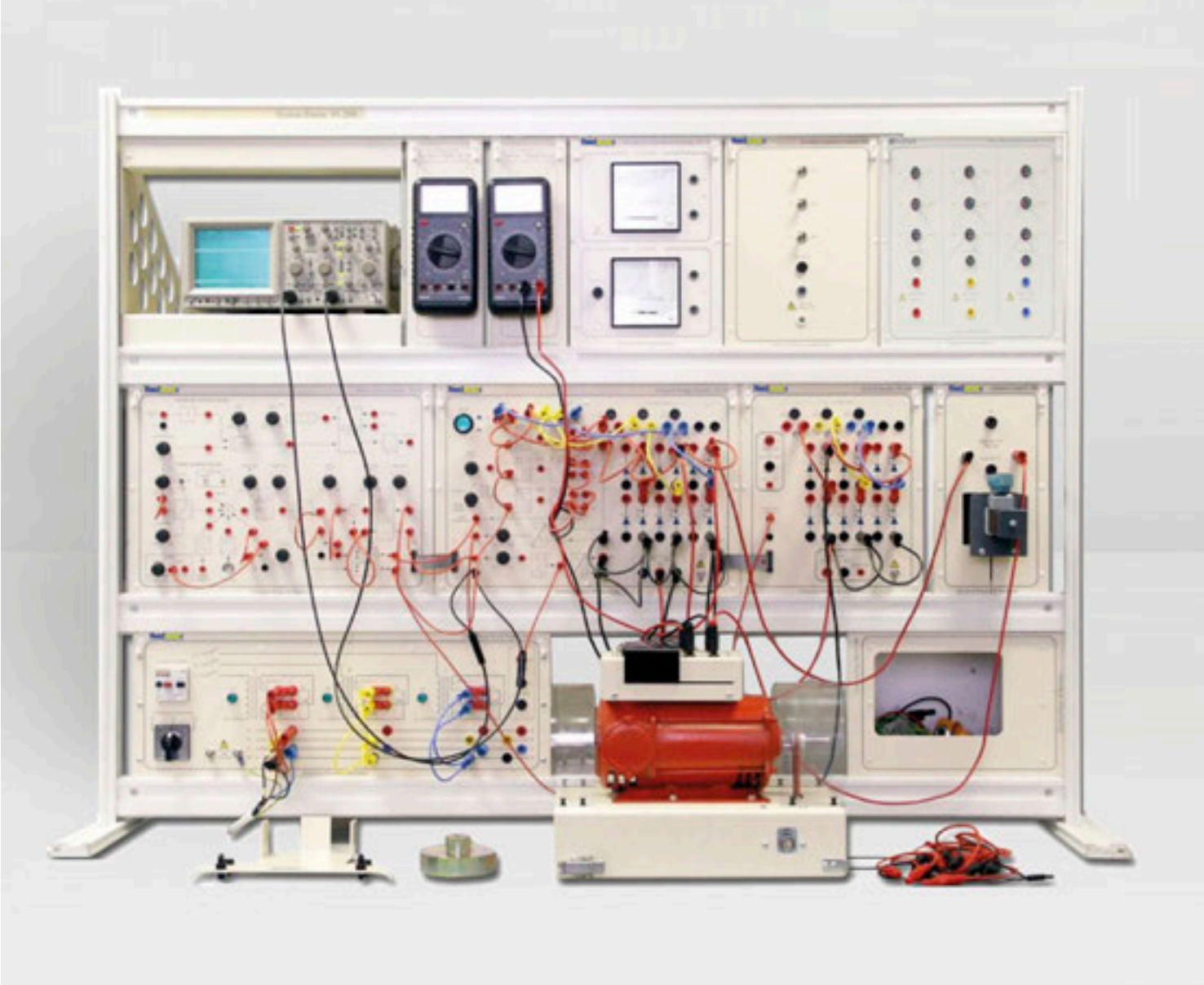
- Dimensions (packed): width 1250 mm x depth 860 mm x height 1130 mm
- Weight: gross 86 kg, net 70 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	60-132-230	3 Phase Supply
1	67-142-230	Switched Three Phase Resistive Load
1	67-201-1	SW CAPACITIVE LOAD 50uF
1	67-300	Inductive Load 700mH
1	68-114	Moving Iron Voltmeter & Ammeter
1	68-116	a.c./d.c. Voltmeter & Ammeter
1	68-800	Standard Set of Patch Leads
1	70-220	Firing & Bridge Circuits
1	91-200	System Frame
1	91-210-1	Oscilloscope/Computer Housing
1	91-240	Universal Bin

70-002-230	Thyristor Control Principles





Thyristor & d.c. Motor Control Trainer

The 70-003 Thyristor & d.c. Motor Control Trainer comprises a firing and bridges panel, a motor control circuits panel, a three phase supply panel, SCR & diodes panel, electrical and mechanical components and instrumentation to enable the study of the principles of single and three phase rectification applied to passive loads and to apply these thyristor circuits, and principles learnt, to the control of d.c. motors. The 70-003 combines the capability and functionality of the 70-002 & 70-005 added together. Available in 230 V or 120 V versions.

CURRICULUM COVERAGE

- Uncontrolled rectification circuits - single phase half & full wave, three phase half & full wave, d.c. levels
- Controlled rectification circuits - single phase half wave & full wave, three phase half wave (star connected supply), three phase full wave, fully controlled bridge
- Basic firing circuits - firing circuit requirements
- Advanced firing circuits - thyristor phasing, multipulse firing circuits single & three phase
- Advanced motor control - feedback measurement, full wave controlled bridge with speed feedback, PI control, full wave controlled bridge with armature voltage feedback and / or current feedback, full wave controlled bridge with technogenerator / feedback

- Four quadrant control - dual converter (single phase), dual converter (three phase), converter selection by error signal, continuous & discontinuous current operation, bi-directional speed & current control, bi-directional control time behaviour, regenerative braking, effects of inertia on system performance

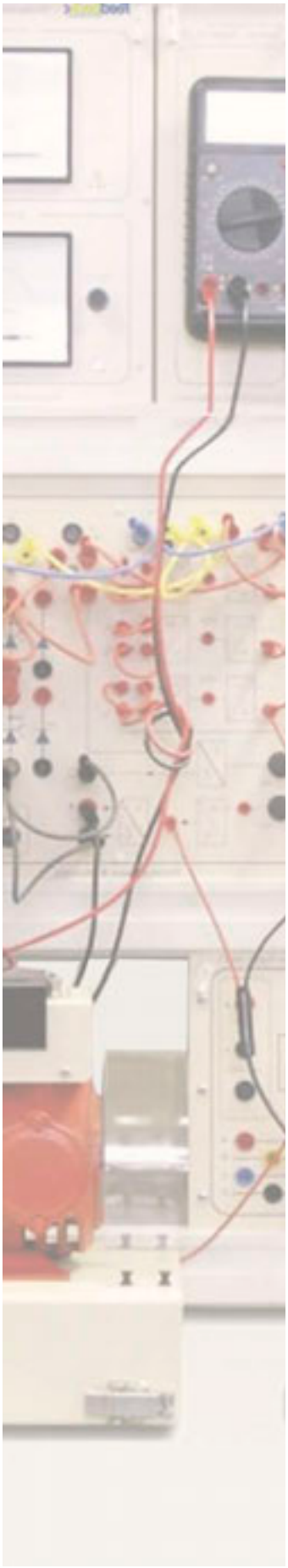
Technical data:

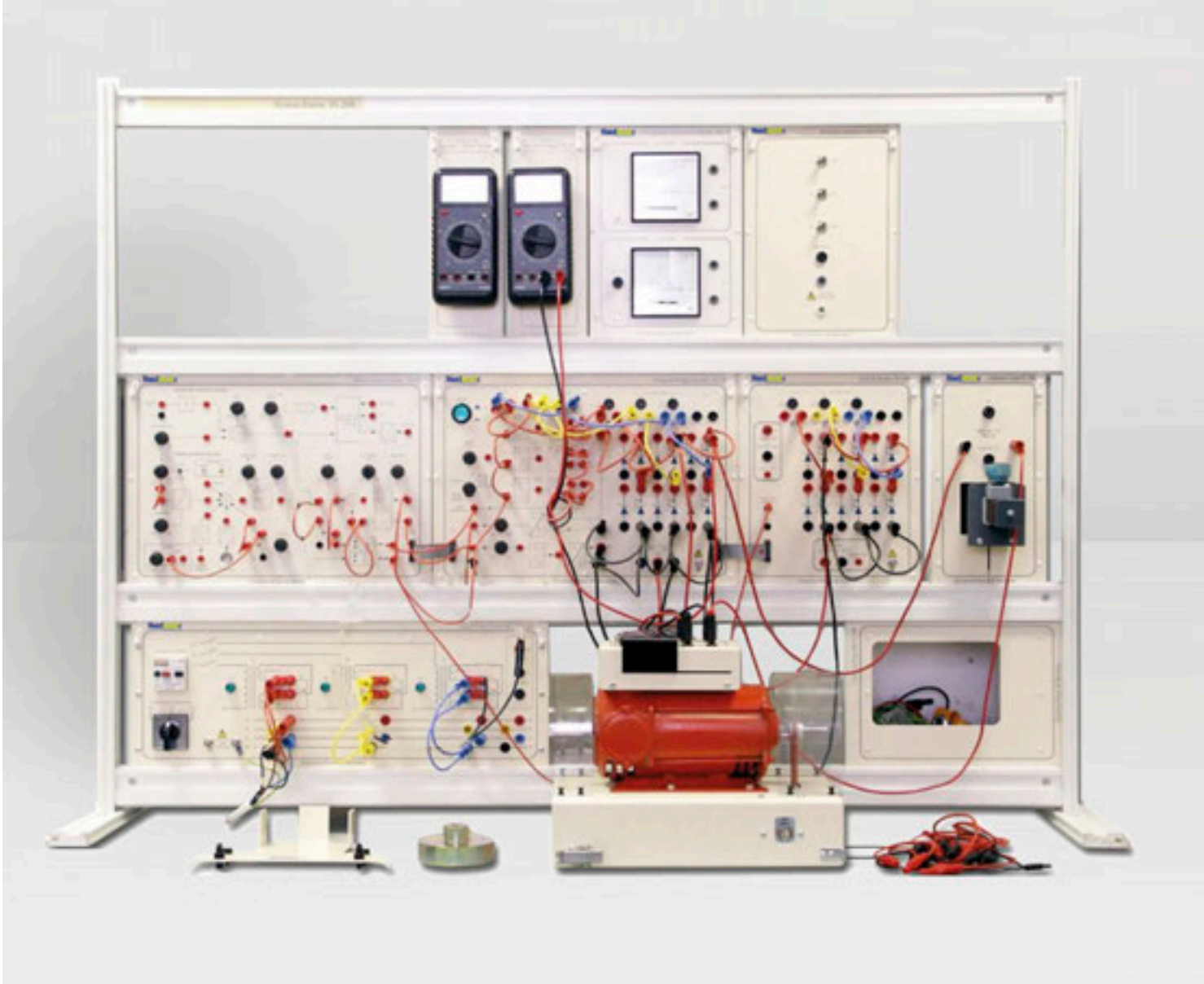
- Dimensions (packed): width 1250 mm x depth 850 mm x height 1430 mm
- Weight: gross 115 kg, net 93 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	60-132-230	3 Phase Supply
1	63-111-230	d.c. Shunt Machine 230V
1	67-113	Variable Resistance 200 ohm 3A
1	67-142-230	Switched Three Phase Resistive Load
1	67-201-1	SW capacitive load 50uF
1	67-300	Inductive Load 700mH
1	67-450	Inertia Wheel
1	67-470	Friction (Prony) Brake
1	68-114	Moving Iron Voltmeter & Ammeter
1	68-116	a.c./d.c. Voltmeter & Ammeter
1	68-430	d.c. Tachogenerator
1	68-470	Digital Optical/Contact Tachometer
1	68-800	Standard Set of Patch Leads
1	68-810	5-pin DIN - DIN Lead
1	70-100	SCR & Diodes
1	70-220	Firing & Bridge Circuits
1	70-310	Motor Control Circuits
1	91-200	System Frame
1	91-210-1	Oscilloscope/Computer Housing
1	91-240	Universal Bin

70-003-230	Thyristor & d.c. Motor Control Trainer





d.c. Motor Control Trainer

The d.c. Motor Control Trainer comprises a firing and bridges panel, a motor control circuits panel, a three phase supply panel, SCR & diodes panel, d.c. motor and instrumentation to enable the study of the principles of single and three phase thyristor circuits and their application in the control of d.c. motors. The equipment is provided with a comprehensive teaching manual including background, theory, thorough experimentation and a questions and answers section. Available in 230 V or 120 V versions.

CURRICULUM COVERAGE

- Basic firing circuits - firing circuit requirements
- Basic motor control - single phase half & full wave controlled bridge, three phase half & full wave controlled bridge
- Advanced firing circuits - thyristor phasing, multipulse firing circuits
- Advanced motor control - feedback measurement, full wave controlled bridge with speed feedback, PI control, full wave controlled bridge with armature voltage feedback and / or current feedback, full wave controlled bridge with tachogenerator / feedback

- Four quadrant control - dual converter (single phase), dual converter (three phase), converter selection
  by error signal, continuous and discontinuous current operation, bi-directional speed and current control,
  bi-directional control time behaviour, regenerative braking, effects of inertia on system performance

Technical data:

- Dimensions (packed): width 1250 mm x depth 860 mm x height 1450 mm
- Weight: gross 112 kg, net 92 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	60-132-230	3 Phase Supply
1	63-111-230	d.c. Shunt Machine 230V
1	67-300	Inductive Load 700mH
1	67-450	Inertia Wheel
1	67-470	Friction (Prony) Brake
1	68-116	a.c./d.c. Voltmeter & Ammeter
1	68-430	d.c. Tachogenerator
1	68-470	Digital Optical/Contact Tachometer
1	68-800	Standard Set of Patch Leads
1	68-810	5-pin DIN - DIN Lead
1	70-100	SCR & Diodes
1	70-220	Firing & Bridge Circuits
1	70-310	Motor Control Circuits
1	91-200	System Frame
1	91-210-1	Oscilloscope/Computer Housing
1	91-240	Universal Bin

70-005-230	d.c. Motor Control Trainer

FEATURES

- Enables automatic plotting of cell IV curves
- Light source simulates solar illumination
- Suitable for undergraduate study & projects
- Espial software featuring virtual instrumentation
- Series & parallel connection methods compared
- Removable project board allowing further study
- Comprehensive theory & experiment manual

3.5 Renewable Energy

Photovoltaic Principles Trainer

The Feedback Photovoltaic Principles trainer is a bench-top instrument which teaches the fundamental principles of photovoltaic energy. The course content is relevant to engineering undergraduates complementing theoretical studies on renewable energy and would also serve as a basis for project work. The photovoltaic effect is a method of energy generation that converts solar radiation into an electrical current by means of semiconductors that are arranged into solar cells. This method of generating electrical energy has seen rapid expansion in recent years as the global pursuit of renewable power generation gains momentum. There is a range of experiments that the student can conduct that are based on Feedback's Espial Courseware which delivers course content, virtual instrumentation and relevant background theory.

CURRICULUM COVERAGE

- Open circuit voltage & short circuit cells in series & parallel
- Maximum power point with resistive load at constant illumination
- Maximum power point with varying illumination & plotting of MPP curve
- Effects of temperature on cell output
- Effects of shading and physical layout
- Bypass diodes
- Solar day simulator
- PV applications

Technical data:

- Dimensions (net): width 315 mm x depth 270 mm x height 455 mm
- Weight (net): 10 kg

PV75-100	Photovoltaic Principles Trainer

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

FEATURES

- Now includes Espial Tools
- Allows teachers & lecturers full edit facilities
- New content & additional assignments
- Free of charge online software updates
- Hands off for teachers, hand on for students
- Self-paced
- Unrestricted, open learning environment
- Practical demonstration of theory & concepts
- Interactive patching diagrams
- Real-time embedded instrumentation
- Automatic instrumentation configuration
- Data export for analysis
- USB connection to hardware
- Editing tools include laboratory architect, assignment builder, Winwiz & manual builder
- Compatible with 32 bit & 64-bit versions of Windows XP, Vista, Windows 7 & Windows 8
- Optional 93-410 Espial Course Manager

Espial Software Package

Espial is used extensively within the telecommunications, control and basic electronics ranges. It is therefore required for use with 12-300 series, 33-033, 53-004 (& 53-200 series), 57-200-USB, 38 series & PV75-100. The teaching content is provided within the software; this includes the underlying theory, written so that it does not make extensive use of mathematics. An important part of the content is to highlight the assignment learning objectives and to convey relevant background to the student. Consequently, the student is well prepared for the practical work using the hardware, and can put the results into perspective. Espial operates so that its appearance and the range of instrumentation depend on the context. So, for example, if the practical-work requires the use of complex instrumentation such a constellation or a phase meter, one is made available, whereas at lower levels of study it would not be provided. Test instruments are initialised with settings suitable for the required measurements, but students are often expected to change them during the practical work. The instruments have cursors to make measurements and their displays may be printed or exported for inclusion in laboratory reports. The 93-420 Espial Software Package now includes Espial Tools. This allows teachers and lecturers full edit facilities with the creation of new content and additional assignments. Laboratory Architect determines the range of assignments available to the students and to configure the look and feel of the Espial environment. Assignment Builder creates new or edits existing laboratory assignments and configures the test equipment. Content is edited using any HTML editor or Microsoft Word. Winwiz creates and edits work board „patching" diagrams. It also configures test equipment monitor points and „further information" points on the practical diagrams. Practical diagrams are edited by Microsoft Visio. (Visio is not supplied as part of Espial) Manual Builder creates a version of the content ready formatted for printing. Free of charge online software updates are included. An optional addition is 93-410 Espial Course Manager, although it is not necessary for equipment operation. The 93-410 creates complete courses containing assignments from any of the installed Espial products plus external resources such as documents, multimedia material, thrid party programs, web urls, or locations on local intranets. Includes Course Designer and Course Presenter.

Technical data:

- Dimensions & weight of a CD

93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	93-410	Espial Course Manager

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

CONTROL ENGINEERING

PROCESS CONTROL

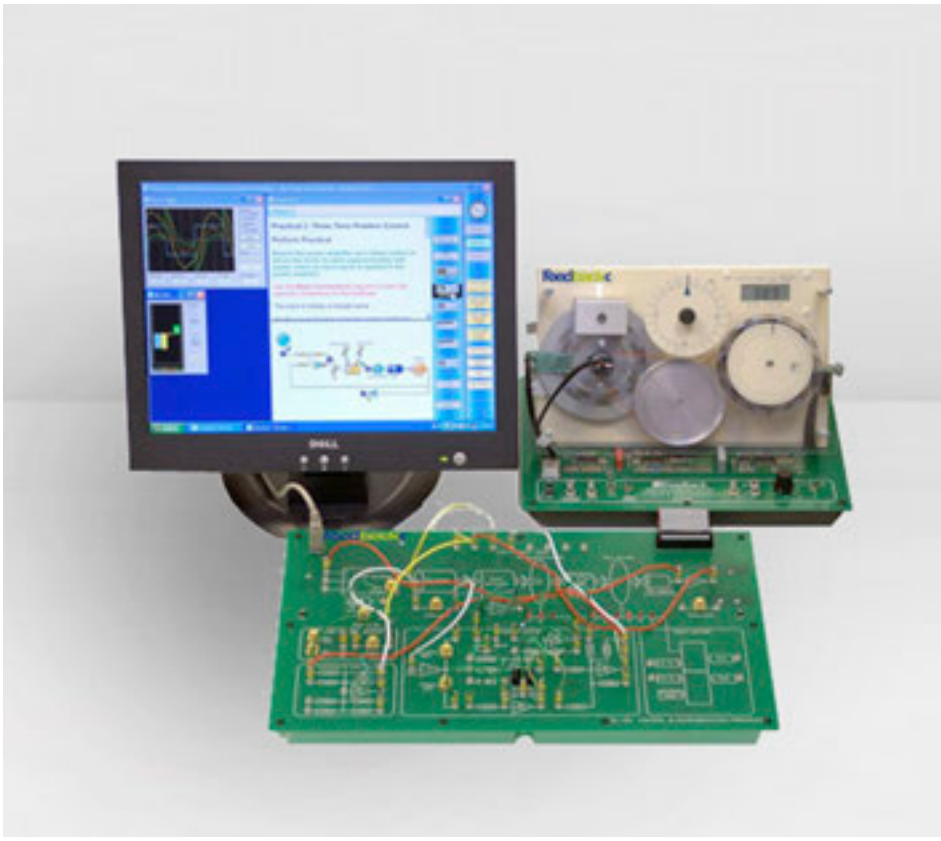
REFRIGERATION & AIR CONDITIONING

PNEUMATICS & HYDRAULICS

CONTROL ENGINEERING

FEATURES

- Teaches the concepts of control, sensors & signal processing
- 24 assignments
- Comprises mechanical plant, electronic unit & power supply
- Analogue & digital controllers
- Analogue & digital sensors
- Digital controller using an embedded processor
- Linear & PWM motor drive
- On board sine, square & triangle wave generator
- Open & closed loop transfer functions with Bode & Nyquist displays
- Functional workstation including power supply
- Espial software with built-in instrumentation required (supplied separately)
- Comprehensive experiment manual



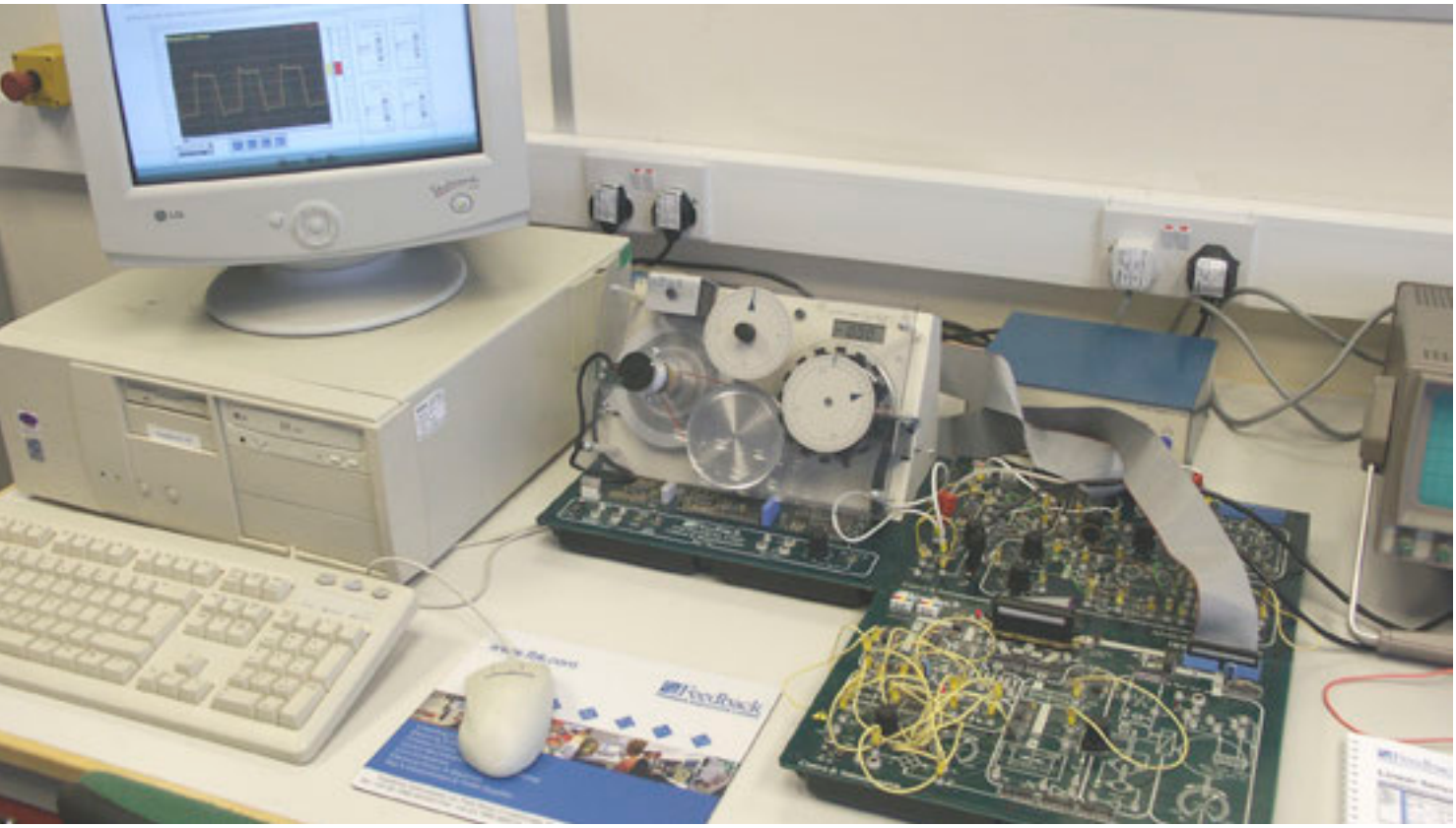
4.1 Control

Control & Instrumentation Principles

This trainer allows the investigation of control system principles by using a servo mechanism comprising a d.c. motor, a variety of sensors and both analogue and digital controllers. Students are also introduced to the fundamentals of transducers and signal processing. The curriculum is divided into twenty four assignments ranging from basic control concepts to more advanced topics such as transfer function analysis.
The product uses Espial software (supplied separately) in which each assignment comprises clear objectives, background, theory and experimentation. All required test instrumentation is provided within the software and includes a four-channel real-time data logger and bar-graph display, voltmeter, frequency counter and transfer function analyser with Bode and Nyquist displays. The system comprises three items, the mechanical unit, electronic unit and a power supply. The mechanical unit is an open-board format containing a servo mechanism and support electronics. It contains a power amplifer driving a d.c. motor connected to a set of transducers and an adjustable eddy current brake. the digital encoders are of pen construction to allow visual inspection of their functionality. A dual-function LCD meter measures either voltages or rotation speed. The electronic unit comprises an open printed circuit board with front panel mimic. It contains analogue signal processing blocks, an embedded controller with USB interface, analogue to digital converters, PWM drive and the instrumentation data converters. A complete block diagram is on the front panel with access via 2 mm sockets to allow each practical to be configured rapidly and the instrumentation blocks connected. LEDs show the output signals from the digital encoders. A function generator block is provided with sine, square and triangle output signals.

CURRICULUM COVERAGE

- Operational amplifiers
- Analaogue transducers
- Motor & eddy current characteristics
- Positive & negative feedback
- Gain & stability
- Velocity feedback
- Following error
- System time constant
- Closed-loop position & speed control
- Analogue controllers (PID)
- Feed-forward systems
- Analogue & digital conversion
- Digital speed & position measurement
- Absolute & incremental encoders
- Digital controllers
- Transfer function analysis
- Open & closed-loop transfer functions



Technical data:

- Tachogenerator 2.5 volts/1000 rpm
- Dimensions: height 150 mm x width 295 mm x depth 220 mm
- Weight: 2.3 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A
1	33-100	Servo Mechanical Unit
1	33-125	Analogue & Digital Control Board

33-033	Control & Instrumentation Principles

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

PC with Windows Vista, Windows 7 or 8, 32-bit or 64-bit or higher with USB interface

FEATURES

- Now includes Espial Tools
- Allows teachers & lecturers full edit facilities
- New content & additional assignments
- Free of charge online software updates
- Hands off for teachers, hand on for students
- Self-paced
- Unrestricted, open learning environment
- Practical demonstration of theory & concepts
- Interactive patching diagrams
- Real-time embedded instrumentation
- Automatic instrumentation configuration
- Data export for analysis
- USB connection to hardware
- Editing tools include laboratory architect, assignment builder, Winwiz & manual builder
- Compatible with 32-bit & 64-bit versions of Windows XP, Vista, Windows 7 & Windows 8
- Optional 93-410 Espial Course Manager

Espial Software Package

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Technical data:

- Dimensions & weight of a CD

93-420	Espial Software Package

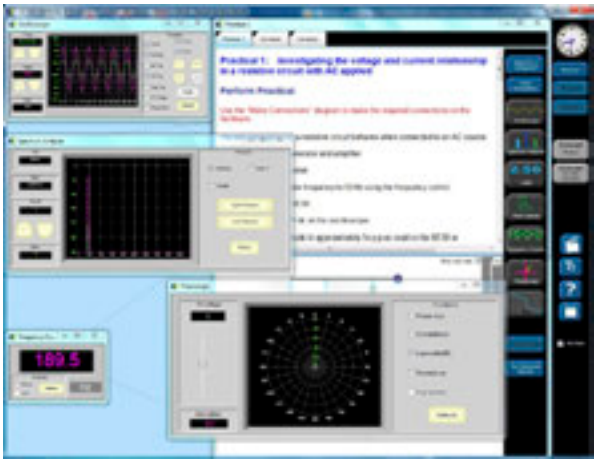
Additionally recommended:

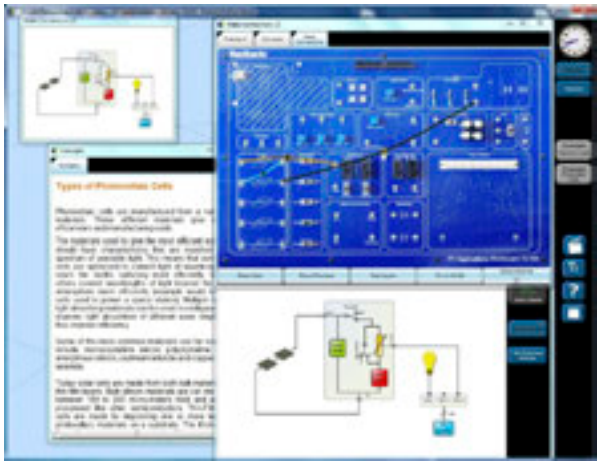
Qty	Cat.-No.	Name
1	93-410	Espial Course Manager

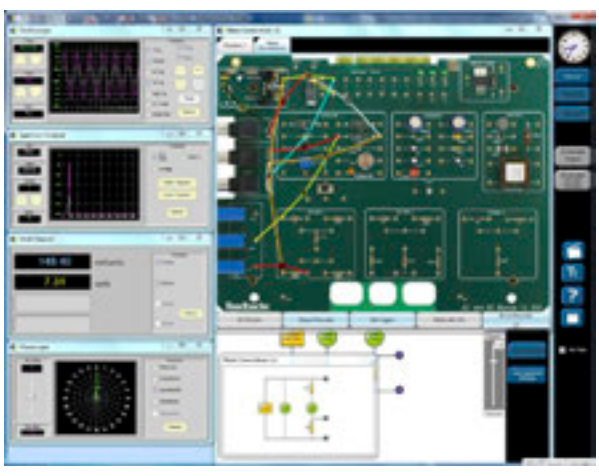
Feedback Instruments Ltd. - ESPIAL Software

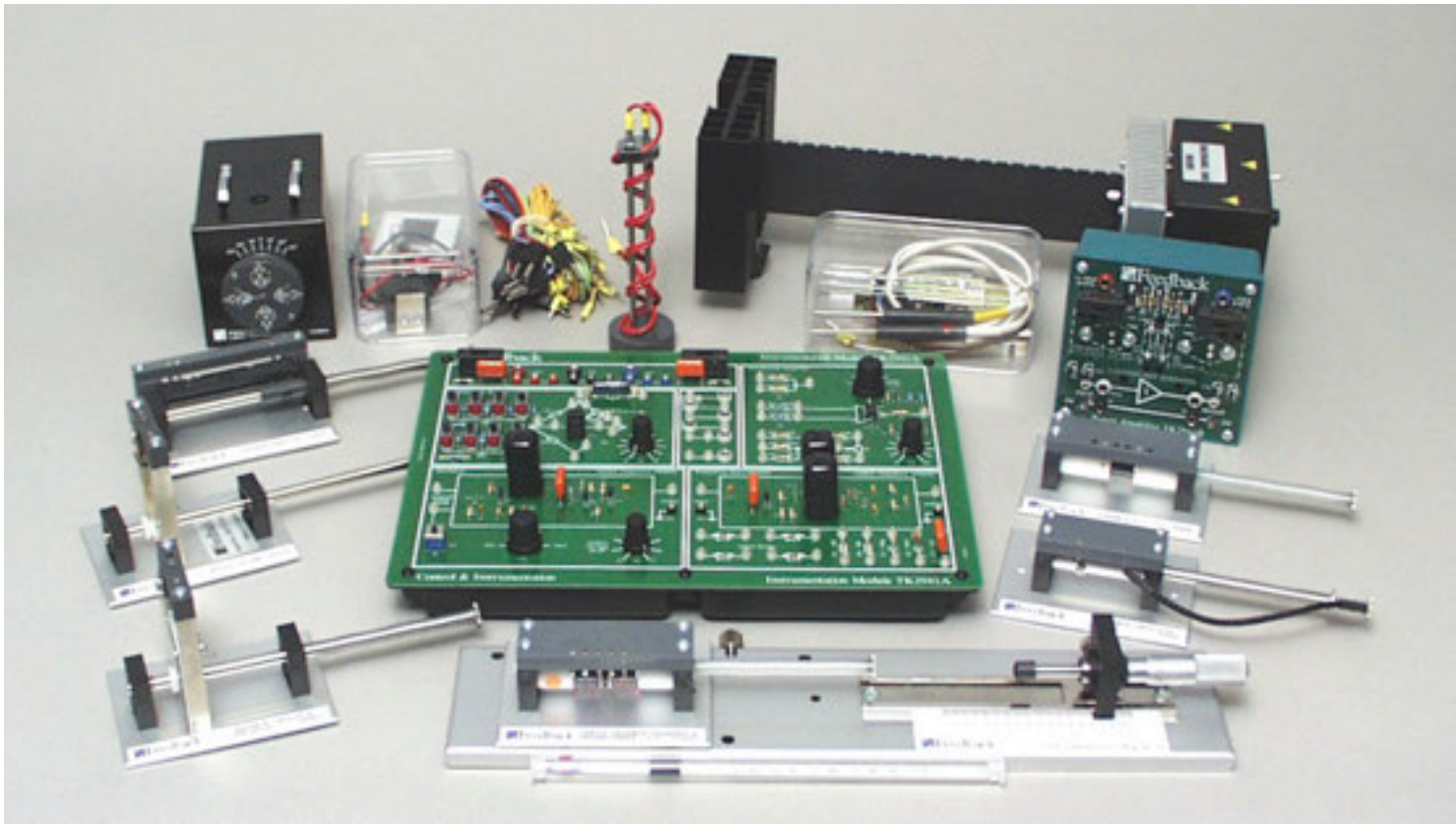
Software and Tools

espial









Transducers Kit

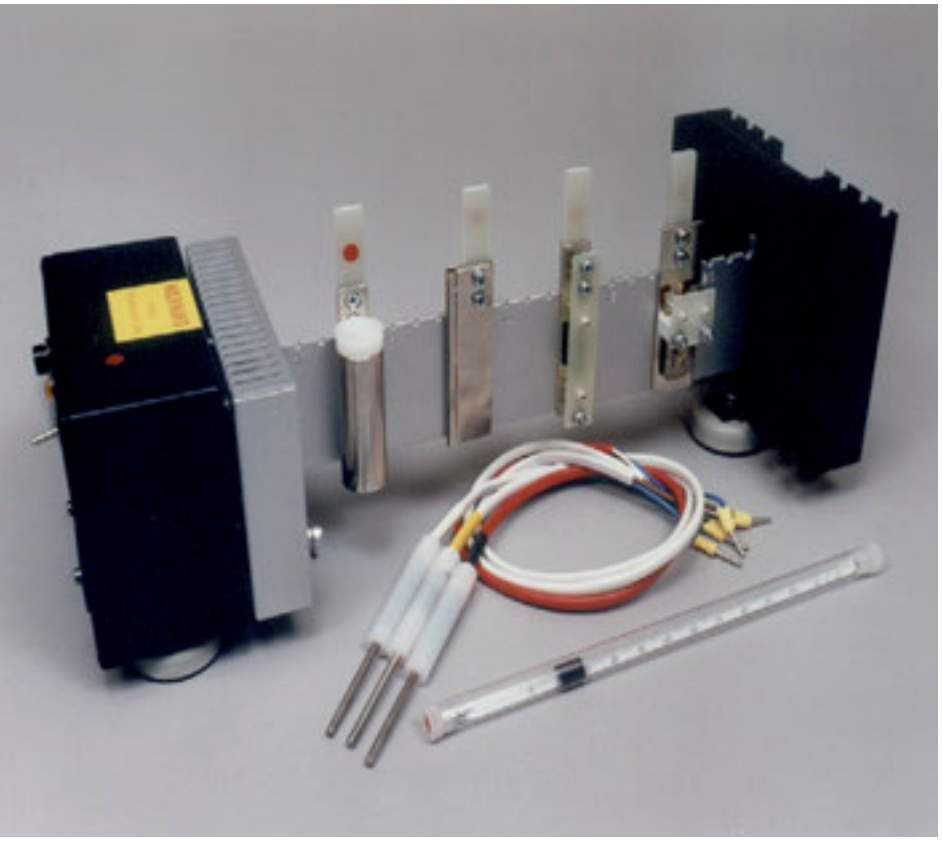
Many engineering applications and systems depend on accurate measurements and monitoring. Transducers are fundamental to the measurement process, consequently the study of different types of transducers, how they operate and how their output signals can be processed, is essential knowledge for engineers. The TK2942-001 Tranducers Kit introduces students to the concepts and understanding of common transducer devices and standard signal conditioning methods via 28 excellent practical assignments. It comprises the Measurements Package TK2941M, the Electro-mechanical Transducers Kit TK2941E, the Heat Transducers Kit TK2941H, the Light Transducers Kit TK2941L, the Power Supply 01-100 and includes all leads, accessories and courseware. The measurements package is an instrumentation module with signal conditioining circuitry and includes a wheatstone bridge, oscillator, operational amplifier, discriminator and power amplifer. The electro-mechanical kit includes 6 linear displacement transducers, namely a linear variable resistor, variable inductor, variable area capacitor, linear variable differential transducer (LVDT), variable distance capacitor and a strain gauge. The heat transducers kit includes 4 thermal devices and a heat bar assembly with temperature gradient. It includes a thermistor, platinum resistance, a bi-metallic strip and thermocouple. The light transducers kit comprises a light source, photoconductive cell, photodiode and phototransistor. A power supply, leads and theory and experiment manual with 28 comprehensive assignments completes transducers teaching kit.

Purchasing Options

- TK2942-001 Tranducers Kit, or
- TK2942-1 Complete Transducers Kit (which includes TK2942-001 plus function generator, timer counter, oscilloscope, capacitance box, resistance box & digital multimeter)

CURRICULUM COVERAGE

- Electro-mechanical transducers utilising variation in resistance
- Wheatstone bridge
- Amplifiers
- Liquid depth & resistivity
- Displacement
- Strain
- Electro-mechanical transducers utilising variation in capacitance
- Wheatstone bridge
- Variable area & distance
- Use of an oscillator & discriminator in FM systems
- Electro-mechanical transducers utilising variation in inductance
- Electromagnetic inductance
- Variable inductance transducer
- Mutual inductance transistor
- Linear variable differential transformer
- Transducer circuits
- Light transducers
- The nature of light
- Photoconductive cell
- Semiconductor photodiode
- Phototransistor
- Spectral response
- Heat transducers



FEATURES

- Bench-top study of transducers
- Comprehensive manual includes theory, 28 practical assignments and industrial applications
- Uses 14 industrial transducers
- Includes a.c. & d.c. instrumentation schemes
- Minimal set-up times ensure maximum experimentation time
- Comprehensive experiment manual

- Heat distribution
- Thermocouples
- Thermistors
- Resistance thermometers
- Temperature control

Technical data:

- Dimensions (net): Instrumentation module: width 295 mm x depth 220 mm x height 72 mm, power amplifier: width 107 mm x depth 107 mm x height 76 mm
- Weight (net): Instrumentation module 1.0 kg, power amplifer 0.45 kg

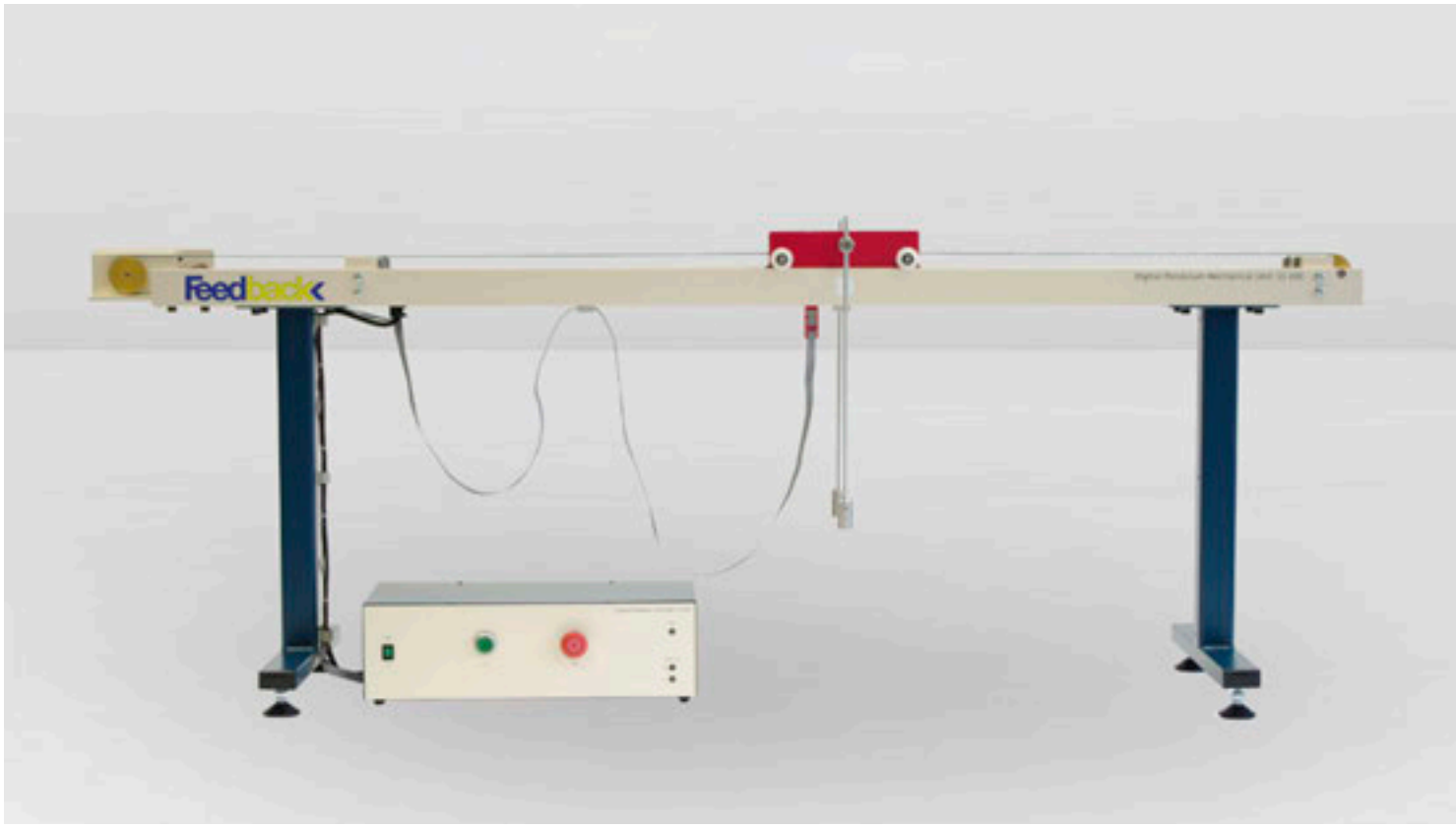
Scope of delivery:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A
1	TK2941E	Electro-mechanical Transducers kit
1	TK2941H	Heat Transducers kit
1	TK2941L	Light Transducers kit
1	TK2941M	Measurements package

TK2942-001	Transducers Kit

The addition of the items below to the TK2942-001 forms the Complete Transducers Kit TK2942-1:

- Function Generator
- Timer Counter
- Oscilloscope
- Capacitance Box
- Resistance Box
- Digital Multimeter



Digital Pendulum System

The Digital Pendulum is a modern version of a classical control problem; that of erecting and balancing a free swinging pendulum in its inverted position or moving a hanging pendulum in a controlled manner. The cart on the track is digitally controlled to swing up (self erecting) and to balance the pendulum into an upright sustained position or to move the cart with pendulum in an unperturbed down position. The cart track is of limited length, imposing constraints on the control algorithm. In pendulum mode the system is used to control the twin arm pendulum from an initial position, hanging at rest with the cart in the centre of its travel along the track, to a final position with the pendulum upright and the cart restored to its central position. In crane mode the control problem is to move the position of the cart without undue movement of the pendulum. This problem is typical of that experienced when controlling a gantry crane. Using MATLAB™ together with the detailed training manuals supplied by Feedback and an Advantech PCI card (which creates an impressive digital control system development environment) the user is guided through the design process using phenomenological process models, dynamics analysis, discrete models identification, controller design, controller tests on the model, controller implementation in real-time applications, implementation of various control strategies and visualisation.

Purchasing Options

- 33-005-PCI, as described here, or
- 33-005I, content as per 33-005-PCI except the 33-005I is not supplied with interface card, cable adaptor & connecting cables

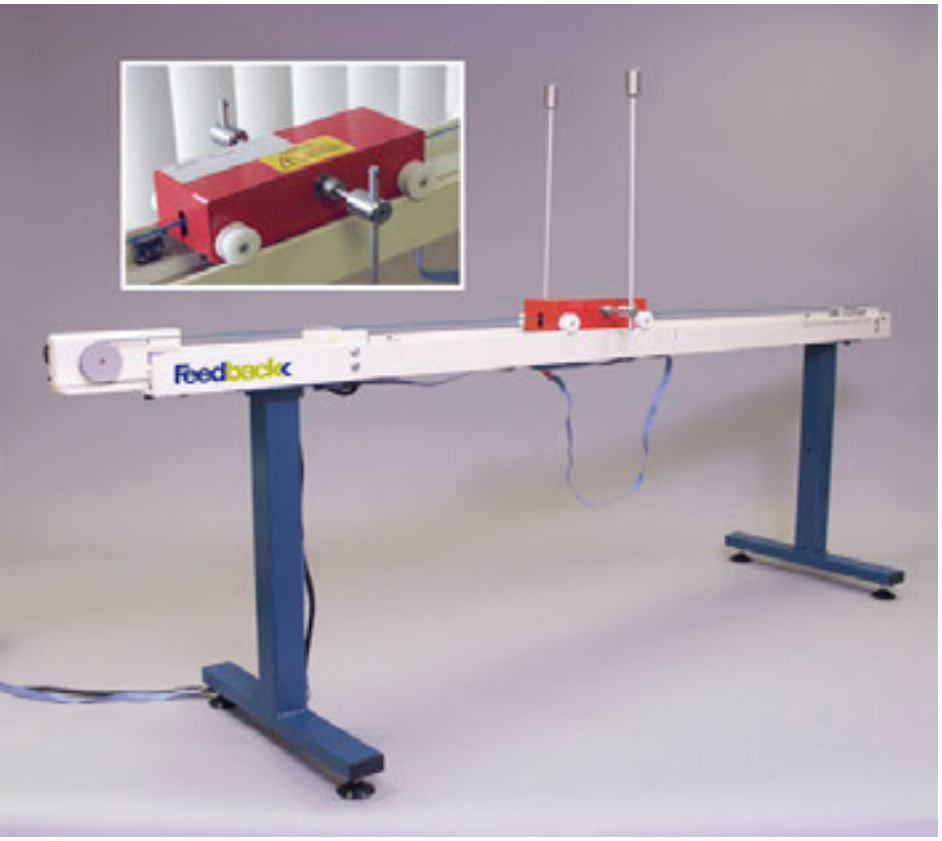
CURRICULUM COVERAGE

Pendulum Model

- Equations of motion
- Non-linear model
- Linear models
- Static friction compensation
- Running a real-time model
- Dynamic model
- Cart model identification
- First model identification
- Using MATLAB control (MATLAB not supplied)
- Crane linear model identification
- Inverted pendulum linear model

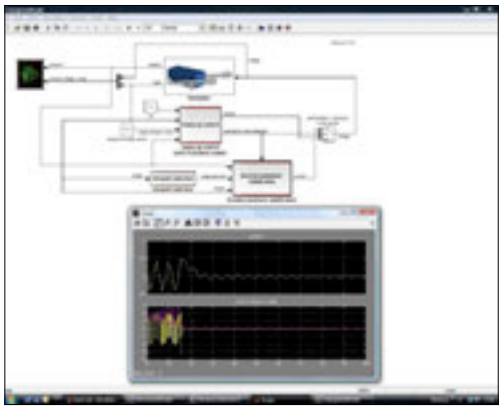
Pendulum set-up control

- Plant control
- PID controller
- PID control of cart model position
- Real-time PID control of cart position
- Real-time swing-up control
- Inverted pendulum control of swing-up
- Inverted pendulum stabilisation
- Crane control
- Combined control techniques
- Swing-up & hold
- Up & down model



FEATURES

- Classic control problem
- MATLAB compatible
  (MATLAB not supplied)
- Dual mode system - crane /
  inverted pendulum /
  self-erecting pendulum mode
- Comprehensive experiment manual



Technical data:

- Operates from either 110 V or 230 V, 50 Hz or 60 Hz
- Power requirements Line voltage: 200/250 V or 100/125 V, 50 or 60 Hz, 100 VA
- Dimensions: length 1720 mm x height 600 mm without cart, height 655 mm with cart,
  depth of stand 410 mm, depth of channel 100 mm
- Weight: 23 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	33-200	Digital Pendulum Mechanical
1	33-201	Digital Pendulum Controller

- Advantech 1711/U interface card, cable adaptor and connecting cables

33-005-PCI	Digital Pendulum System

- Windows PC required suitable for the user's chosen MATLAB version with PCI slot. 32-bit with MATLAB ver 7.6 (2008a) or 64-bit with ver 8.0 (2012b) or later are supported (not supplied)

MATLAB toolbox required to include:- Simulink, Control System, System Identification, Real-Time Windows Target, Matlab Coder, Simulink Coder (not supplied)

FEATURES

- Visually & technically interesting control problem
- Non-linear model
- Unstable system
- MATLAB-compatible version available
- LabVIEW-compatible version available
- All-in-one system
- Analogue operation
- Digital operation
- Comprehensive experiment manual

Magnetic Levitation System (MATLAB Vers.)

This classic magnetic levitation control problem is now presented in a new and innovative form. A 25 mm diameter, hollow steel sphere is suspended in space with visually appealing results and convenient time constants. Both analogue & digital control solutions are implemented. Convenient sockets on the enclosure panel allow for quick changes of analogue controller gain and compensation components. The equipment is self-contained in analogue mode, with built-in power supply. In the digital mode the system operates within a MATLAB™ environment (MATLAB not supplied) which allows the system parameters to be determined and the system to be modelled.

Purchasing Options

- 33-006-PCI (MATLAB version, MATLAB software not supplied), as described here, or
- 33-006I (MATLAB version, MATLAB software not supplied), content as per 33-006-PCI except the 33-006I is not supplied with interface card, cable adaptor & connecting cables, or
- 33-026 (LabVIEW version), comprises 33-210 mechanical unit, 33-301 analogue control interface, national instruments LabView software, interface card & cable, or
- 33-026I (LabVIEW version), content as per 33-026 except the 33-026I is not supplied with National Instruments LabView software, interface card & cable

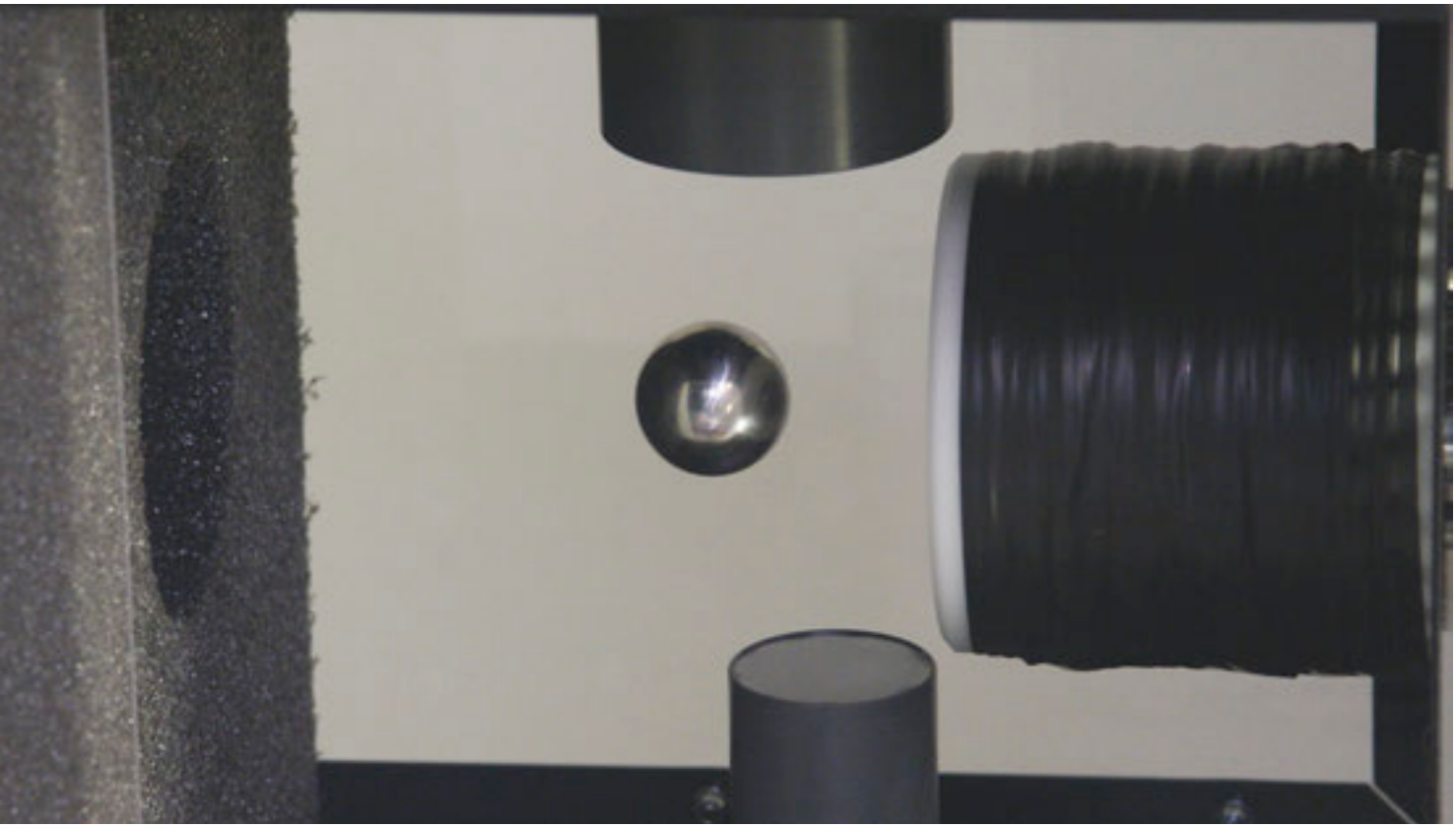
CURRICULUM COVERAGE

Analogue Operation

- Non-linear models
- Unstable systems
- Linearisation about an operating point
- Infra-red sensor characteristics
- Lead-lag compensation
- Perturbation sensitivity
- PD control

Digital Operation

- Non-linear models
- Unstable systems
- Linearisation about an operating point
- A/D & D/A conversion
- State space PD control
- PID control
- Calibration
- Regulation & tracking control



Technical data:

- Dimensions (packed): width 530 mm x depth 450 mm x height 450 mm
- Weight: gross 13.9 kgs, net 12.6 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	33-210	Magnetic Levitation Mechanical
1	33-301	Analogue Control Interface

- Advantech 1711/U interface card, cable adaptor & connecting cables

33-006-PCI	Magnetic Levitation System (MATLAB Vers.)

Additionally recommended:

Qty	Cat.-No.	Name
1	33-006I*	Magnetic Levitation System (MATLAB Vers.)
1	33-026*	Magnetic Levitation System (LabView Vers.)
1	33-026I*	Magnetic Levitation System (LabView Vers.)

* alternative

Additionally required:

- Windows PC required suitable for the user's chosen MATLAB version with PCI slot. 32-bit with MATLAB ver 7.6 (2008a) or 64-bit with ver 8.0 (2012b) or later are supported (not supplied)
- MATLAB toolbox required for 33-006-PCI and 33-006I versions to include:- Simulink, Control System, System Identification, Real-Time Windows Target, MATLAB Coder, Simulink Coder (not supplied)
- NI LabVIEW software required for LabVIEW-compatible versions as described above

Twin Rotor MIMO System

The twin-rotor system demonstrates the principles of a non-linear MIMO (multiple input, multiple output) system, with significant cross-coupling. It's behaviour resembles a helicopter, but the angle of attack of the rotors is fixed and the aerodynamic forces are controlled by varying the speeds of the motors. Significant cross-coupling is observed between the actions of the rotors, with each rotor influencing both angle positions. Using MATLAB™ (not supplied) together with the detailed training manuals supplied by Feedback and an Advantech PCI card which creates an impressive digital control system development environment, the user is guided through the design process using phenomenological process models, dynamics analysis, discrete models identification, controller design, controller tests on the model, controller implementation in real-time applications, implementation of various control strategies and data visualization.

Purchasing Options

- 33-007-PCI, as described here, or
- 33-007I, content as per 33-007-PCI except the 33-007I not supplied with interface card, cable adaptor & connecting cables

CURRICULUM COVERAGE

- 1-degree of freedom (DOF), PID stabilising & tracking horizontal controller
- 1-DOF, PID stabilising & tracking vertical controller with gravity compensation
- 2-DOF, PID stabilising & tracking controller
- Parameter tuning
- Coupled dynamics analysis
- Dynamics decoupling
- Phenomenology analysis
- Model identification

FEATURES

- Visually & technical interesting control problem
- Non-Linear model
- MATLAB compatibility (not supplied)
- Excellent for demonstration laboratory work
- Excellent model for more advanced research work including designing your own control systems
- Comprehensive experiment manual

Technical data:

- Dimensions: width 800 mm x depth 350 mm x height 750 mm
- Weight: 11 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	33-220	Twin Rotor Mechanical Unit

- Advantech 1711/U interface card, cable adaptor & connecting cables

33-007-PCI	Twin Rotor MIMO System

Additionally recommended:

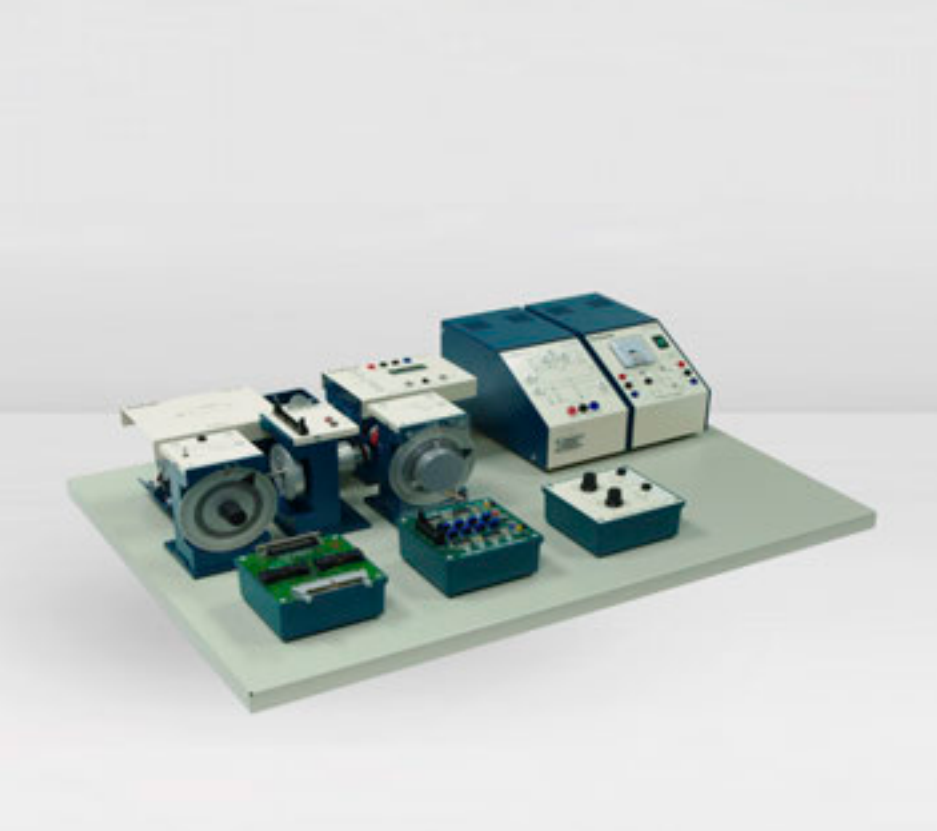
Qty	Cat.-No.	Name
1	33-007I*	Twin Rotor System

* alternative

- Windows PC (not supplied) is required suitable for the user's chosen MATLAB version with PCI slot. 32-bit with MATLAB ver 7.6 (2008a) or 64-bit with ver 8.0 (2012b) or later are supported
- MATLAB toolbox required to include:- Simulink, Control System, System Identification, Real-Time Windows Target, MATLAB Coder, Simulink Coder (not supplied)

FEATURES

- Linear servo control systems
- d.c. motor model
- Analogue servo operation
- Digital servo operation
- MATLAB compatible (not supplied)
- Supplied with a comprehensive theory & experiment manual
- Ideal for laboratory experiments & demonstration
- ideal for advanced research study including designing your own control systems



Precision Modular Control Workshop

The Precision Modular Servo Workshop provides a rapid and direct path from control system design to hardware implementation. The resolution and accuracy of the system and the consistency of it's performance, makes the Precision Modular Servo Workshop ideal for serious study of digital linear servo control systems. As well as allowing study of digital control the Precision Modular Servo Workshop also provides a complete introduction to servos, from fundamental studies of analogue servos through to full, real-time digital control using MATLAB™, SIMULINK™, Real-time Workshop and Real-time Windows Target (not supplied). It is fully supported with laboratory assignments which have been designed to give students a full understanding of the control paths within the equipment.

Purchasing Options

- 33-008-PCI, as described here, or
- 33-008I, content as per 33-008-PCI except the 33-008I does not include the interface card & connecting cables

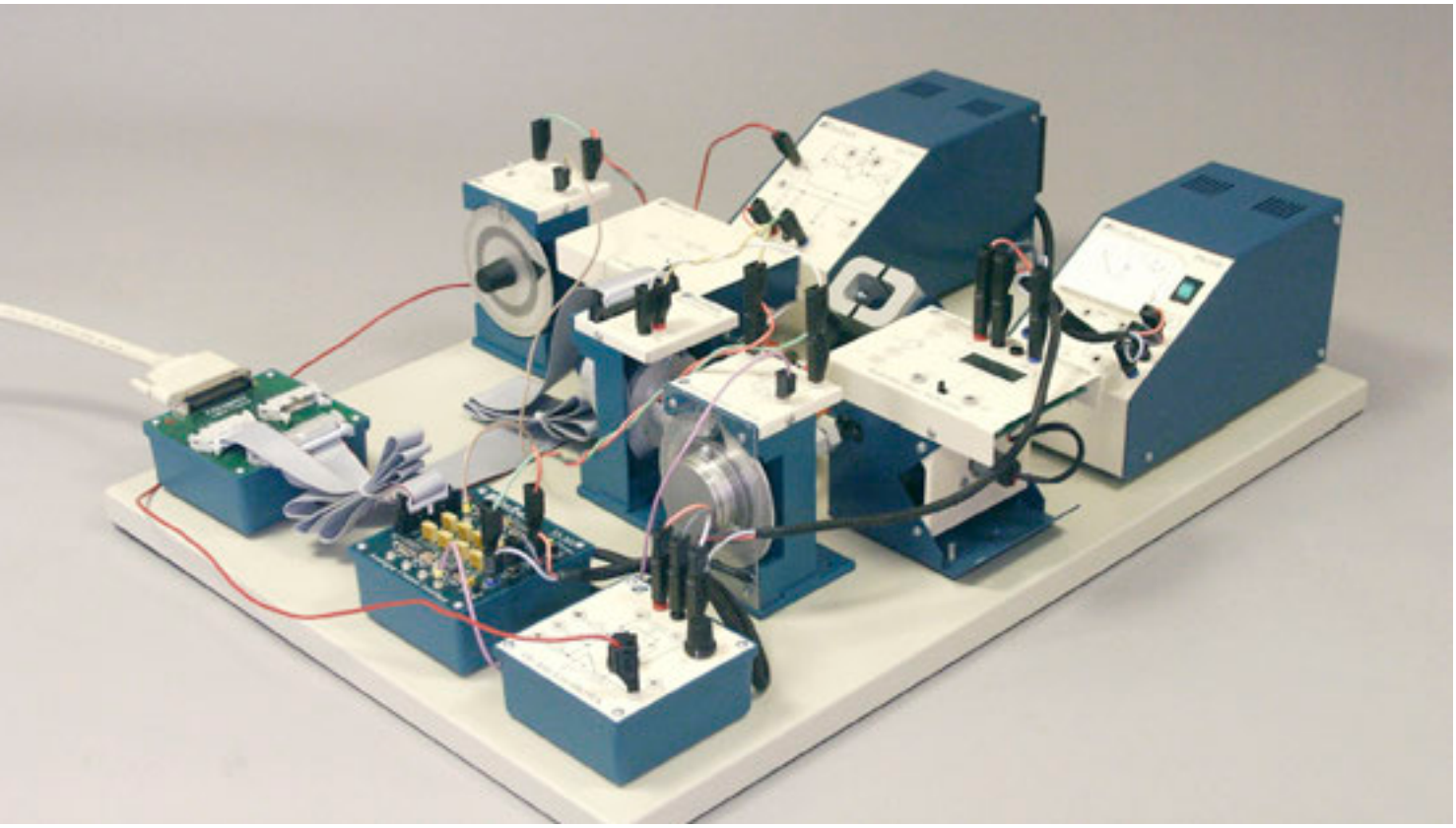
CURRICULUM COVERAGE

- Precision modular servo (PMS)
- Testing the d.c. motor
- PMS model identification - static friction compensation, model 1 & 2 identification
- PMS set-up control - plant control, PID controller, PMS velocity control, PID control of motor velocity, real-time PID control of motor velocity, control signal saturation, anti-wind up design, anti-wind up for PMS
- PMS position control - PID control of motor position, real-time PID control of motor position, position tracking
- PMS control, under variable control conditions - simple gain scheduling algorithm, gain scheduling

Technical data:

- Dimensions: width 720 mm x depth 520 mm x height 50 mm
- Weight: 21 kgs

MATLAB



Scope of delivery:

Qty	Cat.-No.	Name
1	33-300	Digital Encoder
1	33-301	Analogue Control Interface
1	MS150	Modular Servo System (d.c., a.c., d.c./a.c, complete system)

- MS150 comprises: MS150A, MS150B, MS150C, MS150D, MS150E, MS150F, MS150H, MS150K, MS150L, MS150X, MS150Z
- Advantech 1711/U interface card & connecting cables

33-008-PCI	Precision Modular Control Workshop

Additionally recommended:

Qty	Cat.-No.	Name
1	33-008I*	Precision Modular Control Workshop

* alternative

- Windows PC (not supplied) required suitable for the user's chosen MATLAB version with PCI slot. 32-bit with MATLAB ver 7.6 (2008a) or 64-bit with ver 8.0 (2012b) or later are supported.
- MATLAB toolbox required to include:- Simulink, Control System, System Identification, Real-Time Windows Target, MATLAB Coder, Simulink Coder (not supplied)

FEATURES

- Interesting control problem based on a „real-life" industrial situation
- Fully compatible with MATLAB (model 33-041)
- Fully compatible with LabVIEW (model 33-042)
- Self-contained floor-standing or bench-mounted equipment
- Four tanks each water level measurement
- Two independently controlled pumps
- Wide range of control scenarios due to flexible ways of coupling tanks
- Basic to advanced level control
- System dynamics modified by easy to change orifice caps
- Supplied with a comprehensive theory & experiment manual

Coupled Tanks System

The Coupled Tanks set-up is a model of a chemical plant fragment. Very often tanks are coupled through pipes and the reactant level and flow has to be controlled. The Coupled Tanks experiment is designed so that the system can be configured. The Coupled Tanks system has 4 translucent tanks each with a pressure sensor to measure the water level. The couplings between the tanks can be modified by the use of seven manual valves to change the dynamics of the system imposing the use of different controllers. Water is delivered to the tanks by two independently controlled, submersed pumps. Step disturbances generation is provided by four manual valves. Drain flow rates can be modified using easy-to-change orifice caps. The Coupled Tanks are controlled by using MATLAB SIMULINK® (not supplied) and the supplied Advantech PCI1711 Interface card. The 33-042 Coupled Tanks System version is for use with LabVIEW. The user may build their own models or use the models supplied together with the curriculum. The process variables can be observed on-screen in plots. Control algorithms are developed, tested on models and then implemented in a real-time application.

Purchasing Options

- 33-041, MATLAB version (MATLAB not supplied) as described here, or
- 33-041I, MATLAB version (MATLAB not supplied), content as per 33-041 except the 33-041I does include the interface card & connecting cables, or
- 33-042, LabVIEW version including the main unit, LabView software, interface card & connecting cables, or
- 33-042I, LabVIEW version with content as per 33-042 except the 33-042I does not include the LabView software, interface card & connecting cables

CURRICULUM COVERAGE

- Non-linear model
- Linearisation
- Linear model simulation
- 1 tank & 2 tank identification
- PID control of water levels in top tanks
- PID control of water levels in bottom tanks
- Parallel PID control in two double tank columns
- Cross-coupling introduction & analysis
- Dynamics decoupling with cross-coupling identification
- PID control with decoupling
- Disturbance compensator with PID control

Technical data:

- Dimensions: floor-standing: 1700 mm x 680 mm x 450 mm, bench-mounted: 1360 mm x 680 mm x 450 mm
- Weight (net) : 36 kgs
- Reservoir tank capacity: 32 litres

Scope of delivery:

Qty	Cat.-No.	Name
1	33-230	COUPLED TANKS

- Interface card & connecting cables

33-041	Coupled Tanks System

Additionally recommended:

Qty	Cat.-No.	Name
1	33-041I*	Coupled Tanks
1	33-042*	Coupled Tanks
1	33-042I*	Coupled Tanks

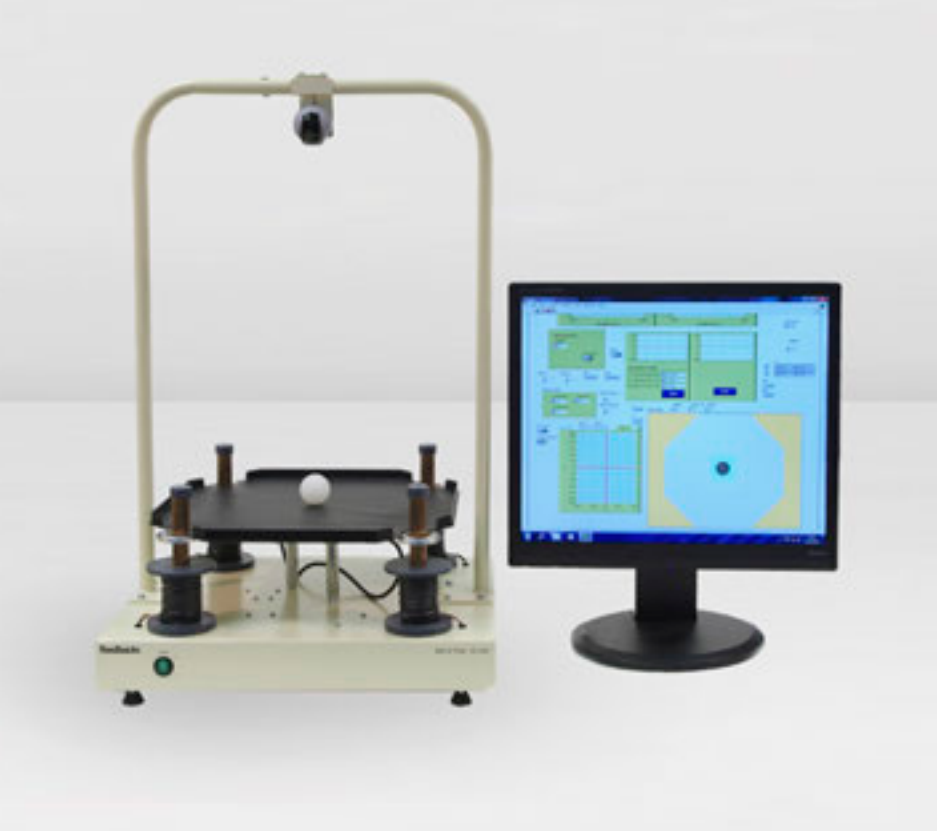
* alternative

Additionally required:

- Windows PC (not supplied) suitable for the user's chosen MALAB version with PCI slot. 32-bit with MATLAB ver 7.6 (2008a) or 64-bit with ver 8.0 (2012b) or later are supported.
- MATLAB toolbox to include:- Simulink, Control System, System Identification, Real-Time Windows Target, MATLAB Coder, Simulink Coder (not supplied)
- NI LabVIEW software required for LabVIEW-compatible units as described above

FEATURES

- Intriguing control experiment
- Progressive student exercises
- Enables study of real-time control of a non-linear & unstable process
- Implementation of digital control techniques using NI LabVIEW
- Ball position sensing & image processing using USB camera
- Open and closed loop configurations
- Fully assembled plant with integral power supply
- Open architecture, design-orientated system
- Suitable for undergraduate courses in electrical, electronic and mechanical engineering
- Comprehensive theory & experiment manual



Ball & Plate Control System

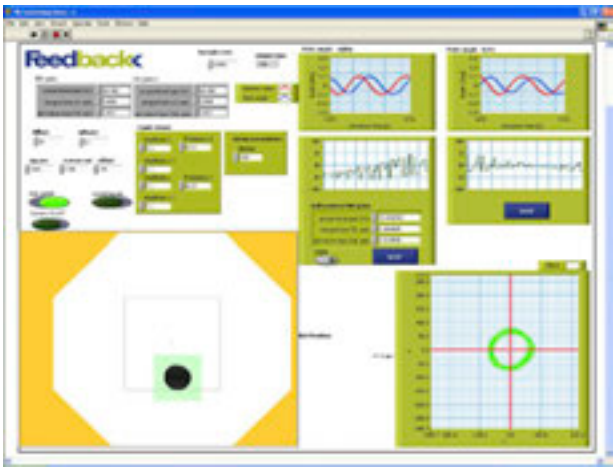
The Ball and Plate Control System is controlled by NI LabVIEW using a NI interface card and demonstrates a classic control problem of balancing a sphere on a flat surface and maintaining its position. It can then be programmed to make the ball describe a circular or any other shaped path around the plate. The unique electromagnetic table actuation enables the study of this unstable system in real-time using sophisticated controllers in NI LabVIEW. The progressive nature of the student exercises enables the study of the problem from first principles to more advanced control concepts. The product provides a useful insight into control engineering at all levels of undergraduate study and enables advanced users to model and control the Ball and Plate using their own strategy.

Purchasing Options

- 33-052, LabVIEW-compatible version, as described here, or
- 33-240, LabVIEW-compatible version with content as per 33-052 except 33-240 does not include the LabVIEW software, interface card & connecting cables

CURRICULUM COVERAGE

- Non-linear model simplification
- Non-linear model testing
- Model linearization
- Plant control
- PID controllers
- Plate orientation control
- PID control of plate orientation
- Real-time PID control
- 1-D PID control of ball position
- 2-D PID control of ball position
- Real-time trajectory tracking with ball



POWERED BY NATIONAL INSTRUMENTS LabVIEW

Technical data:

- Dimensions (net): width 460 mm x depth 390 mm x height 730 mm
- Weight (net): 15 kg

Scope of delivery:

- LabView software, interface card & connecting cables

33-052	Ball & Plate Control System

Additionally recommended:

Qty	Cat.-No.	Name
1	33-240*	Ball & Plate

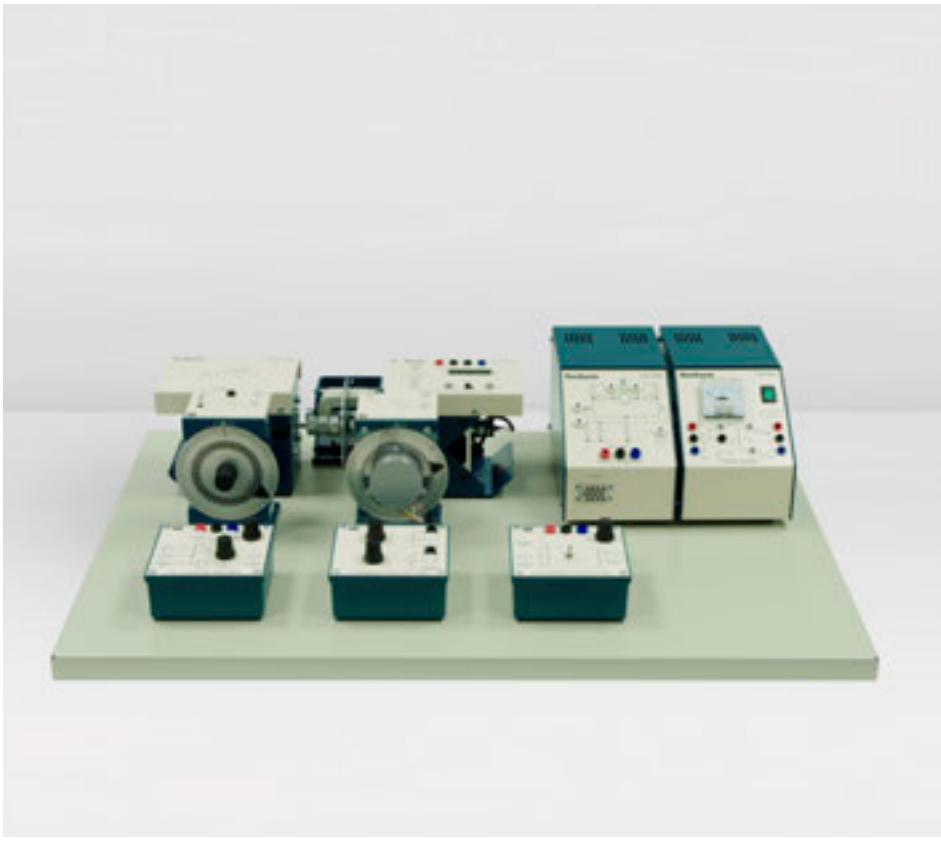
* alternative

Additionally required:

- Windows PC dual or quad core with PCI slot for supplied interface card required

FEATURES

- Modular & flexible
- Self-contained units with mimic diagrams on function blocks
- Units can be investigated individually before building systems
- „Hands on" assembly of working systems
- Magnetic unit bases creating a versatile & stable system
- Robust product used & trusted for many years
- Can be used for advanced work
- Upgrade pack (33-310-PCI) to enable MATLAB compatibility, alternatively see product 33-008-PCI
- Comprehensive theory & experiment manual



Modular Servo System (d.c., a.c., d.c./a.c, complete system)

The modular servo system enables students to study the theory and practice of automatic control systems. It illustrates modern circuit and constructional techniques. The system is modular and, therefore, versatile. Each unit is fitted with a magnetic base which holds the unit to the plastic coated steel baseplate, irrespective of the angle at which the baseplate is positioned. Individual units may be so arranged to create operating block schematic systems and interconnections between the units are made by jumper leads terminated in 4 mm stackable plugs. The modular concept of the MS150 system permits the study of individual units and also, by combination, the investigation and performance testing of complete systems. A series of instructional manuals is supplied to provide comprehensive coverage of servo system theory and assignments.

Purchasing Options

- MS150 d.c. Modular Servo System (comprises units, A, B, C, D, E, F, H, K, L, X & Z), or
- MS150A a.c. Modular Servo System (comprises units A, B, D, E, K, L, R, S, T, U, V, W, X & Z), or
- MS150-2 d.c./a.c. Modular Servo System (comprises units A, B, C, D, E, F, H, K, L, R, S, T, U, V, W, X & Z), or
- MS150-3 Complete Modular Servo System (comprises units A, B, C, D, E, F, G, H, J, K, L, M, R, S, T, U, V, W, X, Y & Z)

Upgrades

- To upgrade from MS150 to MS150-2, purchase the MS150 units R, S, T, U, V, W
- To upgrade from MS150A to MS150-2, purchase the MS150 units C, F, H
- To upgrade from MS150-2 to MST150-3, purchase MS150 units G, J, M, Y

CURRICULUM COVERAGE (MS150)

- Operational amplifiers
- Motor speed characteristics
- d.c. error channel
- Simple position control
- Closed-loop position control
- Simple speed control
- Deadband & step response
- Velocity feedback
- Analysis of simple speed control with speed response
- Position response
- Closed-loop frequency response
- Identification of motor time constants
- Identification of velocity error constant
- Frequency and transient response
- Measurement of following error
- Stability considerations & the use of lead, lag & combined networks
- Tachogenerator feedback & the effect on system performance
- Acceleration feedback
- Linearisation of systems

CURRICULUM COVERAGE (MS150A)

- Motor characteristics
- a.c. tachogenerator
- Motor speed control
- a.c. pre-amplifiers
- Position control system
- Importance of correct phasing on performance
- Compensation using the adjustable notch filter
- Notch filter design exercises
- Frequency selective
- Characteristics for the elimination of noise & harmonics
- Detailed analysis of carrier system
- Frequency transformation for compensator techniques
- Principles & measurement of compensation unit characteristics
- Measurement of system characteristics
- Instability
- Reduction in steady following error

CURRICULUM COVERAGE (MS150-2)

Curriculum coverage of MS150 plus MS150A

CURRICULUM COVERAGE (MS150-3)

Curriculum coverage of MS150 plus MS150A plus the following:

- Relay characteristics
- Relay-operated control system
- Following characteristics of relay system
- Effect of backlash on system stability
- Relay-operated speed-control system
- Phase-plane analysis
- Motor charcteristics - trajectories
- Trajectory for a sequence of switchings
- Phase-plane analysis of relay-operated systems
- Rotation of switching lines by velocity feedback
- Waveform sampling
- Sampled data servo control system
- Simulated sampled data control system
- Sampled data process control system - transfer functions of hold circuits and the sampling theorem
- Speed control of an MS150 servo
- Position control
- Following error

Technical data:

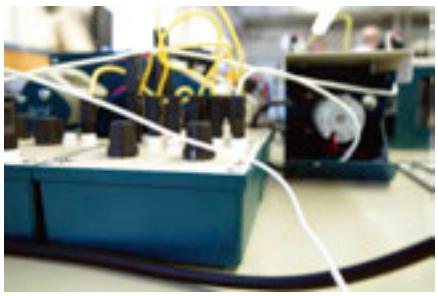
- Dimensions (packed) for MS150, MS150A, MS150-2 or MS150-3: width 720 mm x depth 520 mm x height 203 mm
- Weight (packed): MS150 18 kgs, MS150A 20 kgs, MS150-2 23 kgs, MS150-3 25 kgs

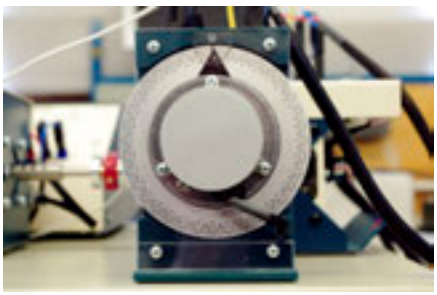
Scope of delivery:

- MS150 - A, B, C, D, E, F, H, K, L, X, Z
- MS150A - A, B, D, E, K, L, R, S, T, U, V, W, X, Z
- MS150-2 - A, B, C, D, E, F, H, K, L, R, S, T, U, V, W, X, Z
- MS150-3 - A, B, C, D, E, F, G, H, J, K, L, M, R, S, T, U, V, W, X, Z

MS150	Modular Servo System (d.c., a.c., d.c./a.c, complete system)

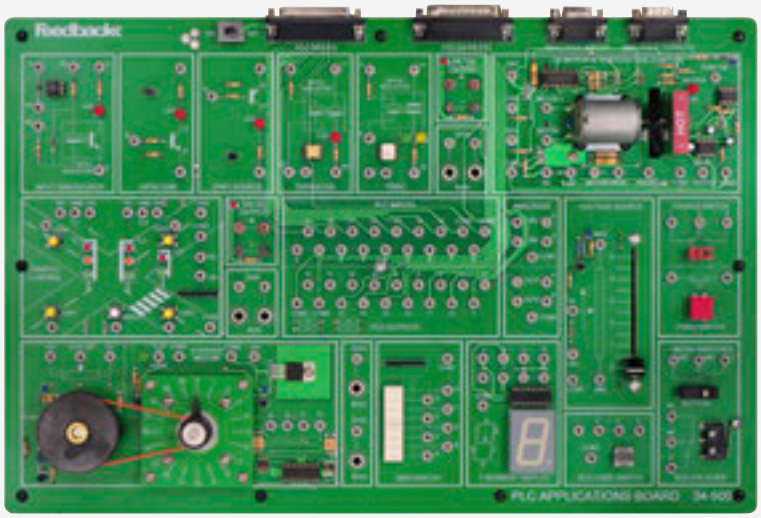
- Upgrade from MS150 to MS150-2, purchase units R, S, T, U, V, W
- Upgrade from MS150A to MS150-2, purchase units C, F, H
- Upgrade from MS150-2 to MS150-3, purchase units G, J, M, Y





FEATURES

- Complete integrated range
- Plug and play with cabled system
- d.c. motors & temperature control
- Traffic light control
- Stepper motor
- Micro-switches
- Low cost start up with 34-501 Automatic Washing Machine & 34-502 Traffic Sequence control applications (purchased separately)
- Mitsubishi, Siemens & Allen Bradley PLC choices (purchased separately, or use your own)
- Basics to more complex applications
- Programming examples included
- Common PLC connectivity between trainers simplifies connections
- External connection highway by D type connector leads
- On-board connections by 2 mm plug leads
- Designed for those with little or no knowledge of PLCs
- 16 areas of components to study
- Comprehensive theory & experiment manual



4.2 PLC

PLC Trainer

The Feedback PLC Trainer offers the training required to understand and apply both PLC hardware and software programming through the structured students' manual that provides a progressive level of learning. The manual deals with the fundamentals of PLC hardware and software through to basic program writing and more advanced applications, finally to motor control.
The PLC Trainer is an A3 size board that is divided into many individual smaller areas. Each one of these areas contains a number of components that are described and applied to gain an appreciation of their application. PLC programs are available for Allen Bradley, Mitsubishi and Siemens.

CURRICULUM COVERAGE

- Downloading & uploading programs
- Selecting inputs & outputs
- Input & output data processing
- Logic functions AND, OR & inverse
- Understanding flags
- Understanding registers
- Using timers
- Using counters
- Writing programmes to operate devices & control processes
- Simple logic configurations with LED output
- Input from a code switch to internal counter value
- Input code from a code switch to seven segment display
- LED count sequence 1,2,4,8, etc
- LED count sequence 1, 10, 100, etc
- LED traffic light sequencing, single and dual ways (cross-roads)

- Stepper motor device sequencing, forward & reverse
- Stepper motor positioning to a desired point & home position
- Stepper motor device sequencing with counter & display
- d.c. motor speed PWM control

Technical data:

- Dimensions (packed): width 460 mm x depth 310 mm x height 110 mm
- Weight (packed): 2 kg

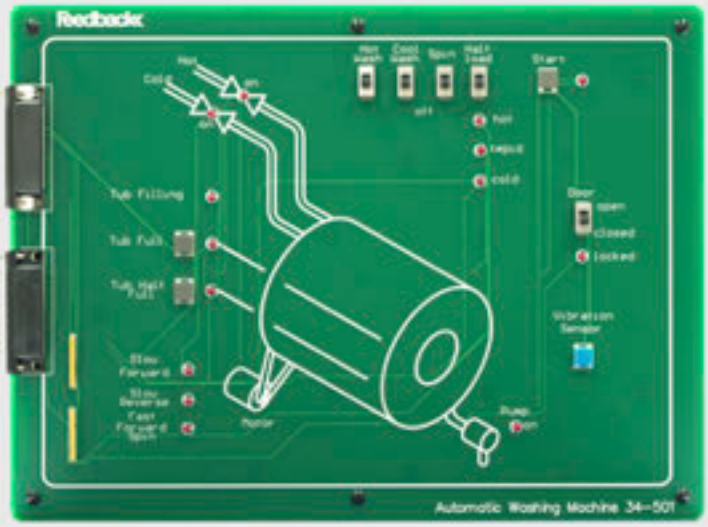
34-500	PLC Trainer

PLC required, recommend the following options

- 34-020 Mitsubishi PLC
- 34-020-1 Mitsubishi PLC pre-wired
- 34-040 Allen Bradley PLC
- 34-040-1 Allen Bradley PLC pre-wired
- 34-060 Siemens PLC
- 34-060-1 Siemens PLC pre-wired
- PC running Windows XP or higher required for use with PLC

FEATURES

- Real-life application
- Demonstrates sequential control
- Initial process conditions can be set
- Demonstrates to use of interrupts
- Low cost PLC application
- Used with the major PLC types
- Pre-wired or „wire your own" Mitsubishi, Allen Bradley & Siemens PLCs available (supplied separately) or use your own
- Comprehensive experiment manual



Washing Machine – PLC Application

In this washing machine PLC application initial program conditions can be set by switched selection. This allows the development of several different programs that can be used as conditional jumps; depending on how the initial conditions have been set. Using push-button switches to simulate interrupt conditions, such as unbalanced drum load, more complex control problems can be developed.

CURRICULUM COVERAGE

- Logic fundamentals
- Basics of PLC programming
- Developing ladder logic programs
- Programming timers

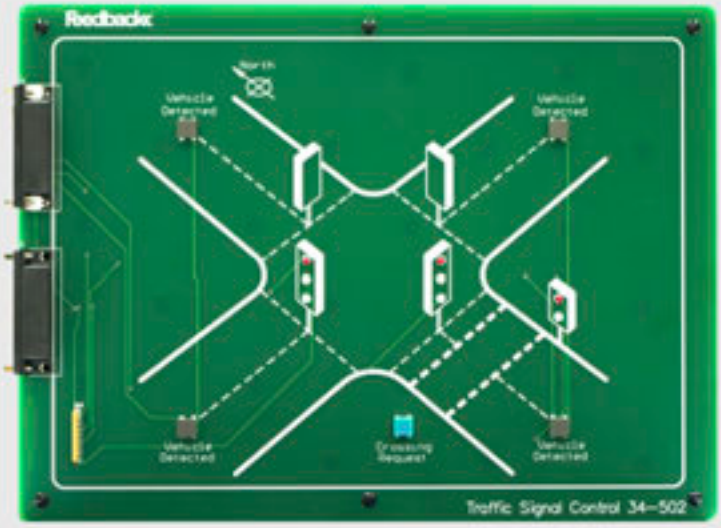
Technical data:

- PLC requirements - 14 outputs, 9 inputs
- Dimensions (packed): width 330 mm x depth 330 mm x height 150 mm
- Weight (packed): 1.1 kg

34-501	Washing Machine - PLC Application

PLC required, recommend the following options

- 34-020 Mitsubishi PLC
- 34-020-1 Mitsubishi PLC pre-wired
- 34-040 Allen Bradley PLC
- 34-040-1 Allen Bradley PLC pre-wired
- 34-060 Siemens PLC
- 34-060-1 Siemens PLC pre-wired
- PC running Windows XP or higher required for use with PLC



FEATURES

- Real-life application
- Timed sequence control
- Interrupt device control
- Easy to understand process
- Low cost application
- Operates with major PLC types
- Pre-wired or „wire your own" Mitsubishi, Allen Bradley & Siemens PLCs available (supplied separately), or use your own
- Comprehensive experiment manual

Traffic Lights – PLC Application

This simple sequence PLC application allows traffic light control of a cross-road to be implemented on a timed sequence basis. The control program can be further developed to cope with interrupts generated from pedestrian crossing requests or off-peak vehicle detector inputs.

CURRICULUM COVERAGE

- Programming counters
- Setting initial conditions
- Time-based process control
- Use of interrupts & emergency stop

Technical data:

- PLC requirements - 8 outputs, 5 inputs
- Dimensions (packed): width 330 mm x depth 330 mm x height 150 mm
- Weight (packed): 1.1 kg

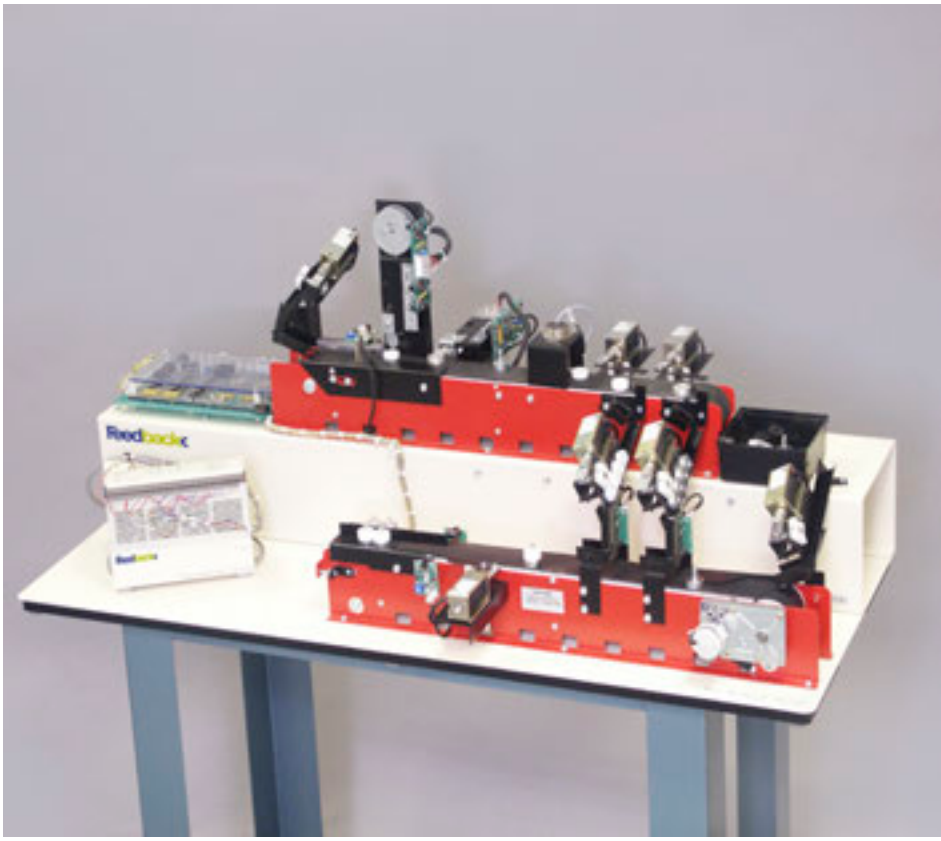
34-502	Traffic Lights - PLC Application

PLC required, recommend the following options

- 34-020 Mitsubishi PLC
- 34-020-1 Mitsubishi PLC pre-wired
- 34-040 Allen Bradley PLC
- 34-040-1 Allen Bradley PLC pre-wired
- 34-060 Siemens PLC
- 34-060-1 Siemens PLC pre-wired
- PC running Windows XP or higher for use with PLC

FEATURES

- Fully working model of a real-life application
- Part selection by sensors
- Induction sensors
- Opto-electronic sensors
- Component sort process
- Assembly process
- Interfaces to most major PLCs
- Pre-wired or „wire your own" Mitsubishi, Allen Bradley & Siemens PLCs available (purchased separately), or use your own
- Comprehensive theory & experiment manual



Dual Conveyor - PLC Application

Programmable Logic Controllers (PLCs) are used extensively in many manufacturing processes and control applications being readily programmed and reprogrammed when variations in the controlled process are required. This dual conveyor system allows greater study of PLCs in process control systems. More complex control scenarios can be developed using combinations of timers and counters with master and zone control functions. The self-contained unit comprises a power supply, interface board and a range of sensors and solenoid actuators and a height gauging unit. The interface circuits allow the conveyor system to be operated from any standard industrial PLC using 24 V dc logic levels.

CURRICULUM COVERAGE

- Logic fundamentals
- Basics of PLC programming
- Developing ladder logic programs
- Programming timers
- Programming counters
- Structure of control systems
- Sequencer programmes
- Jump instructions & sub-routines
- Combined counter & timer functions
- PLC installation practices

Technical data:

- Dimensions: (net) width 1000 mm x depth 400 mm x height 425 mm, (packed) width 1235 mm x depth 855 mm x height 820 mm
- Weight: gross 47 kgs, net 35 kgs

34-120-1	Dual Conveyor - PLC Application

PLC required, recommend the following options

- 34-020 Mitsubishi PLC
- 34-020-1 Mitsubishi PLC pre-wired
- 34-040 Allen Bradley PLC
- 34-040-1 Allen Bradley PLC pre-wired
- 34-060 Siemens PLC
- 34-060-1 Siemens PLC pre-wired
- PC running Windows XP or higher required for use with PLC

FEATURES

- Fully working model of an elevator with 4 floors
- Floor sensing and visual indication of travel
- Motorised elevator car door
- Brake to hold car at desired floor
- Up/down call button at each floor
- Front panel manual switch for testing
- Integral motor servo controller
- Interfaces with most PLC types
- Pre-wired or „wire your own" Mitsubishi, Allen Bradley & Siemens PLCs available (purchased separately) or use your own
- Analogue inputs & outputs available
- Switchable faults
- Elevator units can be „banked" together, as per numerous elevators in a larger hotel
- Comprehensive experiment manual

Elevator – PLC Application

Programmable Logic Controllers (PLCs) are used extensively in many manufacturing processes and control applications being readily programmed and reprogrammed when variations in the controlled process are required. This elevator illustrates the principles of PLC interfacing & control based on a real-life and easily identified application, therefore providing excellent interest for students. Starting with simple program sequences to control elevator speed, direction and floor arrival/departure, the student can progress to advanced floor request handling and continuous (analogue) control with acceleration profiling and compensation for varying car loads. The internal motor speed controller has both logic and analogue interfaces such that a basic PLC with minimal digital I/O can be used to implement control. More sophisticated control may be developed if analogue I/O is available. The load-cell and motor position feedback signals are available to develop programs for continuous control. The load-cell indicates elevator car loading and a set of weights simulates varying numbers of car occupants. The position feedback signal allows for the development possibility of advanced control of the elevator car motion.

CURRICULUM COVERAGE

- Logic fundamentals
- Basics of PLC programming
- Developing ladder logic programmes
- Basic sequencer control
- Advanced sequence control

Technical data:

- Dimensions (packed): width 520 mm x depth 480 mm x height 1110 mm
- Weight: gross 21 kgs, net 16 kgs

34-150-1	Elevator - PLC Application

PLC required, recommend the following options

- 34-020 Mitsubishi PLC
- 34-020-1 Mitsubishi PLC pre-wired
- 34-040 Allen Bradley PLC
- 34-040-1 Allen Bradley PLC pre-wired
- 34-060 Siemens PLC
- 34-060-1 Siemens PLC pre-wired
- PC running Windows XP or higher required for use with PLC

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

CONTROL ENGINEERING

PROCESS CONTROL

REFRIGERATION & AIR CONDITIONING

PNEUMATICS & HYDRAULICS

PROCESS CONTROL

FEATURES

- Low cost teaching for the basic principles of process control
- A practical process in miniature
- Closed and open-loop continuous control
- Two-step control
- Fast response times enable dynamic behaviour to be seen on an oscilloscope
- Used for instruction of students at all levels
- Exhibits thermal time constants & time transport lag
- Meters with side-by-side pointers indicate set and measured values
- Can be used with the Feedback PID150Y module to apply three term control
- Comprehensive experiment manual

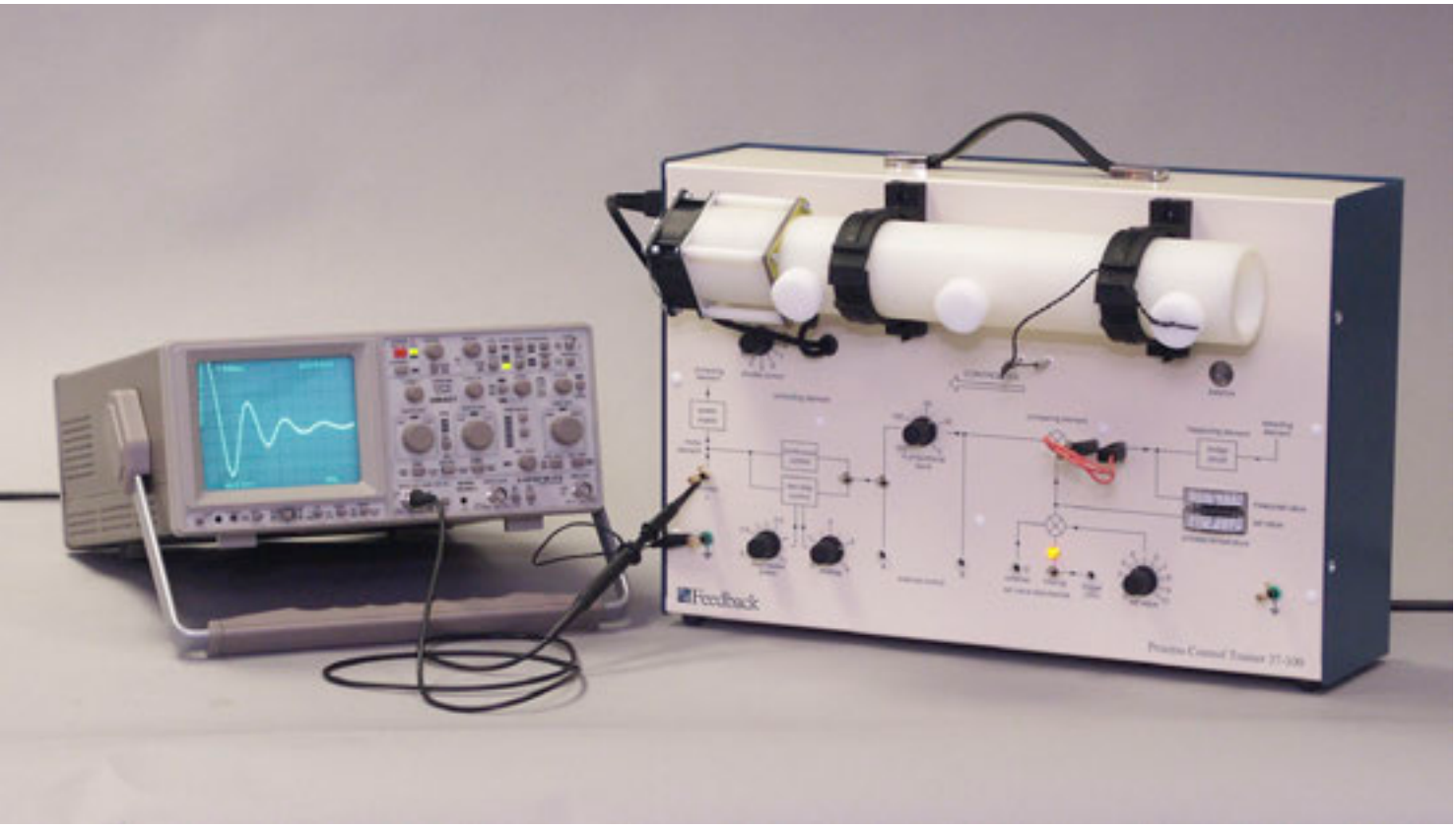
Process Control Trainer

The 37-100 Process Control Trainer teaches the basic characteristics of a large plant, but is compact and portable. It enables distance/velocity lag, transfer lag, system response, proportional and two step control to be demonstrated. Owing to its relatively fast response, changes in set value and measured value can be displayed on an oscilloscope. A heating element controlled by a thyristor circuit feeds heat into the airstream circulated by an axial fan along a polypropylene tube. A thermistor detector, which may be placed at one of three points along the tube length, senses the temperature at that point. The volume of air flow is controlled by varying the speed of the fan via a potentiometer. A change in setting represents a supply side disturbance and the effects are easily demonstrated. The detector output is amplified to provide both an indication of the measured temperature and a feedback signal for camparison with a set value derived from a separate control. A comparison of these signals generates a deviation signal which is supplied to the heater control circuit such that the controlled condition is maintained at the desired level. Two step (on-off) and proportional band control is standard.

An external controller is available to enable the operation of compound control to be investigated. The three term controller module PID150Y provides variable controls for adjustment of proportional, integral and derivative terms. An external +/- 15 V, 100 mA power supply is required for the PID150Y module. Optional accessories include a function generator FG601 and Electronic Wattmeter EW1604.

CURRICULUM COVERAGE

- Basic process control principles
- Distance / velocity lag
- Transfer lag
- Calibration
- Two-step control
- Proportional control
- System response
- Frequency response



Technical data:

- Selectable 100 - 120 V or 220 - 250 V a.c. supply
- Maximum heater power 80 W
- Velocity flow range 0.3-3.0 m/s
- Detector temperature range
- Ambient to 80 Deg C
- Heater / Detector time constant 400 ms
- Typical distance / velocity lag 200 ms
- Typical natural period 1 s
- Tube length 298 mm
- Dimensions (packed): width 460 mm x depth 300 mm x height 230 mm
- Weight (packed): 9 kgs

37-100	Process Control Trainer

Additionally recommended:

Qty	Cat.-No.	Name
1	01-100	d.c. Power Supply. +5V d.c. @ 0.5A, +/- 15V d.c. @ 1.5A
1	EW1604	Electronic Wattmeter
1	FG601	Function Generator
1	PID150Y	PID (proportional-integral-derivative) Controller

FEATURES

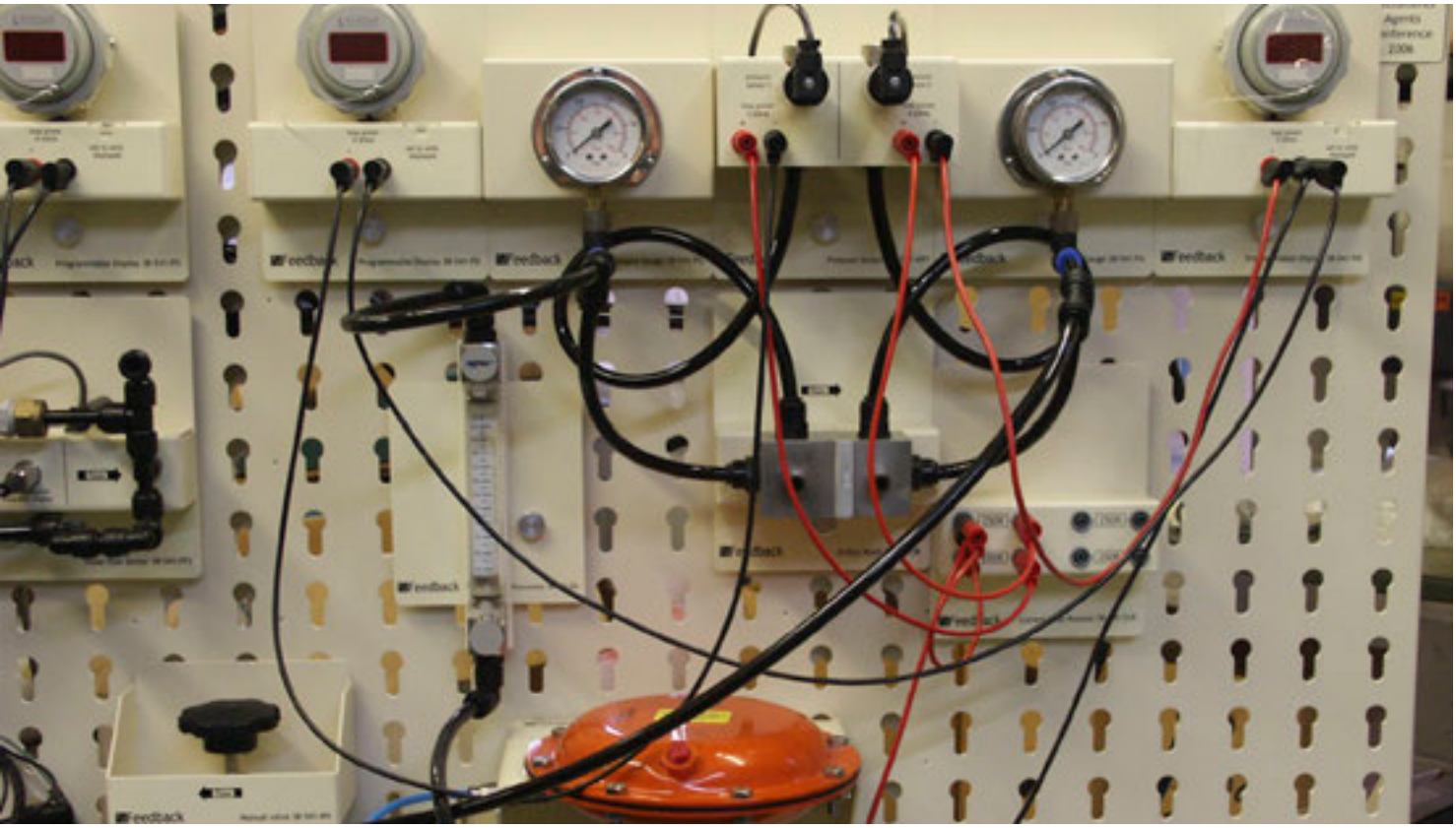
- Self-contained unit
- Industrial control devices & sensors
- Modular & versatile
- Calibration & testing
- 4-20 mA current loops
- Mobile (wheeled) trolley
- Comprehensive experiment manual

Process Instrumentation Trainer (PIT)

Modern control devices and sensors are becoming increasingly complex and functionally very powerful. This trainer enables students to be exposed to the selection and utilisation of such devices, the sensors, actuators and programmable devices being industrial units. It provides hands-on experience of their setting-up, calibration and use. The equipment is based on a mobile trolley incorporating all electrical, water (including a water heater) and air controls, a self-contained unit. The punched front panel provides a construction area that allows devices to be firmly fixed to it.

Modules included:

- Current loop resistor
- Current / pressure converter
- Control valve
- Pressure transmitters
- Flowmeter
- Frequency transmitter
- Level probe
- Manual valve
- Orifice block
- Programmable display
- Pulse flow sensor
- Pressure gauge
- Programmable equipment
- Solenoid valve
- Temperature probes
- Temperature transmitter
- Universal transmitter



CURRICULUM COVERAGE

- 4-20 mA current loops
- 4-20 mA programmable display
- Capacitive level sensor & transmitter
- Flowmeter & pulse-flow sensor
- Control valves
- Pressure devices
- Current to pressure converter
- The orifice block
- Universal transmitter

Technical data:

- Dimensions (net): width 1470 mm x depth 560 mm x height 1700 mm
- Weight (net): 120 kgs

38-023	Process Instrumentation Trainer (PIT)

Level & Flow Process Control

The Level & Flow Process Control Trainer is a single loop system allowing the study of the principles of process control, using liquid level and flow rates as the measured process variables. The system is a completely self-contained, low pressure flowing water circuit supported on a benchtop-mounted panel, making it suitable for individual student work or for group demonstrations. It comprises a dual compartment process tank, linked to a sump tank by manual and solenoid operated valves. Water is pumped through the system, via a variable area flow meter and motorised control valve. Level is measured in the process tank. Flow is measured through an optical pulse flowmeter.

CURRICULUM COVERAGE

- Flow & level familiarisation & calibration
- Interface familiarisation & calibration
- Controller familiarisation & calibration
- Float Level Transmitter
- Pulse Flow Transmitter
- On-Off Control
- Study of P, PI & PID Control of Level & Flow
- Tuning PID Controllers
- Advanced Process Control

Technical data:

- Dimensions (net): 930 mm width x 400 mm depth x 710 mm height
- Weight: gross 70 kg, net 45 kg

FEATURES

- Contains a selection of level & flow sensors & indicators
- Flow controlled by linear motorised control valve
- On-Off and proportional control
- P, PI and full PID control with autotune facility
- Couples with Temperature Process Control Tainer (supplied separately 38-002) for dual loop control
- Modern push fittings
- Water used as the prices fluid
- Comprehensive manual with laboratory notes
- Espial Software (supplied separately 93-420)

Scope of delivery:

Qty	Cat.-No.	Name
1	38-100	Basic Process Rig
1	38-200	Process Interface
1	38-300	Process Controller
1	38-400	Level Sensor Pack
1	38-420	Flow Sensor Pack
1	38-490	Digital Display Module

38-001	Level & Flow Process Control

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	38-002	Temperature Process Control

PC with Windows Vista, Windows 7 or 8, 32-bit or 64-bit or higher with USB interface

Temperature Process Control

The Temperature Training System is a two loop system, using water as the process fluid which allows the study of the principles of process control using primary and secondary circuit temperatures as the process variables to be controlled. Both circuits pass through the heat exchanger and the secondary circuit contains a fan-assisted cooling radiator. Thermistor temperature sensors are located in the inlet and outlet streams of both primary and secondary sides of the heat exchanger and the outlet of the radiator. The primary flow is also monitored. The Trainer can be used with a cold mains water supply through the Auxiliary Temperature Control Pack 38-480, which is supplied as part of the system. This comprises a motorised control valve, a flow meter and a signal conditioning unit. Alternatively the Temperature Trainer can be connected to the Level & Flow Process Trainer, which then supplies the cold water circuit. This combination allows more complex control systems to be investigated.

CURRICULUM COVERAGE

- Temperature familiarisation & calibration
- Interface familiarisation & calibration
- Controller familiarisation & calibration
- Pulse Flow Transmitter
- On-Off Control
- Study of P, PI and PID control of temperature & flow
- Manual Flow Control
- Temperature Process Control
- Complex Control Loops

Technical data:

- Operates from mains water supply using water pressure regulator 38-481
- For operation with 110 V or 120 V 50/60 Hz supplies
- 3 phase supply is required so nominal 220 volts available across 2 phases
- Dimensions (net): 1080 mm width x 375 mm depth x 705 mm height
- Weight: gross 72 kg, net 52 kg

FEATURES

- Temperature monitored in primary & secondary circuits
- Flow monitored
- P, PI & PID control with autotune facility
- Primary circuit flow controlled by motorised control valve
- Primary circuit heater and pump
- Secondary circuit fan-assisted cooling radiatior
- Modern push fittings
- Water used as the process fluid
- Operates from mains water supply using water pressure regulator 38-481
- Comprehensive experiment manual

Scope of delivery:

Qty	Cat.-No.	Name
1	38-200	Process Interface
1	38-300	Process Controller
1	38-480	Temperature Auxiliary Control
1	38-490	Digital Display Module
1	38-600	Temperature Process Rig (240V)

38-002	Temperature Process Control

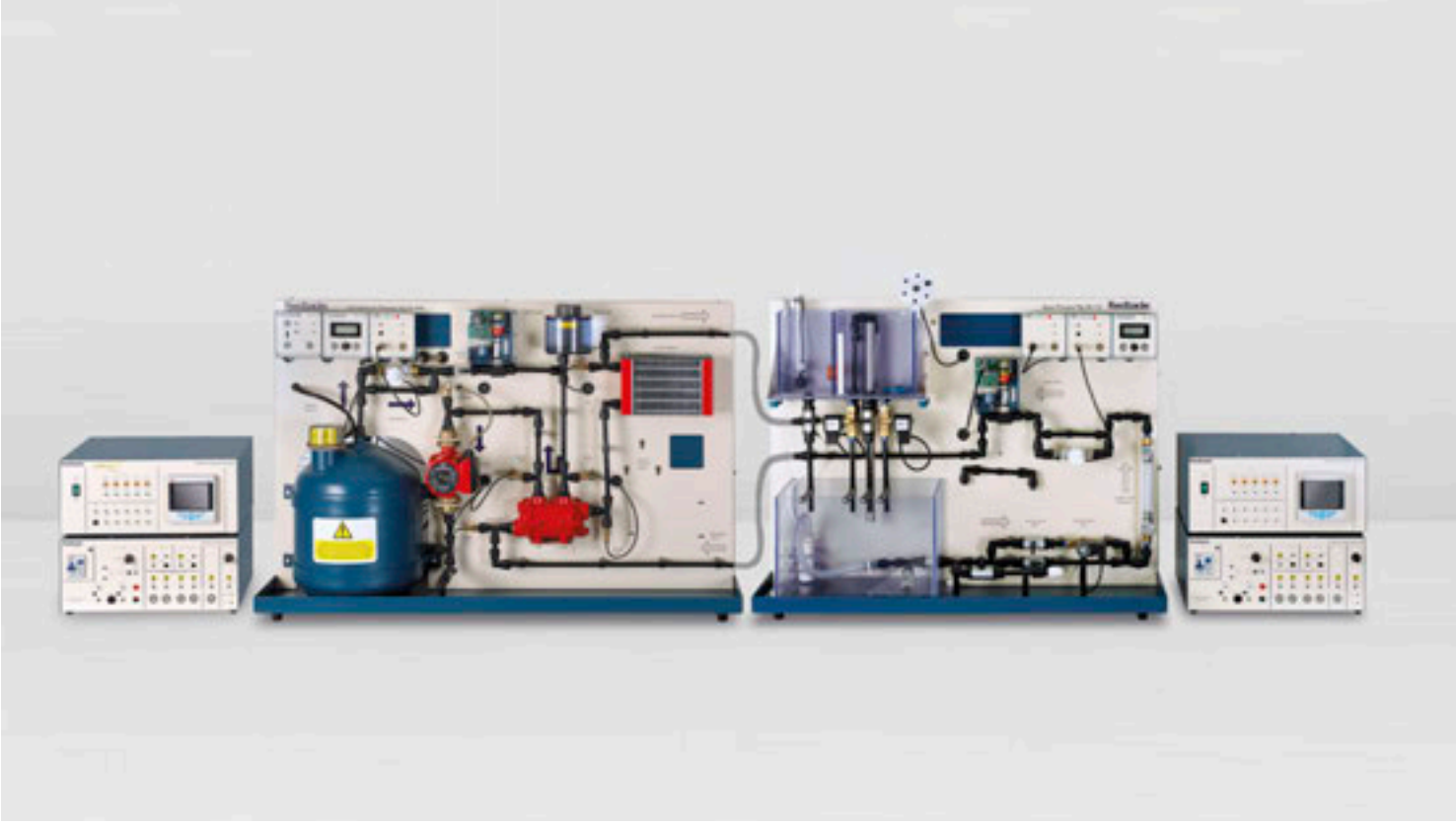
Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	38-001	Level & Flow Process Control
1	38-610	Forced Air Cooler

PC with Windows Vista, Windows 7 or 8, 32-bit or 64-bit or higher with USB interface



Level, Flow & Temperature Process Control

The combined PROCON Level, Flow & Temperature Process Control System is self-contained and has all of the features of the individual Level & Flow and Temperature systems plus remote set-point control. Remote set-point control can be affected with the PROCON Level, Flow & Temperature Process Control System by using two process controllers. The 4-20mA analogue remote set-point input allows various forms of cascade control to be implemented between linked or interactive control loops. The process set-point can be local and remote or dual, selected from the front panel, or in response to a logic input. When dual set-point is selected the function can be ratio or bias action. A Programmable Logic Controller (PLC) 38-350 is also available separately. It can be used with the Process Interface 38-200 to provide an alternative control method with on/off elements to the standard Process Controller 38-300 (included).

CURRICULUM COVERAGE

- Flow & level familiarisation & calibration
- Temperature familiarisation & calibration
- Interface familiarisation & calibration
- Controller familiarisation & calibration
- Float level transmitter
- Pulse flow transmitter
- On-Off control
- Temperature process control
- Complex control loops
- Dual loop (process) control - using Level, Flow & Temperature Control Trainers
- Remote set-point control
- Set-point ratio control (dual loop)
- Cascade control (temperature & flow)
- Feedforward Control

FEATURES

- Study of P, PI and PID control of level & flow
- Tuning PID controllers
- Advanced process control
- Study of P, PI and PID control of temperature & flow
- Manual flow control
- Comprehensive experiment manual

Technical data:

- For operation with 110 V or 120 V 50/60 Hz supplies
- 3 phase supply is required so nominal 220 volts are available across 2 phases
- Dimensions (net): overall width 2010 mm x depth 400 mm x height 710 mm
- Weight: gross 142 kgs, net 97 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	38-100	Basic Process Rig
2	38-200	Process Interface
2	38-300	Process Controller
1	38-400	Level Sensor Pack
1	38-420	Flow Sensor Pack
2	38-490	Digital Display Module
1	38-600	Temperature Process Rig (240V)

38-003	Level, Flow & Temperature Process Control

Additionally required:

Qty	Cat.-No.	Name
1	93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	38-610	Forced Air Cooler

PC with Windows Vista, 7 or 8, 32-bit or 64-bit or higher with USB interface

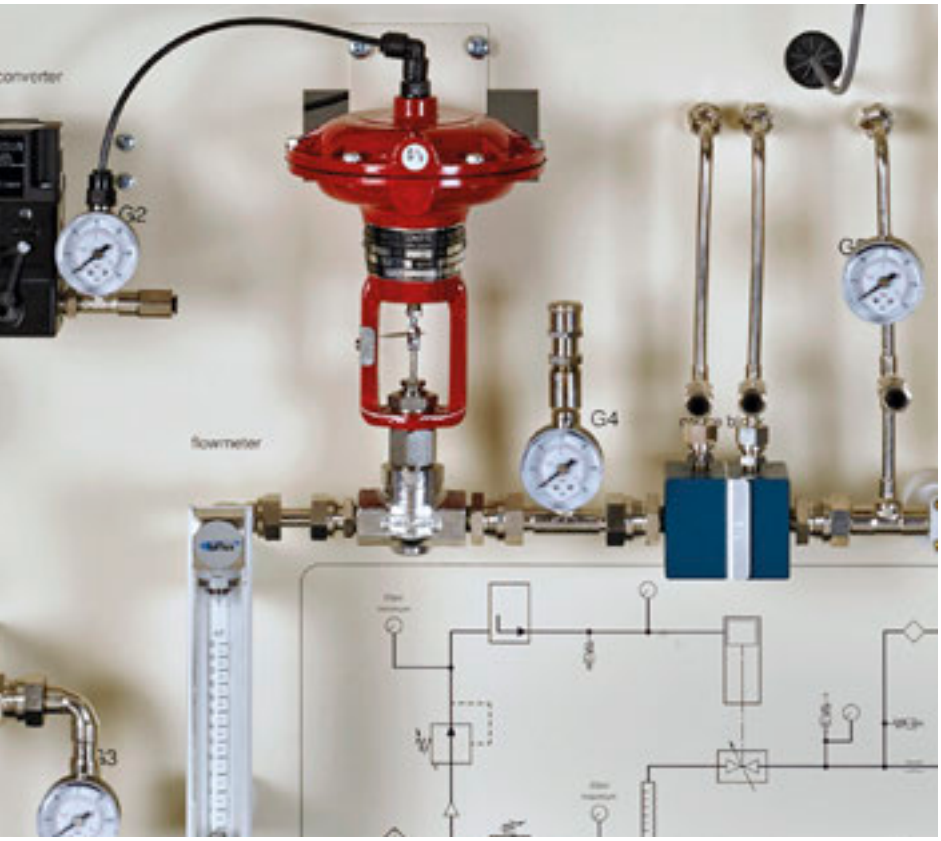
Pressure Process Control Trainer

The Pressure Process Control Training System is a single loop pneumatic control system. It enables the study of the principles of both pressure regulation of a process and the control of flow in a pressurised system. The system comprises a low pressure air circuit supported on a bench-mounted panel, making it suitable for individual student work or for group demonstration. The trainer requires a compressed air supply at a recommended input pressure of 40 psi (not supplied) An input filter/drier is used to clean the supplied air.

Separately regulated branches provide air for the process and for valve control. The process branch comprises a regulator, a variable area flow meter, a pneumatically operated control valve, an orifice block with changeable orifice plates and both differential and point of measure pressure sensors. The process air flow can be discharged to atmosphere via adjustable diffused outlets. An air receiver tank can be switched in and out of the circuit. The valve control branch comprises a regulator and an electrically operated current to pressure input converter. This is used to regulate the pneumatic control valve in the process line. The input converter operates from a 4-20 mA signal. Signal conditioning for the sensors is provided by pressure transmitters. The Differential Pressure Transmitter gives a linear differential pressure sensor output. The system is fully equipped with pressure gauges to indicate the pressures around the system.

CURRICULUM COVERAGE

- Pressure safety, familiarisation & calibration
- I/P converter & pneumatic control valve operation
- Controller familiarisation & calibration
- Automatic control systems
- Serial communication
- Pressure sensor
- Transmitter & I/P converter - linearity & hysteresis
- Pneumatic control valve
- Characteristics at different pressure ranges
- System response & air receiver
- Principles of proportioning valve & proportional process control
- Study of P, PI and PID control of pressure
- Calibration of the differential pressure sensor & transmitter
- Flow control in the process rig



FEATURES

- Safe, low pressure operation
- Fully gauged for pressure & flow rate
- Differential & Gauge pressure sensors
- Currect controlled (4-20 mA) pneumatically operated control valve
- Standard industrial components
- Self-sealing outlets for the manometer
- Safety valves fitted as standard
- Air used as the process fluid
- Comprehensive experiment manual

Technical data:

- 4-20 mA operation
- Dimensions (net): width 900 mm x depth 460 mm x height 720 mm
- Weight: gross 110 kg, net 72 kg

Scope of delivery:

Qty	Cat.-No.	Name
1	38-200	Process Interface
1	38-300	Process Controller
1	38-490	Digital Display Module
1	38-714	Pressure Process Rig

38-004	Pressure Process Control Trainer

Additionally required:

Qty	Cat.-No.	Name
1	38-820-120	Air Compressor
1	38-820-230*	Air Compressor

* alternative

PC with Windows Vista, 7 or 8, 32-bit or 64-bit or higher with USB interface

FEATURES

- Now includes Espial Tools
- Allows teachers & lecturers full edit facilities
- New content & additional assignments
- Free of charge online software updates
- Hands off for teachers, hand on for students
- Self-paced
- Unrestricted, open learning environment
- Practical demonstration of theory & concepts
- Interactive patching diagrams
- Real-time embedded instrumentation
- Automatic instrumentation configuration
- Data export for analysis
- USB connection to hardware
- Editing tools include laboratory architect, assignment builder, Winwiz & manual builder
- Compatible with 32 bit & 64-bit versions of Windows XP, Vista, Windows 7 & Windows 8
- Optional 93-410 Espial Course Manager

Espial Software Package

Espial is used extensively within the telecommunications, control and basic electronics ranges. It is therefore required for use with 12-300 series, 33-033, 53-004 (& 53-200 series), 57-200-USB, 38 series & PV75-100. The teaching content is provided within the software; this includes the underlying theory, written so that it does not make extensive use of mathematics. An important part of the content is to highlight the assignment learning objectives and to convey relevant background to the student. Consequently, the student is well prepared for the practical work using the hardware, and can put the results into perspective. Espial operates so that its appearance and the range of instrumentation depend on the context. So, for example, if the practical-work requires the use of complex instrumentation such a constellation or a phase meter, one is made available, whereas at lower levels of study it would not be provided. Test instruments are initialised with settings suitable for the required measurements, but students are often expected to change them during the practical work. The instruments have cursors to make measurements and their displays may be printed or exported for inclusion in laboratory reports. The 93-420 Espial Software Package now includes Espial Tools. This allows teachers and lecturers full edit facilities with the creation of new content and additional assignments. Laboratory Architect determines the range of assignments available to the students and to configure the look and feel of the Espial environment. Assignment Builder creates new or edits existing laboratory assignments and configures the test equipment. Content is edited using any HTML editor or Microsoft Word. Winwiz creates and edits work board „patching" diagrams. It also configures test equipment monitor points and „further information" points on the practical diagrams. Practical diagrams are edited by Microsoft Visio. (Visio is not supplied as part of Espial) Manual Builder creates a version of the content ready formatted for printing. Free of charge online software updates are included. An optional addition is 93-410 Espial Course Manager, although it is not necessary for equipment operation. The 93-410 creates complete courses containing assignments from any of the installed Espial products plus external resources such as documents, multimedia material, thrid party programs, web urls, or locations on local intranets. Includes Course Designer and Course Presenter.

Technical data:

- Dimensions & weight of a CD

93-420	Espial Software Package

Additionally recommended:

Qty	Cat.-No.	Name
1	93-410	Espial Course Manager

FEATURES

- Maintains constant temperature for fluid input
- Enables quick response times in temperature reduction
- Variable speed fan
- Variable speed pump
- Comprehensive experiment manual

Forced Air Cooler

The Forced Air Cooler is optional equipment for extending the range of experimentation when used with the Temperature Process Control Trainer (38-002) or between that unit and the Level & Flow Process Control Trainer in the 38-003 to maintain a constant fluid input temperature. The Forced Air Cooler extends the operating temperature of the Temperature Control Rig and allows direct control of its operating characteristics. It consists of an electric pump, a fan and radiator unit to cool the circulating water. The unit may be initially charged through the header tank which should be maintained „topped-up" to avoid the ingress of air. There are two signals which may be applied for controlling the degree of cooling. The speed of the fan may be controlled by submitting a 4-20 mA current into the top DIN socket of the control section. The speed of the pump may be similarly varied by inputting a 4-20 mA signal through the separate adjacent DIN socket. The speed of the pump and fan are then controlled via phase controlled circuitry taking as it's input the 4-20 mA signal. Alternatively, the fan and the pump may be set to continuous for full speed operation. The optional accessory is the 38-481 water pressure regulator.

CURRICULUM COVERAGE

- Familiarisation of the equipment
- Use as a manually controlled cooler
- Temperature control by varying fan speed
- Temperature control by varying pump speed
- Temperture control by varying secondary flow

Technical data:

- 4-20 mA signals
- Dimensions (net): 800 mm width x 380 mm depth x 705 mm height
- Weight: gross 40 kg, net 25 kg

38-610	Forced Air Cooler

FEATURES

- Windows-based workstation
- Graphic user interface (GUI)
- DCS controlled by Emerson Delta V industrial package
- Graphical & audible alarms (PC, software, speakers)
- Continual & sequential control of processes
- Industry-standard 4-20 mA signals
- 16 analogue & 8 digital inputs
- Simple interconnect system to provide easy installation & system configuration
- Graphical representation of the trainers & processes to simulate industry
- „Design" & „Run" modes
- Housed in a 19 inch industrial rack
- Software provides an integrated SCADA environment
- Comprehensive experiment manual

Distributed Control System Upgrade Package

This trainer provides an upgrade from the standard 38-series Feedback products to form a full Distributed Control System by the addition of the Emerson Delta V controller plus other items summarised below to form the upgrade package.

DCS Package includes:

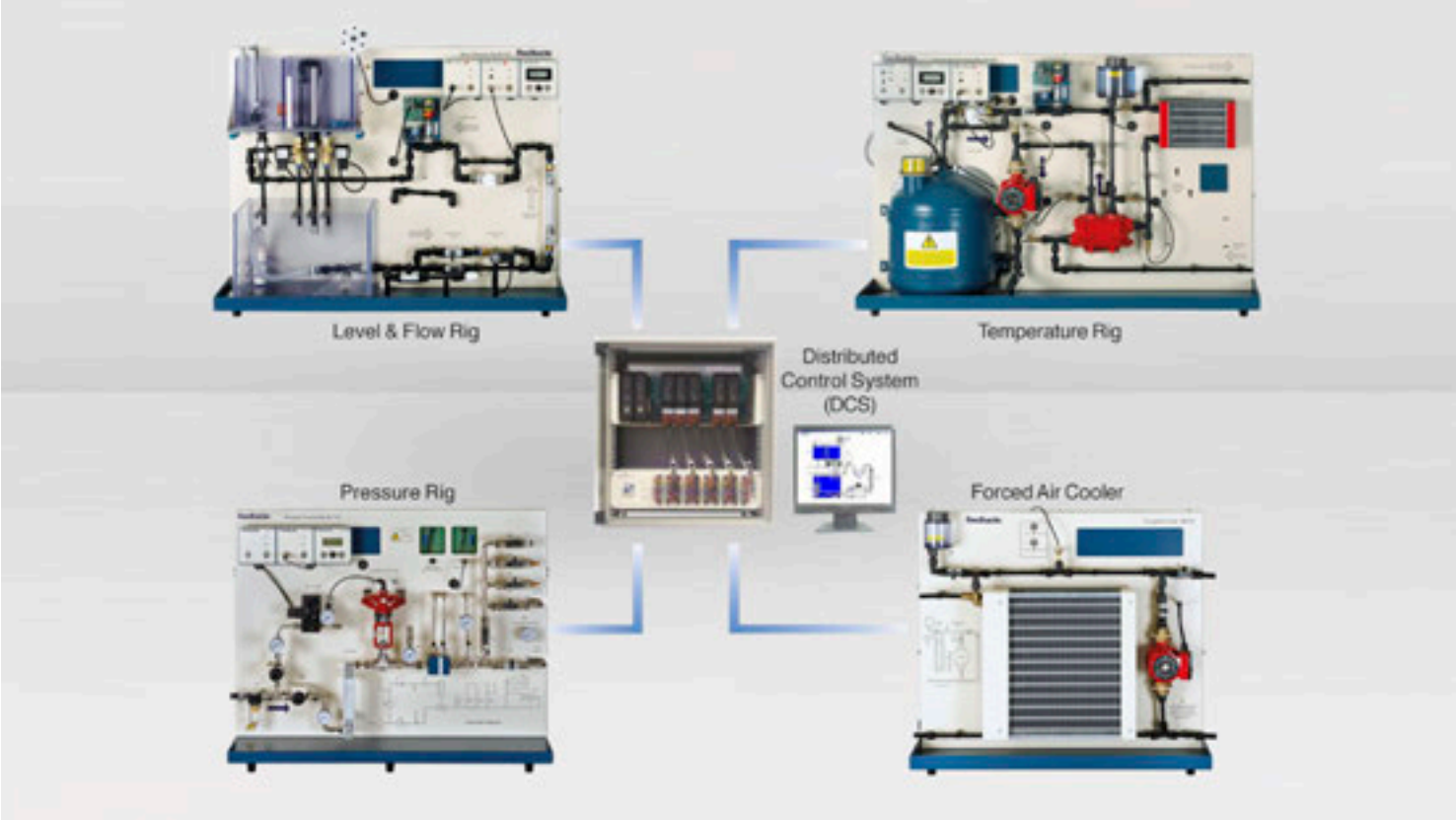
- 1 x PC with speakers & software
- 1 x Emerson Delta V controller
- 1 x System power supply (a.c./d.c.)
- 2-wide power / controller carrier
- 8-wide I/O interface carrier, carrier shield bar
- 2 x analogue input cards, 8 channels
- 1 x analogue output card, 8 channels
- 1 x discrete (digital) input card, 8 channels
- 1 x discrete (digital) output card, 8 channels
- Termination blocks for each I/O card
- Industrial 19 inch rack
- Required cables & connections

Technical data:

- Dimensions (net): width 553 mm x depth 500 mm x height 589 mm
- Weight (net): 20 kgs

38-306	Distributed Control System Upgrade Package


FIELDVUE
Instruments
FISHER



Distributed Control System (DCS)

The Feedback Distributed Control System (DCS) trainer is a complete training solution that combines the operations of a leading commercial DCS process management controller package, namely the Emerson Delta V, with an assortment of our proprietary training rigs. The training rigs offer a range of processes:

- Level & Flow
- Temperature
- Pressure
- Forced Air Cooling

These may be operated separately or combined to produce a multi-process, multi-loop system. The trainer is supplied complete with the PC, software, controller and I/O modules that are needed to monitor and control the process rigs. A control cabinet houses the components that provide the interface between the PC and the rigs. The control cabinet is easily connected to the PC and rigs using the supplied cables. The valves, transducers and transmitters associated with the training equipment are standard industrial components that operate using simple 4–20 mA current loop control, and 24 V d.c. The trainer can be used to perform a set of operations that will guide the student from the basics of field components in the process industry to the final control algorithms that are used in various applications. The features and curriculum coverage highlighted below are specific to the DCS as a whole and in addition to those covered by the individual units 38-001, 38-002, 38-004 & 38-610.

Curriculum Coverage

- Distributed control system background theory
- Delta V Explorer
- Trainer configuration
- Basic on-off control
- Advanced on-off control
- Levels & alarms
- Sequential function charts
- PID control
- Shutting down the workstation

FEATURES

- Windows-based workstation
- Includes a PC with speakers to provide graphical and audible alarms
- Provides a graphical user interface
- Includes an Emerson Delta V industrial controller
- Continuous & sequential control of processes
- Industry standard 4-20 mA signals with 24 V DC outputs
- 16 analogue & 8 digital inputs
- 8 analogue & 8 digital outputs
- Displays graphical representations of the trainers and processes to simulate an industrial environment
- „Design" & „Run" modes
- Controller & interface package housed in a 19 inch rack
- Software provides an integrated SCADA environment with I/O tags held in a database
- Comprehensive experiment manual

Technical data:

- 4-20 mA control loop, 24 V d.c.
- Dimensions (net): the sum of the units 38-001, 38-002, 38-004, 38-610 & 38-306
- Weight: gross 220 kgs, net 176 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	38-100	Basic Process Rig
1	38-306	Distributed Control System Upgrade Package
1	38-400	Level Sensor Pack
1	38-420	Flow Sensor Pack
1	38-490	Digital Display Module
1	38-600	Temperature Process Rig (240V)
1	38-610	Forced Air Cooler
1	38-714	Pressure Process Rig

38-009	Distributed Control System (DCS)

Additionally required:

Qty	Cat.-No.	Name
1	38-820-120	Air Compressor
1	93-420	Espial Software Package
1	38-820-230*	Air Compressor

* alternative

Windows PC running Vista or higher with USB

Industrial (fault-finding) Process Trainer

This trainer teaches fault diagnosis and rectification in industrial processes. Faults are introduced by the instructor via switches concealed behind a locked compartment, to which the student does not have access. These switches provide both short circuits and open circuits and can also switch in or out circuit elements to simulate a variety of fault conditions. Additional faults can be inserted into the process through the replacement of working components with faulty ones, e.g. faulty flow switches; faulty relays; faulty solenoid coils and faulty control valve electronic circuit board. The process involves initially filling a header tank with water and then cycling the level between a set upper and lower limit, whilst simultaneously creating a demand from the header tank via two on/off solenoid drain valves into a sump tank.

Flow is produced by a pump and controlled by relay operated on/off solenoid valves which control:

- the inflow of water to the header tank from the sump tank
- the outflow of water from the header tank to the sump tank

The level of water in the header tank is monitored by float switches which open and close at the following points:

- Header tank low (nearly empty)
- Header tank normal operation lower limit
- Header tank normal operation upper limit
- Header tank overflow

Designed for students studying industrial process maintenance, it can also be used as a process trainer in its own right, using either Industrial Process Controllers or Programmable Logic Controllers (PLCs). A 34-252-1 PLC Board (supplied separately) is available for users to develop their own PLC programs.

FEATURES

- Teaches Fault diagnosis
- Faults introduced by teacher via switches housed in a lockable compartment
- Can be externally controlled using process controllers and PLCs
- Self-contained process
- Wide range of faults easy to apply
- Fully protected for safety
- Comprehensive instructor & student manuals

CURRICULUM COVERAGE

- Introduction to the system
- Fault finding methodologies
- Fault analysis flow charts
- Fault finding from circuit diagrams
- Fault identification to line replaceable unit level
- Mechanical, electrical & electonic faults
- Diagnostic tools
- Maintenance procedures
- Process control techniques
- Fault finding processes controlled from electronic controllers
- Interfacing to PLCs

Technical data:

- Power requirements 220 – 250 V a.c. @ 250 VA or 110 – 125 V a.c. @ 250 VA, 50/60 Hz
- Dimensions (net): width 1450 mm x depth 450 mm x height 70 mm

34-250	Industrial (fault-finding) Process Trainer

Additionally recommended:

Qty	Cat.-No.	Name
1	34-252-1	PLC Interface for 34-250

If 34-252-1 purchased, would need a PLC, examples being our recommended 34-020, 34-020-1, 34-040, 34-040-1, 34-060, 34-060-1

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

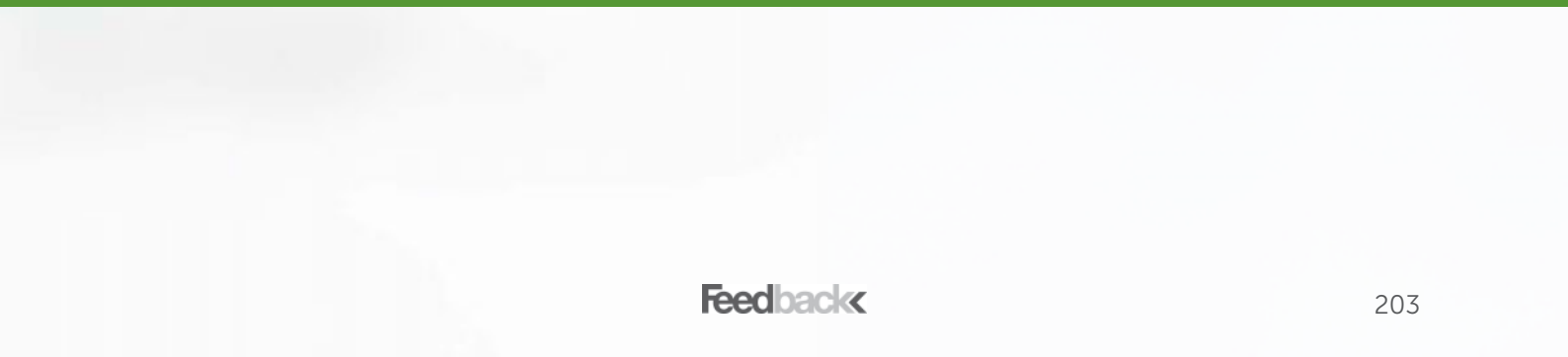
CONTROL ENGINEERING

PROCESS CONTROL

REFRIGERATION & AIR CONDITIONING

PNEUMATICS & HYDRAULICS

REFRIGERATION & AIR CONDITIONING



FEATURES

- Industrial components
- Use non-ozone-depleting gas (R134a)
- Open frame design enables hands-on access to all areas
- Option available for simulating faults
- 230 V and 120 V versions available
- Comprehensive experiment manual included

Commercial Refrigeration Skills Trainer (230 V)

This trainer enables students to conduct practical training and experiments on a typical system whilst learning the principles of refrigeration. Utilising authentic, industry standard components it allows the student to perform fault finding and servicing using a safe and accessible system. Students can learn how to perform the safe recovery and recharging of refrigerant and use the system to practice the repair and replacement of pipework. The unit constitutes a vapour compression refrigeration system that emulates the plant and control system of a typical small commercial chiller or walk in cold store. The unit comprises a 0.5 hp condensing unit, forced air evaporator; thermostatic expansion valve and an electronic thermostat controller with natural defrost capability. The system is protected by a filter drier and high and low pressure switches for safety and protection of the compressor. A sight glass with a moisture indicator enables monitoring of the refrigerant charge as well as alerting the user of potentially damaging moisture ingress within the circuit. The system is equipped with 100 mm glycerine filled gauges indicating high and low pressure and service ports for the fitting of an industry standard manifold service gauge.

There are two versions available, 230 V and 120 V.

Technical data:

- Electrical Power Consumption: 490 W
- Refrigerant charge: 450 grams
- Duty: 880 W @ 3°C
- Dimensions (net): width 480 mm x depth 460 mm x height 1500 mm
- Weight (net): 45 kg

39-301-230	Commercial Refrigeration Skills Trainer (230 V)

FEATURES

- Complies with City & Guilds 2079
- Industrial components
- Portable design
- Open frame allows easy access to all areas
- Option available incorporating simulated faults
- Comprehensive experiment manual included

Automotive Air-conditioning Trainer

This is an authentic vehicle air conditioning system mounted on a frame for teaching purposes. It teaches the principles of the refrigeration cycle and the function of the component parts of the system. The unit has four switchable faults that simulate actual faults found on vehicle air conditioning systems. This unit is charged with R134a non-ozone depleting refrigerant.

There are two versions available, 230 V and 110 V.

The system is an example of a refrigeration circuit from which the basic vapour-compression cycle can be studied. This process entails the circulation of a refrigerant medium that is forced to change state in the evaporator by expansion from a liquid through to a superheated gas. During this phase of change, large amounts of heat energy are absorbed into the refrigerant, which is then pumped round and rejected to atmosphere through the condenser. Complete with compressor, condenser, receiver dryer, TEV (Thermal Expansion Valve) and evaporator, the unit is pre-installed with R134a type refrigerant which is a HFC non-ozone depleting gas and is in line with global emissions guidelines.

The system is furnished with high and low-side pressure service ports that facilitate easy connection of a gauge set or for the recovery and recharging of refrigerant. These ports are typical quick coupler type as would be found on modern vehicles.

Technical data:

- Dimensions (net): width 910 mm x depth 565 mm x height 460 mm
- Weight (net): 80 kg
- Power rating 2200 W

39-305-230	Automotive Air-conditioning Trainer

FEATURES

- Complete refrigeration circuit
- Uses R134a non-ozone depleting refrigerant
- Experiment teaching material
- Includes digital multimeter

Reverse Cycle Heat Pump AC Trainer

This is a genuine commercial air-conditioner built onto a rigid frame for bench or floor mounting. The unit will demonstrate the principles of air conditioning, reverse cycle heat pump technology and refrigeration. The unit comes ready to run pre-charged with environmentally friendly non-polluting R404a refrigerant. The front and top panels of the outdoor unit are sectioned, illuminated and have a transparent covering to enable observation of the internal components.

CURRICULUM COVERAGE

- System pump down
- Recovery of the refrigerant charge
- Pressure testing
- Evacuating & recharging
- Air-conditioning system installation training
- Fundamentals of refrigeration
- Heat pump principles
- Refrigerant handling
- Setting refrigeration controls
- Refirgeration system fault diagnosis
- The servicing of systems

Technical data:

- Refrigerant type: R404a

39-306-230	Reverse Cycle Heat Pump AC Trainer

Refrigeration AC Controls Skills Trainer

The Commercial Refrigeration and Air-Conditioning Controls Skills Trainer is an authentic, self-contained bench-mounted small refrigeration system complete with thermostat, pressure controls and fans. The system teaches students how to diagnose common faults with refrigeration controls and wiring as well as how to set up and calibrate the controls correctly.

There are fifteen faults that can be assigned to the unit selected with a push button. The student can then trace the fault using the multimeter and wiring diagram provided. The unit is supported by a manual that explains how to trace each fault and set up the controls. The unit is charged with a very small quantity of R134a non-ozone depleting refrigerant.

Technical data:

- Non-ozone depleting refrigerant: R134a

39-307-230	Refrigeration AC Controls Skills Trainer

FEATURES

- Simulates common compressor faults
- Uses N2 OFN non-ozone depleting refrigerant
- Suitable for technician training
- Teaching material provided
- Supplied with multimeter & current clamp meter

Hermetic Compressor Fault Simulator

The Hermetic Compressor Fault Simulator is a bench-mounted unit designed to enable students and technicians to diagnose common electrical faults associated with small single-phase hermetic refrigeration compressors. There are a total of fifteen faults that can be assigned to the unit by push button and these can be traced by the student by following and using the multimeter and supplied manual.

The unit is charged with N2 OFN and is completely non-polluting.

39-308-230	Hermetic Compressor Fault Simulator

FEATURES

- Chiller unit compressor generating 5 kW
- Refrigerant R407C
- Safety pressure switch to avoid compressor damage
- Airflow provided by an axial fan
- Comprehensive experiment manual included

Chilled Water A/C Skills Trainer (230 V)

The Feedback Instruments Chilled Water Air Conditioning Skills Trainer 39-310 is a complete chilled water A.C. system integrated onto a single frame. The plant is capable of demonstrating the principles of air conditioning using chilled water as a cooling medium and is a training platform for practising the balancing of chilled water circuits. The training equipment comprises a 5 kW water chiller and five chilled water circuits.

Each of these incorporate terminal fan coil units and dummy sections, which have been adapted to provide technicians with a teaching facility for understanding typical air-conditioning systems.

Technical data:

- Power consumption: 3.2 kW (at full load)
- Dimensions: width 1480 mm x depth 1380 mm x height 2200 mm
- Weight: 230 kgs

39-310-230	Chilled Water A/C Skills Trainer (230 V)

PRODUCT RANGES

TEACHING SOFTWARE

ELECTRICITY & ELECTRONICS

TELECOMMUNICATIONS

ELECTRICAL POWER & MACHINES

CONTROL ENGINEERING

PROCESS CONTROL

REFRIGERATION & AIR CONDITIONING

PNEUMATICS & HYDRAULICS

PNEUMATICS & HYDRAULICS

FEATURES

- Portable
- Rugged construction
- Real industrial components
- Push-fit connections, no tools required
- Speedy set-up
- Comprehensive experiment manual

7.1 Pneumatics Trainers

Pneumatics Tutor Kit

The Pneumatics Tutor is a briefcase unit offering the ultimate in ease of use, portability and component storage. It has been specifically designed to give practical and in-depth knowledge of Pneumatics.

CURRICULUM COVERAGE

Circuits based around single-acting cylinder control

- Extend & retract speed control
- OR, AND, YES & NOT functions

Circuits based around double-acting cylinder control

- Direct control
- Direct with extend & retract speed controls
- Indirect control
- Indirect with extend & retract speed controls
- Semi-automatic circuit (reverse operation)
- Semi-automatic circuit & speed control
- Automatic circuit & speed control
- Slow speed extend & rapid retract
- Time delay
- OR & AND functions & time delay
- MEMORY function
- Auto cycle, speed control & memory
- OR, AND & NOT operations
- MEMORY function & speed control
- Time delay using YES function
- OR & time delay using YES function
- OR & AND functions, semi-automatic circuit
- Memory control & pilot control
- Sequential control
- Cascade control
- Automatic control - time delay & repeat pattern
- Automatic control - slow & fast
- AND function

Technical data:

- Dimensions (net): 530 mm width x 400 mm depth x 140 mm height
- Weight (net): 9 kgs

36-100	Pneumatics Tutor Kit

Additionally required:

Qty	Cat.-No.	Name
1	36-112	Air Compressor (Small)

FEATURES

- Portable
- Rugged construction
- Real industrial components
- Push-fit connections, no tools required
- Speedy set-up
- Comprehensive experiment manual

Electro-Pneumatics Tutor Kit

The Electro-Pneumatics Tutor is a briefcase unit offering the ultimate in ease of use, portability and component storage. It has been specifically designed to give practical and in-depth knowledge of Electro-Pneumatics, preparing students for further/higher education and entry into industry. All components used are genuine industrial items to give maximum exposure and familiarisation with the relevant technology. Each component is clearly marked with its appropriate ISO 1219-1 fluid power symbol.

CURRICULUM COVERAGE

- Direct & indirect lamp control
- Switches - roller operated & push-button
- Direct & indirect solenoid control
- Direct & indirect single- and double-acting cylinder control
- Direct & indirect solenoid / spring poppet valve
- Direct & indirect solenoid / spring spool valve
- Direct & indirect solenoid / solenoid spool valve
- AND & OR logic functions
- Semi-automatic, automatic & latching circuits
- Repeat & non-repeat patterns
- Relay control

Technical data:

- Dimensions (net): 530 mm width x 400 mm depth x 140 mm height
- Weight (net): 9 kgs

36-200	Electro-Pneumatics Tutor Kit

Additionally required:

Qty	Cat.-No.	Name
1	36-112	Air Compressor (Small)
1	36-210	24 V Power Supply

FEATURES

- Comprehensive experiment manual included

AVAILABLE PRODUCTS

- 36-202 fitted with the Mitsubishi Alpha PLC
- 36-203 fitted with the Mitsubishi FX1S PLC
- 36-204 fitted with the Allen Bradley Pico
- 36-205 fitted with the Siemens S7-200 PLC

PLC Electro-Pneumatics Trainer

This Electro-Pneumatics Trainer is a briefcase contained unit designed to enhance the study of the subject by providing a platform for practice programming industrial PLCs. In addition to the coursewear each PLC trainer is supplied with a PC interface lead, PLC software and PLC manual. There are various PLCs available, hence:

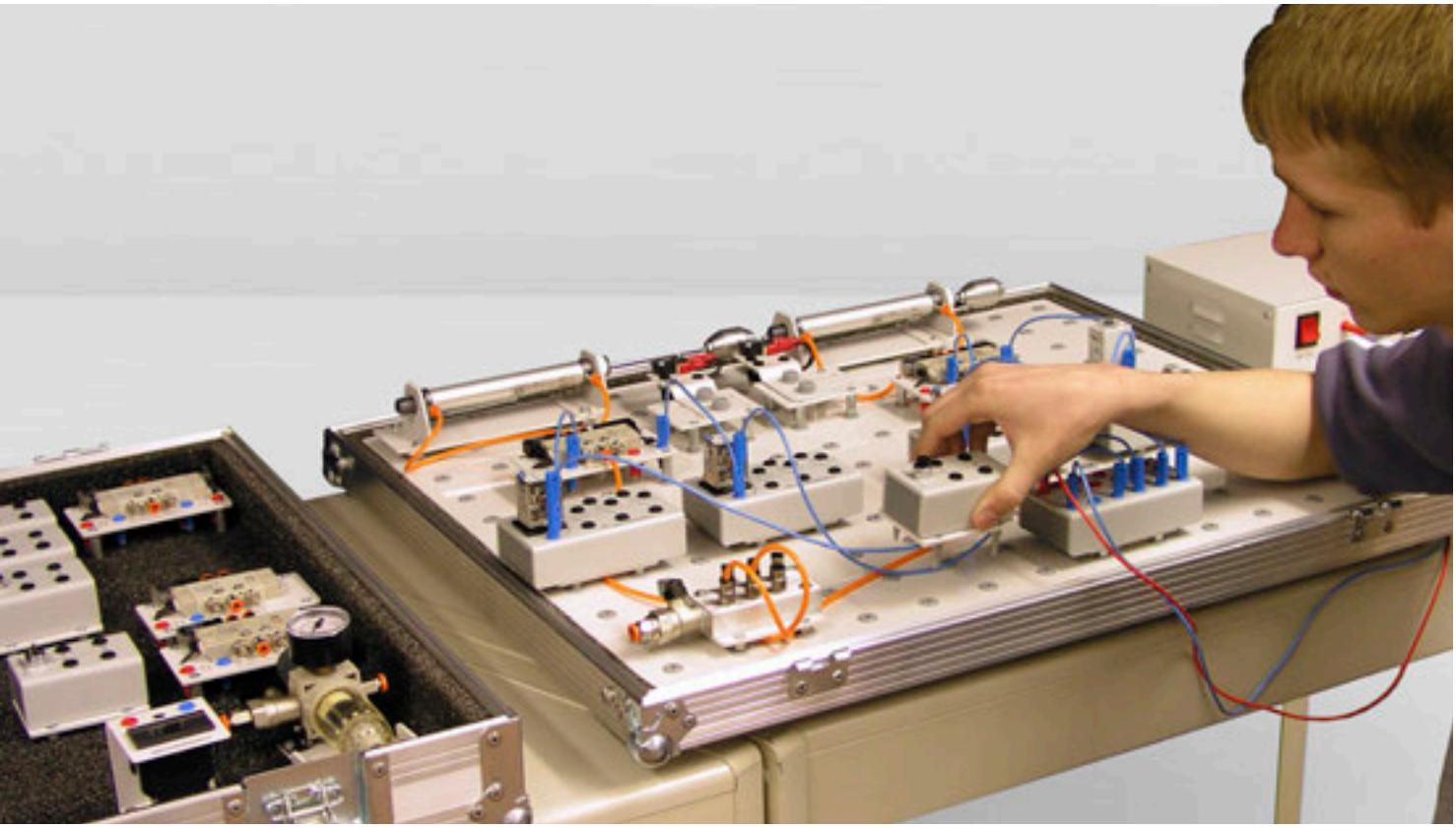
CURRICULUM COVERAGE

- Direct & indirect lamp control
- Roller-operated & push-button switches
- Direct & indirect solenoid control
- Direct & indirect single- & double-acting cylinder control
- Direct & indirect solenoid / spring poppet valve
- Direct & indirect solenoid / spring spool valve
- Direct & indirect solenoid / solenoid spool valve
- AND & OR logic functions
- Semi-automatic, automatic & latching circuits
- Repeat & non-repeat patterns
- PLC control & theory including set, reset, counter, timer, flag & logic functions
- Logic plans (Alpha)
- Ladder diagrams (Pico)
- Ladder diagrams & statement lists (FX1S, S7-200)

Technical data:

- Dimensions (net): 530 mm width x 400 mm depth x 140 mm height
- Weight (net): 10 kgs

36-202	PLC Electro-Pneumatics Trainer



Additionally required:

Qty	Cat.-No.	Name
1	36-112	Air Compressor (Small)
1	36-210	24V Power Supply

PC running Windows XP, Vista or Win 7 32-bit or 64-bit required

Alternatives

- 36-202 fitted with the Mitsubishi Alpha PLC
- 36-203 fitted with the Mitsubishi FX1S PLC
- 36-204 fitted with the Allen Bradley Pico
- 36-205 fitted with the Siemens S7-200 PLC

FEATURES

- Industrial components
- Industrially-relevant experiments
- Portable storage case
- Robust construction
- Comprehensive experiment manual

Portable Pneumatics Trainer, Level 1

This portable and compact trainer uses the transit case lid as the circuit construction platform. It is an ideal laboratory resource providing the introductory training of pneumatic components and circuits. The trainer includes a set of Level 1 pneumatic components and a collection of experimental exercises.

Technical data:

- Dimensions (net): 750 mm width x 600 mm depth x 125 mm height
- Weight (net): 30 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	36-110	Air Compressor (Large)
1	36-602	Set of Components, Pneumatics, Level 1
1	36-606	Circuit Building Panel (700 mm x 550 mm)
1	36-607	Portable Transit/Storage Case for 36-606 & 36-603
1	36-810	Circuit exercises, questions & answers, Pneumatics Level 1

36-004	Portable Pneumatics Trainer, Level 1

A number of different component kits can be added (see datasheet).

FEATURES

- Industrial components
- Industrially-relevant experiments
- Portage storage case
- Robust construction
- Comprehensive experiment manual

Portable Electro-Pneumatics Trainer, Level 1

This portable and compact trainer uses the transit case lid as the circuit construction platform. It introduces electrical signalling into the training of pneumatic components and circuits. The trainer includes a set of Level 1 electro-pneumatic components and a collection of experimental exercises.

Technical data:

- Dimensions (net): 750 mm width x 600 mm depth x 125 mm height
- Weight (net): 30 kgs

Scope of delivery:

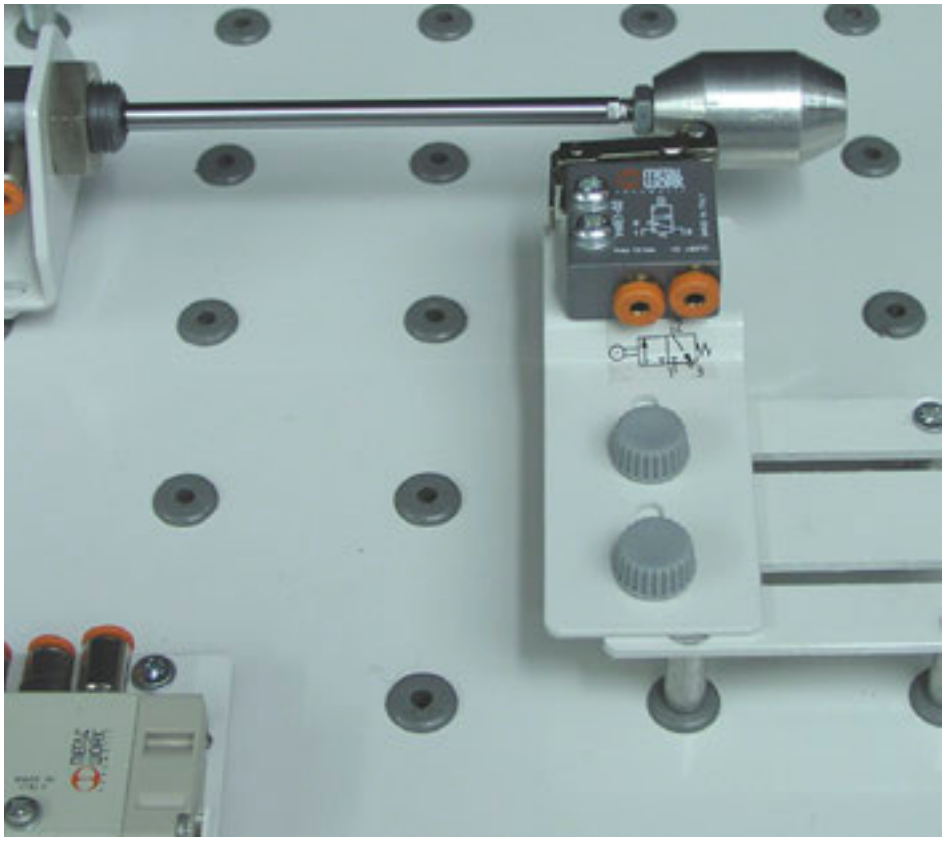
Qty	Cat.-No.	Name
1	36-110	Air Compressor (Large)
1	36-603	Set of Components, Electro-pneumatics
1	36-606	Circuit Building Panel (700 mm x 550 mm)
1	36-607	Portable Transit/Storage Case for 36-606 & 36-603
1	36-811	Circuit exercises, questions & answers, Electro-pneu. Level 1

36-005	Portable Electro-Pneumatics Trainer, Level 1

A number of component kits can be added to extend the experimentation (see datasheet).

FEATURES

- Industrial components
- Industrially-relevant experiments
- Portage storage cases
- Robust construction
- Comprehensive experiment manual



Portable Pneumatics & Electro-Pneumatics Trainer

This portable and compact trainer comes with two cases and uses the transit case lid of one as the circuit construction platform. It combines all the elements of the 36-004 and 36-005 to produce a complete trainer covering pneumatics and electro-pneumatic components and circuits. The trainer includes a set of Level 1 pneumatic and Level 1 electro-pneumatic components and a collection of experimental exercises.

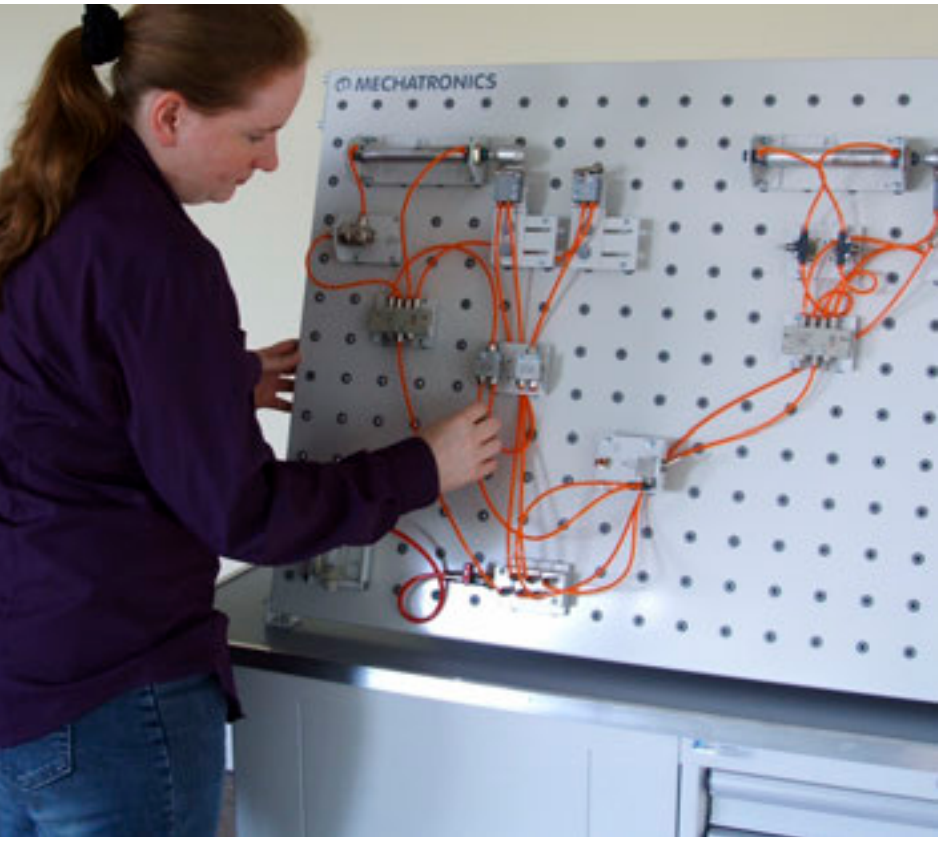
Technical data:

- Dimensions (net): 2 cases, each one has dims 750 mm width x 600 mm depth x 125 mm height
- Weight: 2 x 30 kgs = 60 kgs total

Scope of delivery:

Qty	Cat.-No.	Name
1	36-110	Air Compressor (Large)
1	36-602	Set of Components, Pneumatics, Level 1
1	36-604	Set of Components, Electro-pneumatics abridged
1	36-606	Circuit Building Panel (700 mm x 550 mm)
2	36-607	Portable Transit/Storage Case for 36-606 & 36-603
1	36-810	Circuit exercises, questions & answers, Pneumatics Level 1
1	36-811	Circuit exercises, questions & answers, Electro-pneu. Level 1

36-006	Portable Pneumatics & Electro-Pneumatics Trainer



FEATURES

- Double-sided mobile trolley
- 2 x large circuit construction panels
- Industrial components
- Air Compressor, 44 litres / minute
- Modular, expandable system
- Robust construction
- Comprehensive experiment manual

Trolley-mounted Pneumatics Trainer

This trolley based trainer is an ideal laboratory resource providing the introductory training of pneumatic components and circuits. The trainer consists of a double sided mobile laboratory trolley, air compressor, a set of Level 1 pneumatic components and a collection of experimental exercises.

CURRICULUM COVERAGE

- Assembly fixture
- Date stamping a product
- Bending fixture
- Panel removal from a jig
- Product separation
- Foundry ladle control
- Barrier control
- Component test machine
- Cold room door control
- Roof ventilator control
- Product sorting
- Machine feed
- Product cleansing
- Plastic bag heat sealing
- Hopper door control
- Clamping fixture
- Blister pack assembly
- Conveyor selection
- Lift & transfer station

Technical data:

- Dimensions (net): width 1500 mm x depth 750 mm x height 1570 mm
- Weight (net): 350 kgs

Scope of delivery:

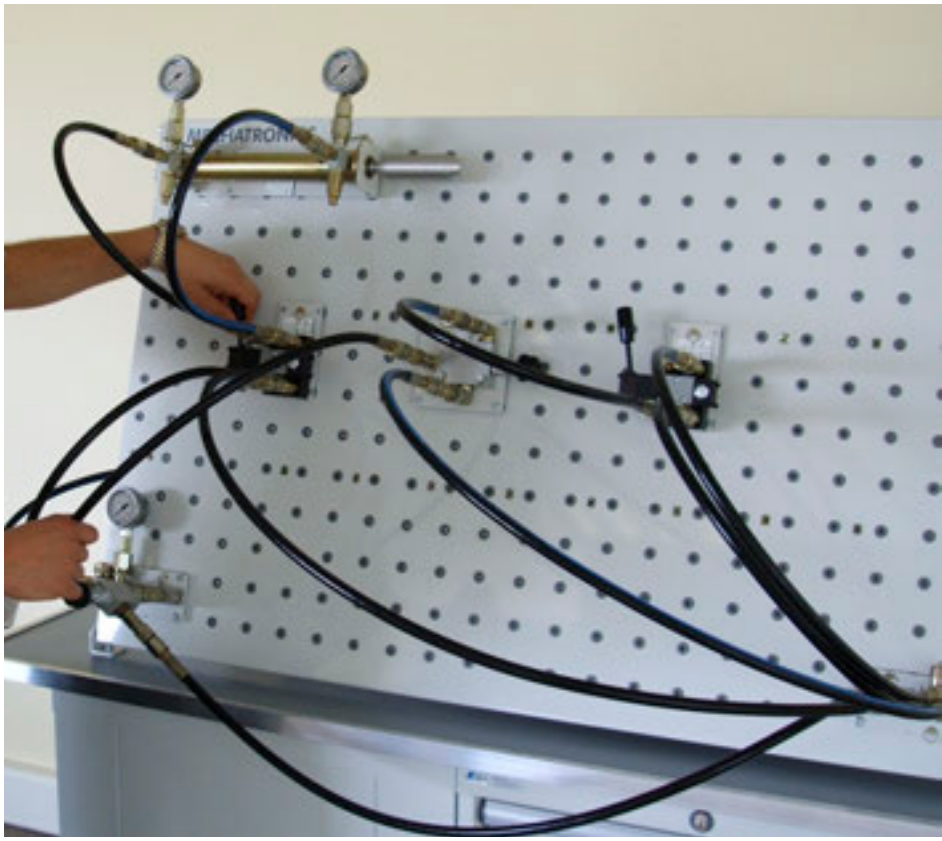
Qty	Cat.-No.	Name
1	36-110	Air Compressor (Large)
1	36-601	Double-sided Mobile Trolley
1	36-602	Set of Components, Pneumatics, Level 1
1	36-810	Circuit exercises, questions & answers, Pneumatics Level 1

36-001	Trolley-mounted Pneumatics Trainer

A number of different component sets can be used to extend the range of experimentation (see datasheet).

FEATURES

- Double-sided mobile trolley
- 2 x large circuit construction panels
- Air compressor, 44 litres / minute
- Industrial components
- Modular, expandable system
- Comprehensive experiment manual included



Trolley-mounted Electro-Pneumatics Trainer

This trolley based trainer introduces electrical signalling into the training of pneumatic components and circuits. The trainer consists of a double sided mobile laboratory trolley, air compressor, a set of Level 1 electro-pneumatic components 36-603 including a power supply, and a collection of experimental exercises.

CURRICULUM COVERAGE

- Assembly fixture
- Date stamping a product
- Bending fixture
- Panel removal from a jig
- Product separation
- Foundry ladle control
- Barrier control
- Component test machine
- Cold room door control
- Roof ventilator control
- Product sorting
- Machine feed
- Product cleansing
- Plastic bag heat sealing
- Hopper door control
- Clamping fixture
- Blister pack assembly
- Conveyor selection
- Lift & transfer station

Technical data:

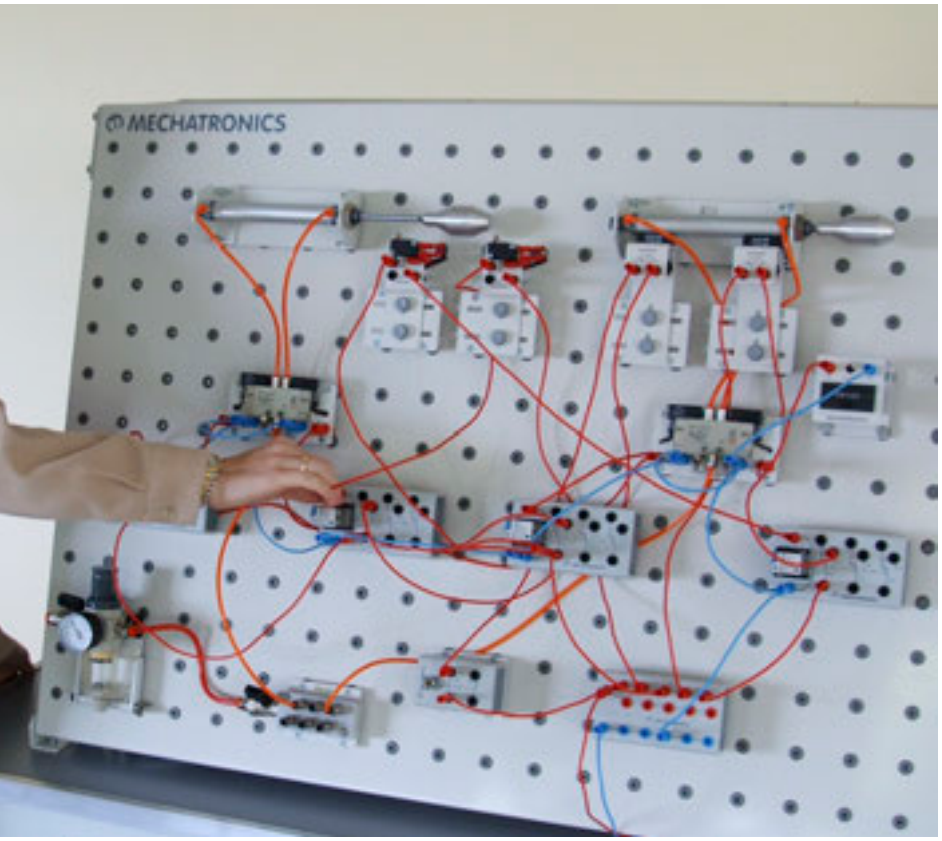
- Dimensions (net): width 1500 mm x depth 750 mm x height 1570 mm
- Weight (net): 350 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	36-110	Air Compressor (Large)
1	36-601	Double-sided Mobile Trolley
1	36-603	Set of Components, Electro-pneumatics
1	36-811	Circuit exercises, questions & answers, Electro-pneu. Level 1

36-002	Trolley-mounted Electro-Pneumatics Trainer

A number of different component sets can be purchased to extend the range of experimentation (see datasheet).



FEATURES

- Double-sided mobile trolley
- 2 x large circuit construction panels
- Air compressor, 44 litres per minute
- Industrial components
- Modular, expandable system
- Robust construction
- Comprehensive experimental manual included

Trolley-mounted Pneumatics & Electro-Pneumatics Trainer

This trolley based trainer combines all the elements of the 36-001 and 36-002 to produce a complete trainer covering electro-pneumatic components and circuits. The trainer consists of a double sided mobile laboratory trolley, air compressor, a set of level 1 pneumatics (with power supply) and level 1 electro-pneumatic components and a collection of experimental exercises.

CURRICULUM COVERAGE

- Assembly fixture
- Date stamping a product
- Bending fixture
- Panel removal from a jig
- Product separation
- Foundry ladel control
- Barrier control
- Component test machine
- Cold room door control
- Roof ventilator control
- Product sorting
- Machine feed
- Product cleansing
- Plastic bag heat sealing
- Hopper door control
- Clamping fixture
- Blister pack assembly
- Conveyor selection
- Lift & transfer station

Technical data:

- Dimensions (net): width 1500 mm x depth 750 mm x height 1570 mm
- Weight (net): 370 kgs

Scope of delivery:

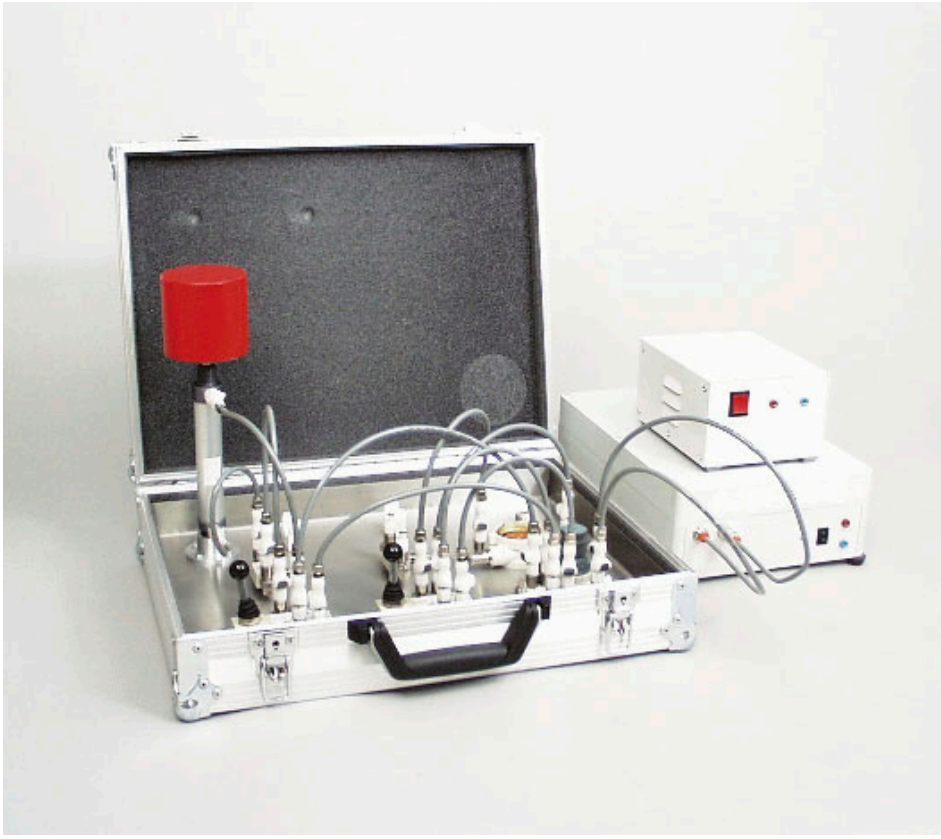
Qty	Cat.-No.	Name
1	36-110	Air Compressor (Large)
1	36-601	Double-sided Mobile Trolley
1	36-602	Set of Components, Pneumatics, Level 1
1	36-604	Set of Components, Electro-pneumatics abridged
1	36-810	Circuit exercises, questions & answers, Pneumatics Level 1
1	36-811	Circuit exercises, questions & answers, Electro-pneu. Level 1

36-003	Trolley-mounted Pneumatics & Electro-Pneumatics Trainer

A number of different component sets can be purchased to extend the range of experimentation (see datasheet).

FEATURES

- Portable
- Rugged construction
- Easily stored
- Genuine industrial components
- Push-fit connections
- Comprehensive experiment manual



7.2 Hydraulics Trainers

Portable Hydraulics Trainer (Basic)

A complete Basic Hydraulics Trainer in a briefcase supplied with a hydraulics power pack and uses water at a maximum pressures of 3 bar, making it safe to teach the fundamental principles of hydraulics.

CURRICULUM COVERAGE

- Directional control
- Speed control
- Pressure control
- Single-acting cylinder control
- Double acting cylinder (with 4/2 way valve)
- Double acting cylinder (with 4/3 way valve)
- Metering „IN" & „OUT"
- Weight loading of cylinder
- Motor control (speed in one direction)
- Motor control (speed in both directions)

Technical data:

- Dimensions (net): main unit 530 mm width x 400 mm depth x 140 mm height
- Dimensions (net): power pack 320 mm width x 170 mm depth x 260 mm height
- Weight (net): 15.5 kgs

Scope of delivery:

- Double-acting cylinder with cam
- 4 kg mass (for use with cylinder)
- Bi-directional motor (simulator)
- Pressure manifold
- Tank-return manifold
- Pressure relief valve with gauge
- Lever-operated 4-2 way & 4/3 way valves
- One-way flow control valve (2 off)
- Hydraulic power pack
- Comprehensive experiment manual

36-500	Portable Hydraulics Trainer (Basic)

FEATURES

- Portable
- Rugged construction
- Easily stored
- Genuine industrial components
- Push-fit connections
- Comprehensive experiment manual

Portable Hydraulics Trainer (Advanced)

A complete Portable Hydraulics Trainer (Advanced) in a briefcase supplied with a hydraulics power pack and uses water at a maximum pressures of 3 bar, making it safe to cover the fundamental principles of hydraulics. Everything is included in the 36-500 plus some additional components.

CURRICULUM COVERAGE

- Directional control
- Speed control
- Pressure control
- Single-acting cylinder control
- Double-acting cylinder control with 4/2 way valve
- Double-acting cylinder control with 4/3 way valve
- Metering „IN" & metering „OUT"
- Weight loading of cylinder
- Motor control with speed control in one direction
- Motor control with speed control in both directions

Technical data:

- Dimensions (net): main unit 530 mm width x 400 mm depth x 140 mm height
- Dimensions (net): power pack 320 mm width x 170 mm depth x 260 mm height
- Weight (net): 16 kgs

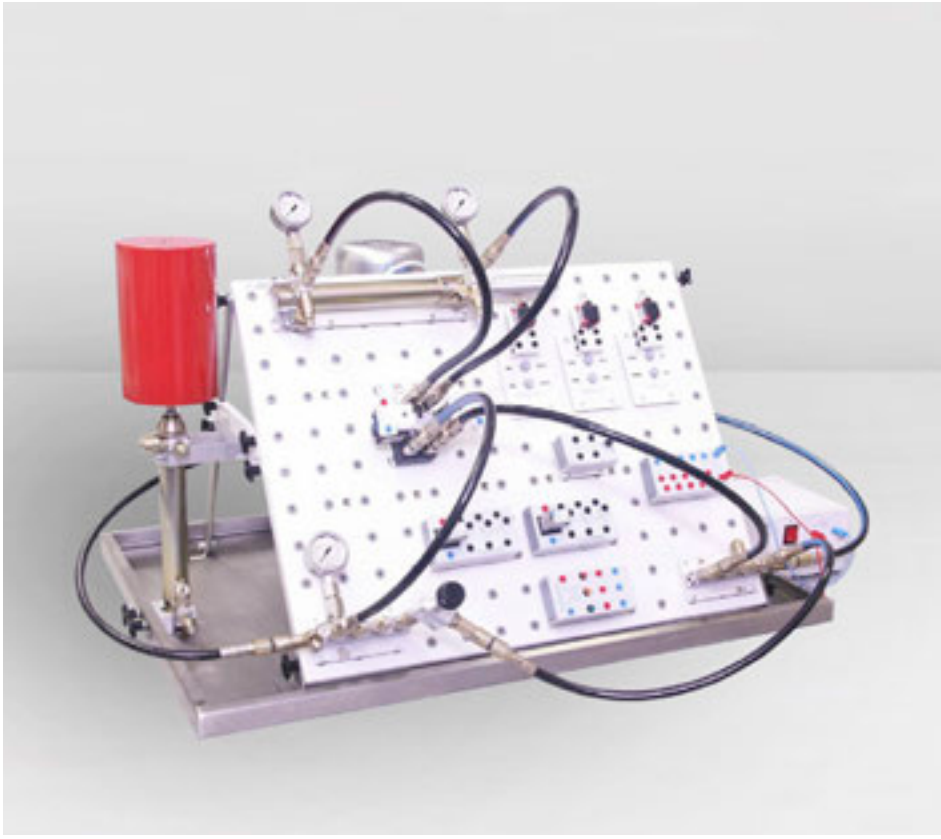
Scope of delivery:

- Double-acting cylinder with cam
- 4 kg mass (for use with cylinder)
- Bi-directional motor (simulator)
- Pressure manifold
- Tank-return manifold
- Pressure relief valve with gauge
- Lever-operated 4/2 way & 4/3 way control valves
- One-way flow control valve (2 off)
- Check valve
- Pilot-operated check valve
- Pressure relief / sequence / counterbalance valve
- Hydraulic power pack
- Comprehensive experiment manual

36-502	Portable Hydraulics Trainer (Advanced)

FEATURES

- Industrial components
- Industrially-relevant experiments
- Portable storage cases
- Robust construction
- Comprehensive experiment manual



Portable Hydraulics Trainer, Level 1

The portable trainer is suited to the introduction of hydraulic components and circuits covering the range of exercises available with the Level 1 component set. All components are of an industrial standard and mounted on a construction panel with a stainless steel drip tray. When not in use the components are housed in a heavy duty aluminium storage case.

Curriculum Coverage (36-652)

- Pump performance test
- Pressure relief valve
- Direction control valves (reading the circuit diagram)
- Lift table (2 position DVC)
- Hopper door control (3 position DVC)
- Surface grinding traverse (differential, regenerative circuit)
- Hydraulic crane (flow control)
- Straightening rollers (pressure reducing)
- Hydraulic press (piloted 2-stage pressure release)
- Rolling mill conveyor (motor control)
- Power winch (motor control)

Technical data:

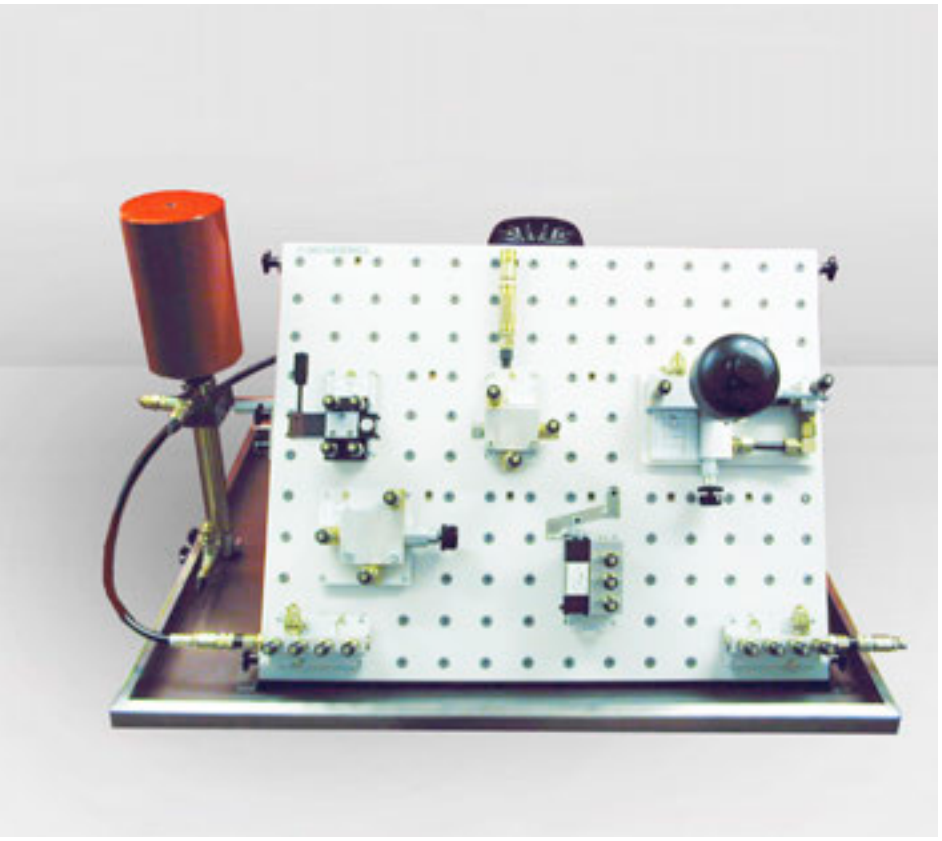
- Dimensions (net): 2 off 710 width x 610 mm depth x 280 mm height plus 1 off 910 mm width x 660 depth x 50 mm height plus 1 off 480 mm width x 250 mm depth x 500 mm height
- Weight (net): 100 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	36-650	Portable mini-hydraulic training unit & hydraulic power pack
1	36-652	Set of Components, Hydraulics Level 1
1	36-656	Portable Transit/Storage Case for 36-652/36-653
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1

36-014	Portable Hydraulics Trainer, Level 1

A number of additional component sets can be purchased to extend the experimentation (see datasheet).



FEATURES

- Industrial components
- Industrially-relevant experiments
- Portable storage cases
- Robust construction
- Comprehensive experiment manual

Portable Hydraulics Trainer, Levels 1 & 2

The portable trainer is a more advanced introduction of hydraulic components and circuits covering the range of exercises available with the levels 1 & 2 component sets (36-652 & 36-653). All components are of an industrial standard and mounted on a construction panel. When not in use the components are housed in a heavy duty aluminium storage case.

CURRICULUM COVERAGE (36-652 PLUS 36-653)

Same curriculum coverage as 36-014 (36-652 components), plus curriculum coverage for 36-653 as follows:

- Door operation (double-acting cylinder with weight loading)
- Door with inching facility (pilot operation check valve)
- Scrap car crusher (multiple pressure relief)
- Pressure with counter balance
- Clamp & press (pressure sequence)
- Lift & transfer station (2 cylinder - sequential circuit)
- Machine feed (fast/slow cylinder feed)
- Injection moulding machine (accumulator circuit)

Technical data:

- Dimensions (net): 2 off 710 mm width x 610 mm depth x 280 mm height plus 1 off 910 mm width x 660 mm depth x 50 mm height plus 1 off 480 mm width x 250 mm depth x 500 mm height
- Weight (net): 130 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	36-650	Portable mini-hydraulic training unit & hydraulic power pack
1	36-652	Set of Components, Hydraulics Level 1
1	36-653	Set of Components, Hydraulics Level 2
2	36-656	Portable Transit/Storage Case for 36-652/36-653
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1
1	36-813	Circuit exercises, questions & answers, Hydraulics Level 2

36-015	Portable Hydraulics Trainer, Levels 1 & 2

A number of different component sets can be purchased to extend the range of experimentation (see datasheet).

FEATURES

- Industrial components
- Industrially-relevant experiments
- Portable storage cases
- Robust construction
- Comprehensive experiment manual

Portable Electro-Hydraulics Trainer

The portable trainer introduces the electrical control of hydraulic components through a range of exercise and practical applications. All components are of an industrial standard and mounted on a construction panel with a stainless steel drip tray. When not in use the components are housed in a heavy duty aluminium storage case.

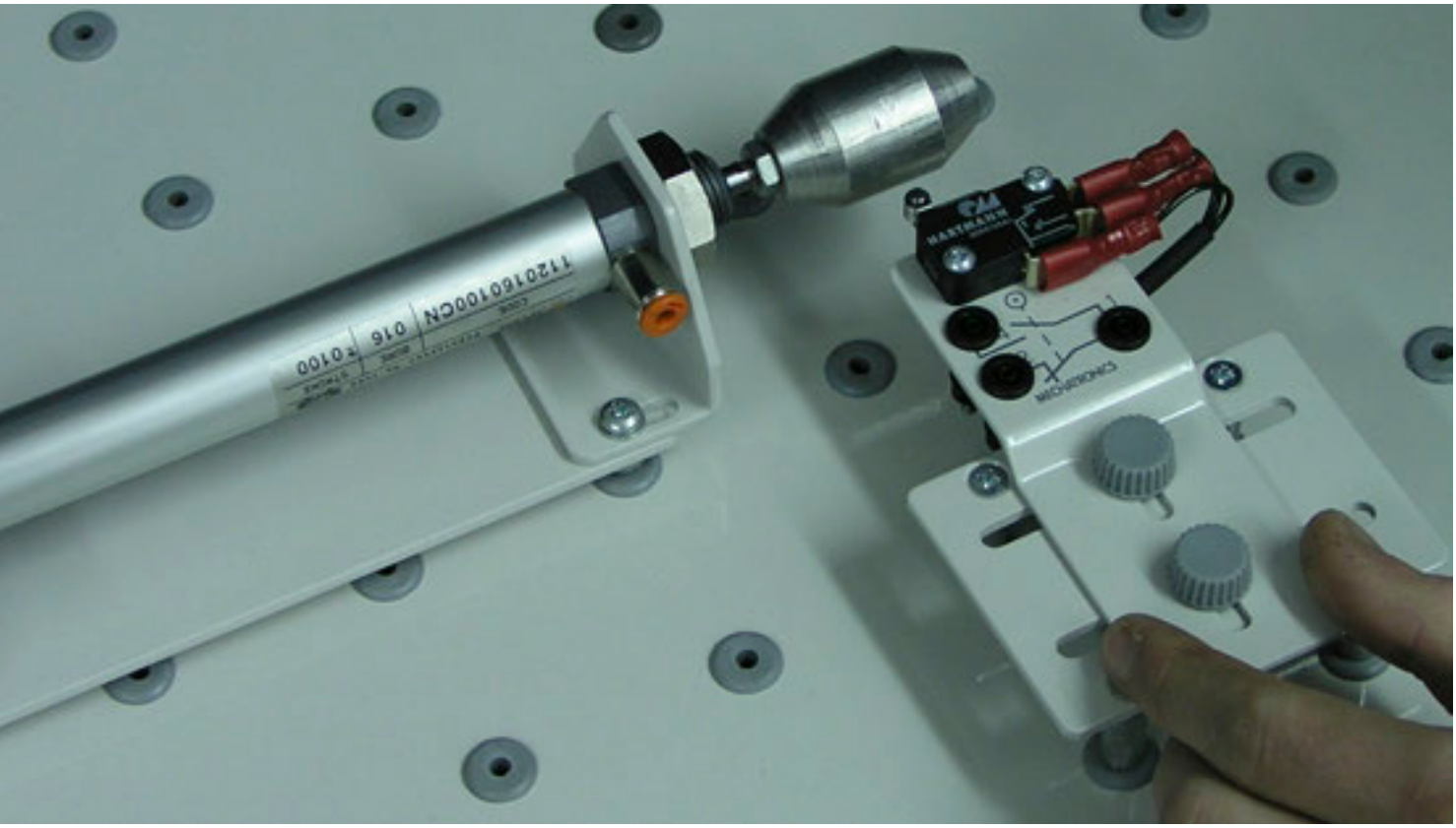
CURRICULUM COVERAGE (36-652, 36-653, 36-654)

Same curriculum coverage as for 36-015 (36-652 components plus 36-653 components)
plus curriculum coverage for 36-654 components as follows:

- Door operation
- Chipboard press
- Panel removal from a jig
- Product sorting
- Rolling mill conveyor
- Lift table
- Lift truck
- Power winch
- Hydraulic press with limit switch return
- Hopper door control
- Door with inching facility
- Milling machine
- Surface grinder traverse with regenerative circuit
- Concrete mixer
- Clamp & press

Technical data:

- Dimensions (net): 2 off 710 mm width x 610 mm depth x 280 mm height plus 1 off 910 mm width x 660 mm depth x 50 mm height plus 1 off 480 mm width x 250 mm depth x 500 mm height plus 1 off 920 mm width x 700 mm depth x 150 mm height
- Weight (net): 110 kgs



Scope of delivery:

Qty	Cat.-No.	Name
1	36-650	Portable mini-hydraulic training unit & hydraulic power pack
1	36-652	Set of Components, Hydraulics Level 1
1	36-653	Set of Components, Hydraulics Level 2
1	36-654	Set of Components, Electro-hydraulics
2	36-656	Portable Transit/Storage Case for 36-652/36-653
1	36-657	Portable Transit/Storage Case for 36-654
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1
1	36-813	Circuit exercises, questions & answers, Hydraulics Level 2
1	36-814	Circuit exercises, questions & answers, Electro-hydraulics

36-016	Portable Electro-Hydraulics Trainer

A number of different component sets can be purchased in order to extend the range of experimentation (see datasheet).

Portable Proportional Hydraulics Trainer

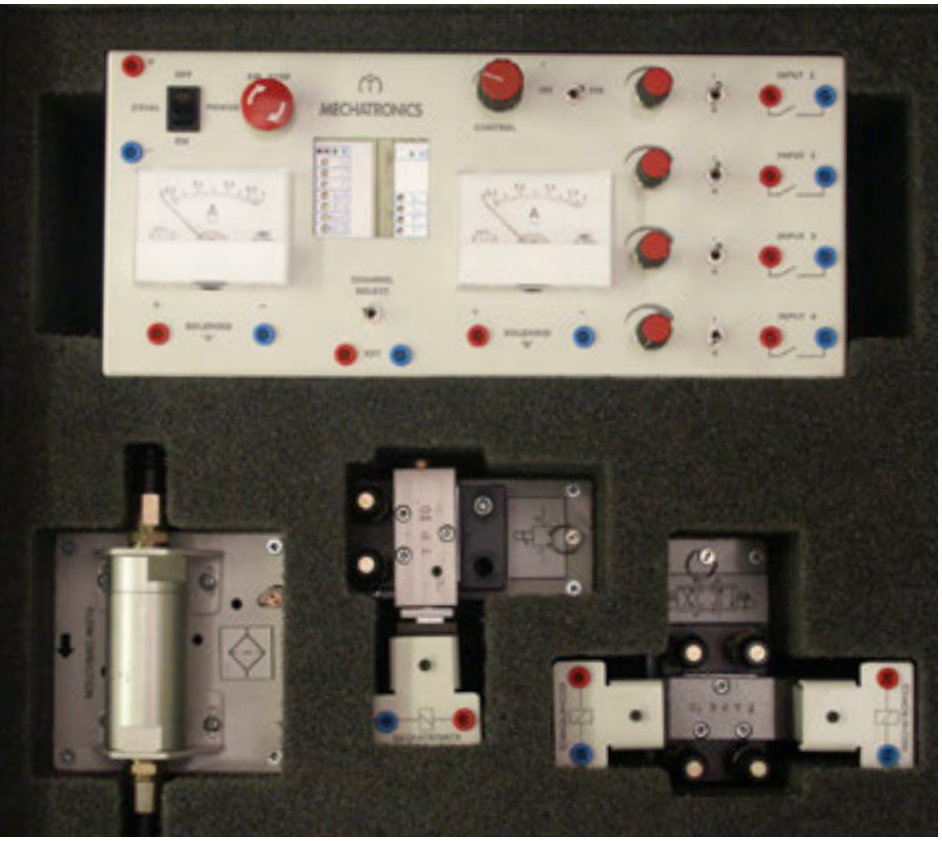
The portable system is a complete hydraulics trainer covering hydraulics, electro-hydraulics and proportional hydraulics. All components are of an industrial standard and mounted on a construction panel with a stainless steel drip tray. The trainer is housed in a heavy duty aluminium storage case.

CURRICULUM COVERAGE

- Proportional direction control
- Chipboard press
- Lift truck
- Surface grinder traverse
- Surface grinder traverse with ramp control
- Milling machine
- Rolling mill conveyor
- Brick firing kiln
- Concrete mixer
- Proportional pressure relief valve
- Straightening rollers
- Hydraulic press

Technical data:

- Dimensions (net): 2 off width 710 mm x depth 610 mm x height 280 mm plus 1 off width 910 mm x depth 660 mm x height 50 mm plus 1 off width 480 mm x depth 250 mm x height 500 mm plus 1 off width 920 mm x depth 700 mm x height 150 mm plus 1 off width 480 mm x depth 450 mm x height 210 mm
- Weight: 120 kgs



FEATURES

- Industrial components
- Industrially-relevant experiments
- Portable storage case
- Robust construction
- Comprehensive experiment manual

Scope of delivery:

Qty	Cat.-No.	Name
1	36-650	Portable mini-hydraulic training unit & hydraulic power pack
1	36-652	Set of Components, Hydraulics Level 1
1	36-654	Set of Components, Electro-hydraulics
1	36-655	Set of Components, Proportional Hydraulics
2	36-656	Portable Transit/Storage Case for 36-652/36-653
1	36-657	Portable Transit/Storage Case for 36-654
1	36-658	Portable Transit/Storage Case for 36-655
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1
1	36-814	Circuit exercises, questions & answers, Electro-hydraulics
1	36-815	Circuit exercises, questions & answers, Proportional Hydraulics

36-017	Portable Proportional Hydraulics Trainer

A number of different component sets can be purchased to extend the range of experimentation (see datasheet).

FEATURES

- Double-sided mobile trolley
- Industrial components
- Components positioned using quarter-turn locking mechanism
- Robust construction
- Modular, expandable system
- Comprehensive experiment manual

Trolley-mounted Hydraulics Trainer, Level 1

The trolley-based trainer is suited to the introduction of hydraulic components and circuits covering the range of exercises available with the level 1 component set, 36-652. All components are of an industrial standard, mounted on plug-in base plates that are push fit into the construction panel and locked with a quarter-turn fastener for firm fitting. The hole format of the construction panel enables a flexibility approach to circuit layouts. The system can be expanded by adding further component sets.

CURRICULUM COVERAGE

- Pump performance test
- Pressure relief valve
- Direction control valves
- Lift table
- Hopper door control
- Surface grinding traverse
- Hydraulic crane
- Straightening rollers
- Hydraulic press
- Rolling mill conveyor
- Power winch

Technical data:

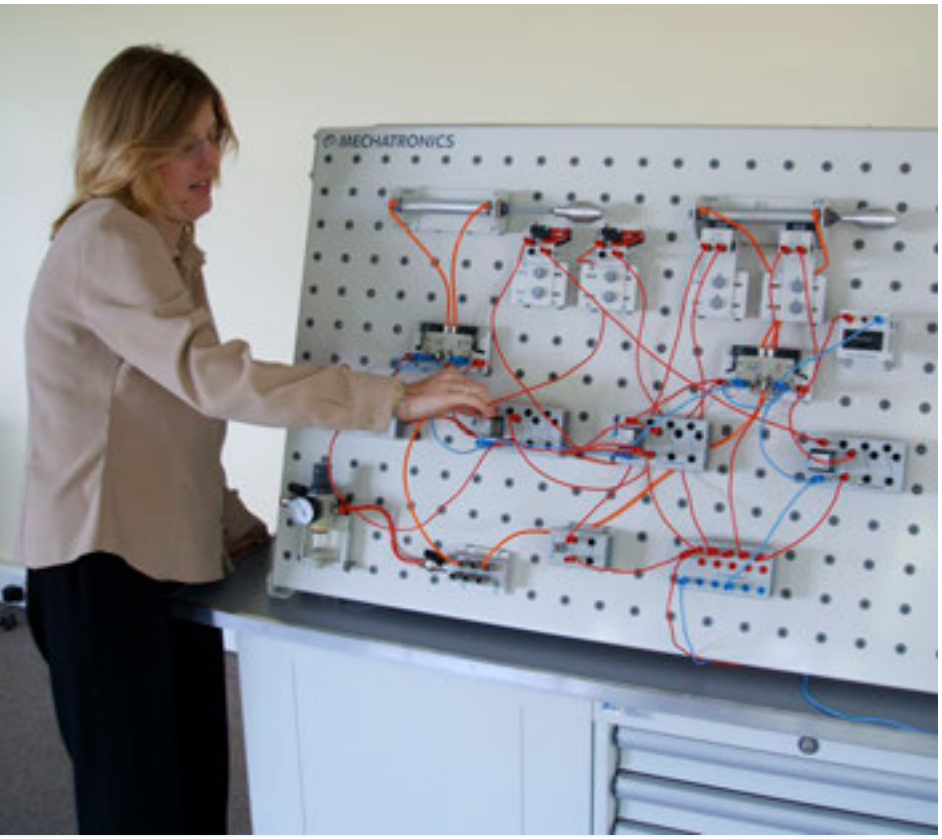
- Dimensions (net): width 1500 mm x depth 750 mm x height 1570 mm
- Weight (net): 350 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	36-651	Double-sided Mobile Trolley
1	36-652	Set of Components, Hydraulics Level 1
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1

36-010	Trolley-mounted Hydraulics Trainer, Level 1

A number of different component sets can be purchased in order to extend the range of experimentation (see datasheet).



FEATURES

- Double-sided mobile trolley
- Industrial components
- Quarter-turn locking system
- Robust construction
- For individual use or group demonstration
- Comprehensive experiment manual

Trolley-mounted Hydraulics Trainer, Levels 1 & 2

The trolley-based trainer allows more advanced exercises than those provided by the 36-010 through the addition of the level 2 component set (36-653). All components are of an industrial standard and are plugged and locked using a firm quarter-turn locking system into a large circuit building panel for individual or group demonstration. The hole format used on the construction panels provides great circuit formation flexibility.

CURRICULUM COVERAGE (36-652)

- Pump performance test
- Pressure relief valve
- Direction control valves
- Lift table
- Hopper door control
- Surface grinding traverse
- Hydraulic crane
- Straightening rollers
- Hydraulic press
- Rolling mill conveyor
- Power winch

CURRICULUM COVERAGE (36-653)

- Door operation
- Door with inching facility
- Scrap car crusher
- Pressure with counter balance
- Clamp & press
- Lift & transfer station
- Machine feed
- Injection moulding machine

Technical data:

- Dimensions (net): width 1500 mm x depth 750 mm x height 1570 mm
- Weight (net): 430 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	36-651	Double-sided Mobile Trolley
1	36-652	Set of Components, Hydraulics Level 1
1	36-653	Set of Components, Hydraulics Level 2
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1
1	36-813	Circuit exercises, questions & answers, Hydraulics Level 2

36-011	Trolley-mounted Hydraulics Trainer, Levels 1 & 2

A number of different component sets can be added to extend the range of experimentation (see datasheet).

FEATURES

- Double-sided mobile trolley
- Industrial components
- Robust construction
- Modular, expandable system
- Comprehensive experiment manual

Trolley-mounted Electro-Hydraulics Trainer

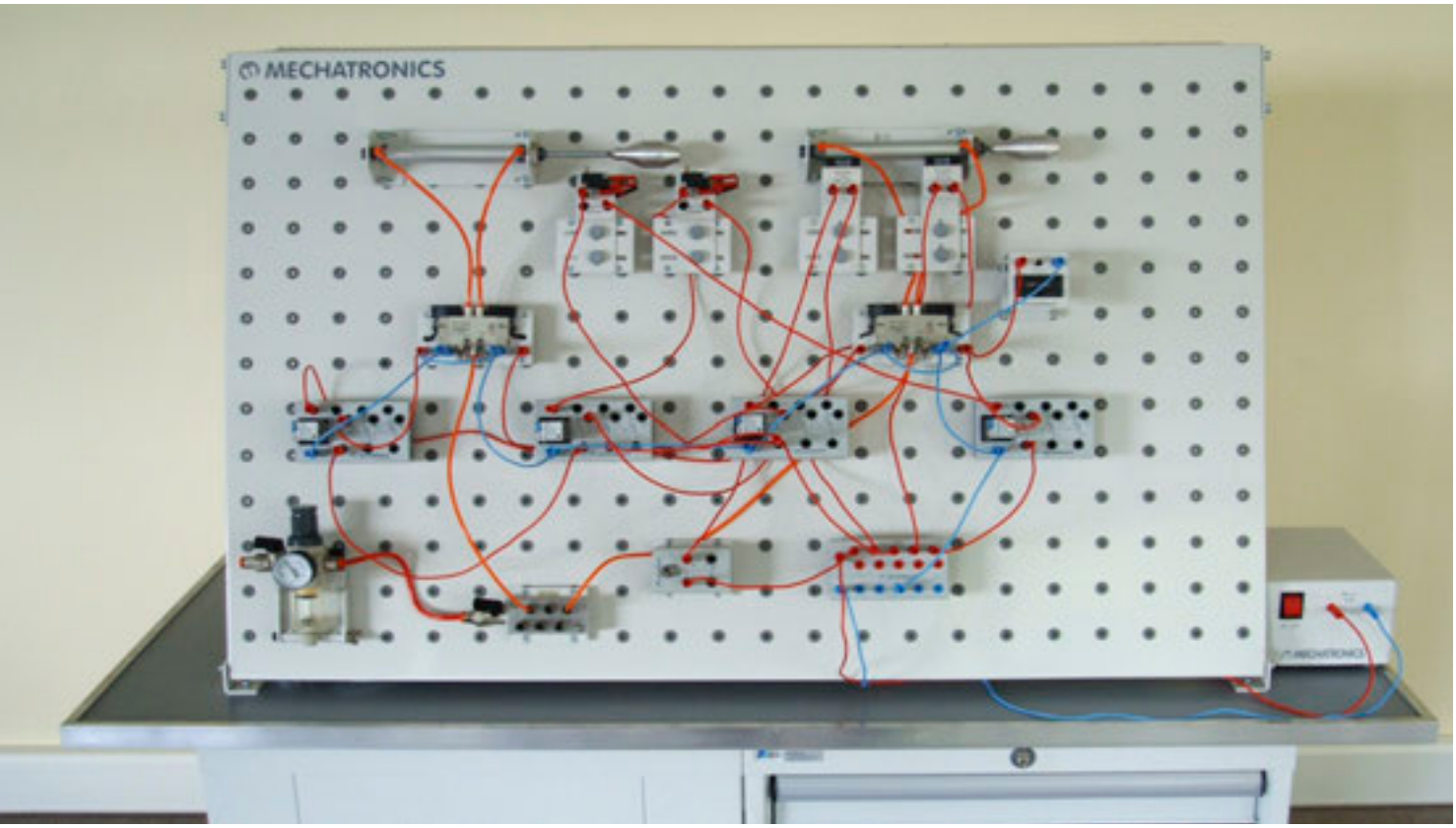
The trolley-based trainer introduces the electrical control of hydraulic components through a range of exercises and practical applications. All components are of an industrial standard and are plugged and locked, using a quarter-turn locking system, into a large circuit building panel for individual or group demonstration. The package includes the double-sided trolley, two hydraulics power packs, hydraulics components level 1, electro-hydraulics components including a power supply plus experiment exercises.

CURRICULUM COVERAGE (36-652)

- Pump performance test
- Pressure relief valve
- Direction control valves
- Lift table
- Hopper door control
- Surface grinding traverse
- Hydraulic crane
- Straightening rollers
- Hydraulic press
- Rolling mill conveyor
- Power winch

CURRICULUM COVERAGE (36-654)

- Door operation
- Chipboard press
- Panel removal from a jig
- Product sorting
- Rolling mill conveyor
- Lift table
- Lift truck
- Power winch



- Hydraulic press with limit switch return
- Hydraulic press with pressure switch return
- Hopper door control
- Door with inching facility
- Milling machine
- Surface grinder traverse
- Clamp & press
- Concrete mixer
- Surface grinder traverse with regenerative circuit
- Lift & transfer station

Technical data:

- Dimensions (net): width 1500 mm x depth 750 mm x height 1570 mm
- Weight (net): 420 kgs

Scope of delivery:

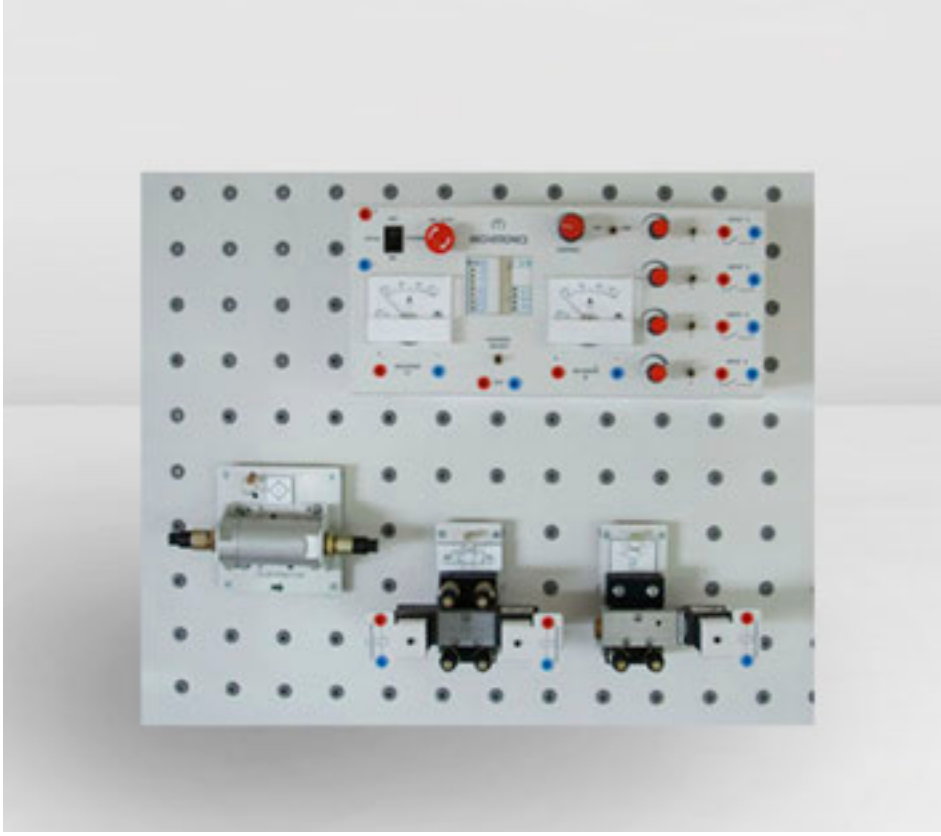
Qty	Cat.-No.	Name
1	36-651	Double-sided Mobile Trolley
1	36-652	Set of Components, Hydraulics Level 1
1	36-654	Set of Components, Electro-hydraulics
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1
1	36-814	Circuit exercises, questions & answers, Electro-hydraulics

36-012	Trolley-mounted Electro-Hydraulics Trainer

A number of different component sets can be added in order to extend the range of experimentation (see datasheet).

FEATURES

- Double-sided mobile trolley
- Industrial components
- Hydraulics
- Electro-hydraulics
- Proportional hydraulics
- Robust construction
- Comprehensive experiment manual



Trolley-mounted Proportional Hydraulics Trainer

The trolley-based system is a complete hydraulics trainer covering hydraulics, electro-hydraulics and proportional hydraulics. It therefore includes the same equipment provided in the 36-012 with the addition of the proportional hydraulics components and exercises. All components are of an industrial standard and are plugged and locked into a large base plate, using a secure, quarter-turn locking mechanism, for individual or group demonstration.

CURRICULUM COVERAGE (36-652)

- Pump performance test
- Pressure relief valve
- Direction control valves
- Lift table
- Hopper door control
- Surface grinding traverse
- Hydraulic crane
- Straightening rollers
- Hydraulic press
- Rolling mill conveyor
- Power winch

CURRICULUM COVERAGE (36-654)

- Door operation
- Chipboard press
- Panel removal from a jig
- Product sorting
- Rolling mill conveyor
- Lift table
- Lift truck
- Power winch
- Hydraulic press with limit switch return
- Hydraulic press with pressure switch return
- Hopper door control
- Door with inching facility
- Milling machine
- Surface grinder traverse
- Clamp & press
- Concrete mixer
- Surface grinder traverse with regenerative circuit
- Lift & transfer station

CURRICULUM COVERAGE (36-655)

- Proportional direction conmtrol valve
- Chipboard press
- Lift truck
- Surface grinder traverse
- Surface grinder traverse with ramp control
- Milling machine
- Rolling mill conveyor
- Brick firing kiln
- Concrete mixer
- Proportional pressure relief valve
- Straightening rollers
- Hydraulic press

Technical data:

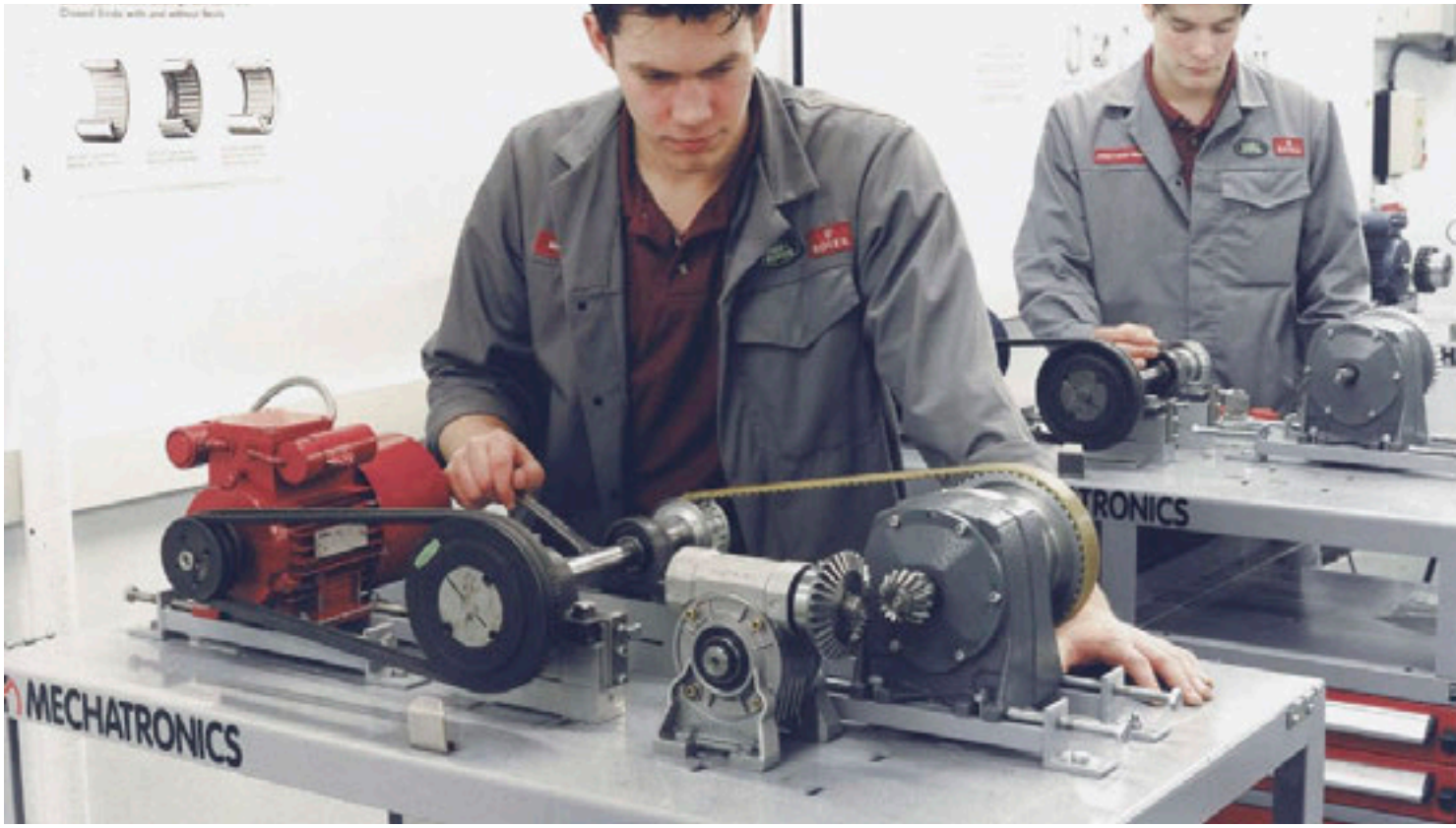
- Dimensions (net): width 1500 mm x depth 750 mm x height 1570 mm
- Weight (net): 435 kgs

Scope of delivery:

Qty	Cat.-No.	Name
1	36-651	Double-sided Mobile Trolley
1	36-652	Set of Components, Hydraulics Level 1
1	36-654	Set of Components, Electro-hydraulics
1	36-655	Set of Components, Proportional Hydraulics
1	36-812	Circuit exercises, questions & answers, Hydraulics Level 1
1	36-814	Circuit exercises, questions & answers, Electro-hydraulics
1	36-815	Circuit exercises, questions & answers, Proportional Hydraulics

36-013	Trolley-mounted Proportional Hydraulics Trainer

A number of different component sets can be added to extend the range of experimentation (see datasheet).



7.3 Mechanical transmission Trainers

Trolley-mounted Mechanical Transmission Trainer

The 40-001 is a mobile, trolley-mounted Mechanical Transmission Trainer providing a variety of fully working components to demon-strate belt, chain, shaft, gear, coupling, gearbox and transmission drive with full industrial safety facilities. The trainer provides hand-on experience to enable students to set up different transmission systems and compare them in terms of underlying principles, ease of assembly, maintenance issues and operational characteristics. The guards can be easily lifted away (without tools) to allow full access during transmission set-up, however operation of the motor is only possible when the guards are replaced and closed. A complete tool kit is included. Other versions of the trainer available include a benchtop version (40-002) and a trolley version with an inverter drive and 3-phase electgric motor (40-003).

CURRICULUM COVERAGE

- VEE belt pulleys / belts
- Sprockets
- Timing belts
- Shaft & plummer blocks
- Gear coupling
- Spider coupling
- Torque limiter
- Spur gear set
- Bevel gear set
- Gearbox drive via shaft, torque limiter & gear coupling
- 3-stage speed reduction using vee belts, gears & gearbox
- 3-stage speed reduction using vee belts, timing belt & gearbox
- 3-stage speed reduction using vee belts, spur gears & gearbox
- 5-stage speed reduction using vee belts, shaft, spur gears, sprockets / chain & 2 gearboxes
- 5-stage speed reduction using vee belts, shaft, timing belt, bevel gears & 2 gearboxes

Technical data:

- 40-001 Dimensions (net): width 1150 mm x depth 700 mm x height 1350 mm
- 40-001 Weight (net): 250 kgs
- 40-002 Dimensions (net): width 1150 mm x depth 700 mm x height 470 mm
- 40-002 Weight (net): 130 kgs
- 40-003 Dimensions (net). width 1150 mm x depth 700 mm x height 1350 mm
- 40-003 Weight (net): 250 kgs

40-001	Trolley-mounted Mechanical Transmission Trainer

FEATURES

- Covers belt, chain, shaft, gear, coupling, gearbox & transmission drive
- Industrial components for a real experience
- Flexible configuration
- Minimal set-up required, supplied ready to use
- Comprehensive experiment manual

Purchasing options

- 40-001 Mobile trolley-mounted mechanical transmission trainer with equipment storage cabinet and toolkit, or
- 40-002 Bench-top mechanical transmission trainer with toolkit, or
- 40-003 Mobile trolley-mounted mechanical transmission trainer with equipment storage cabinet, inverter drive & 3-phase motor, with toolkit

7.4 Mechatronics

Mechatronics Kit

The Mechatronic Systems kit provides a wide range of resources suitable for studying mechatronics using three types of control system:

- PIC microcontroller
- Micro PLC
- PC

Students can learn the basics of control using flowcharts before progressing to other languages including C++ or LabVIEW software (C++ and LabView not included). A wide range of curriculum is included covering Industrial Sense and Control with C++ or LabVIEW (LabVIEW not supplied) programming and design of pneumatic control systems. Further curriculum options for programming in C or Assembly are available.

CURRICULUM COVERAGE

- PIC & controller programming using flowcharts
- Programming options: Embedded C, Assembly, C++ or LabVIEW
- Mathematical models of sensors
- PID control of DC motors with speed & position (2nd order)
- Sensors: thermistor, light, thermocouple, rotary, gyroscope, hall effect, PIR, cap touch, magnetometer, ultrasonic & colour
- Actuators: relays, stepper motors, DC motors with feedback & servo motors

Technical data:

- Dimensions (packed): 6 boxes, each 500 mm x 400 mm x 300 mm
- Weight (packed): 15 kg

35-350	Mechatronics Kit

PC with Windows XP or higher & 32/64-bit OS required

FEATURES

- Complete working system
- Includes all required experimental hardware, power supply, cables & software
- 50 hours of lab time
- Comprehensive experiment manual

FEATURES

- Low cost, affordable
- Compact
- Easy to use
- Addresses numerous technologies
- Modular system
- Expandable, build up the system
- Robust construction
- High quality components & build
- Complete, ready for use
- Excellent manuals

Compact Mechatronics System (CMS)

The Compact Mechatronics System (CMS) consists of a range of different modules which can be used independently with stand-alone operation, or connected together as a complete system simulating a production process. Each module is built onto an extruded aluminium profile panel and supplied completely assembled and ready for use. Included with each module are connecting cables, any required programming software and manuals. This modular approach enables the purchasing of one unit at a time as budget becomes available until the CMS provides the complete production process. All that is required is a compressed air supply and a standard electricity supply.

The 35-400 CMS comprises 9 units:
35-401 Distribution Unit

- Separate components from a gravity-feed magazine
- Feed separated components into a process

35-402 Pick & Place with Vacuum Unit

- Transfer components from one station to another utilising vacuum

35-403 Processing Unit

- Clamp component with single-acting cylinder
- Feed component into drilling fixture with guided double-acting cylinder
- Feed drill with twin rod double-acting cylinder
- Drill component (simulated) with d.c. motor

35-404 Handling Unit

- Pick-up component by means of a vacuum
- Transfer component from incoming (upstream) station to outgoing (downstream) station
- Place component in downstream station

35-405 Hydraulic Press Unit

- Feed component into hydraulic press with double-acting guided cylinder
- Stamp component using hydraulic double-acting cylinder

35-406 Pick & Place with Gripper Unit

- Transfer components from one station to another station utilising pneumatic grippers

35-407 Sorting Unit

- Workpieces of differing materials and colours are sorted into different output chutes

35-408 Hydraulic Power Pack

- Required for use with the 35-405 Hydraulic Press Unit

35-409 PLC Control Unit

- Can be used to operate the CMS or individual stations
- Individual stations may be operated by electro-pneumatics or the customer's own PLC (s)

Technical data:

- 35-401: Dimensions, width 160 mm x depth 400 mm x height 330 mm, Weight: 2.35 kg
- 35-402: Dimensions, width 160 mm x depth 400 mm x height 180 mm, Weight: 3.10 kg
- 35-403: Dimensions, width 160 mm x depth 400 mm x height 350 mm, Weight: 4.30 kg
- 35-404: Dimensions, width 160 mm x depth 400 mm x height 350 mm, Weight: 3.70 kg
- 35-405: Dimensions, width 160 mm x depth 400 mm x height 375 mm, Weight: 4.00 kg
- 35-406: Dimensions, width 160 mm x depth 400 mm x height 200 mm, Weight: 3.00 kg
- 35-407: Dimensions, width 320 mm x depth 400 mm x height 160 mm, Weight: 5.10 kg
- 35-408: Dimensions, width 170 mm x depth 325 mm x height 260 mm, Weight: 7.00 kg
- 35-409: Dimensions, width 450 mm x depth 130 mm x height 300 mm, Weight: 7.00 kg

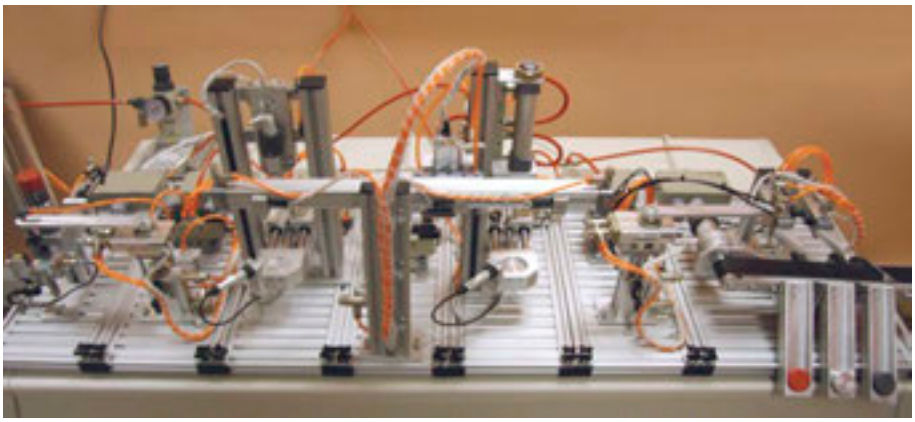
Scope of delivery:

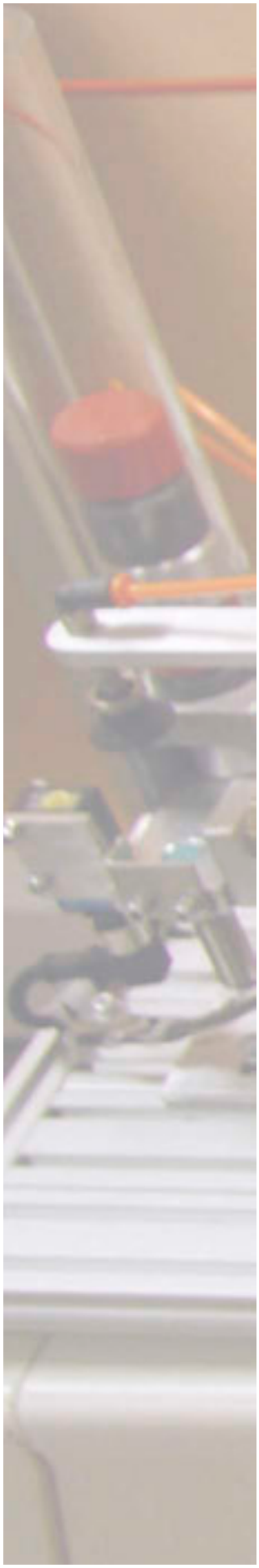
Qty	Cat.-No.	Name
1	35-401	Distribution Centre Unit
1	35-402	Pick & Place with Vacuum Unit
1	35-403	Processing Unit
1	35-404	Handling Unit
1	35-405	Hydraulic Press Unit
1	35-406	Pick & Place with Grippers Unit
1	35-407	Sorting Unit
1	35-408	Hydraulic Power Pack
1	35-409	PLC Control Unit

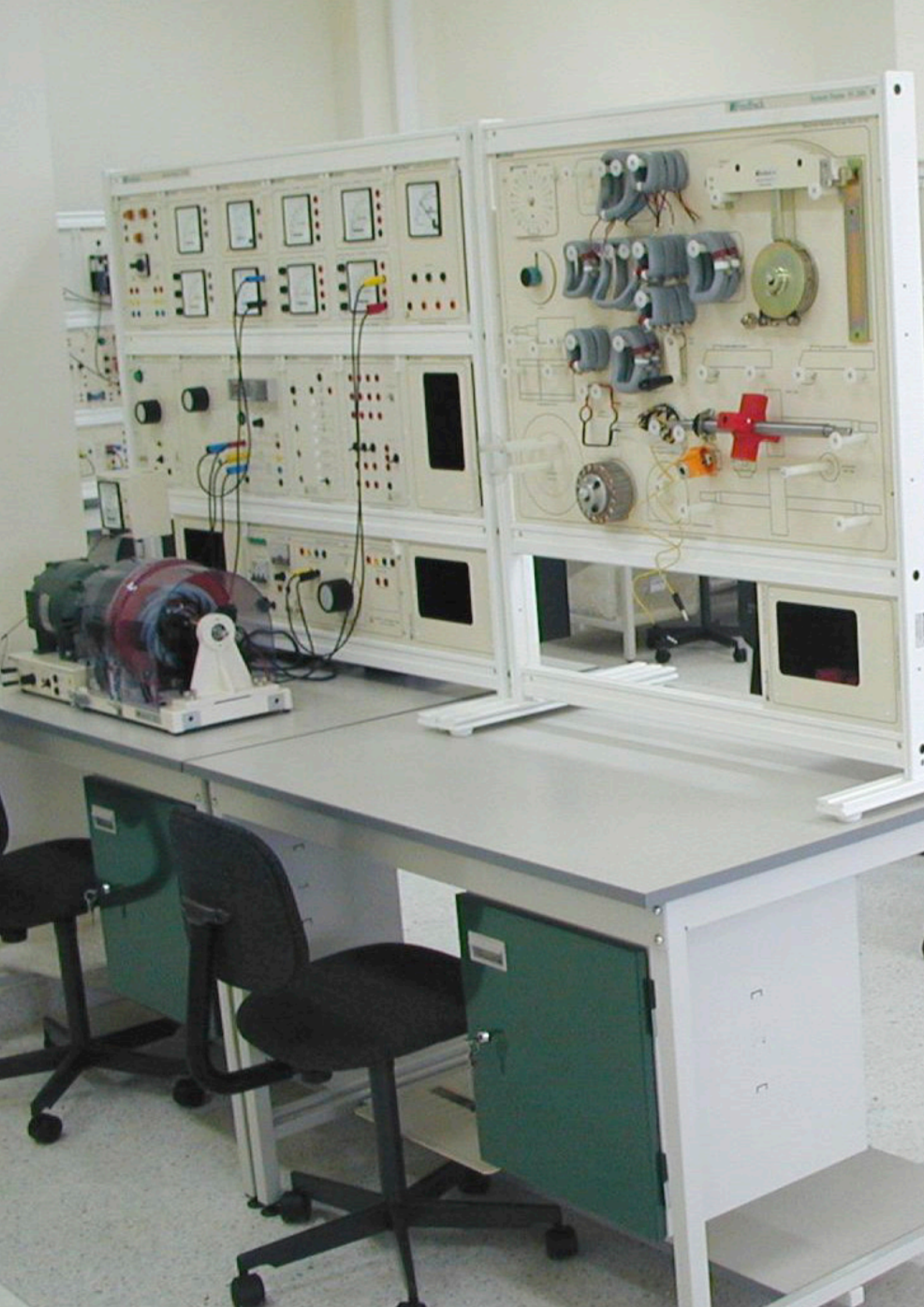
35-400	Compact Mechatronics System (CMS)

Service Requirements

- Compressed air supply required







Feedback

Engineering Teaching Solutions

1305122 09.2015 FB
Technical details subject to change without notice.

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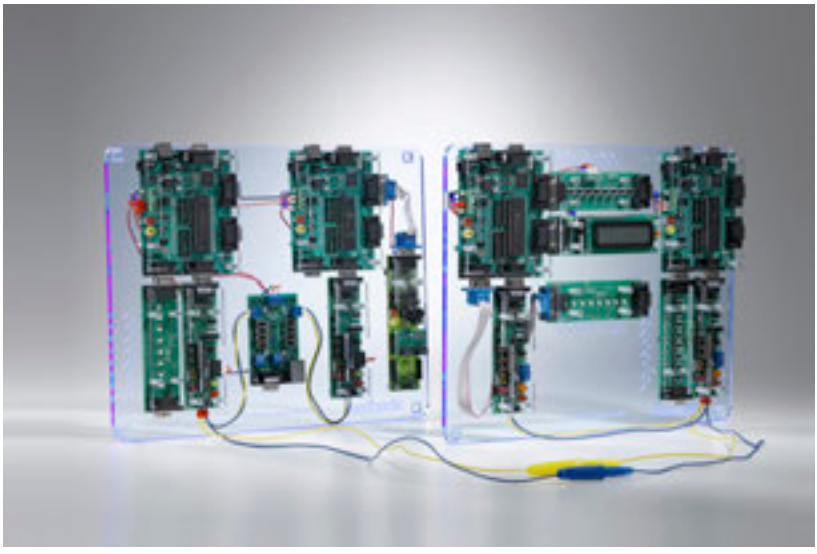

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