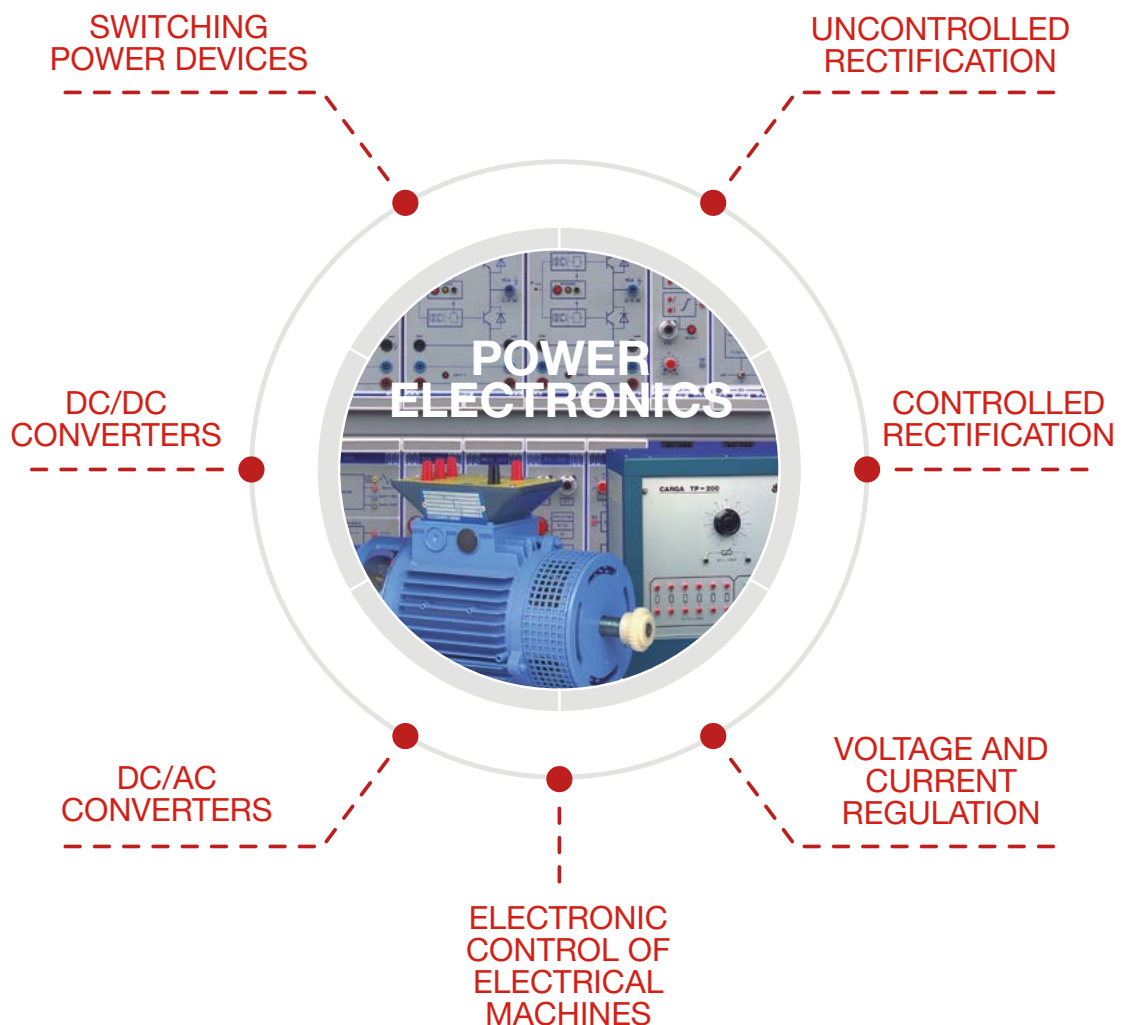


The trainer system for power electronics takes the form of a modular programme for study through analysis of the four types of power converters used in industrial applications (rectifiers, choppers, inverters/undulators and AC regulators) and the power devices forming the basis for the design of these applications.



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## Safety

Safety connections at voltage points exceeding 30 V (connectors and sockets).

## Quality

Compliant with the European low voltage and electromagnetic compatibility directives. Elements stamped in accordance with the IEC (Electrotechnical Commission) standard.



## MODULAR PROGRAMME

The system is based on a “module” support, which can be configured and set up in a frame according to user needs. The frame has its benefits: **Less wires and less wasted time.**



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### Back-up resources

This equipment includes a set of back-up elements to aid the trainer, e.g.:

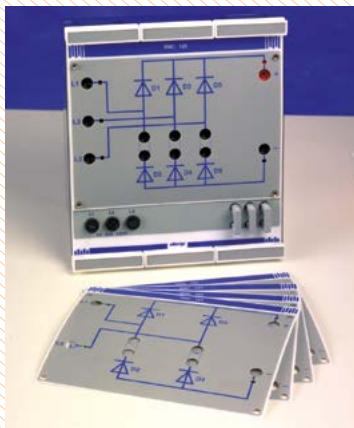
- Training Guide, or trainer's class work guide, which defines goals, activities, sequencing, etc. and proposes a course outline. The activities and use of the different available resources (training devices, instruments, etc.) are structured on the basis of this guide.
- Practical Manual, which contains a series of units describing goals, teaching sequence, materials required, assessment criteria, etc.
- User Manual, with a technical description and information on the equipment.
- Theory Manual.



## EP1/EP2

### Controlled and uncontrolled rectification

Equipment for studying uncontrolled rectification (EP1), controlled rectification and alternating current regulation (EP2). It can be used at either low voltage (22/38 VAC, with CIR-120 and CRC-120 charges) or mains voltage.

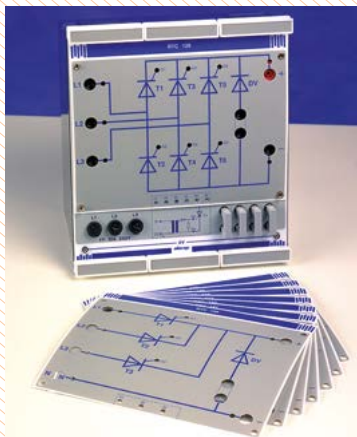


#### Uncontrolled rectification RNC-120

Ref: MDULRNC120

It enables the study of power diode-based rectifiers and their applications: single-phase, two-phase and three-phase half wave and full wave rectifiers.

- Based on the multi-panel concept.
- Includes the base module and five panels for study of the different bridges.
- Operating range: 22 VAC - 380 VAC.
- Safety connections and over-voltage and overload protection.

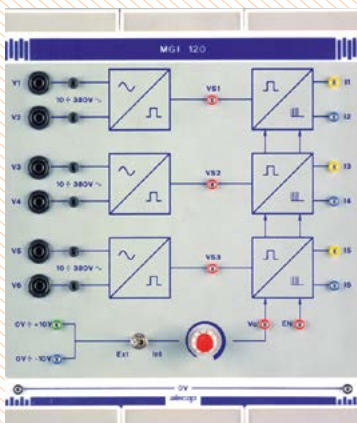


#### Controlled rectification RTC-120

Ref: MDULRTC120

It enables the study of power thyristor based controlled rectifiers and their applications: semi-controlled and fully controlled single-phase, two-phase and three-phase half wave and full wave rectifiers.

- Based on the multi-panel concept.
- Includes the base module and eight panels for study of the different bridges.
- Operating range: 22 VAC - 380 VAC.
- Safety connections and over-voltage and overload protection.

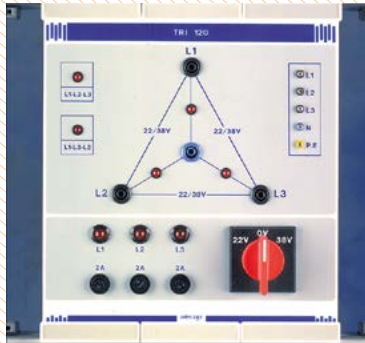


#### Pulse generator MGI-120

Ref: MDULMGI120

Sync and pulse train generator for ignition of the RTC-120 module thyristors.

- Control of up to 6 thyristors in three-phase bridge configuration.
- Three separate sync inputs, 10 – 380 VAC.
- Six pulse outputs, simultaneous and electrically insulated in pairs.
- Time-shifted pulse train according to external or internal set point.
- Input terminal for enabling/inhibiting pulse outputs.
- Requires ALI-700  $\pm 15$  V power supply module and table-mounted frame.

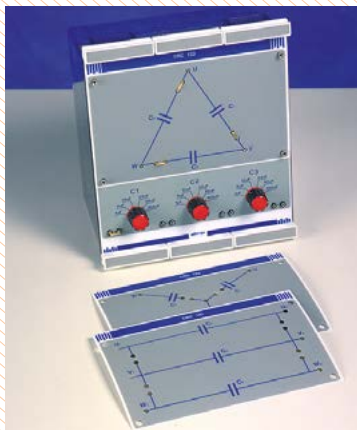


## Three-phase transformer 220/380-22/38 Vac **TRI-120**

Ref: MDULTRI120

Phase transformer, depending on the model has a ratio of 220 V. to 22/38 V. or 380 V. a 22/38 V, with an apparent power of 300 VA. It is required for obtaining a low-power three-phase system, supplying the RNC/RTC-120 modules.

- Selection of 22/38 V output voltage by selector switch.
- Successive phase indicator light.
- Overload and over-voltage protection.
- Requires ALI-700  $\pm 15$  V power supply module and table-mounted frame.



## Resistive-inductive charge **CIR-120**

Ref: MDULCIR120

Charge module for low-power rectifier bridge work.

- Multi-panel system.
- Twelve panels for configuring different charge connection types.
- Charges: Y/A, R, L, R-L, free connection, etc., up to 50 Vef.
- Self-powered fan.



## Rechargeable battery **BAT-120**

Ref: MDULBAT120

Module for simulating counter-electromotive force (DC motor), with single-phase 230 VAC mains supply. Charging circuit 12 V/6.5 Ah.

## Resistive-capacitive charges **CRC-120**

Ref: MDULCRC120

Charge module for low-power rectifier bridge work.

- Multi-panel system.
- Three panels for configuring different types of charge connection.
- Charges: Y/A, free connection, etc., up to 63 Vef.

## EP3

### Switching power devices

Set of modules enabling practical analysis of the behaviour, advantages, disadvantages and problems of control of switching mode power devices.

Each module includes a block with the circuit's most significant voltage and current measurements, at reduced voltage and measured at the same point. The modules also include an electronic overcurrent and short-circuit protection system.

#### Bipolar transistor **TRS-200**

Ref: MDULTRS200

For studying the bipolar switching power transistor. It includes a PWM signal generator circuit for transistor control, which generates the input signal to the basic circuit (DRIVER), obtaining a 4 KHz rectangular signal with a variable duty cycle according to the user-accessible PWM potentiometer and Ton selector incorporated.

Equipped with a switching aid circuit via an anti-saturation diode.

#### IGBT **GTR-200**

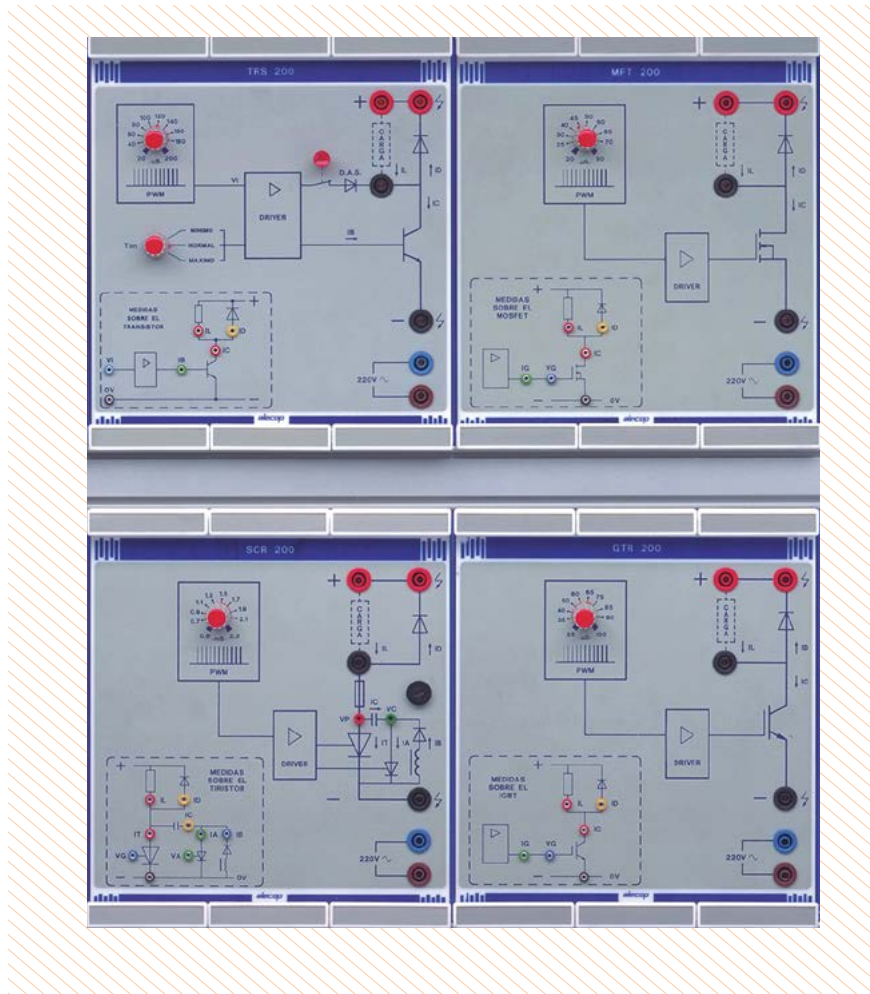
Ref: MDULGTR200

Didactic module to study the switching behaviour of the IGBT (insulated gate bipolar transistor), included on the power IGBT module, as well as its control circuitry. To control the IGBT, a PWM signal generator is used which generates the input signal to the gate circuit (DRIVER), the latter is a rectangular 8 KHz. signal with a variable Ton of between 25 and 100  $\mu$ sec, depending on the accessible potentiometer.

#### MOSFET **MTF-200**

Ref: MDULMFT200

Didactic module to study the switching behaviour of the MOSFET power transistor, including a MOSFET module, as well as its control circuitry. To control the MOSFET, a PWM signal generator is used which generates the input signal to the gate circuit (DRIVER); the latter is a rectangular 10 KHz. signal with a variable Ton of between 25 and 80  $\mu$ sec, depending on the PWM potentiometer.



## THYRISTOR

Ref: MDULSCR200

Didactic module to study the switching behaviour of the power thyristor, including a thyristor module, as well as its control circuitry. To control the thyristor, a PWM signal generator is used which generates the input signal to the gate circuit (DRIVER); the latter is a rectangular 350 Hz. signal with a variable  $T_{on}$  of between 0.6 and 2.3  $\mu\text{s}$ c, depending on the PWM potentiometer.

The DRIVER block generates pulses for the power thyristor gate, as well as for the auxiliary thyristor of the integrated forced commutation circuit.

### Elements REQUIRED:

- Table-mounted frame.
- ALI-700 supply module.
- ALI-200 supply module.
- TRF-200 transformer module.

## EP4/EP5

### DC/DC and DC/AC converters, choppers and inverters

A set of modules that can be configured differently for studying DC/DC and AC/DC converters (inverters or undulators), the various modulation techniques and their different applications such as the regulation and control of DC and AC motors, uninterruptable power systems, etc.

#### Continuous power bus **ALI-200**

Ref: MDULALI200

This didactic module contains a power supply of 310 V. continuous voltage, and can provide as far as a 10 A current. This is the constant direct voltage source for supplying the different converters, and it distributes the mains voltage to the other power modules.

It incorporates 10 A fuses on the alternate and continuous side, protecting the module against line surges and short circuits.

The module disposes of a voltage sampling on the continuous bus; this signal is used as a protection measurement against possible high voltages on the BUS.

#### Isolation transformer **TRF-200**

Ref: MDULTRF200

230/230 VAC transformer isolating the ALI-200 module network. It has primary and secondary protection by means of 10 A fuses.

#### Safety device centralisation **SEG-200**

Ref: MDULSEG200

This is a safety stage that must be included in all converters. It is a centralised protection block that protects the various converter circuits against bus overvoltage and overloads. It also adapts the control signals to be sent to the RAMA modules of the converter in question in both amplitude and impedance, to act on the transistor base drivers.



## Branch of bipolar transistors **RAMA-200**

Ref: MDULRAM200

These modules allow configuring of the power blocks of any type of transistorised converter, each of them forming one of the branches of the converter. The number of modules to use depends on the type of circuit which will be implemented (two for DC/DC converters and three for DC/AC converters).

Each module includes two power transistors as well as base DRIVER circuits required for control purposes.

It includes a JACK-type connector where the control signals from the SEG-200 module are received. These signals are optocoupled allowing a complete separation of the circuits from the power circuits.

Inside the module, a logic processor has been integrated which is responsible for detecting any error in the RAM operation. If an error occurs, the processor blocks automatically and remains inoperative. The factors why the protection system lock the operation of the module are:

- Instantaneous intensity by transistors greater than 25 A with a longer duration than 4 msec.
- BUS voltage below 120 V.
- Network supply failure.
- Internal defects of circuit.

### Elements **REQUIRED**:

- Table-mounted frame.
- ALI-700 supply module.
- ALI-200 supply module.
- TRF-200 transformer module.

## Set point generator **SNG-200**

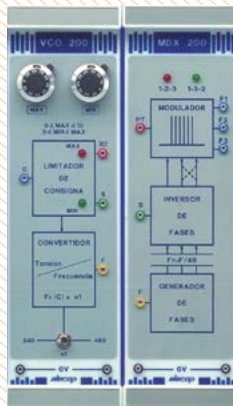
Ref: MDULSNG200

This module generates three types of control set points: step, ramp and a set point that can be varied manually through potentiometric control.

## Voltage-frequency converter **VCO-200**

Ref: MDULVCO200

It converts the set point voltage applied at the input into a frequency using a voltage-controlled oscillator. It forms the control part of the transistorised inverter together with the TON-200 and MDX-200 modules, for asynchronous machine speed variation.



## Ton driver **TON-200**

Ref: MDULTON200

The TON-200 module is in charge of the pulse width modulation coming from the voltage-frequency converter (VCO-200) for the control of the transistorised ondulator. It includes a pulse width adjustment circuit (Ton) and an overdrive circuit.

## Generator-inverter-phase modulator **MDX-200**

Ref: MDULMDX200

This module generates the control signals to be applied to the six transistors that make up the inverter bridge. It has a phase generator, a phase inverter in accordance with the set point sign and a modulating circuit.

## Pulse width modulator **PWM-200**

Ref: MDULPWM200

It generates pulse width-modulated signals, providing the control commands to the power converters. It includes an oscillator block, which generates a triangular voltage and three 120° out-of-phase sinusoidal voltages, a “three-phase control” unit, for control of three-phase inverters, and a “single-phase control” unit for the single-phase inverters.

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# EP6

## Speed and current regulation accessories

A small set of two modules that can complement the sets of converters to enable study of closed loop speed regulation.



## Current Loop PI Controller **PII-200**

Ref: MDULPII200

Equipped with a current sensor, based on a Hall-effect cell, with an incorporated adjustable gain conditioner and three possible user-selectable control actions (proportional, integral and proportional-integral).

## Speed Loop PI Controller **PIV-200**

Ref: MDULPIV200

Provided with an adjustable gain conditioner circuit for tachometer, comparator of set point with feedback voltage, and three possible control operations (proportional, integral and proportional-integral).

# Assembly and power supply system

## Table-mounted training frame

This is a physical support for the modules, blocks and panels used for the practical activities. It transmits the electrical supply from the power supply modules to all the modules requiring it.

Ref.: 9EBxPxxCP



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The assembly frame and the ALI-700 power supply module form the basis of the modular programme and are required for all training module configuration requiring an electronic power supply.

The frame dimensions are selected in accordance with the equipment to be mounted on the frame. Its horizontal structure consists of an aluminium section and the rectangular side supports are oven-dried painted iron sections.

As regards locating the frame on the work tables, it may be fixed (the frame can be fixed to the tables) or mobile (in which case it is supplied with removable legs with non-slip feet).

The module power supply and fixing systems consist of a series of connectors, into which the connection points located on the rear of the modules are inserted, exerting a slight pressure.

All the frame connectors are interwired in order to share a common voltage, guaranteeing a suitable power supply to the modules installed. The power is supplied via the ALI-700 module.

x: 1,2: frame height in tiers.

xx: 10, 14, 18, 20, 22, 28, 36, 44: n° of insertable single modules.

## ±15 V SUPPLY

### Training module

A supply source of  $\pm 15$  V. The power supply is transmitted via the table-mounted frame, and these voltages are also available at 2 mm terminals.

It includes the corresponding pilot LEDs to indicate correct output functioning, providing a nominal current of 2 A. It includes thermal and short-circuit protection, with automatic reset after a few seconds.

Ref.: MDULALI700