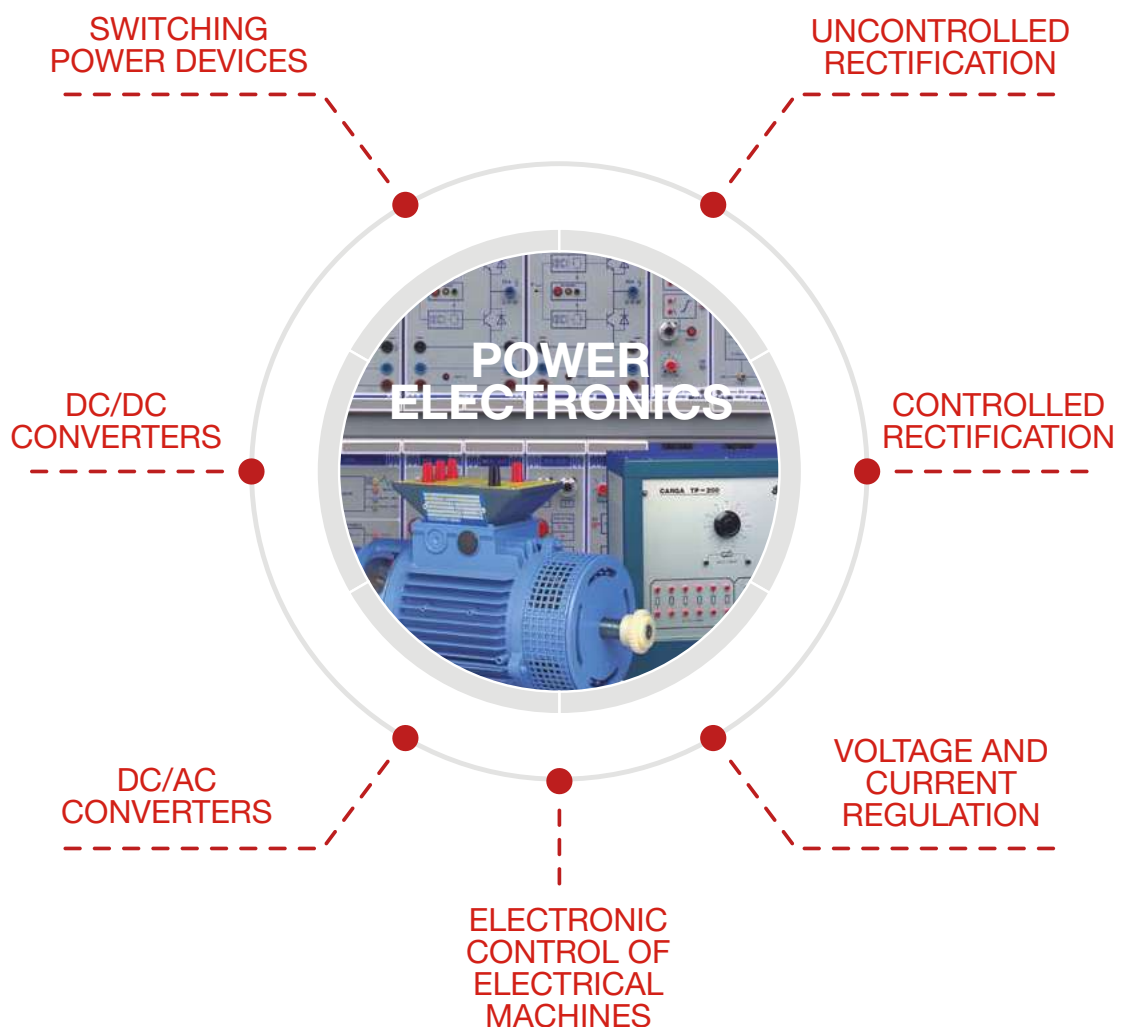


The trainer system for power electronics takes the form of a modular programme for study through analysis of the four types of power converters used in industrial applications (rectifiers, choppers, inverters/undulators and AC regulators) and the power devices forming the basis for the design of these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



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Safety

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

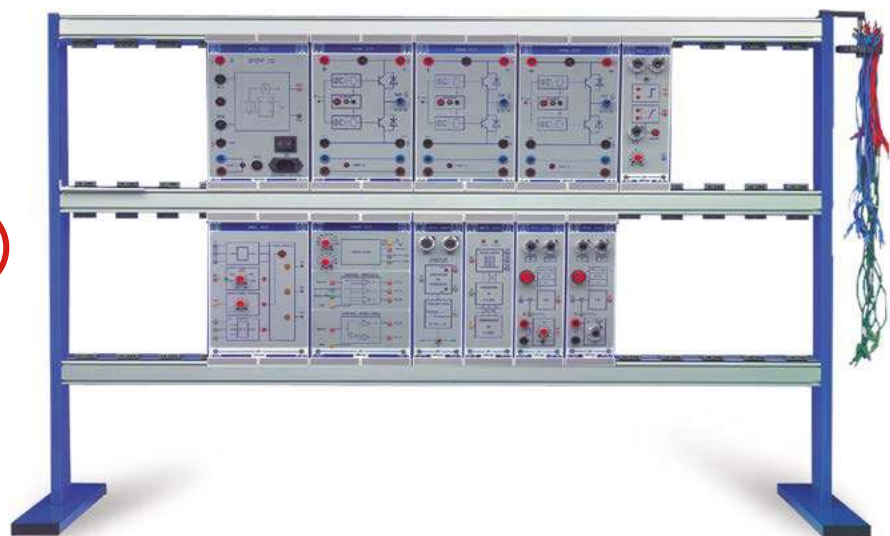
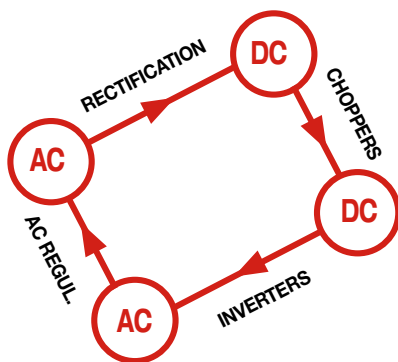
Quality

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.:

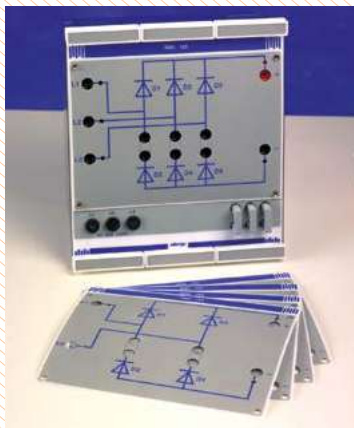
- Training Guide, or trainer's class work guide, which defines goals, activities, sequencing, etc. and proposes a course outline. The activities and use of the different available resources (training devices, instruments, etc.) are structured on the basis of this guide.
- Practical Manual, which contains 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.

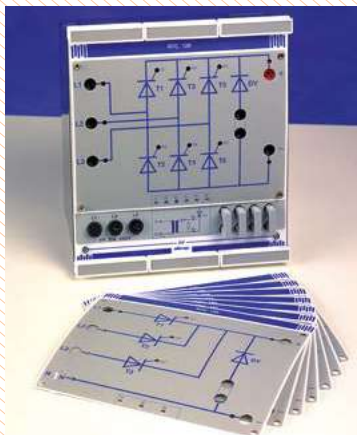


Uncontrolled rectification RNC-120

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.

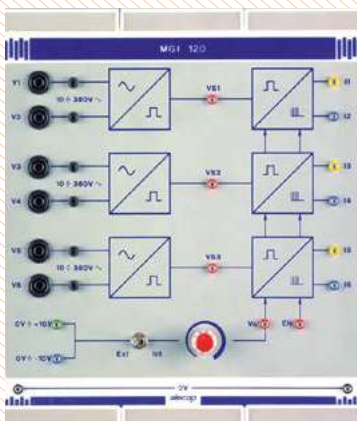


Controlled rectification RTC-120

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.

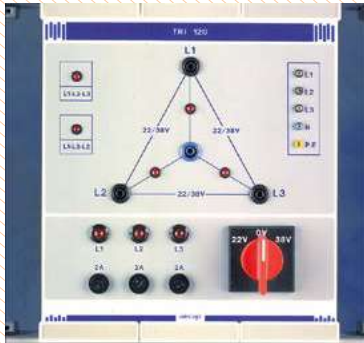


Pulse generator MGI-120

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 ± 15 V power supply module and table-mounted frame.

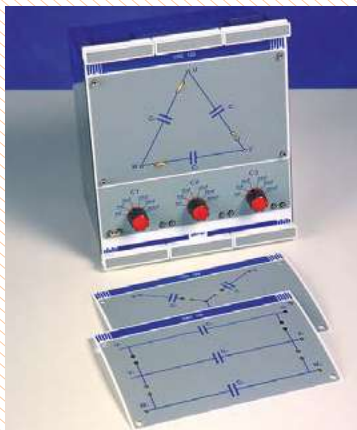


Three-phase transformer 220/380-22/38 Vac **TRI-120**

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 ± 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**

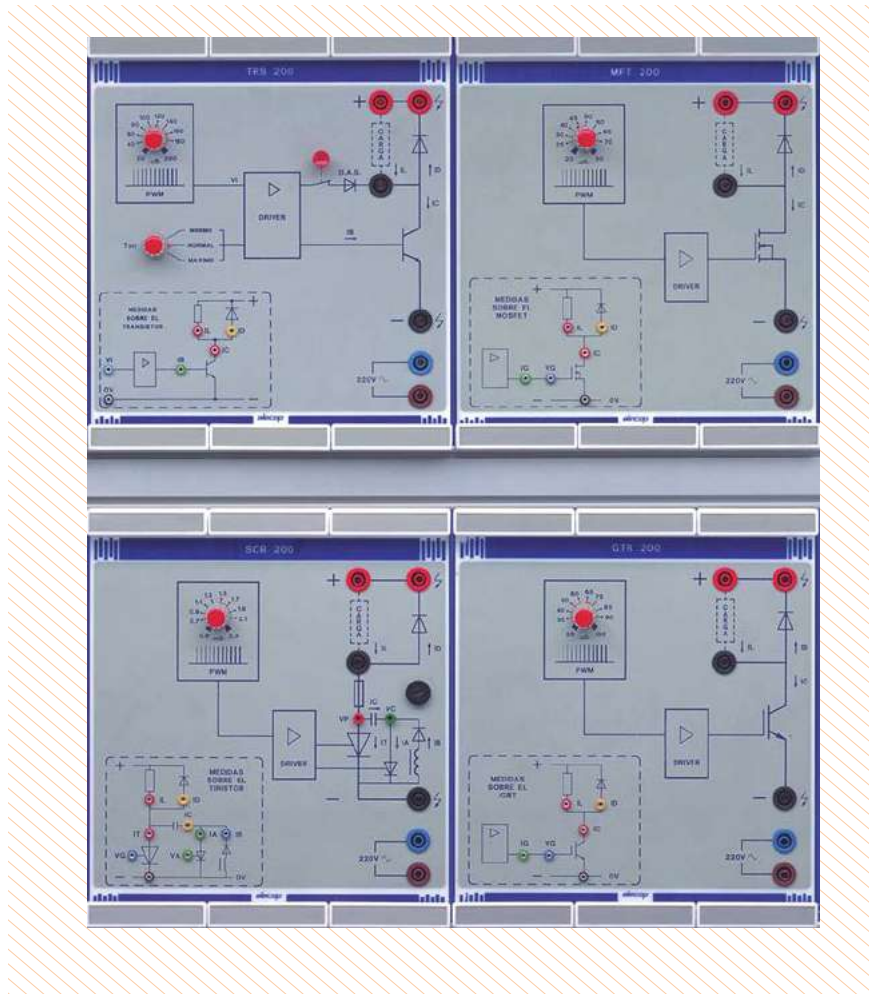
Ref: MDULGTR200

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 μ 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 μ 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 μs 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.

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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

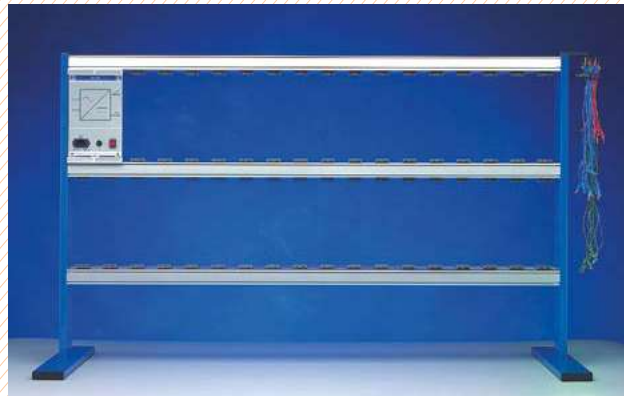
Provided with an adjustable gain conditioner circuit for tachometer, comparator of set point with feedback voltage, and three possible control operations (proportional, integral and proportional-integral).

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 ± 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

Electronic control of electrical machines



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The electronic motor speed regulation training devices presented in this catalogue are the result of having converted the corresponding industrial regulators into training devices, reproducing their construction and operating principles while providing major educational and functional advantages.

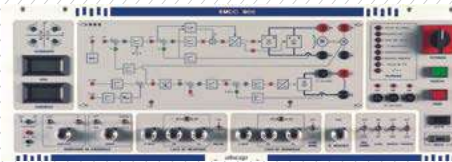
Basic content that can be worked on using this equipment:

- Block diagram representation of control systems.
- Speed control in both rotation directions.
- Four-quadrant operation.
- Operation at constant torque and power.
- Current and speed regulation, types of feedback and correctors.
- Speed regulation, P and PI correctors.
- Torque and speed regulation. Feedback loops and correctors.
- Torque regulation: detection of rotor position and set point generation.
- Dissipative braking: crowbar circuit.
- Analytic corrector tuning in accordance with the symmetric optimum criterion.
- Adjustment and tuning techniques.
- Asynchronous motor speed variation. Voltage/frequency ratio.
- Failure diagnosis and repair.

ELECTROTECHNICAL POWER SYSTEMS

DC motor speed regulation

RMCC-900



AC motor speed regulation

RMCA-900



Brushless motor speed regulation

RMBR-900



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Functions

- Panel support, for use in either vertical position (frame) or table-mounted.
- Wireless equipment configuration.
- Power and control circuit symbols printed according to the IEC (International Electronic Commission) European standards.
- Test points in 2 mm sockets for control signal measurement.
- External set points may be worked with, to enable actuation from an automaton or other control element.
- Motor operating conditions (voltage, current, speed, etc.) can be viewed on a display on the panel, with no need for additional instruments.
- One single supply for all the equipment.

Failures

The training devices enable students to develop failure diagnosis and repair skills: they can analyse and diagnose the failures and repair them virtually.

Back-up resources

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

- User Manual, containing the instructions for start-up and operation of the equipment, its technical characteristics and detailed information on the failure repair system.
- Practical Manual, describing goals, teaching sequence and solutions for each of the practical activities.
- Theory Manual.

Safety

Both the control panels and the electrical machines have safety terminals at voltage points exceeding 30 V, in compliance with the European Low Voltage Directive.

RMCC-900 DC

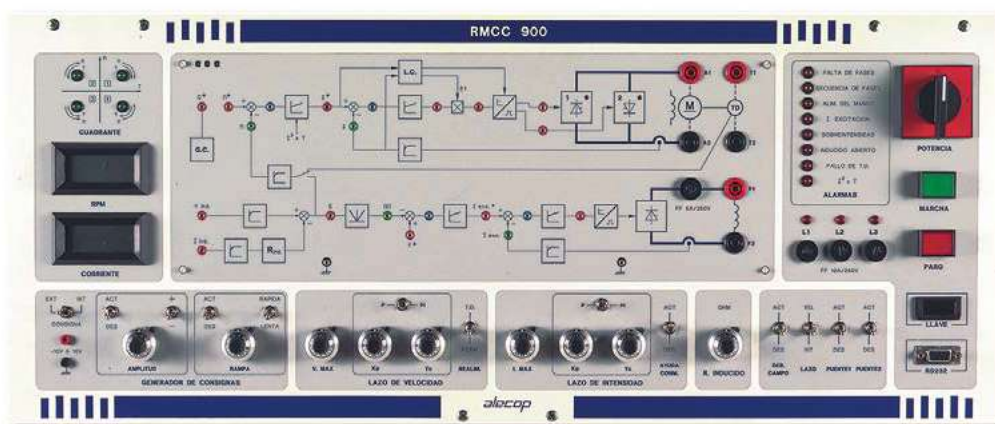
Electronic speed regulation of DC SCR motors

Equipment designed for studying the functioning, adjustment and repair of the speed regulation systems of DC motors, based on double thyristor bridge technology, and the different associated control options.

The following basic content may be worked on:

- Block diagram representation of control systems.
- Current and speed regulation, types of feedback and correctors.
- Four-quadrant operation.
- Constant torque and power operation.
- Adjustment and tuning techniques.
- Failure diagnosis and repair.

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DC engine regulation unit RMCC-900

A multi-panel system which enables different types of controls to be set up. It has six panels, each with unit diagrams printed on it, which are automatically recognised by the equipment when they are fixed in place. This allows for the following setups:

- Torque regulator in a single quadrant.
- One-way speed regulator, with feedback via tachodynamo.
- Speed regulator with feedback via f.c.e.m.
- One-way speed regulator, with operation at a constant torque and power.
- Four quadrant torque regulation.
- Speed regulator in both spin directions, with regenerative braking. The board controls allow selection of the working mode of the controller and adjusting the system parameters.
- Slogans external, internal, manual, ramps, etc.
- Parameters of the different weightings.
- Limitations of current and speed.
- Etc.

The panel incorporates two LCD displays which enables the speed and current to be displayed, as well as indicator lights for the functioning quadrant of the motor.

The unit is equipped with a set of protection devices and alarms to facilitate analysis of any occurrence, guaranteeing total safety:

- Phase loss.
- Incorrect phase sequence.
- Control supply failure.
- Excitation current loss.
- Maximum current limitation.
- Open armature circuit.
- I₂ x t protection.

Accessories supplied:

- User's manual and practical activities.

NECESSARY elements which are not supplied:

- AL-506 or 1006 motor (page 104).
- Braking system (page 105).

Optional elements:

- Failure programming console (page 103).
- Theory Manual.
- Data collection and display system.
- 380-220 Triphasic autotransformer.

Technical characteristics

Reference: 9EQRMC900
Supply: Three-phase 230 V- 50/60 Hz
Armature output: 0 to 230 V- 3 A
Excitation output: 0 to 230 V- 0.6 A
Power: 0.6 kW
Regulation range at constant torque: 0 to 1,500 rpm
Regulation range at constant power: 0 to 3,000 rpm

Didactic transformer 380-220 triphasic AT-3822

An autotransformer for various applications in which it is necessary to have a 220 V triphasic voltage, with the following characteristics:

- Supply: triphasic 380 V - 50 Hz.
- Output: triphasic 220 V - 50 Hz.
- Power: 1 KVA.
- Output available as safety terminals and power points.
- Pilot lights indicating presence of phases.
- Fused protection in each phase.



RMCA-900 AC

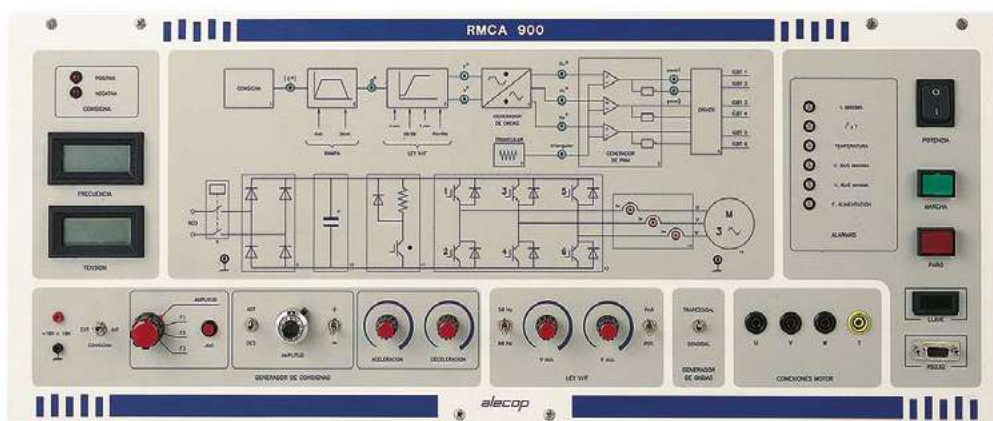
Electronic speed regulation of alternating current motors

Equipment designed for studying the functioning, adjustment and repair of asynchronous motor speed regulation systems, based on frequency converter technology.

The following basic content may be worked on:

- Block diagram representation of control systems.
- Asynchronous motor speed variation. Voltage/frequency ratio.
- Dissipative braking: crowbar circuit.
- Speed control in both rotation directions: four-quadrant operation.
- Operation at constant torque and power.
- Adjustment and tuning techniques.
- Failure diagnosis and repair.

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AC engine regulation unit **RMCA-900**

The panel incorporates a frequency converter designed to supply an asynchronous motor of up to 1 kW power. It consists of a triphasic inverter based on IGBTs and all of the circuitry necessary for their control.

It enables a triphasic output voltage, variable in amplitude and frequency, to be obtained, by means of the PWM modulation. The frequency may be increased to double the nominal frequency in the constant power mode, which enables a control to be obtained above and beyond the nominal speed of the motor. Sine or trapezoidal PWM modulation can be selected.

The controls incorporated enable the work mode of the converter to be selected, as well as the parameters of the system to be adjusted:

- External, internal, manual commands, ramps, etc.
- Parameters at constant torque and power.
- Low speed torque compensation.
- Etc.

The effective voltage and frequency may be displayed alternately on the panels LCD display, and additionally there are lights indicating the quadrant of the functioning of the motor and the activation of energy devolution system (braking).

The unit is equipped with a set of protection devices and alarms to facilitate analysis of any occurrence, guaranteeing total safety:

- Maximum current.
- Maximum temperature.
- Maximum bus voltage.
- Minimum bus voltage.
- Control supply failure.
- I² x t protection.

Accessories supplied:

- User's manual and practical activities.

NECESSARY elements which are not supplied:

- AL-1106/06 motor (page 104).
- Tachodynamo (page 105).
- Braking system (page 105).

Optional elements:

- Failure programming console (page 103).
- Theory Manual.
- Data collection and display system.

Technical characteristics

Reference: 9EQRMCA900

Supply: Single-phase 230 V- 50/60 Hz

Output voltage: Three-phase 0 to 220 V

Output frequency at constant torque: 0 to 50 Hz or 0 to 60 Hz

Regulation range at constant power: 0 to 100 Hz or 0 to 120 Hz

Power: 1 kW

RMBR-900

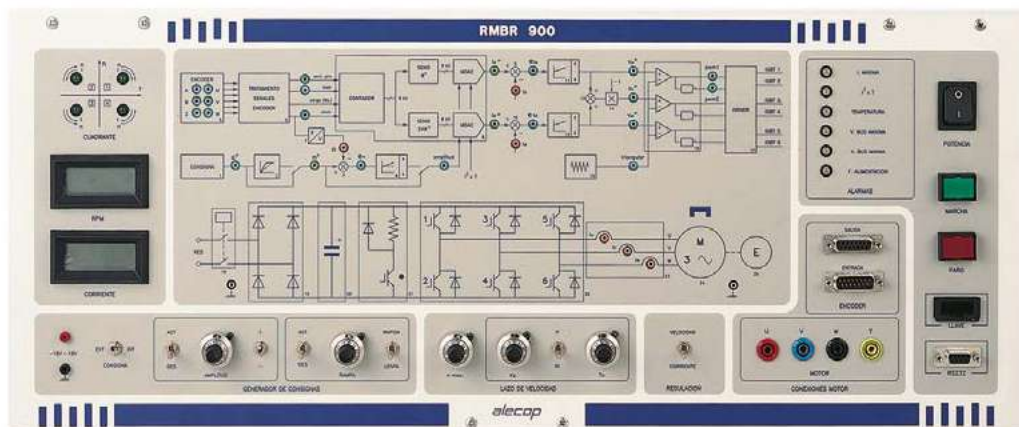
Electronic regulation of Brushless motor speed

Equipment designed for studying the functioning, adjustment and repair of AC brushless motor speed regulation.

The following basic content may be worked with:

- Block diagram representation of control systems.
- Torque regulation: detection of rotor position and set point generation.
- Speed regulation, P and PI correctors.
- Dissipative braking: the crowbar circuit.
- Adjustment and tuning techniques.
- Failure diagnosis and repair.

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Brushless engine regulation unit RMBR-900

The power circuit is made up of a rectifier bridge, a filter condenser and a triphasic inverter based on IGBTs. In addition to this, it incorporates a crowbar circuit for protecting the equipment when the voltage in the bus increases through braking energy devolution.

The controls incorporated enable the function mode of the converter to be selected, in addition to enabling the parameters of the system to be adjusted:

- External, internal, manual commands, ramps, etc.
- Corrector parameters.
- Regulation in current or in speed.
- Limitation of maximum speed.

The speed and current may be displayed on the panel's LCD display, and additionally there are lights indicating the quadrant of the functioning of the motor and the activation of energy devolution system (braking).

The unit is equipped with a set of protection devices and alarms to facilitate analysis of any occurrence, guaranteeing total safety:

- Maximum current.
- Maximum temperature.
- Maximum bus voltage.
- Minimum bus voltage.
- Control supply failure.
- I² x t protection.

Accessories supplied:

- User's manual and practical activities.

NECESSARY elements which are not supplied:

- Brushless motor (page 105).
- Braking system (page 105).

Optional elements:

- Failure programming console (page 103).
- Data collection and display system.

Technical characteristics

Reference: 9EQRMBR900

Supply: Single-phase 230 V- 50/60 Hz

Output voltage: 0 to 196 V

Output frequency: 0 to 200 Hz

Power: 1 kW

Failure programming and repair system

The RMCC, RMCA and RMBR-900 regulation panels have a system for failure diagnosis and virtual repair, based on a micro processor in the panel which communicates with the user via a failure programming console with a 4 x 24 character LCD display and a 21-key membrane keyboard.

An electronic key, inserted in a slot in the panel, allows access to the trainer menu to change the codes that generate the failures.



UNIT	Nº OF FAILURES PROGRAMMABLE	Nº OF FAILURES PROGRAMMABLE
RMCC-900	31	Set point failures, tacho dynamo failures, thyristor triggering failures, etc.
RMCA-900	14	Set point failures, rotation reversal failures, crowbar failure, etc.
RMBR-900	26	Set point failures, corrector failure, failure in the encoder processing circuit, etc.

Electrical machines and braking systems

All the electrical machines are mounted on an aluminium bedplate, with their corresponding end connections for quick, easy coupling to other machines, brakes or tacho dynamos. They also include a printed terminal block with safety terminals and protection guards on the shafts.



DC motor AL-506 / AL-1006

Model AL-506 is an independent excitation motor.
Model AL-1006 is an compound excitation machine.

Characteristics	AL-506	AL-1006
Reference	9MAK0506ZC	9MAK1006ZC
Power	370W	370W
Nominal voltage	220V	220V
Nominal speed	2500 rpm	2500 rpm
Shaft height	80	80



Three-phase asynchronous motor AL-1106

Single-speed three-phase asynchronous squirrel-cage motor (50Hz/60Hz).

Characteristics	AL-1106	AL-1106
Reference	9MAK1106GC	9MAK1106HC
Power	400W	400W
Nominal voltage	230/400V	230/400V
Nominal speed	1420 rpm	1690 rpm
Shaft height	80	80

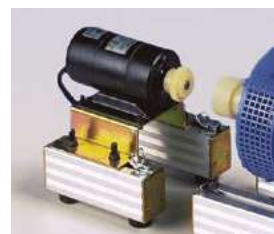
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Asynchronous motor BRUSHLESS AC

AC Servomotor, associated to the corresponding regulator, it behaves as a high prestaton's DC motor (high nominal speed, low inertia, small, etc.), without needing of brushes. It is composed by an inducted winding placed in the stator, permanent magnets in the rotor and solidary encoder.

Characteristics	AL-BRU80
Reference	MTRALBRU80
F.c.e.m.	150 V
Nominal intensity	4 A
Nominal torque	2.5 Nm
Maximum speed	4,000 rpm
Encoder	2,000 impulses/turn
Shaft height	80 mm



Tachogenerator REO-444

Characteristics	REO-444-80
Reference	9EQDINTQ80
Constant	60 V/1000 rpm
Maximum speed	10,000 rpm
Axis height	80 mm



FUNCTION. Drag motor and braking of machines for testing.

Braking system - bank

This machine can be easily coupled to the bedplate, in accordance with safety standards preventing bedplate malfunctioning.

The bedplate is controlled by potentiometric dials for torque and speed, or by means of external signals enabling it to be controlled by DAS and computer.

Constant display of power, speed and torque exerted on the bedplate axis, signals available at an external connector.

Technical characteristics

GENERAL

Supply:

Single-phase mains 190 – 250 VAC – 5.25 Amp.- 50/60Hz

Type of machines tested:

- Free-standing, heights 71, 80 and 90 mm.
- Heights 80 and 90 mm on Alecop sections.

Machine fixed for testing by elastic coupling.

FUNCTIONING AS A DRAG MOTOR

Speed: 0 to 2000 rpm

Rated: 800 W

Maximum torque: 9.7 Nm

FUNCTIONING AS A BRAKE

Maximum speed: 2450 rpm

Torque: 0 to 10 Nm

Rated: 800 W

Braking system by a d.c. generator FRE-506

Ref.: 9EQREF0437

Electrical machines braking system by means of a dc generator coupled to the shaft of the machine. The kit includes:

- 1 EXC-281 module. Variable output rectifier with autotransformer. Input 220 V ac, output: 0 – 220 V dc
- 1 Rheostat 150 Ohm / 500 W
- 1 DC generator independent excitation 370 W, AL-506. Nylon coupling.

4 mm safety sockets. Frame (optional) not included.

