

## ELECTRICAL TECHNOLOGY

There follows a presentation of the teaching aids for the study of electrical engineering from both an experimental and an analytical perspective, with the focal point or mainstay of the work being the “Analysis of Electrical Circuits”, addressing other blocks of content (Electromagnetism, Transformation, etc.) as and when they become important and relevant to the student’s teaching-learning process.

### Teaching activities

These activities permit the instructor to organise different types of activities (demonstrations, explanations, etc.) for small or large groups. This means removing the traditional gap between classroom theory and workshop practice, integrating the entire process within a single physical setting.

44 /

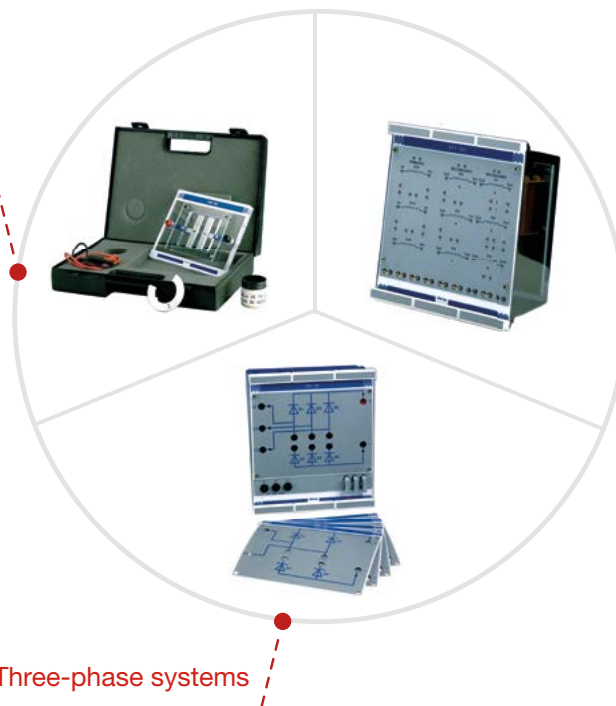
### Learning activities

These enable the student to undertake activities for analysing and experimenting with circuits, machinery and components. They include a series of technological features on a range of media that prepare the ground for the analysis and quick and reliable building of the circuits.

Electrostatic and  
electromagnetism

Transformers

Three-phase systems





## Documentation

A full array of documents, which in addition to the required user manuals for the equipment includes:

- The Teaching Guide: a description of the syllabus with the definition of goals, activities, scheduling, etc.
- The Handbook of Practical Activities, catering for the comprehensive use of the equipment in this catalogue.
- The Handbook of Content, as an introduction to the basics of electricity.

## Auxiliary equipment

The laboratory can be fully fitted out with ancillary equipment, such as furniture, whiteboards, projectors, commercial instruments (multimeters, oscilloscopes, function generators), etc.

The ancillary equipment distributed by Alecop appears in full in the online catalogue ([www.alecop.com](http://www.alecop.com)).

## Safety

All the equipment within the field of three-phase systems, transformation and the introduction to electrical machinery has been designed to operate at 22/38 V, with an assurance of safety for users that should be considered within its proper context: the operating voltages are 1/10th of the real ones (220/380 V).

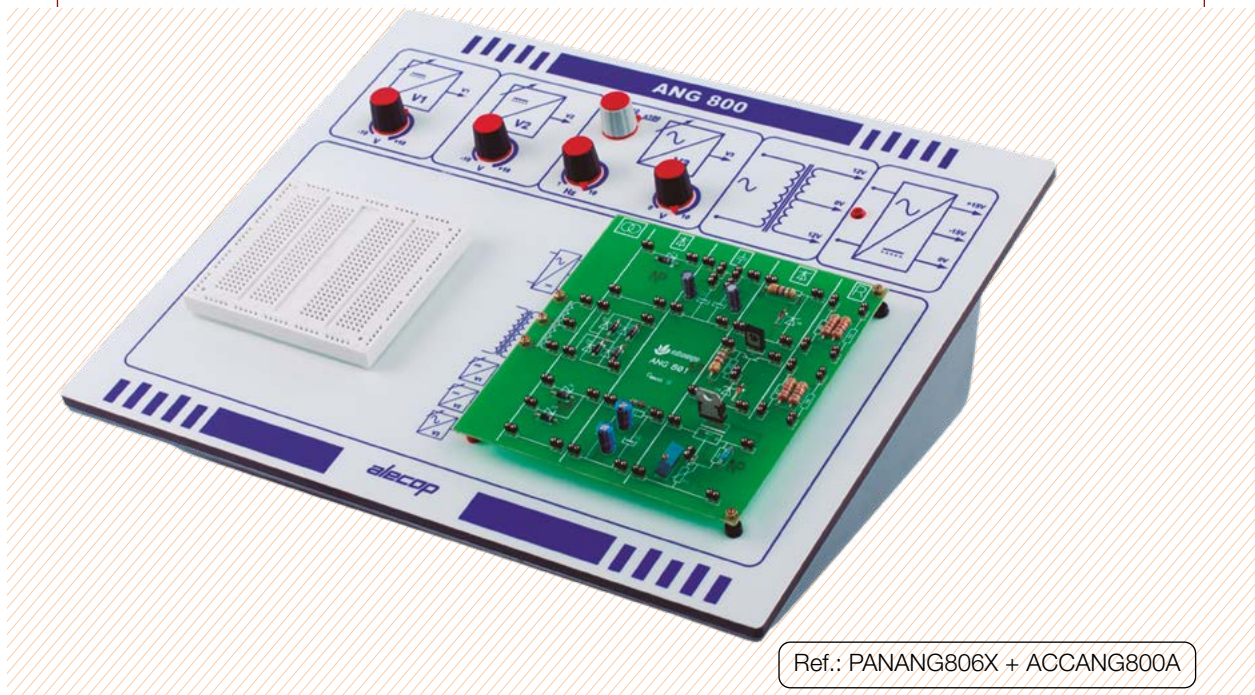
## Modularity

Each item of equipment in this catalogue has a modular arrangement in order to fulfil teaching requirements as per the user's needs.

45 /



## ANG-800 didactic equipment for circuit analysis



46 /

Modular trainer for the study of the basic principles of d.c. and a.c. circuits. The system is based on the ANG-800 console where the pre-constructed boards with the different systems of signal modulation and coding are placed. The console includes a prototyping area to allow for extra experiments and project work to be undertaken.

These trainers not only offer a convenient and robust platform, but also include all necessary power and signal sources. When the pre-constructed boards are inserted into the panel, the necessary connections to the power supply are made automatically keeping the number of required connections to a minimum. The only additional equipment required is an oscilloscope and a multimeter. They include a complete set of manuals for the teacher and students, as well as storage drawers, connection cables and components.

- Fixed dc source:  $\pm 15V$  ( $I_{max}$  0.5A).
- Fixed ac power supply (centre-tapped transformer) 12-0-12V ( $I_{max}$  0.3A).
- Two variable voltage sources (V1 & V2) providing  $\pm 10$  volts dc ( $I_{max}$  0.1A).
- Variable ac voltage source (V3) 0-10V and 1Hz-1kHz using variable and switched ranges.
- Board insertion area with 2mm sockets for boards fastening and power supply.
- 600-contact protoboard, for the realization of free-design circuits.
- Mains power cable.

This composition includes the set of cards and accessories for the study of DC and AC circuit fundamentals and theorems:

- ANG 800-DC1: DC fundamentals and networks theorems I.
- ANG 800-DC2: DC fundamentals and networks theorems II.
- ANG 800-AC1: AC Circuits I.
- ANG 800-AC2: AC Circuits II.

List of practices that can be performed with this equipment:

#### DC fundamentals and networks theorems I

- Basic DC circuit.
- OHM Law.
- Series circuit.
- Parallel circuit.
- Kirchoff's voltage law.
- Kirchoff's current law.
- Kirchoff's law combined.
- Thevenin circuits.
- Kirchoff with 2 sources.
- Superposition theorem.

#### DC fundamentals and networks theorems II

- Thevenizing a bridge circuit.
- Delta to star conversion.
- Charge and discharge of capacitors.
- Capacitors connected in parallel and series.
- Resolution of a DC circuit with capacitors.

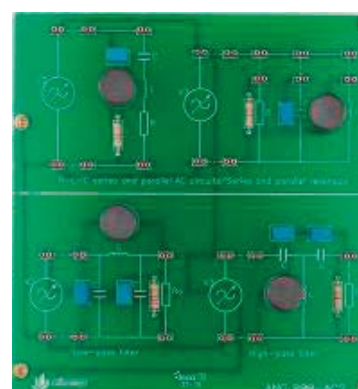
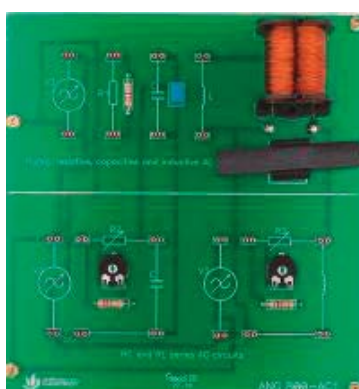
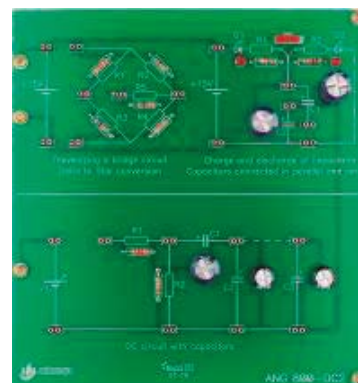
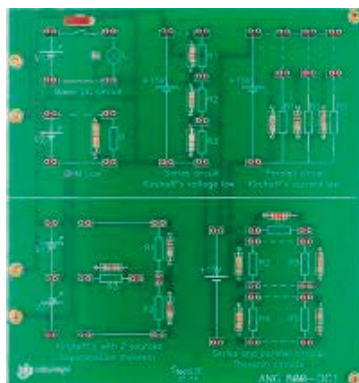
#### AC Circuits I

- Sinusoidal waveform, AC values.
- Purely resistive AC circuit.
- Purely capacitive AC circuit.
- Purely inductive AC circuit.
- RC series AC circuits.
- RL series AC circuits.

#### AC Circuits II

- RLC series circuit.
- RLC series resonance.
- RC parallel circuit.
- RL parallel circuit.
- RLC parallel circuit.
- RLC parallel resonance.
- Low pass filter.
- High pass filter.

47 /





## Electrostatics and



### DIDACTIC ELECTROSTATICS KIT

Ref.: 9EQKEL1200

Carrier case for analysing electrostatic phenomena, which contains the following items:

- A cat-skin cloth.
- A cork ball frame.
- A PVC stick.
- A perspex stick.

#### Standard accessories included:

- User manual.

#### Recommended Optional Accessories:

- Coulombimeter COL-120.



### DIDACTIC ELECTRICAL FIELD KIT

Ref.: 9EQKCE1200

This consists of a set of elements which are assembled by the user on a perspex base, which enable the force of a charge on an electric field, the principle of the workings of the condenser, etc., to be analysed. The phenomena can be observed on a screen with the aid of an over-head projector.

#### The elements included in the briefcase are:

- A base plate.
- 2 specific charge parts.
- 2 straight condenser parts.
- 1 cup part.
- 1 jar of semolina.
- 2 wires.
- 1 steel ball.

#### Standard accessories included:

- User manual.

#### NECESSARY accessories:

- FAT-120 high voltage source.

# electromagnetism



## DIDACTIC MAGNETIC FIELD KIT

Ref.: 9EQKCM1200

This is a set of elements which, once they have been assembled on a perspex base, allow the force lines of a magnetic field generated by different types of conductor elements to be analysed. The resulting phenomena can be visualised on a screen with the aid of an over-head projector. The various parts supplied with the briefcase include:

- A magnet base plate.
- A plain base.
- A straight-line current wire base.
- A spire plate.
- A coil plate.
- 4 20 x 40 mm magnets.
- 4 pieces of iron, 20 x 40 mm.
- 4 pieces of aluminium, 20 x 40 mm.
- 4 pieces of plastic, 20 x 40 mm.
- 1 jar of iron filings.
- 6 magnetised needles.
- 1 magnetised needle with frame.

### Standard accessories included:

- User manual.

### NECESSARY accessories:

- FAC-120 high voltage source.



## HIGH VOLTAGE SOURCE FOR TEACHING PURPOSES

Ref.: 9EQFAT1200

A high voltage source that is fully protected to ensure user safety. It provides a direct voltage of up to 7,500 V that can be regulated by means of a potentiometer control, with a maximum current of 100  $\mu$ A. It has a digital display with a voltage reading. The power supply is 110-230 V / 50-60 Hz depending on the model.

### Standard accessories included:

- User manual.

## DIDACTIC HIGH CURRENT SUPPLY

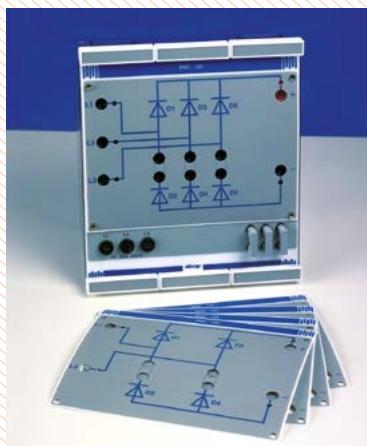
Ref.: 9EQFAC1200

A source of high current set into a panel which can be placed on a frame or on a tabletop. It provides a current of up to 100 amp AC in the founder. Direct and alternating output, via separate sockets. A potentiometer allows you to vary the current. It has a visual display and special connectors for connecting different types of metal wires (for the analysis of heating, melting, etc).

### Standard accessories included:

- User manual.
- Conductor materials: copper, nichrome and constantan.
- Fuses.

## Three-phase systems



### UNCONTROLLED SINGLE-THREE-PHASE RECTIFICATION

Ref.: MDULRNC120

There is a series of rectifier bridges incorporated onto a 6 power diode base (10A/600W) which are interconnectable and individually insulated against over voltage.

With the use of set of templates and connectors, it is possible to select and configure the various types of rectifier bridges which are under analysis:

- RNC-121 Template: medium wave single phase rectifier.
- RNC-122 Template: single phase bridge rectifier.
- RNC-123 Template: medium wave two-phase rectifier.
- RNC-124 Template: medium wave three phase rectifier.
- RNC-125 Template: three phase bridge rectifier.

The unit is designed to work on both standard as well as low voltage (22/38). There are high security 4mm bushes and 2m bushes provided for this, which also allow you to be able to measure the voltages and the currents of the circuits.

The unit s supply inputs are protected by 10A ultra-rapid fuses.

#### Standard accessories included:

- User manual.
- Connection bridges.

#### NECESSARY accessories:

- TRI-120 teaching module: three-phase transformer (for low voltage operation, if required).

### BATTERY MODULE

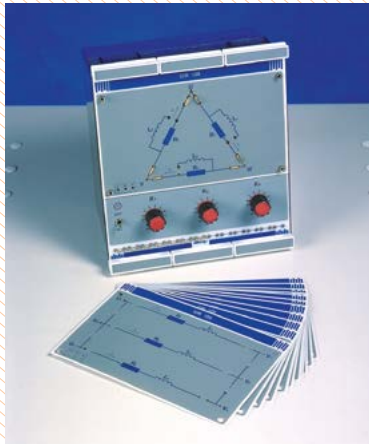
Ref.: MDULBAT120

Modular item for simulating a back electromotive force, consisting of a 12 V, 6.5 Ah battery. The battery is charged internally by connecting the module to the power supply (110-230 V / 50-60 Hz depending on the module) and turning on the light switch. Safety bushings included.

#### Standard accessories included:

- User manual.





## RESISTIVE-INDUCTIVE CHARGE

Ref.: MDULCIR120

This is a triple unit with three groups of R-L charges. Each group is composed of a 150mH/1A inductance and a 33 ohm/35W resistance in series with a rheostat of the same value. There is protection against over current measured at 1A for each group. The maximum charge applicable is 50Vef.

Using a different multi-template and jumpers, you can select the type of connection charges and the desired work. The use of cables in the assembly is minimal.

The template collection includes:

- CIR-121 Template: Charge R free connection.
- CIR-122 Template: Charge L free connection.
- CIR-123 Template: Charge R-L free series connection.
- CIR-124 Template: Charge R-L free parallel connection.
- CIR-125 Template: Charge R triangle connection.
- CIR-126 Template: Charge L triangle connection.
- CIR-127 Template: Charge R-L triangle series connection.
- CIR-128 template: parallel RL load delta connection.
- CIR-129 template: Charging R star connection.
- CIR-130 template: Cargo L star connection.
- CIR-131 template: Load RL series star connection.

**Standard accessories included:**

- User manual.
- Connection bridges.

**NECESSARY accessories:**

- TRI-120 teaching module: three-phase transformer.



## CAPACITIVE CHARGE

Ref.: MDULCRC120

This is a triple modular frame which incorporates a series of condensers grouped electrically into three groups: C1, C2, and C3. By means of a set of templates (3) and connectors (no more than three), it is possible to configure:

- CRC-121 Template: Free connection.
- CRC-122 Template: Star connection.
- CRC-123 Template: Triangle connection.

Each group of condensers can adopt capacities of 1, 5, 10, 25, 50 and/or 100(F which can be selected by means of a change-over switch. The maximum working voltage of each group is 63V.

**Standard accessories included:**

- User manual.
- Connection bridges.

**Recommended Optional Accessories:**

- Instrumentation: voltmeter, ammeter, phase meter, ...

**NECESSARY accessories:**

- TRI-120 teaching module: three-phase transformer.



# Transformers



## SINGLE-PHASE TRANSFORMER AND ELECTROMAGNETISM KIT

Ref.: 9EQKTM1200

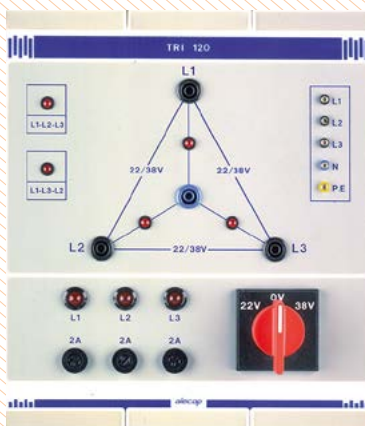
A kit for assembling and studying different types of single phase transformers. It enables you to analyse the principles of electromagnetism: the functioning of a relay, of a bell, ...

It consists of a triple unit for a assembly base and a briefcase which contains the various construction elements such as:

- A U nucleus.
- An I nucleus with an air gap variation control.
- 2 x 500-spire coils.
- 2 x 250-spire coils.
- 2 x 100-spire pendulum coils.
- Pendulum sheet (relay, bell, etc.).
- Bell ringer.
- 2 frames (relay contact).
- Pendulum arm (Foucault).
- Magnets.
- Various parts (pieces of iron, aluminium, etc.).

### Standard accessories included:

- User manual.



## THREE-PHASE TRANSFORMER 230/400-22/38V

Ref.: MDULTRI122

Ref.: MDULTRI123

This is a three-phase transformer which, depending on the model (TRI-122 or TRI-123), has a transformation ratio of either 220V to 22/38V or 380V to 22V-38V, with an apparent power of 300 VA.

The output voltage is 22V between phases (12.7V neutral phase) and 4 Amperes or 38V between phases (22V neutral phase) and 3.75 Amperes which can be selected by means of a commutator on the front template.

The output is by both 4mm and 2mm bushes and they are protected against overcurrent and shortcircuit with a light indicator per phase. They are thermally insulated with resetting being produced automatically after the protective elements have been cold for a period of time.

The frontal light display shows the order of phases (L1-L2-L3 or L1-L3-L2).

The transformer primary is protected by 2A fuses with a light indication if any should blow (pilot light out).

### Standard accessories included:

- User manual.



## SINGLE-PHASE AUTOTRANSFORMER

Ref.: MDULAUT120

Single-phase autotransformer with 230 V / 50-60 Hz input voltage and variable output adjusted by a potentiometer control.

- Maximum output voltage: 250 V.
- Maximum output load: 1 A.
- Protection: 1 A fuse.
- Safety bushings.

Standard accessories included:

- User manual.



## THREE-PHASE TRANSFORMER STUDY

Ref.: MDULETT120

Equipment for analysing the different types of connections on three-phase transformers.

It is composed of an ETT-120 three-phase transformer multitemplate unit and a set of 12 templates.

The unit incorporates three single phase transformers, each of which has two secondaries of an identical transformation ratio (0.5/1). The nominal voltage for the primary windings is 22v and 11V for the secondary ones.

By means of the templates (12), and connectors (never more than 9), the following three-phase transformer configurations may be obtained:

- T-E-1 Template: Triangle-Startime phase difference 1.
- T-E-5 Template: Triangle-Startime phase difference 5.
- T-E-11 Template: Triangle-Startime phase difference 11.
- T-2E Template: Triangle-Double Star.
- T-T-0 Template: Triangle-Triangle-time phase difference 0.
- T-Z-0 Template: Triangle-Zig/Zag-time phase difference 0.
- E-E-0 Template: Star-Star- time phase difference 0.
- E-E-6 Template: Star-Star- time phase difference 6.
- E-T-5 Template: Star-Triangletime phase difference 5.
- E-T-11 Template: Star- Triangletime phase difference 11.
- E-Z-5 Template: Star-Zig-Zagtime phase difference 5.
- E-Z-11 Template: Star-Zig-Zagtime phase difference 11.

The input/output terminals are printed on all the labels. Each one of the six secondary windings is fitted with a thermal protection circuit with a light indicator, set at 0.65 A.

Required accessories:

- TRI-120 three phase transformer didactic module.

## 800 series

The ANG-800 and DIG-800 are complementary analog and digital training systems providing a reliable and cost-effective solution to teaching Electricity and Electronics.

Both systems are based on consoles into which pre-constructed circuit boards and components can be inserted to cover various aspects of analog and digital components and circuits. A prototyping area is included on the console to allow for extra experiments and project work to be undertaken.

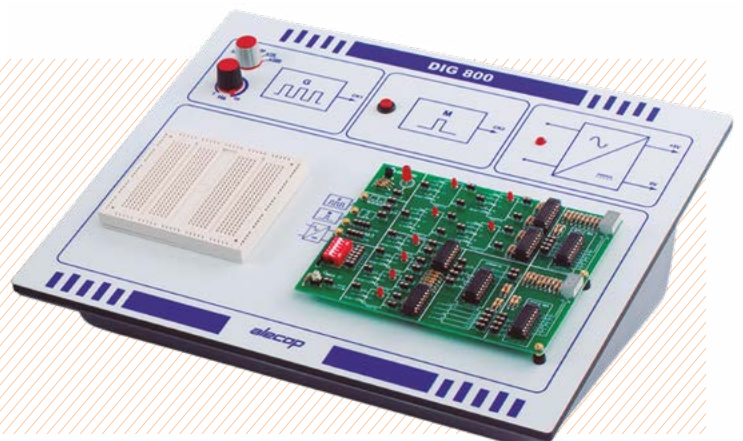
The consoles not only offer a convenient and robust platform for conducting experiments but also provide all necessary power supplies and signal sources. When the preconstructed circuits are inserted into the console the relevant power supply connections are automatically made keeping unnecessary and potentially confusing connections to a minimum. The only additional equipment required is an Oscilloscope and a Multimeter. These trainers are supplied with comprehensive user guides and experimental procedures together with storage cases, connecting leads and components.

80 /

**ANG-800 console:  
Analog electricity and  
electronics**

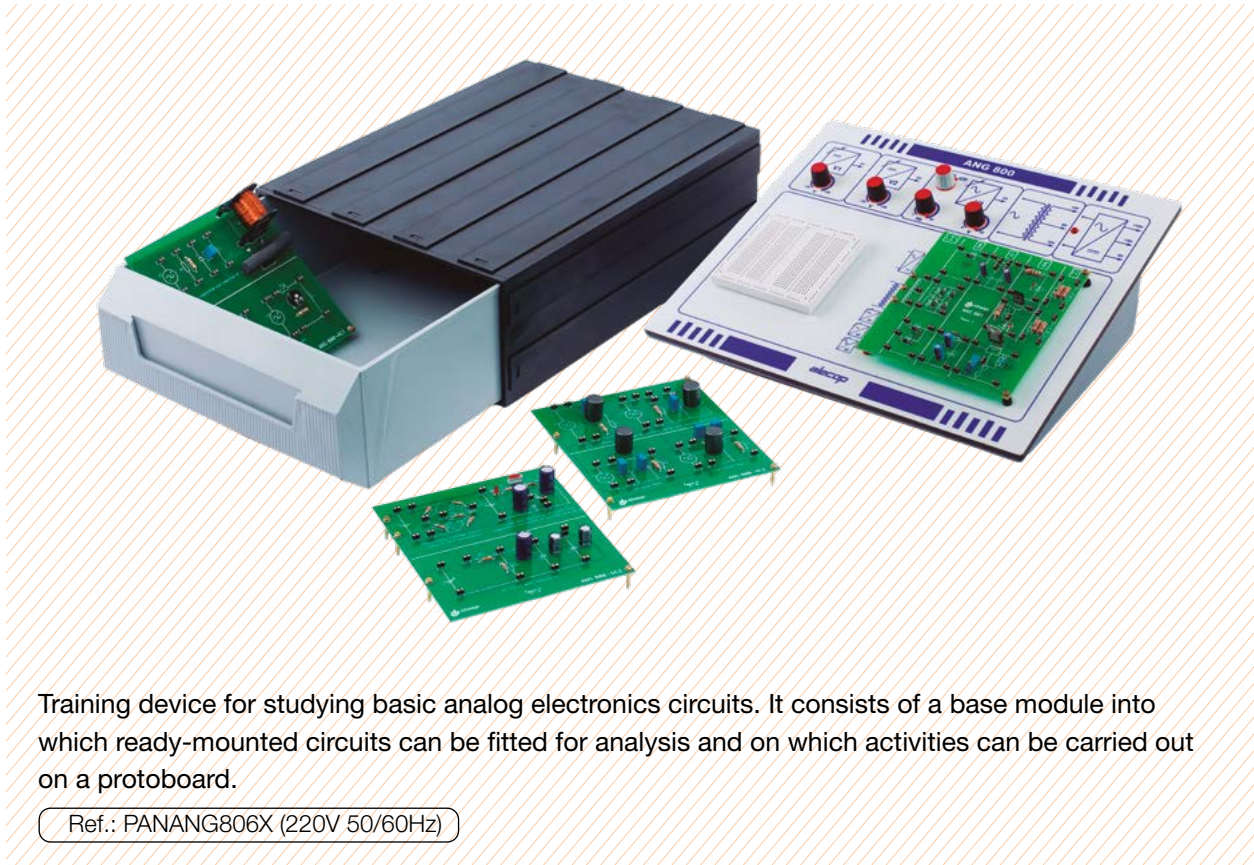


**DIG-800 console:  
Digital electronics**





## ANG-800 console: Analog electricity and electronics



81 /

Training device for studying basic analog electronics circuits. It consists of a base module into which ready-mounted circuits can be fitted for analysis and on which activities can be carried out on a protoboard.

Ref.: PANANG806X (220V 50/60Hz)

### Includes:

- Power source +/-15 volts dc 0.5A.
- Transformer with centre tapping 12-0-12 volts ac 0.3A.
- Two variable voltage sources +/-10 volts dc 0.1A.
- One AC voltage source with variable amplitude (0 - 10 volts) and frequency (1Hz to 1kHz).
- Protoboard.
- Storage drawer with connectors, accessories and electronic components.
- CD with: User Manual, Practical Manual and information about the main electronic components used on the device.

### Complete with 5 sets of circuit boards:

- Set A: DC and AC circuits: (4 boards).
- Set B: introduction to Analog Electronics: (3 boards).
- Set C: analog Communications (3 boards).
- Set D: digital Communications (4 boards).
- Set E: fiber Optics trainer (1 board).



## Set A: DC and AC circuits (4 boards)

Ref.: ACCANG800A

### 1. DC fundamentals and networks theorems I

- Basic DC circuit.
- OHM Law.
- Series circuit.
- Parallel circuit.
- Kirchoff's voltage law.
- Kirchoff's current law.
- Kirchoff's law combined.
- Thevenin circuits.
- Kirchoff with 2 sources.
- Superposition theorem.

### 2. DC fundamentals and networks theorems II

- Thevenizing a bridge circuit.
- Delta to star conversion.
- Charge and discharge of capacitors.
- Capacitors connected in parallel and series.
- Resolution of a DC circuit with capacitors.

### 3. AC Circuits I

- Sinusoidal waveform, AC values.
- Purely resistive AC circuit.
- Purely capacitive AC circuit.
- Purely inductive AC circuit.
- RC series AC circuits.
- RL series AC circuits.

### 4. AC Circuits II

- RLC series circuit.
- RLC series resonance.
- RC parallel circuit.
- RL parallel circuit.
- RLC parallel circuit.
- RLC parallel resonance.
- Low pass filter.
- High pass filter.

## Set B: introduction to Analog Electronics (3 boards)

Ref.: ACCANG800B

### 1. ANG-801 Rectification and filtering

- Single phase half wave rectifier.
- Single phase full wave rectifier with intermediate centre tap.
- Single phase full wave bridge rectifier.
- Filtering.
- Parallel stabilizer.
- Serial stabilizer.
- Stabilized adjustable power supply.

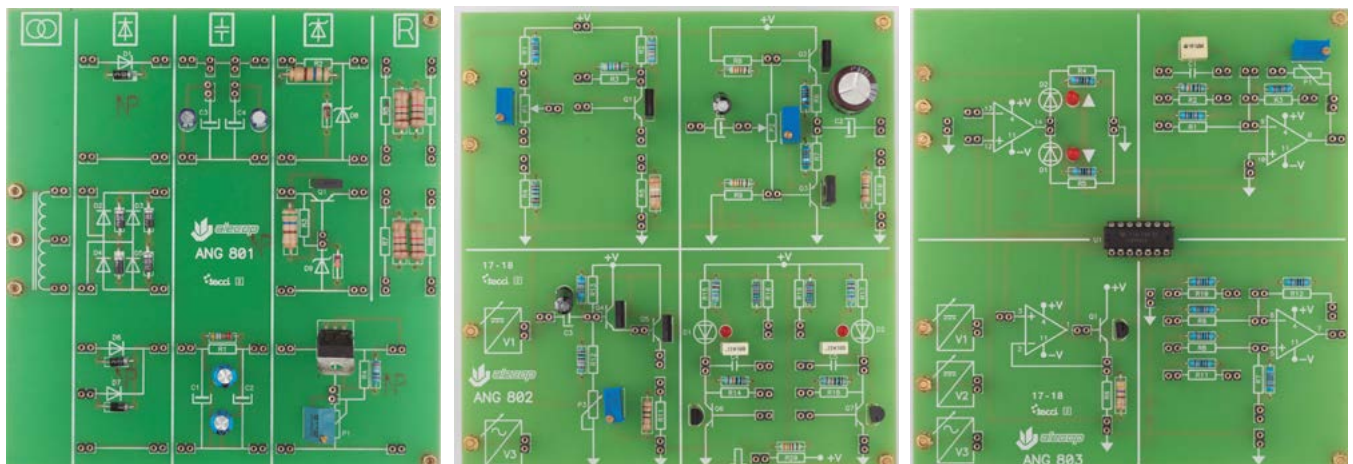
### 2. ANG-802 Transistor circuits

- Polarization of the bipolar transistor.
- A Class power amplifier.
- AB Class power amplifier.
- The switching transistor
- Astable multivibrator.
- Monostable multivibrator.
- Bistable multivibrator.

### 3. ANG-803 Operational amplifiers

- Comparator without feedback.
- Variable gain inverting amplifier.
- Non inverting amplifier.
- Inverting amplifier.
- Subtractor.
- Power amplifier.

82 /



Set B boards.

## Set C: analog communications (3 boards)

Ref.: ACCANG800C

### 1. ANG800-AM Amplitude Modulation

- AM double sideband (DSB) with full carrier.
- Measuring modulation depth.
- Double sideband with no carrier.
- Generation of single sideband (SSB) with a filter.
- Recognising different modulation types from oscilloscope patterns.
- Demonstration of spectral components i.e. two sidebands and a carrier.
- AM demodulation with an envelope diode detector.
- AM and DSB using a product detector.
- Single sideband demodulation with a product detector.
- Post detection filters.

### 2. ANG800-FM Frequency Modulation

- Generation of FM with a voltage controlled oscillator.
- Modulation Index, narrow and wideband FM.
- Recognising FM from its oscilloscope pattern.
- Slope detection of FM.
- Demodulation with a phase locked loop (PLL).
- Operation of a quadrature detector (used in most commercial FM radios).
- Operation and advantages of a limiter.
- Post detection filters.
- Pre-emphasis and de-emphasis.

### 3. ANG800-PM Phase Modulation

- Generation of PM with phase index from 0 to  $\pm 360$  degrees.
- Recognising PM from its oscilloscope pattern.
- Relationship between phase and frequency modulation.
- PM detection using an FM demodulator and an integrator.
- Detection using a balanced mixer and carrier reference.
- Effect of phase modulation index on residual carrier amplitude.
- Carrier reference recovery using a PLL.

## Set E: fiber optics trainer (1 board)

Ref.: ACCANG800E

### 1. ANG800-OPT Fiber optics

- LED optical source and driver.
- Fiber characteristics relative to wavelength and physical length.
- Estimation of light entry characteristics.
- Bandwidth and linearity.
- Estimation of bending and joint losses.
- Detectors and interface electronics.
- Compare Analog and Digital coding.
- Low frequency channel characteristics.
- PWM link implementation.

## Set D: digital communications (4 boards)

Ref.: ACCANG800D

### 1. ANG800-BDE Baseband digital encoding

- Using a Pseudorandom Binary Sequence (PRBS) as a test bit-stream.
- Non Return to Zero (NRZ) unipolar and bipolar.
- Return to Zero (RZ) unipolar and bipolar.
- Alternate Mark Inversion (AMI) coding.
- Manchester coding.
- Identify coding systems from their oscilloscope patterns.
- Magnitude of dc component in different coding systems.
- Bit-rate clock recovery strategies.
- Word framing in bit-streams.

### 2. ANG800-ADK Advanced digital keying

- Generation of Binary PhaseShift Keying (BPSK), QPSK, 8-PSK, 16-APSK, 16-QAM with an IQ modulator.
- Symbol mapping into I and Q streams.
- Recognising different keying systems from their constellation diagrams.
- Relationship between bit-rate and symbol rate.
- Identify the effect of noise in a constellation diagram.
- Symbol space and error rate for different signal to noise ratios.
- Demodulation with an IQ demodulator.
- Carrier reference recovery with a Costas loop.

### 3. ANG800-DS Muestreo digital

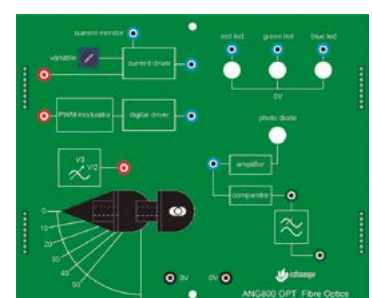
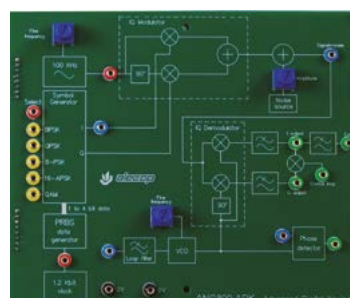
- Pulse Code Modulation (PCM) using a 24 bit frame.
- 3 channel Time Division Multiplexing (TDM).
- Frame synchronisation and false syncing.
- Differential Phase Shift coding and decoding.
- Minimum shift keying, demodulation using phase demodulator.
- Gaussian minimum shift keying.

### 4. ANG800-PCM Pulse code modulation

- Signal sampling.
- A to D and D to A conversion.
- Resolution and number of bits.
- Signal reconstruction and aliasing.
- Pulse Width Modulation (PWM).
- Delta modulation and demodulation.
- Sigma Delta modulation and demodulation.
- Sigma delta modulator as an oversampling A/D converter.
- Conversion of a Sigma delta single bit-stream to N bit data.

83 /

Set D (left) and Set E (right) boards.

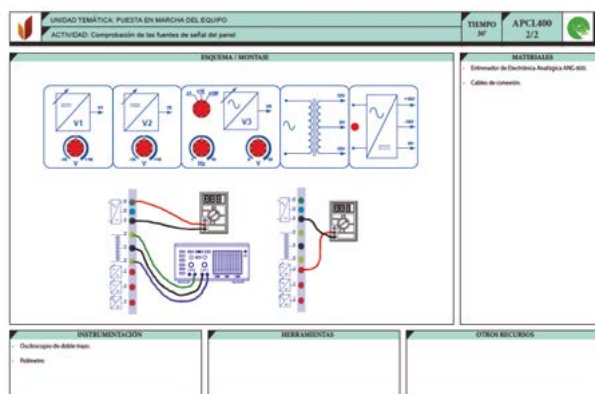


With the equipment, a set of practical activities is delivered on CD support. Given the open nature of the equipment, this set of activities can be complemented with other activities that the teacher considers appropriate. These can be carried out either on the Proto-Board or by designing new application circuits in the center's own laboratory.

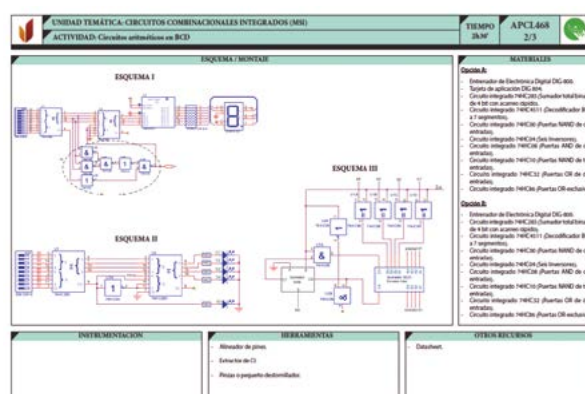


84 /

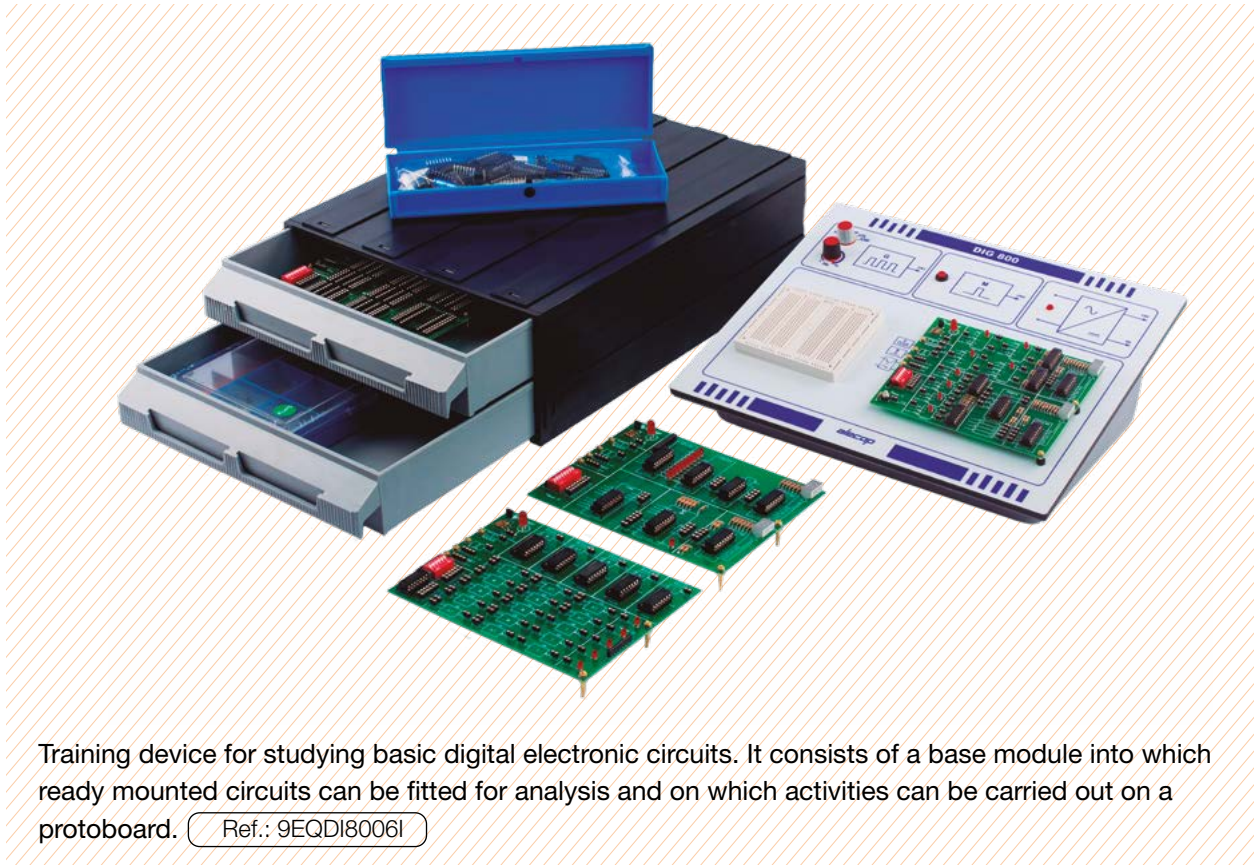
ANG-800 activity example



DIG-800 activity example



## DIG-800 console: Digital electronics



85 /

Training device for studying basic digital electronic circuits. It consists of a base module into which ready mounted circuits can be fitted for analysis and on which activities can be carried out on a protoboard. (Ref.: 9EQDI8006I)

### Includes:

- Power source +5 volts DC 1A.
- Variable frequency oscillator, 1Hz - 100KHz (0-5V TTL).
- Digital pulse generator via push-button with debouncing circuit.
- Protoboard.
- Storage drawer with connectors, accessories and electronic components.
- CD with User Manual, Practical Manual and information on the main electronic components used on the device.

### Complete with 4 applications boards:

- Gate and Logic functions.
- Combinational Circuit applications.
- Sequential Circuits.
- Digital Circuit construction board including 8 x 16 pin DIP sockets, 8 micro switches, 10 LED red diodes and four 7 segment displays.

### Topic coverage includes:

- Knowledge of an IC.
- Light Emitting Diodes (LED).
- Study of the different logic gates (NOT, AND, OR, NAND, NOR, XOR, XNOR).
- Combinational circuits SSI.
- Priority encoders.
- Decoders and demultiplexers.
- Seven-segment Displays.
- Decoders BCD to Seven-segment Display.
- Multiplexors.
- Comparators.
- Arithmetic circuits in natural binary.
- Arithmetic circuits in BCD.
- Asynchronous flip-flops.
- Synchronous flip-flops.