electronic control of electrical machines
Integral equipment for the classroom-workshop

Our in-depth knowledge of the educational world allows us to design classroom-workshops configured down to the last detail and ready to use straight away.
The flame of knowledge

For the last 45 years Alecop has offered technological material with maximum benefits which has led to the most important educational organisations opening their doors to us.

HUMANITY AT WORK

We belong to the educational department of MONDRAGON Corporación: A cooperative project of world renown which contributes a human component to the business world. A different work method which seeks the integral development of people and respect for the environment.

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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.
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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.

**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.

**Basic content that can be worked on using this equipment:**
- 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.

**Functions**

**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.

**Failures**
- The training devices enable students to develop failure diagnosis and repair skills: they can analyse and diagnose the failures and repair them virtually.
ELECTROTECHNICAL POWER SYSTEMS

DC motor speed regulation

RMCC-900

AC motor speed regulation

RMCA-900

Brushless motor speed regulation

RMBR-900

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.
Electronic control of electrical machines

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.

Didactic 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, ...
  - 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.
- $I^2 \times t$ protection.

**TECHNICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Reference</th>
<th>RMCC-900</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply</strong></td>
<td>Three-phase 230 V- 50/60 Hz</td>
</tr>
<tr>
<td>Armature output</td>
<td>0 to 230 V- 3 A</td>
</tr>
<tr>
<td>Excitation output</td>
<td>0 to 230 V- 0,6 A</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>0,6 KW</td>
</tr>
<tr>
<td>Regulation range at constant torque</td>
<td>0 to 1500 r.p.m.</td>
</tr>
<tr>
<td>Regulation range at constant power</td>
<td>0 to 3000 r.p.m.</td>
</tr>
</tbody>
</table>

Accessories supplied:
- User’s manual and practical activities.

**NECESSARY elements which are not supplied:**
- AL-506 or 1006 motor (page 14).
- Braking system (page 15).

Optional elements:
- Failure programming console (page 13).
- Data collection and display system.
- 380-220 Triphasic autotransformer.

**Didactic transformer 380-220 triphasic**

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.
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.

Didactic 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.
- 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.

### TECHNICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Reference</th>
<th>RMCA-900</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply</td>
<td>Single-phase 230 V- 50/60 Hz</td>
</tr>
<tr>
<td>Output voltage</td>
<td>Three-phase 0 to 220 V</td>
</tr>
<tr>
<td>Output frequency at constant torque</td>
<td>0 to 50 Hz or 0 to 60 Hz</td>
</tr>
<tr>
<td>Regulation range at constant power</td>
<td>0 to 100 Hz or 0 to 120 Hz</td>
</tr>
<tr>
<td>Power</td>
<td>1 KW</td>
</tr>
</tbody>
</table>

**Accessories supplied:**
- User’s manual and practical activities.

**NECESSARY elements which are not supplied:**
- AL-1106/06 motor (page 14).
- Tachodynamo (page 15).
- Braking system (page 15).

**Optional elements:**
- Failure programming console (page 13).
- Data collection and display system.
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.

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,...
- 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 14).
- Braking system (page 14).

Optional elements:
- Failure programming console (page 13).
- Data collection and display system.

### TECHNICAL CHARACTERISTICS RMBR-900

<table>
<thead>
<tr>
<th>Reference</th>
<th>9E0RMBR900</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply</td>
<td>Single-phase 230 V- 50/60 Hz</td>
</tr>
<tr>
<td>Output voltage</td>
<td>0 to 196 V</td>
</tr>
<tr>
<td>Output frequency</td>
<td>0 to 200 Hz</td>
</tr>
<tr>
<td>Power</td>
<td>1 KW</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>UNIT</th>
<th>Nº OF FAILURES PROGRAMMABLE</th>
<th>Nº OF FAILURES PROGRAMMABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMCC-900</td>
<td>31</td>
<td>Set point failures, tacho dynamo failures, thyristor triggering failures, etc.</td>
</tr>
<tr>
<td>RMCA-900</td>
<td>14</td>
<td>Set point failures, rotation reversal failures, crowbar failure, etc.</td>
</tr>
<tr>
<td>RMBR-900</td>
<td>26</td>
<td>Set point failures, corrector failure, failure in the encoder processing circuit, etc.</td>
</tr>
</tbody>
</table>
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 training motor

**AL-506 / AL-1006**

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

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>AL-506</th>
<th>AL-1006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>9MAK0506ZC</td>
<td>9MAK1006ZC</td>
</tr>
<tr>
<td>Power</td>
<td>370W</td>
<td>370W</td>
</tr>
<tr>
<td>Nominal voltage</td>
<td>220V</td>
<td>220V</td>
</tr>
<tr>
<td>Nominal speed</td>
<td>2500rpm</td>
<td>2500rpm</td>
</tr>
<tr>
<td>Shaft height</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

Three-phase asynchronous training motor

**AL-1106**

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

**CHARACTERISTICS 50Hz**

| Reference       | 9MAK1106GC   |
| Power           | 400W         |
| Nominal voltage | 230/400V     |
| Nominal speed   | 1420rpm      |
| Shaft height    | 80           |

**CHARACTERISTICS 60Hz**

| Reference       | 9MAK1106HC   |
| Power           | 400W         |
| Nominal voltage | 230/400V     |
| Nominal speed   | 1690rpm      |
| Shaft height    | 80           |
AC Servomotor, associated to the corresponding regulator, it behaves as a high prestation's DC motor (high nominal speed, low inertia, small,...), without needing of brushes. It is composed by an induced winding placed in the stator, permanent magnets in the rotor and solidary encoder.

Asynchronous didactic motor

**BRUSHLESS AC**

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>AL-BRU80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>MTRALBRU80</td>
</tr>
<tr>
<td>F.c.e.m.</td>
<td>150 V</td>
</tr>
<tr>
<td>Nominal intensity</td>
<td>4 A</td>
</tr>
<tr>
<td>Nominal torque</td>
<td>2,5 Nm</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>4000 r.p.m.</td>
</tr>
<tr>
<td>Encoder</td>
<td>2000 impulses/turn</td>
</tr>
<tr>
<td>Shaft height</td>
<td>80 mm</td>
</tr>
</tbody>
</table>

Didactic tachodinamo

**REO-444**

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>REO-444-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>9EQDINTQ80</td>
</tr>
<tr>
<td>Constant</td>
<td>60 V/1000 r.p.m.</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>10000 r.p.m.</td>
</tr>
<tr>
<td>Axis height</td>
<td>80 mm</td>
</tr>
</tbody>
</table>

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 - 2000 rpm
Nominal power: 800 W
Maximum torque: 9.7 Nm

**FUNCTIONING AS A BRAKE**

Maximum speed: 2450 rpm
Torque: 0 - 10 Nm
Nominal power: 800 w