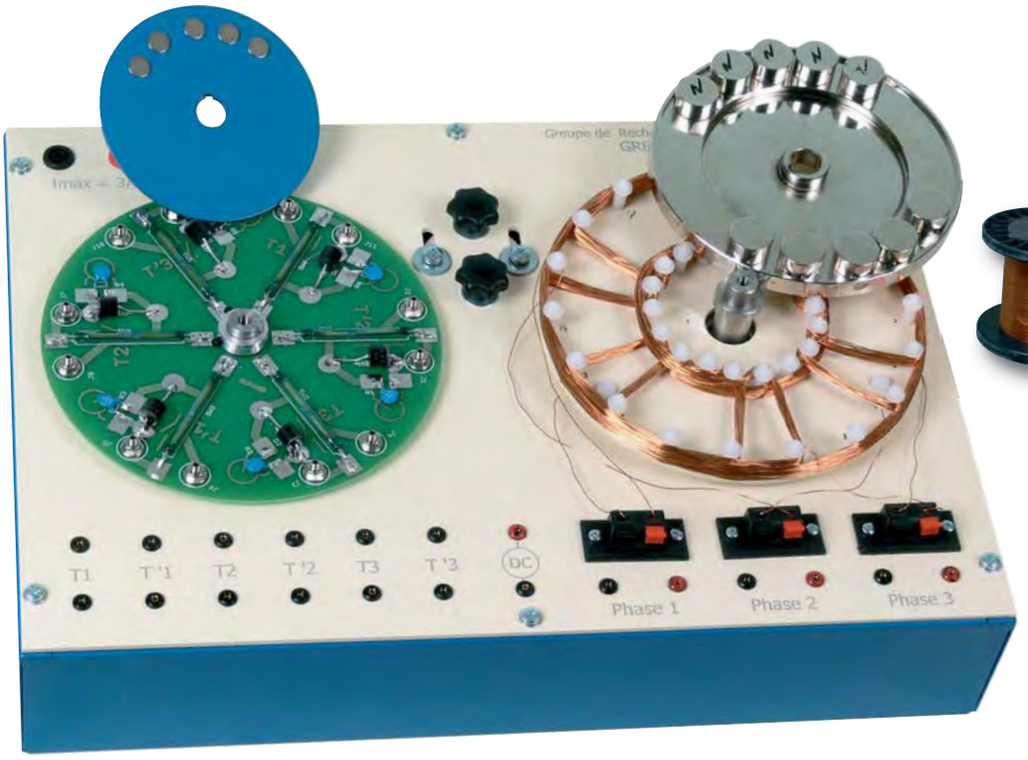
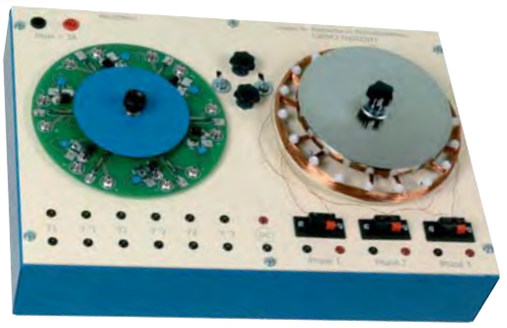
Automatically controlled synchronous machine





SCOPE OF SUPPLY
Supplied complete and in working order, together with:
- 1 wound stator
- 2 additional bare combs for winding
- enamelled wire dia. 0.5 mm
- 14 leads dia. 2 mm
- 1 full set of instructions with amended tutorials.

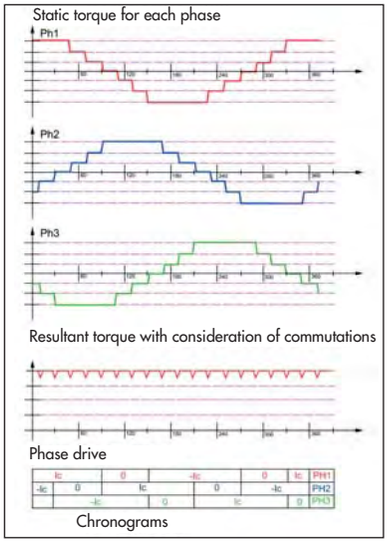
ref. MICROMAG

In contrast to the black box form of an industrial machine, MICROMAG is completely open and can be dismantled. Students can learn to identify all of its components, create one or more windings themselves and adjust the switch. This switch uses only dry contacts (with no complex electronic circuit) so that its operation is accessible to everyone. Using this model, students discover little by little the various components of an automatically controlled synchronous machine and, more generally, of a motor, via a theoretical and practical approach. The theoretical approach can be accessed at three study levels: secondary school leaving qualification targeting immediate employment, Institute of Technology or vocational diploma or engineering school. At the secondary school level, the torque, the EMF and the number of turns in the winding are calculated simply by applying formulae. Engineering students will have the necessary mathematical knowledge to establish these relationships by using the laws of electromagnetism (Laplace's law, Ampere's theory and Faraday's law) and applying them to the MICROMAG machine.
MICROMAG comes with a manual containing all of the basic laws which are necessary for understanding the tutorials. Wherever necessary, colour drawings are used to illustrate comments. Angular diagrams, timing diagrams and schematic diagrams are used to illustrate, step-by-step, the operation and/or stages of implementation. In addition to tutorials which are accessible to all, there are also questions + tutorials for higher education students, along with their answers. In addition, the following is required for all tutorials:
- a 30V DC 2A power supply
- an oscilloscope with a memory function
- a dynamometer
- a gaussmeter – not essential – used for checking the current of the field
- enamelled wire for winding on the rotor(s) (supplied)

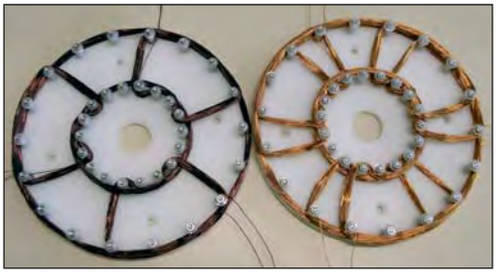
TUTORIALS WHICH CAN BE ACCESSED AT ALL LEVELS OF TRAINING

Because the motor is open, students can see the air gap, the orientation of the magnetic field, the direction of the current, the direction of rotation, the "active" winding part and the yoke. MICROMAG can be used as a motor or a generator. By manually rotating the rotor, the machine will operate as a generator. Students read out from the oscilloscope the EMF on the two-phase terminals. This voltage indicates indirectly the torque ripple when the machine is operating as a motor.

EXAMPLE 1
For each of the three phases, students produce a static torque diagram (or EMF diagrams for each phase) based on the rotor's angular position. Students check the values experimentally by measuring torques using a dynamometer and the EMFs shown on the oscilloscope.
They plot torques in a graph and check them experimentally (EMFs respectively) when the two phases are connected in anti-series, or three phases in anti-series and parallel. They produce a phase power diagram based on the rotor's angular position.

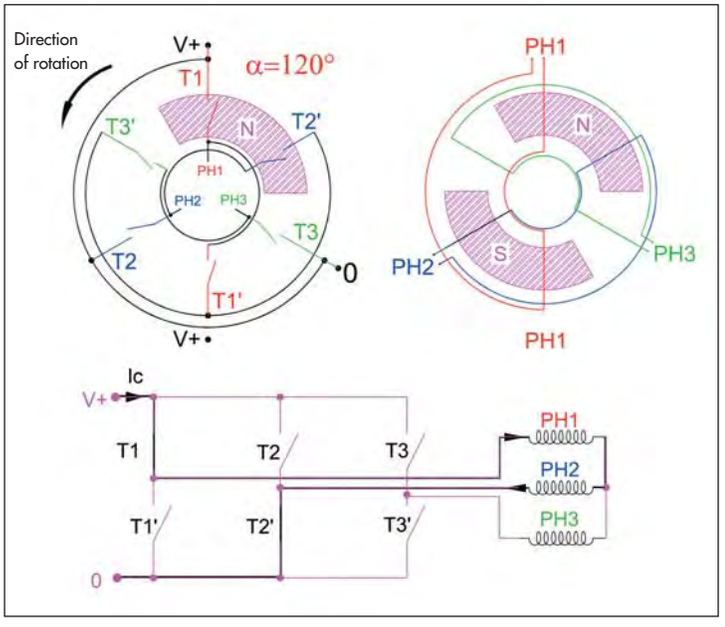


EXAMPLE 3
The MICROMAG winding can include one, two or three notches per pole and per phase. Students perform a theoretical calculation to determine the number of notches and turns of the winding required for a torque specified by the teacher. They then perform this winding on a comb using enamelled wire. Next, they check the obtained static torque in practice using a dynamometer.



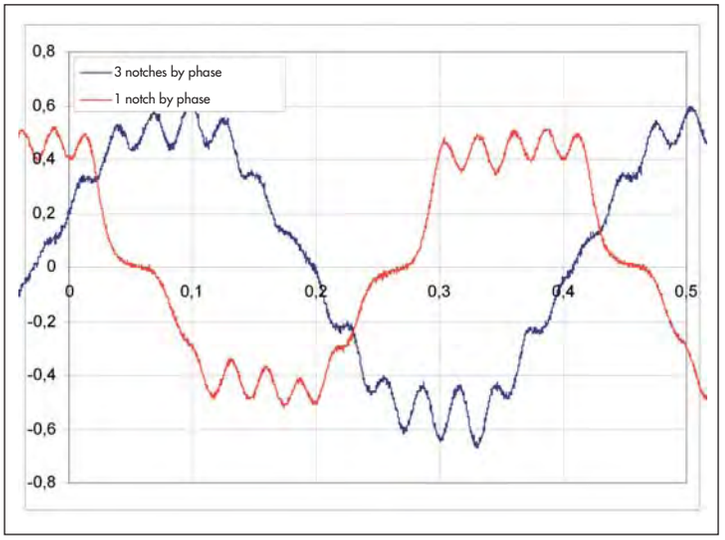
EXAMPLE 2

Using these diagrams, students study the principle of the switch, which powers in sequence the phases of a synchronous machine, based on the rotor's angular position. This switch comprises a "position sensor" and "electrical switching".
This is performed in MICROMAG by means of a rotating disk, which is synchronous with the rotor and carries magnets. The magnets activate reed switches, in series with the windings. Students have to place the magnets onto an angular sector of 120° on the switch's disk in order to power two phases. It is also possible to perform a 180° control by using one anti-series phase and the other two in parallel. By manually activating the disk, students check on the ohmmeter whether the opening/closing sequence of the switches matches the previously established phase power diagram exactly, based on the rotor position.



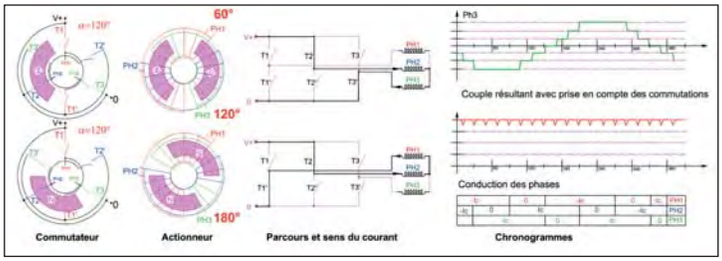
EXAMPLE 4

Students place the windings that they have produced inside the motor. By manually powering one phase after another, they firstly check the connection. Next, they connect the switches of the switching system with the three phases of the stator. By overriding the rotor/switch drive system, students check that its rotation is driving the rotor in synchronism. Finally, by resetting the switch drive by the rotor, students test the machine in automatically controlled operating mode. Students read out from the oscilloscope the currents in two successive phases and their conduction diagram.



EXAMPLE 5

The aim of the tutorials is to draw students' attention to the various power supply strategies, with a view to establishing a rotating field. To this end, they have a document to complete, which shows the successive angular positions of the switch and the rotor, the status of the switches, the current in the windings and the angular diagrams for each phase. They must determine the shape of the torque for each phase, as well as the resulting torque.



TUTORIAL AND MISCELLANEOUS QUESTIONS FOR UNIVERSITY AND ENGINEERING SCHOOL LEVEL

- Principle of axial motor
- Main μa and Ja parameters of a permanent magnet
- Recoil line
- Ampere-turns of a coil equivalent to a magnet.
- Hypotheses about the field and materials
- Magneto-static laws used
- Calculation of field B and comparison with the measurement
- Motor torque calculation Generator EMF calculation
- Relationship between EMF and torque
- Calculation of a number of turns for a given torque
- EMF waveform for a winding with one notch
- Torque wave form for a winding with one notch
- Calculation of the resistance of a phase. Practical check
- For each phase power supply strategy
  - establish the opening and closing sequences of the switches
  - wire the control circuit.
  - based on the waveforms of the torques for each phase, determine the waveform of the resulting torque and currents
  - determine the optimal polar arc

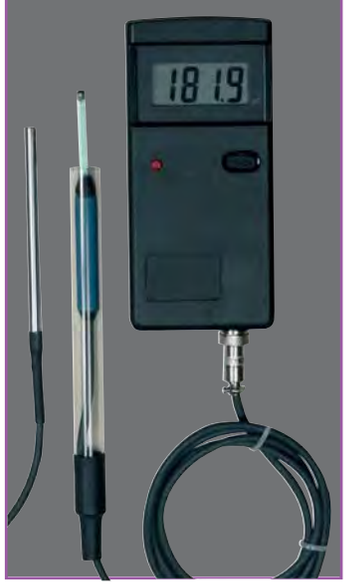
DYNAMOMETER FG5000

ref. FG5000

- Rating: 5000 gf
- Resolution: 1 gf
- Accuracy: 0.2% + 1 dgt
- Automatic shutdown
- Dim.: 240 x 80 x 40 mm
- Weight: 440 g

TESLAMETER

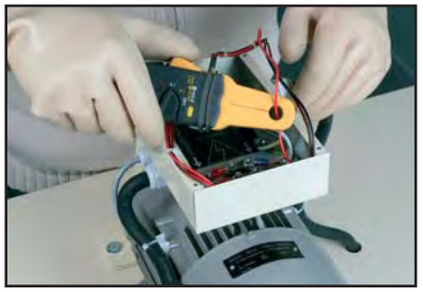
SEE PAGE 243



Fault finding in motor

View of the teacher side, door closed and open.

View of the student side, door closed



Faults can be looked for inside the student unit and in the motor terminal.

This complete kit on casters, comprising two back-to-back units and an asynchronous squirrel cage motor and a parking brake, can be used to simulate the faults which occur most frequently.
The principle and the instructions have been devised by teachers who want to propose a method for diagnosing faults.

PRINCIPLE

Faults are recreated when the teacher rotates a single switch. Students can take measurements or perform tests in complete safety, regardless of the fault type. Faults can be looked for inside the student unit and in the motor terminal. The unit is isolated from the mains by means of an insulation transformer. In addition, a TT earthing system is recreated on the secondary for safety reasons. Therefore, even isolation faults are detected by a 30mA differential mechanism. All safety measures are implemented in order to protect individuals and equipment. (See the faults in the description of the teacher unit)

ref. MOTODIAG

- Overall dimensions: 670 x 750 x 1180 mm
- Laminated bench-top: 670 x 750 mm
- 4 casters Ø 80 mm
- 3-phase Hypra socket on 5m mains cable
- Weight: 80 kg

TEACHER SIDE UNIT

The teacher uses this lockable area to manage faults activated by key switches he/she knows, and to view all of the simulator's workings. Thanks to indicator light. The position of the switches and indicator lights remain invisible to students.
The following faults are possible:

- 3 faults involving «damaged coil». A resistor is connected in series with a coil to change its impedance.
  One switch per phase, or three switches.
- 3 faults involving «power being cut in a coil». The power is cut in a coil. One switch per phase, or three switches.
- 3 faults involving a «short-circuit in a coil». The coils are short-circuited two at a time. One switch per possibility or three switches.
- 3 faults involving «coil earthing». A coil is earthed. One switch per phase, or three switches.
- 1 fault on the brake.
  The power in the parking brake is cut.

Unit from the teacher side, open door

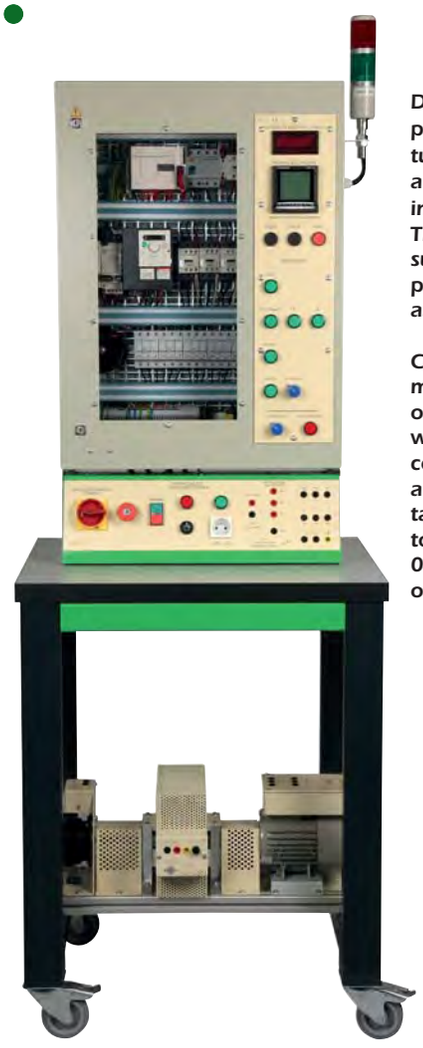
STUDENT SIDE UNIT

This lockable area is used for starting up the simulator (if authorised by the teacher). The transparent door gives the unit a highly didactic appearance.
The student control panel is simpler than the teacher control panel, offering standard normal operation indications. This means that fault finding, testing and measurement are identical to reality in the field.

Unit from the student side, open door.

Instructions devised by teachers to enable rapid product implementation and the creation of tutorials in the spirit of industrial fault finding.

Motor start-up studies



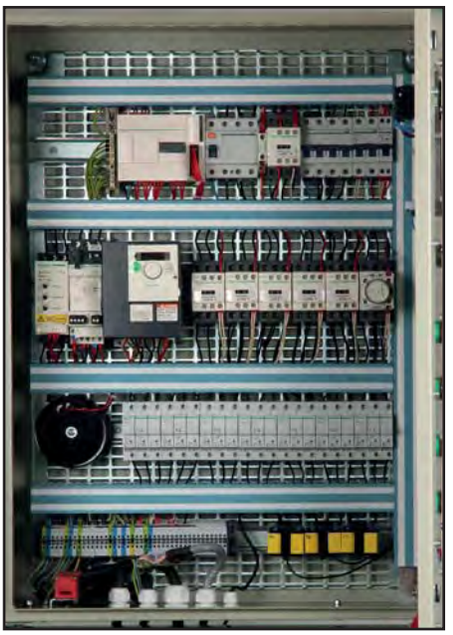
DEMARAC is supplied already wired tutorials, a diagram and technical instructions.
The unit can be supplied without the power unit. Please ask us for details.

Compatibility with motors with a power of up to 1500w, with powder brakes controlled 0-12vdc and all 1000RPM tachometer generators with 0-10v, 0-20v or 0-60v outputs.

ref. DEMARAC

System for studying the start-up of asynchronous motors.
For this completely stand-alone system, all you have to do is connect it to a 3-phase 400V mains socket. Selection of the required motor start-up type via push-buttons at the front of the electrical cabinet:
- Direct start-up
- Star/delta start-up
- Start-up by means of starter/decelerator
- Start-up by means of a frequency converter

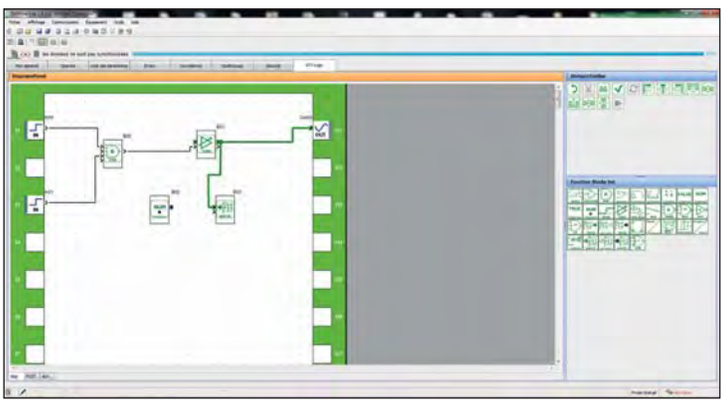
A 300W asynchronous motor, a powder brake and a tachometer generator are fixed directly onto the base with wheels. The power unit and the electrical cabinet are linked together using 4mm safety leads so that measurements can be taken using a hook-on ammeter or voltmeter, etc.
A key-operated switch at the front makes it possible to use the electrical cabinet when it is switched on with the door open. In this way, a qualified individual may take electrical measurements inside the cabinet.
A multifunction measuring unit displays the electrical quantities on the front door. A digital tachometer shows the motor rotation speed.
A potentiometer at the front is used for varying the motor load.
- Dimensions:
  Base with wheels: 750 x 670mm
  Total height: 1970mm



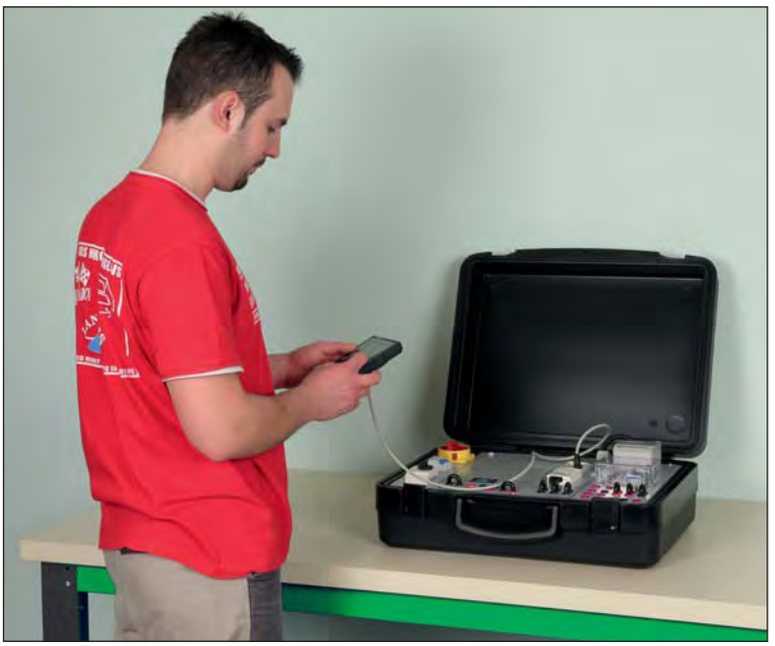
FEATURES
- Three-phase 400V supply voltage.
- Protected by residual current device, circuit breakers and fuses.
- Set of lamps and push-buttons for viewing and controlling the required type of start-up.
- Multifunction measuring unit with digital display, which is wired at the at the start of the circuit measuring:
  - the phase-to-ground and composite voltages
  - the line currents
  - the active, reactive and apparent power, in total
  - the power factor
  - the THD (total harmonic distortion)
- Digital display showing the motor's rotation speed
- Starter/Decelerator. All of the settings are adjusted using potentiometers on the front of the device (acceleration time, deceleration time and torque, etc.)
  Acceleration time: from 1.1 to 5 seconds
  Deceleration time: from 0 to 5 seconds
  Torque adjustment: from 20% to 65% of the breakaway torque of the direct motor
- Frequency converter
  - Possible adjustments:
  - Acceleration ramp
  - Quick stop/free wheel
  - Pre-selected speeds...
- 2 potentiometers at the front of the cabinet adjust the motor's rotation speed and the motor's load.
- Contactor/circuit breaker, wired upstream of the motor, protect against overloads and short-circuits. A display built into the unit indicates the current consumed by the motor and the thermal protection threshold.
- 300W 400V/690V – 1/0.75A asynchronous motor 1500rpm.
- 300W powder brake. 0-10V power supply
- 20V for 1000rpm tachometer generator

Study case for speed controller ATV32 programmable inputs / outputs

VAL-VAR is a study case for the speed controller ATV32 for asynchronous machine. It contains all the equipment required for autonomous operation. The case connects directly to the mains 230V single-phase.
The printed PVC face includes the electrical protection and control equipment, safety terminals for cabling the inputs/outputs of the speed controller and taking current measurements in each phase of the motor.



Programming screen of logical inputs/outputs of the variator.



ref. *VAL-VAR*

COMPRISES

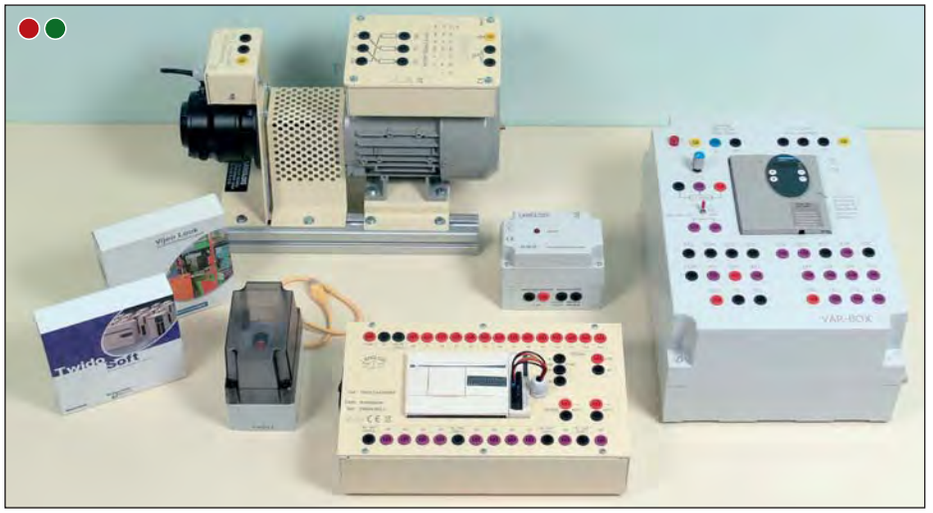
- 1 socket + switch unit module for linking to the mains 230V-50/60Hz.
- 1 main switch.
- 1 differential magneto-thermal circuit-breaker 16A-30mA.
- 1 motor circuit-breaker type GV2
- 1 speed controller for asynchronous machine ATV32 from Schneider® power 0.18kW. This speed controller can be programmed using controls on its front or from the offset programming graphic terminal. It can also be linked to a PC using the RJ45/USB lead or Bluetooth link if your PC is so equipped. All the control inputs and outputs of the speed controller are offset to the safety terminals:
  - 6 binary inputs
  - 1 analogue input -10…10VDC
  - 1 analogue input x…y mA
  - 1 Safety Input STO
  - 3 binary outputs
  - 1 analogue output 0…10V or 0…20mA
  - 1 logic output 30V/100mA
- 1 multifunction programming graphic terminal with large screen monochrome (8 lines) 240x160 pixels.
  This terminal is offset using RJ45 1-m lead (supplied).
- 1 three-phase asynchronous motor 0.12kW-230/400V-AC.
  The rotation of its shaft can be seen through a translucent safety window.
- 1 set of jumpers, a switch and a potentiometer enable immediate operation of the speed controller.

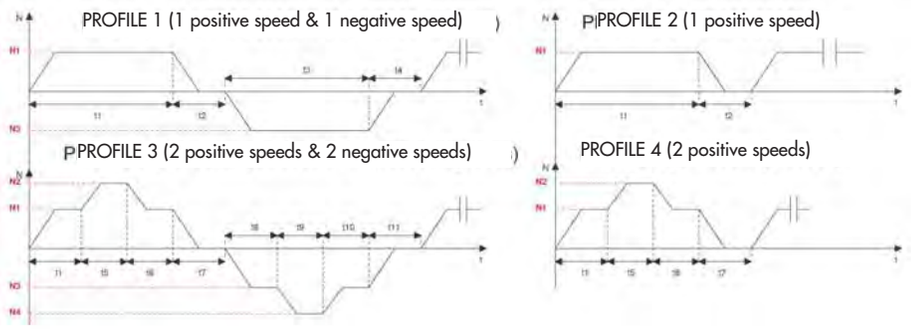
CASE SUPPLIED READY TO USE WITH

- 1 set of safety leads and jumpers.
- 1 programming graphic terminal
- 1 SoMove software (Schneider Electrique®) with RJ45/USB lead to link to PC
- 1 instruction manual, on CD, including the component data sheets and practical assignments for speed controller programming help.

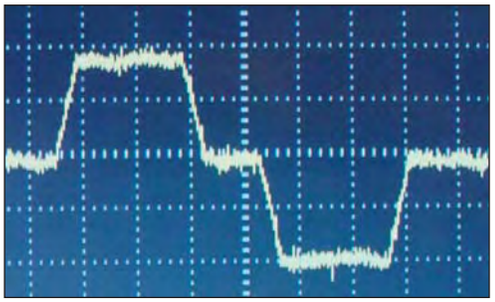
Closed case dimensions: 530 x 430 x 200mm
Open case dimensions: 860 x 430 x 160mm

Speed profiles simulation model

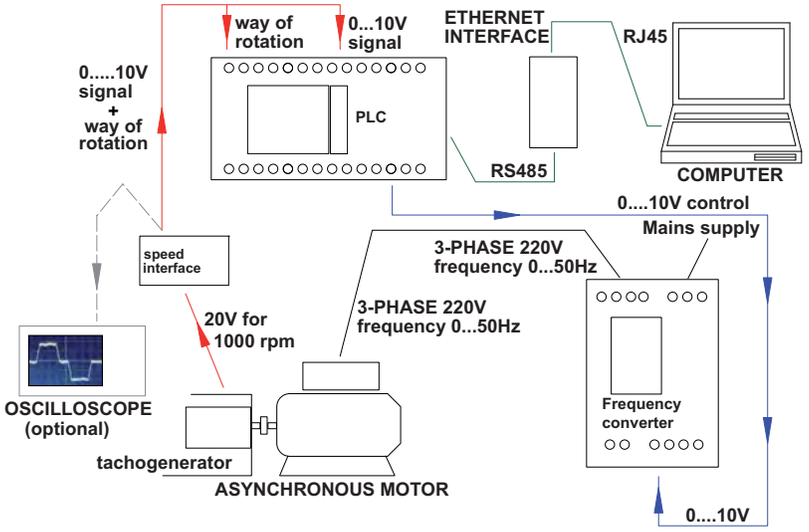




These 4 profiles are configured by way of the monitoring software. The PLC drives the speed controller. Diagrams of speed profiles are recorded on a digital storage oscilloscope.



Example of speed profile on a memory oscilloscope.
PROFILE N°1



PROFIVIS enables users to drive an electric motor based on 4 speed profiles which are commonly encountered in industry.

ref. PROFIVIS

SUPPLIED READY FOR OPERATION WITH THE TECHNICAL INSTRUCTIONS, THE PROGRAMMING SOFTWARE AND THE PLC PROGRAMS WHICH CORRESPOND TO THE VARIOUS TUTORIALS TO BE UNDERTAKEN. ALL OF THE COMPONENTS CAN BE SOLD SEPARATELY.
THE RECORDING OF THE SPEED PROFILE REQUIRES AN OSCILLOSCOPE WITH MEMORY

SPEED PROFILES TO STUDY

- Profile no. 1: goods lift
- Profile no. 2: driving a conveyer
- Profile no. 3: driving a fan
- Profile no. 4: driving a mixer

COMPONENT PARTS OF PROFIVIS

- **PLC:**
  - programming software
  - Monitoring software
  - 14 (24V DC) Inputs/10 Binary Outputs Max. 2A
  - 2 analogue inputs 0-10V/4-20mA
  - 1 analogue output 0-10V/4-20mA
  - Mains power supply by means of socket unit + switch
  - Dimensions: 330 x 200 x 80mm
- **Ethernet communication interface unit**
  - Used for connecting the PLC to a TCP/IP network
  - Dimensions: 100 x 80 x 90mm
- **Speed interface unit**
  - Speed input: 10V/20V/60V for 1000 RPM
  - 0-10V analogue speed output
  - Dry contact for ascertaining the motor's direction of rotation
  - Dimensions: 105 x 120 x 80mm
- **Speed variator (frequency converter)**
  - Max. Power: 1500W
  - For a full list of features, see ref. VAR-BOX Page 92
- **Asynchronous Motor**
  - Power: 300W
  - For a full list of features, see ref. MAS 10 Page 76
- **Tachometer generator**
  - 20V for 1000 RPM
  - For a full list of features, see ref. DYTA1 Page 78

GENERAL INFORMATION

- The PROFIVIS interconnections are made by means of 4mm safety leads.

- **Adjustments via the monitoring device**
  - 4 profile options available
  - 11 time delays
  - 4 rotation speeds

- **Controls via the monitoring device**
  - Cycle start - Cycle stop
  - Initialisation of settings

- **Monitoring display**
  - System ready
  - Forwards - Backwards
  - Motor speed
  - Reminder of selected profile
  - Reminder of frequency settings to reach
  - Speed controller fault

Programming systems (with USB connection)

LIGHTING CONTROL SYSTEM WITH PLC

ref. COFEC
THESE DIFFERENT EQUIPMENTS CAN BE SOLD SEPARATELY

This model is a room lighting unit comprising an electrical cabinet and a console fitted with low-voltage spotlights. Using a TCP/IP PLC and monitoring software, it is possible to control the model and view its operation on a computer.

OPERATING PART: ELECTRICAL CABINET + LIGHTING CONSOLE

- 1 32A rated 30mA residual current four-pole circuit breaker
- 2 double pole circuit breakers for protecting the 6 lighting circuits
- 6 double pole remote control switches.
- 1 double pole circuit breaker for protecting the PLC.
- 1 connection terminal block
- 6 24V LED lamps
- 6 push-buttons for manual lighting control
- 1 3m multiwire cable for connecting the lights to the electrical cabinet.

PLC

- with 10 relay outputs and 14 inputs, supplied with
- a cable for interconnection with the model
- programming software in English/French in ladder language.
- Dimensions: 170 x 130 x 130 mm. 220-240V AC

MONITORING

- Allows you to manage the lighting control model from a PC
- Offers the basic features of a graphical tool
- acquisition and display of PLC variables
- monitoring and control of lights (switching on, switching off and timer)
- The software's graphics editor supports many applications.

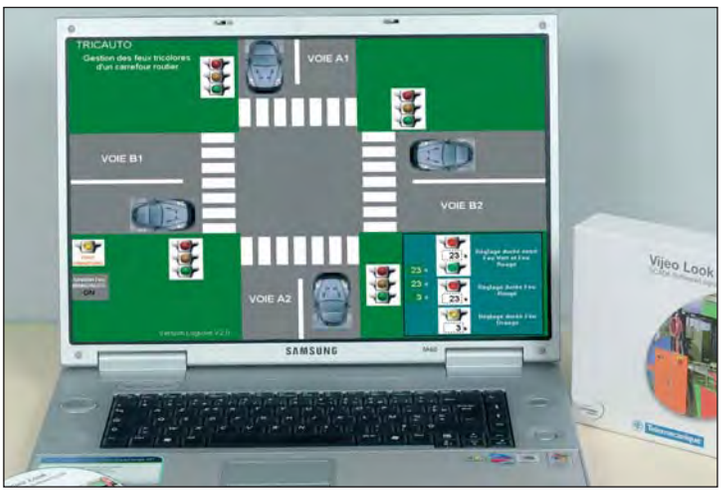
The user can modify the preloaded demo program or create a new one

FEATURES OF THE ASSEMBLY

- Powered by a 230V mains cable
- Metal industrial cabinet with a glazed door. Dims: 400 x 300 x 200 mm
- Lighting console: dim. 400 x 330 x 200mm
- The assembly is supplied already wired with a monitoring example and all mains leads necessary for proper operation

TRAFFIC LIGHTS WITH PLC

ref. TRICAUTO
THESE DIFFERENT EQUIPMENTS CAN BE SOLD SEPARATELY



This model simulates a crossroad equipped with 4 traffic lights. Using a TCP/IP PLC and monitoring software, it is possible to control the model and view its operation on a computer.

OPERATIVE PART

- 6 x traffic lights control INPUT by 24 VDC level
- 4 x car detection sensor OUTPUT by 24 VDC level (supplied by the PLC)
- 6 x traffic lights manual swith on/off
- Interconnection : DB25 plug
- Dimensions : 390 x 325 x 140 mm

PLC

- model : 9 output & 7 relay inputs, supplied with :
  - one interconnection wire plug link on the didactical model.
  - one programming software (english/french) based on "contact" language.
- Dimensions : 170 x 130 x 130 mm / 220-240 VAC

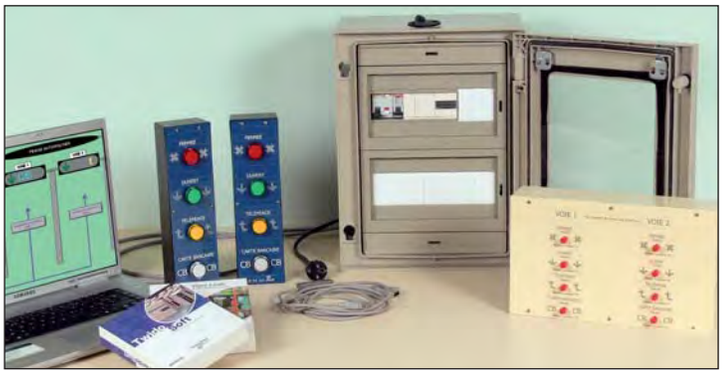
MONITORING

- Traffic lights system controlled from a computer
- Visual and intuitive display interface :
  - Acquisition of PLC parameters and visual control
  - Cars and traffic lights monitoring
  - Traffic lights control (switch on/off adjustement time, orange flashing)
- The software visual editor allowed to adapt the basic settings and to change software visual interface. Large possibility of use according to your particular teaching needs.

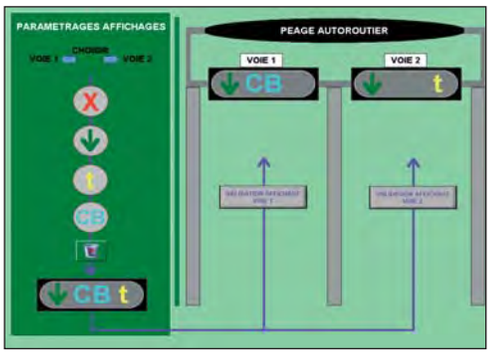
FEATURES OF THE ASSEMBLY

- Dim. 390 x 325 x 160mm
- The assembly is supplied already wired with a monitoring example and all mains leads necessary for proper operation

LIGHT SIGNS SYSTEM (FOR A MOTORWAY TOLL)



ref. AUTO-PEAG
THESE DIFFERENT EQUIPMENTS CAN BE SOLD SEPARATELY



Simulates a motorway toll. Comprises 1 electrical cabinet and 2 toll lane indication signs. Using a TCP/IP PLC and monitoring software, it is possible to control the model and view its operation on a computer : opening/closure of lanes, management of banker's card or telepayment (electronic road pricing (ERP)) payments, manual or automatic function with time-stamp on the PLC, etc.

ELECTRICAL CABINET
- 1 32A rated 30mA residual current four-pole circuit breaker
- 1 single-pole circuit breaker for protecting the PLC and sign
- 1 set of junction boxes

OPERATING PART, EACH CONSISTING OF
- 4 24V lamps (Open / Closed / Banker's card / Telepayment)
- 2 m of multiwire cable for connecting to the electrical cabinet.

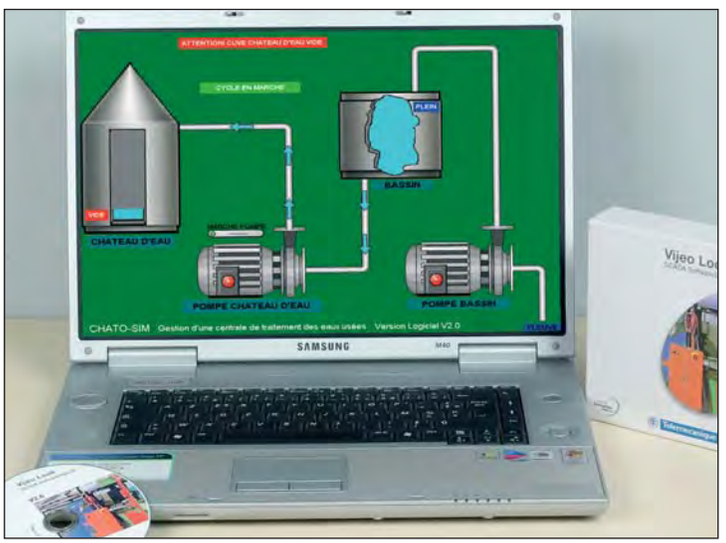
PLC
- with 10 relay outputs and 14 inputs, supplied with
- 1 TCP/IP interface for Ethernet connection
- 2 1.5m multiwire cables for interconnection with the model
- programming software in English/French in ladder language.
- Dimensions: 170 x 130 x 130 mm. 220-240VAC

MONITORING
- Multilingual programming software for managing the toll indication cabinet from a PC.
- Offers the basic features of a graphical tool
- acquisition and display of PLC variables
- monitoring and control of the toll lane (lane open, lane closed, payment by BC or telepayment)
- The software's graphics editor supports many applications. The user can modify the preloaded demo program or create a new one

FEATURES OF THE ASSEMBLY
- Powered by a 230V mains cable
- Metal industrial cabinet with a glazed door Dimensions: 400 x 300 x 200 mm
- Indication sign: 420 x 80 x 70 mm
- The unit is supplied already wired with an example of monitoring and all the linking cables which are required for its proper operation

PUMPING STATION

ref. CHATO-SIM
THESE DIFFERENT EQUIPMENTS CAN BE SOLD SEPARATELY



This model simulates a drinking water pumping station. Using a TCP/IP PLC and monitoring software, it is possible to control the model and view its operation on a computer.

OPERATING PART
- 3 push-buttons for On / Cycle Start / Cycle Stop
- 6 switches representing the water level sensors.
- 4 lamps representing the operation of the two pumps.

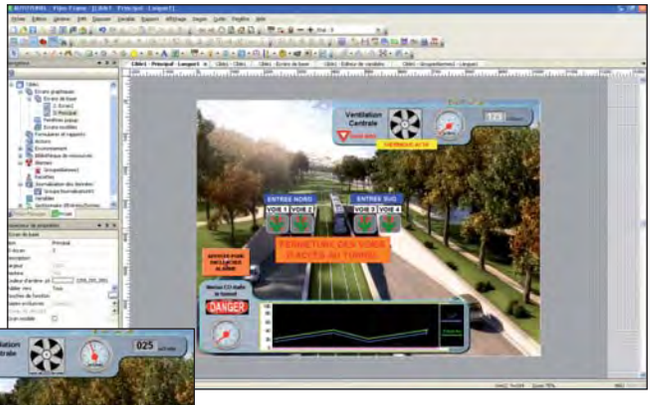
PLC
- with 7 relay outputs and 9 inputs, supplied with
- a TCP/IP interface for the Ethernet connection
- a 1.5m M/F DB25 cable for interconnection with the model.
- programming software in English/French in ladder language.
- Dimensions: 170 x 130 x 130 mm. 220-240V AC

MONITORING
- Multilingual software for controlling the lights using a PC
- Offers the basic features of a graphical tool
- acquisition and display of PLC variables
- monitoring and control of the station' operation (start-up and shutdown of the pumps and maintenance operations, etc.).)
- The software's graphics editor supports many applications.

The user can modify the preloaded demo program or create a new one

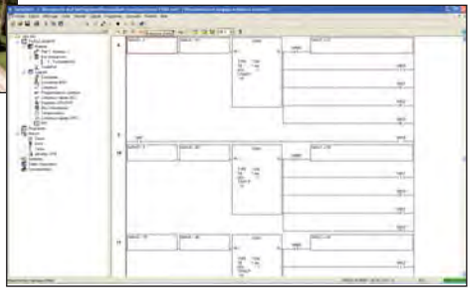
FEATURES OF THE ASSEMBLY
- Dimensions: 330 x 200 x 80mm
- The assembly is supplied already wired with a monitoring example and all mains leads necessary for proper operation

Ventilation control and tunnel access



Monitoring software program

Monitoring from a PC.



TWIDO PLC program

TA11 is a study system used to regulate the CO2 level in a motorway tunnel. It consists of a fan for air renewal and an electrical cabinet grouping the regulation system components. The cabinet and fan are placed on a wheeled frame and connected by a 5m cable.

ref. TA11

OPERATION

On the cabinet's door, a potentiometer simulates the CO2 level in the tunnel. Depending on the CO2 level, the PLC controls the fan's rotation speed and plans the access to the 4 traffic lanes represented by 8 indicator lights positioned above the cabinet. A stand-alone fire sensor indicates there is a fire in the tunnel An electronic buzzer warns that the CO2 level is too high. An anemometer fixed in the fan's air flow controls the rotation. This regulation system is PC monitored via the Schneider® software supplied.

THE MAIN CABINET COMPONENTS

- 1 TWIDO PLC
- 1 2.2kW speed controller
- 1 TWIDO analogue card controls the 4-20mA or 0-10V speed controller signal.
- 1 Ethernet card is used to connect the entire system to an IP computing network such as, for example, the establishment's network to monitor operations from a remote computing room.
- Controls on the front of the door:
  General Start/Stop button
  Emergency stop
  CO2 level potentiometer
  Auto/Manual
  Fan Start/Stop button
  Potentiometer for the fan air flow
  Warning buzzer if excessive CO2 level
  RJ45 connector for the PC link
  Electrical protective devices for users and equipment.

MONITORING FUNCTIONS ON THE PC SCREEN

Display on digital displays and by curves

- CO2 level and air flow in the tunnel
- number of open or closed traffic lanes
- presence of a fire in the tunnel
- controls access to each traffic lane
- regulates the fan air flow
- triggers the fire alarm
- select the Auto or Manual operating mode

Complete unit supplied ready for operation with monitoring.
The PLC is supplied as well as the monitoring program and wiring diagrams.
Are also supplied: The Teachers/Students tutorials on PLC programming, monitoring, the Ethernet network, analogue regulation.

FEATURES OF THE UNIT

- Wheeled frame 750x670mm
- Total height: 1870mm
- Powered by a 400V three-phase hypra socket
- 1000VA Fan, 96m³/min maximum flow rate, 400V 3-phase, Ø 400mm.

Air conditioning system

ref. CLIMABOX

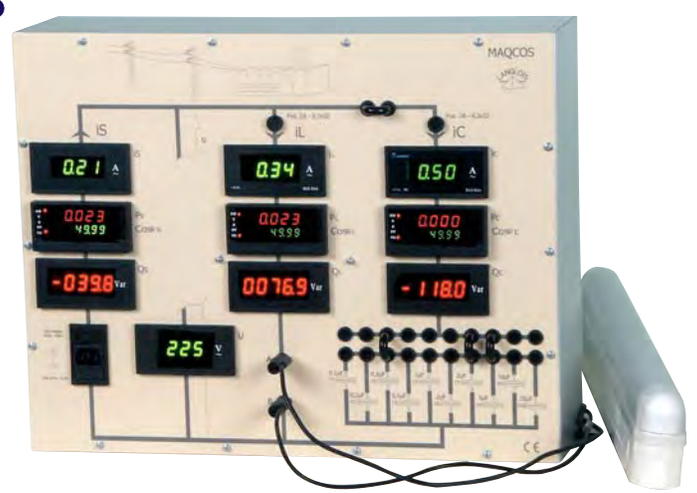
CLIMABOX is an air conditioned industrial electric board, often used in industry whenelectronic components need a steady temperature.With CLIMABOX, the student familiarize himself with functioning and settings of an air conditioned electric board. Completely wired.
Delivered with wiring diagrams and practical works.

MAIN COMPONENTS
- A complete air conditioning system
- An extractor fan
- Many heating resistors
- Two counters : start and time
- Four digital thermometers
- One alarm buzzer

TOPICS
- Stabilization of temperature by ventilation , by air conditioner, by ventilation and air conditioner.
- Sudden internal overheating
- Low external temperature (winter)
- Condensation troubles
- Bad sizing of the air conditioner system preventing stabilization of the temperature
- Setting points of temperature.

FEATURES OF THE BOARD:
230V/50Hz single-phase power supply
Dim : (L x W x H) 550 x 450 x 650 mm

Power factor correction system



ref. MAQCOS

DESCRIPTION
The MAQCOS model is designed for studying and rectifying power factors. It consists of three branches:
- source branch, S, representing the energy supplied by the electricity mains (Network)
- plant branch, L , symbolizing a plant's energy consumption
- plant branch, C, including the padding condensers (integrated in the model and connected using jumper wires)

Each branch is equipped with the same measuring instruments:
- ammeter
- wattmeter, measuring active energy
- Power factor meter, measuring the power factor
- varmeter, measuring reactive energy

Students are thus able to compare four electrical variables in the three branches at the same time. They will observe (surprisingly?) that the source current value in the mains network branch may be much lower than the value in the plant branches. That source reactive energy is close to zero when power factor is around 1, whereas plant reactive energy is at maximum value. The model shows the impact of a power factor regulator on the cost per kWh transmitted and the resulting electricity bill.
MAQCOS is supplied with a fluorescent tube and IPXX connection.

PROPOSED EXERCISES AND CORRECTIONS:
- Study an industrial lighting installation using the fluorescent tube
  Current in the branches - power in the mains with and without power factor compensation - active and reactive energy in the branches – Fresnel patterns.
- Study power factor for a single-phase motor idling and loaded, with and without compensation – power in the transmission line in different cases – Fresnel pattern
- Study of pure inductance in an operating plant to determine the capacitor bank required.
- Role of automatic compensation.
- Study resonance, max/min current

TECHNICAL SPECIFICATIONS
13 displays: 3 x A , 3 x W , 3 x power factor , 3 x VAR , 1 x V
10 condensers: 0.1µF - 41µF
Fuse protection
Dimensions: 510 x 400 x 150 mm - Weight 6.5kg

VARIABLE INDUCTANCE OPTION

ref. PSYJR

Students have to find out the pure resistances and inductances of an installation, without interrupting its operation and with a view to deciding on the compensation condenser battery to activate, via a power factor regulator.

Study of the 3rd and 5th order harmonics

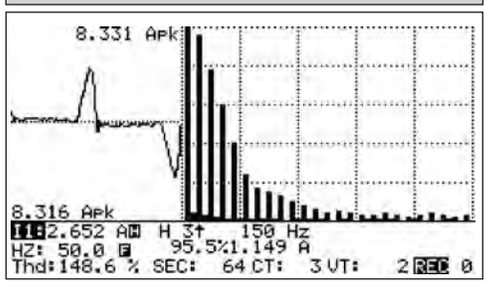
ref. HARMOVAR

Unit on wheels consisting of passive filters used for studying the filtering of the third and fifth order harmonics (and, as a result, the increase in the power factor) during the use of a speed controller for an AC motor or apparatus with a diode-thyristor bridge with a capacitor filter. HARMOVAR uses the industrial methods employed for decreasing the harmonic pollution generated by U/f-type frequency converters or other pollutant receivers with third or fifth order harmonic currents (inverter, switch mode power supply and discharge lamps). The passive filters found there have been specially sized for optimal use and so that the LC-type filtering systems can be studied. They eliminate third or fifth order harmonic currents and show the effect of the third order harmonic current on the neutral.

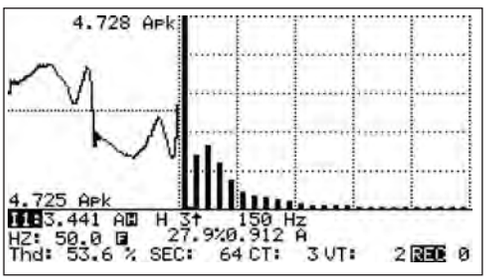
- The network analyser ref. 6830 (option on page 233) records the harmonic graph
- A switch on the front of the unit is used for activating or deactivating the H3 and H5 filters.
- Jumpers and double channel terminals are used for electrical measurements (current, voltage and power), not only on the network side but also on the receiver side and in each filter.

FEATURES

- Operation on 230V single-phase network or 230V/400V three-phase network
- Fitted with induction coils and capacitors which have been specially calculated for optimum filtering.
- Equipment sized under rated conditions for 1500W motor test bench controlled by frequency converter.
- Compatible with our frequency converters (pages 92-95)
- Supports the max. effective line current: 15A/H3 max: 10A/H5 max: 5A
- Wiring consisting of 4mm safety leads
- Supplied with instructions for use and tutorials
- Easy to move, thanks to its wheels
- Dimensions: 450 x 450mm Height: 530mm



H3 filter desactivated



H3 filter activated

Examples of line current measurements taken with our 6830 network analyser (Page 233), on HARMOVAR associated with our ACVAR5 frequency converter (Page 92)

Communicating circuit breaker/contactor

ref. CONTYS

CONTYS from mecatronics is a motor starter which combines mechanical, electrotechnical and electronic technologies. It is designed to be used for directly starting up motors of up to 3kW. This compact device combines power functions (disconnecting switch, commutation) and control functions (protection). Motor settings can be displayed and programmed via a numeric screen.

FEATURES

- protection against overloads and short-circuits.
- protection against undervoltages
- protection against isolation faults (equipment protection only)
- reset can be adjusted manually or automatically
- display of motor settings on the front or on the offset terminal:
  - electric current consumed per phase - adjustment of thermal circuit breaker
  - alarm for motor values (current, thermal status, etc.)

FRONT FACE

- 6 terminals for three-phase power contacts
- 2 terminals for the coil's 24V AC/DC power supply
- 2 terminals for an auxiliary NO contact
- 2 terminals for an auxiliary NC contact

ELECTRICAL FEATURES

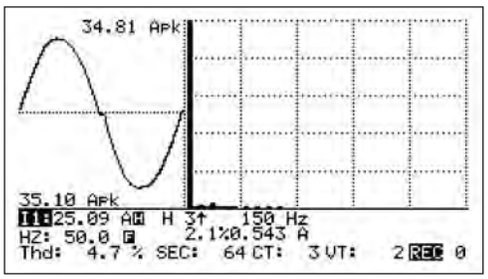
Compatible with 1-3kW motors

Three-phase contact	*Coil*	*Auxiliary contact*
- 600V max.	- supply voltage 24V DC/AC	- 400V max.
- 12A max.		- 10A max

Power quality control

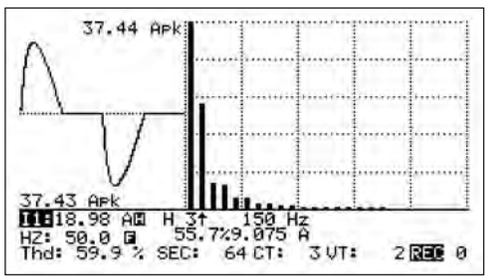
Internal view of the cabinet

ref. HARMO-35

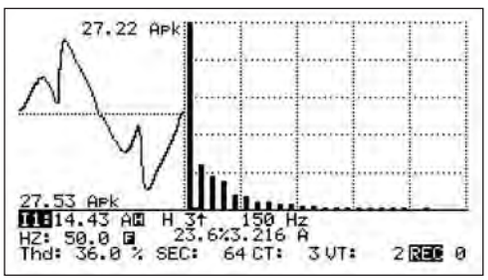


Lighting supplied 100% (no harmonics)

MEASUREMENTS TAKEN IN MANUAL MODE WITH ONE NETWORK ANALYSER REF.: 6830 OPTIONAL SEE PAGE 233



Lighting supplied 50% (high third order harmonic)



Lighting supplied 50% with passive filter (reduction of the third order harmonic)

OPTION

NETWORK ANALYSER SEE PAGE 233

HARMO35 can be used for studying and improving the quality of the power consumption of an industrial lighting system for advertising.
Four 500W halogen lamps on a tripod are powered by a SCR power regulator which creates harmonic pollution and reactive power degrading the power factor.
A passive filter with an LC circuit is used for:

- minimising the third order harmonic pollution
- measuring the power factor by decreasing the reactive power
- observing the resonance phenomenon.

It is also possible to study the operation of the phase-shift of the SCR regulator.

Principle : the industrial lighting of the panel – simulated by the four halogen lamps on a tripod – varies depending on the ambient sunlight, simulated by one low-voltage spotlight placed in the cabinet. When the current in the halogen lamps is significantly degraded, the filtering components are activated, either manually via the switches on the front or automatically by a PLC.
Auto mode: 3 sunlight levels are programmed. For weak sunlight the 3rd order current harmonic is high. The PLC activates a passive filter which tends to decrease this harmonic.
Manual Mode: a potentiometer is used for continually adjusting the sunlight level. Varying it makes it possible to:

- VIEW, with the help of the network analyser (ref. 6830), the effect of the dimmer on the level of the current harmonics;
- MEASURE THE power factor by inserting a capacitor induction coil. The network analyser reveals that the solution can be found in the induction coil.
- FILTER HARMONIC 3 by using a resonant filter which will reduce noticeably its current.

THE FRONT FACE COMPRISES

- Safety terminals for the measurements
- voltages and currents supplied by the network
- voltages and currents in the halogen lamps
- voltages and currents in the filter components
- Switches for activating or deactivating the filter components
- An Automatic/Manual mode switch
- A lighting potentiometer

OTHER FEATURES:

- Light column indicating that the mains power is on
- PLC Software, tutorial and instructions for use are supplied.
- Power supply: 220V 50Hz
- Cabinet: 820 x 400mm Height: 930mm
- Base with wheels, with laminated bench-top: 1200 x 750 x 970mm
- Overall dimensions: 1200 x 750mm Height: 1900mm

Study of the role of the earth & a differential circuit-breaker

NEW

ref. SELDIF

SELDIF is a model intended to make students aware of the hazards of electrocution in the event of indirect contact, and those related to the quality of the earth. This model also explains the role of the residual current circuit-breaker 30mA in a domestic installation.

The front synoptic shows
- the public network, with its medium voltage/low voltage transformer substation, and the neutral to earth connection, in this substation.
- the transmission line from the transformer substation to the dwelling
- the domestic installation, with the residual current circuit-breaker 30mA, the local earth, and a washing machine. The TT neutral system is the same as that of a domestic installation
- A person in the right-hand part has an LED for a heart. If a dangerous leakage current flows here, the LED comes on
- A two-pole industrial residual current circuit-breaker 30mA is located in the centre of the synoptic.
- Two jumpers enable the washing machine to be fully isolated, and current measurements to be taken.
- An ON pushbutton starts the washing machine, and a green LED comes on, symbolizing rotation of the machine.

Safety terminals 4mm, located on the front, let the student measure the fault currents, and insert different resistive modules. These modules simulate two earth resistance values, and two leakage current values. One module with variable resistance enables the differential's tripping current to be measured.

To prevent any risk of electrocution to the student, the model operates at extra low voltage using an isolating transformer to standard NFEN60-742.

THEORETICAL SUMMARIES: DOCUMENTATION SUPPLIED
Operation of a magneto-thermal circuit-breaker
rating, breaking capacity, tripping curve, symbols
Operation of a residual current circuit-breaker
rating, tripping time, symbols
Physiological effects of the current
hazard zones: current function times, dangerous voltages
Maximum resistance of the earth

LIST OF PRACTICAL ASSIGNMENTS
Earth < 100Ω and fault resistance with poor isolation
- with person in contact with the metal enclosure of the machine
- with no contact

Appearance of a fault current greater than 30mA, tripping of the differential.
Demonstration of the short circuit

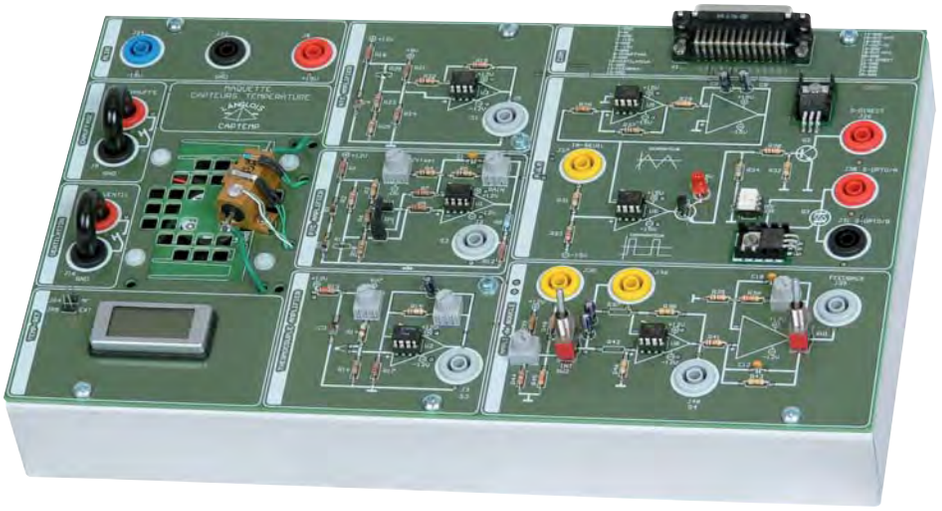
Earth < 100Ω and fault resistance with good isolation
Appearance of a fault current less than 30mA, no tripping of the differential.
Measurement of the fault current in the person in contact with the machine

Earth > 100Ω and fault resistance with good isolation
Appearance of a fault current less than 30mA, no tripping of the differential.
Measurement of the fault current in the person in contact with the machine

Earth > 100Ω and fault resistance with poor isolation
- with person not in contact with the metal enclosure of the machine measurement of the fault current
- with person in contact with the enclosure: measurement of the fault current greater than 30mA, no tripping of the differential. LED symbolizing the heart, coming on.

OTHER TECHNICAL CHARACTERISTICS
Power supply: 230VAC 50Hz - Dimensions/Weight: 390x270x100mm / 2.3kg
Supplied with 5 resistive modules, coupling jumpers and leads

Temperature sensors and heating control



ref. CAPTEMP

This model includes 3 temperature sensors: NTC thermistor – J thermocouple – PT100 platinum probe. These sensors are attached to a resistance or cooled by a built-in fan. The resistance and fan are controlled separately by short circuiting two terminals. The screen-printed front panel shows actual cabling of electronic circuits such as amplifiers and automated temperature control…. All the components are surface-mounted to facilitate signal capture.
Each of the three analog sensors is connected to an amplifier to suit its voltage, impedance, and linearity. The output levels of the three amplifiers are all calibrated at 10mV/°C to facilitate comparisons of accuracy and thermal inertia.
Two temperature control systems may be studied: all or nothing heating by hysteresis circuit or proportional heating with a variable gain automatic control loop. The heating " power " circuit is either powered by transistor-controlled direct current or by Triac-controlled 15VAC alternating current. A digital thermometer provides a continuous readout of heating element temperature.

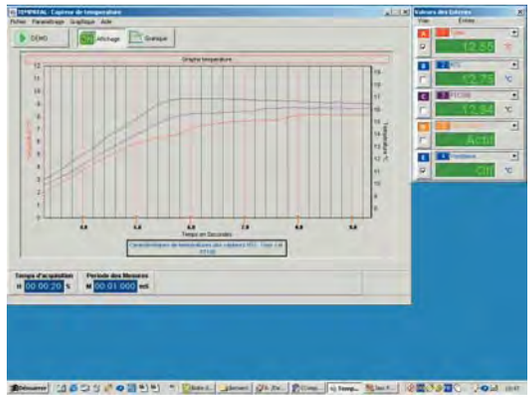
OPERATIONS DESCRIBED IN THE INSTRUCTIONS

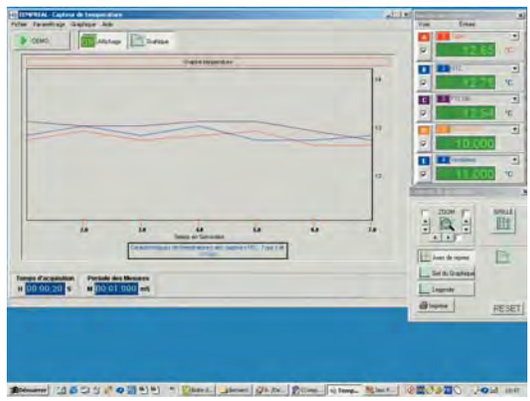
- Calibration of PT100, CTN, and J probes
- Comparison of the linearity and response times of the three sensors.
- Study of 'all or nothing' control with continuous and intermittent heating, including the impact of an air outlet on the sensors.
- Study of closed-loop control and impact of loop gain.

CHARACTERISTICS

- +15V / -15V DC power supply
- Equipped with a DB25 male plug to connect to the PC interface.
- Dimensions : 330 x 200 x 50mm
- Weight : 1kg

DATA ACQUISITION SOFTWARE (OPTION)





ref. LOG-CAPTEMP

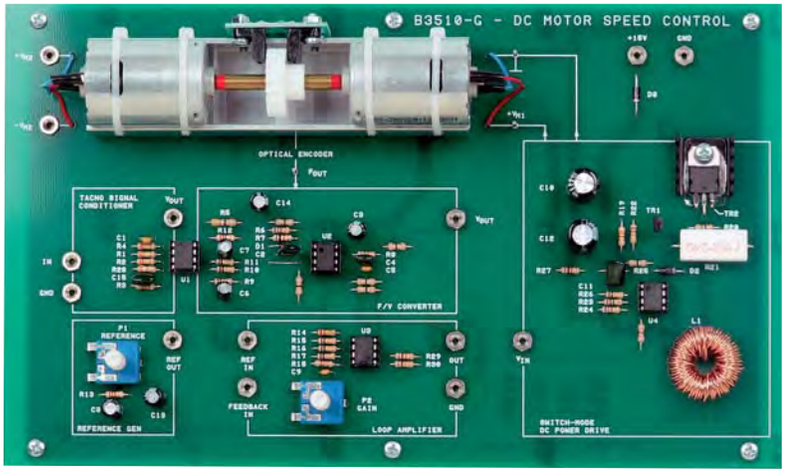
This option consists of an interface unit, a connecting cable, and software.
This software records the temperature readouts for the PT100, NTC, and J sensors on the SENSOR model and displays them on the computer screen. Characteristics such as the "all or nothing" setting for heating and fan power supply may also be displayed on the screen.

CHARACTERISTICS

- On-screen temperature display for the 3 sensors.
- On-screen display of the fan and heating control signal characteristics.
- Configurable acquisition time.
- Zoom function.
- Cursor function x and y axes configurable
- (Scale, notation, Max and Min values)
- Curve and background colours configurable.
- Print characteristics after page layout configuration.
- Acquisition data recovery in spreadsheet form

SOFTWARE AVAILABLE IN ENGLISH AND IN FRENCH

Speed feedback



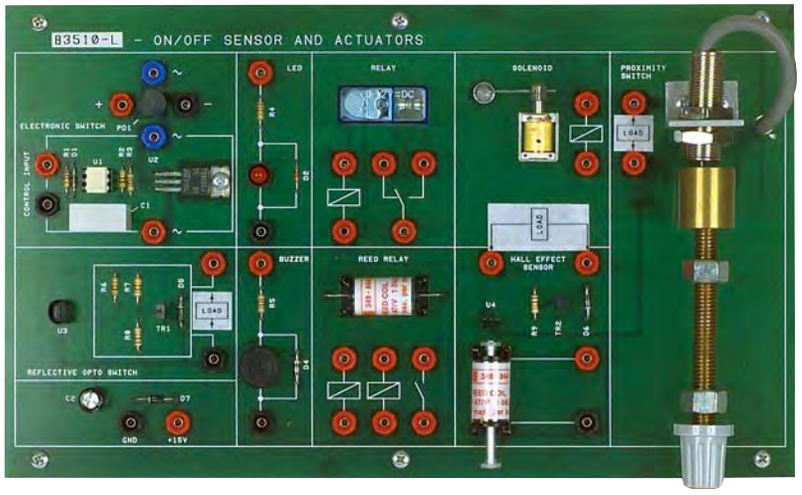
This model is designed for the simplified study of a speed feedback on a closed loop, with a feedback signal generated either by a tachometric dynamo, or by an optical impulsion encoder. It consists of a direct current motor which drives a second direct current motor, functioning as a generator. The signal issuing from this generator is used as an image of the speed. The shaft assembly also drives a toothed disc, which cuts a luminous barrier, the impulses of which are applied to a frequency voltage converter. A direct current adjustable source integrated in the model is used as the voltage reference level. A switching supply controlled by the error voltage supply the motor.

ACCESSORIES SUPPLIED
1 set of leads Ø2mm : 2 x 100cm / 2 x 30cm / 2 x 15cm

ref. B3510-G

Dim. : 250 x 150 x 30mm. Poids : 900g.

All or nothing sensors and actuators



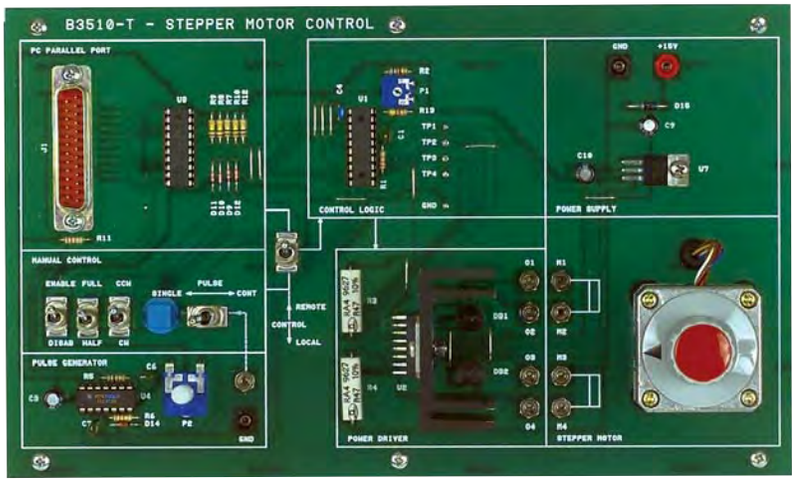
This model includes sensors currently used in industry:
- an optoelectro-reflection barrier, with its output amplifier
- a Hall effect sensor with its output amplifier
- an inductive proximity sensor with its output amplifier
- facing a metallic mass which the operator progressively displaces using a worm screw.

The model also includes:
- an electronic switch consisting of a triac and its electronic control
- a dry relay and a reed relay with two coils
- two solenoids
- one facing the Hall sensor
- a visual LED display and a piezoceramic type buzzer with integral micro-oscillator.

ref. B3510-L

Dim. : 250 x 150 x 30mm. Poids : 900g.

Stepping motor



Includes a stepping motor with 2 separate coils, the motor driver and the specialised logic test circuit. The latter can be accessed either by a PC via a 25 pin parallel port, or by a manual control logic system integrated.
This logic comprises a controled impulse generator by push button for the step by step lead and a variable frequency generator for the continuous working.

ACCESSORIES SUPPLIED
1 set of leads Ø2mm : 2 x 100cm / 4 x 30cm / 3 x 15cm
1 lead DB25 SERIE
1 software on CD

ref. B3510-T

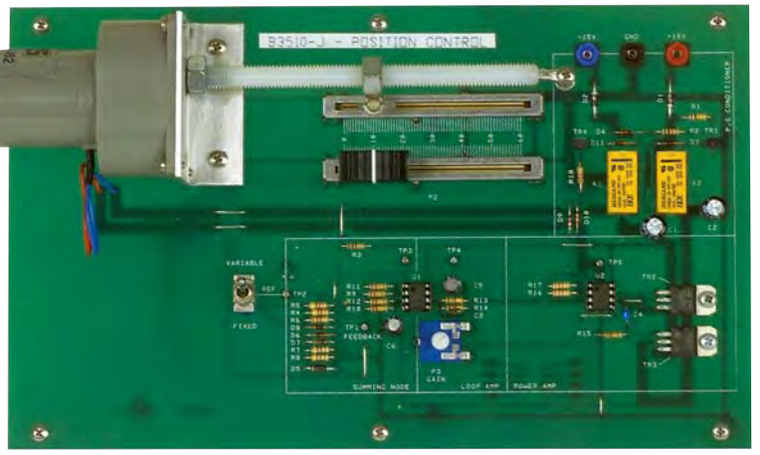
Dim. : 250 x 150 x 30mm. Poids : 900g.

SOFTWARE SUPPLIED

Position feedback

PRACTICAL WORK DESCRIBED IN THE USER'S MANUAL

- Study of the luminous barrier/frequency voltage converter.
- Study of the tachometric filter.
- Study of the loop amplifier and of the controlled switching power supply.
- Comparison of tachometric voltages and optical encoder + converter.
- Comparison of low rotation frequencies with and without feedback loop.
- Study of the feedback response for different values of loop gain.



ref. B3510-J

This model is designed for the simplified study of a closed position feedback loop. It is composed of a direct current motor, the rotation of which drives a worm-screw. The screw cursor is integrally attached to a copying potentiometer which supplies an electrical image of its position. The potentiometer operated manually determines the basic position.

TUTORIALS DESCRIBED IN THE INSTRUCTIONS

- Study of the principle of a closed feedback loop: error voltage, pre-amplification, driver stage, push-pull.
- Study of limitation of movements circuits.
- Anti-jamming system.
- Study of the feedback response to a voltage step for different values of loop gain.

ACCESSORIES SUPPLIED

1 set of leads Ø2mm : 3 x 100cm / 2 x 30cm

Incremental & absolute encoder

PRACTICAL WORK DESCRIBED IN THE USER'S MANUAL

- Description of the different components and their usage.
- Functioning of the amplifiers.
- Measurement of the detection distance of the inductive sensor.
- Analysis of the electronic switch, controlled by direct or alternating current.
- Study of a line consisting of an optoelectro-barrier, a switch and a solenoid.
- Possibility of making other lines: optoelectro-barrier - reed relay - Hall sensor - electronic switch - buzzer

ACCESSORIES SUPPLIED

1 set of leads Ø2mm :
2 x 100cm / 2 x 50cm / 3 x 30cm / 3 x 15cm

ref. B3510-R

This model illustrates how an incremental encoder and an absolute encoder work. They work in exactly the same way as commercial encoders. However, since resolution is not important in our application, the number of sensors is limited to 5. The model has two interchangeable encoder discs, with the sectors representing DCB encoding and Gray encoding.
When the operator turns the disc by hand, the phototransistors underneath send their signals to the decoding logic and the display (4 line x 20 character LCD screen) and to 4mm-diameter terminals, in order to control all of the control or decoding logics performed by the operator. The sensitivity of the phototransistors can be adjusted depending on the ambient light.

PRACTICAL WORK DESCRIBED IN THE USER'S MANUAL

- Study of the principle of a stepping motor and its different ways of functioning by step and half-step.
- Vibrations seen at low frequency, loss of steps at high frequency.
- Determination of the take-in resonance frequency and of the rotation limit frequency
- Observation of signals delivered by the driver to the motor windings.
- Inversion of currents in the motor coils.
- Observation of 4 signals applied by the control logic to the driver out of phase with one another.

PRACTICAL WORK WITH COMPUTER

A program in basic and working in DOS is supplied. This completely listed program can be freely copied and if necessary modified by the user. In particular, it allows control of the speed and direction of rotation.

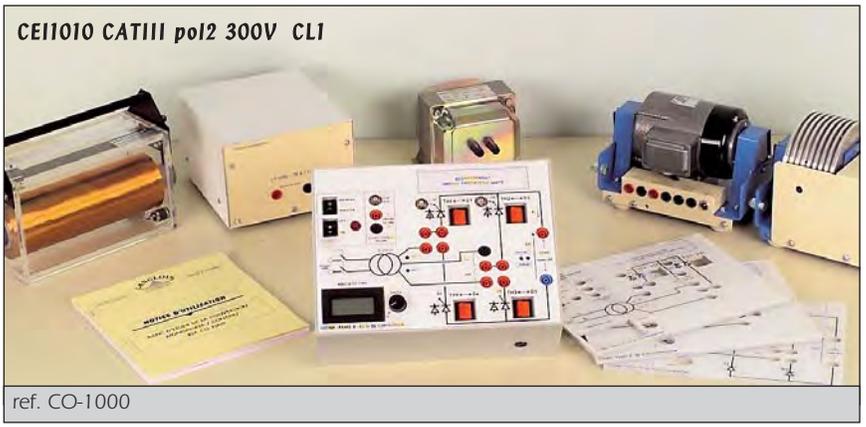
TUTORIALS DESCRIBED IN THE INSTRUCTIONS

- 3-BIT ABSOLUTE DCB ENCODER correspondence between the position of the disc, the status of the sensors and the display. Transition codes and synchronisation sensor.
- INCREMENTAL DCB ENCODER use of the encoder in counter and count-down mode. Detection of the direction of rotation, improvement of accuracy using an angle sensor.
- 4 BIT GRAY ENCODER GRAY/DCB code comparison. A synchro. sensor is required.

Conversion test benches

RECTIFIER

SINGLE-PHASE / DIRECT CURRENT CONVERSION TEST BENCH
CO-1000 IS SUPPLIED WITH 4 MOVEABLE FRONT PANELS, INSTRUCTION BOOK INCLUDED TUTORIALS



ref. CO-1000

ACCESSORIES FOR CO-1000

Ref. ECO1/2 10Ω	Rheostat ECO1/2 10Ω (P.104)
Ref. SH90/24	Motor **90W** (P.62)
Ref. FR90	Powder brake FR90 (P.63)
Ref. PSYJR	Variable coil (P.110)
Ref. CO-104	Smoothing coil 40mH - 3A advised option
Ref. CO-105	Smoothing coil 20mH - 3A
Ref. CO-108	Smoothing coil 60mH - 3A
Ref. CO-106	12V/24V Battery

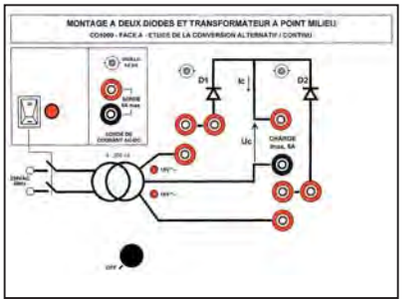
All types of practical tests on the rectification of controlled and uncontrolled single-phase current can be carried out with this single box, which comprises built-in supplies (including a power supply), a probe for measuring the AC+DC current output, an ignition angle display, and four switches to change from the diode assembly to the rectifier assembly.
The test bench is supplied with four movable front panels. Each one is a specific mask, with holes for the indicator lights, input/output terminals, and switches required for a particular set of tests. Each panel is printed with the instructions for just those tests.
None of the components are directly accessible to avoid short circuits. Rectifiers and diodes are specially mounted to facilitate maintenance and are visible behind a movable, transparent cover.
The 30V x 6A output is capable of running a powerful motor (electrical power: 150W, mechanical power: 90W) connected to a brake, making it possible to observe the influence of braking on the conduction angle.
The instruction book supplied with the test bench explains the tests listed below for each front panel.

RECTIFIER CONTROL
The ignition angle is controlled by a potentiometer and displayed.
The control pulses, applied to the trigger through separation pulse transformers, are output via BNC to the oscilloscope.

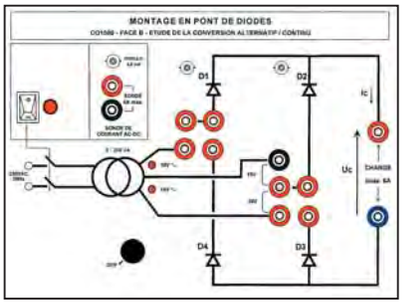
CURRENT PROBE
This probe consists of a Hall-effect sensor and is connected in series, like an ammeter. The current image is a voltage of 0.5 V/A available via BNC .

INDICATOR LIGHTS
LEDs indicate which rectifiers and diodes have been selected, which transformer windings are connected to the power supply, and the rectifier / inverter mode.

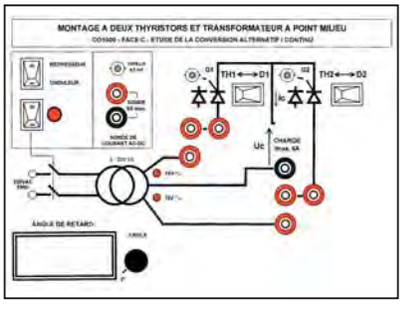
BUILT IN 200VA POWER SUPPLY
2 mid-point reactors: 2 x 15 Vrms
Power supply: 220VAC 50Hz 250VA
Dimensions: 670x370x170mm. Weight: 3.8kg



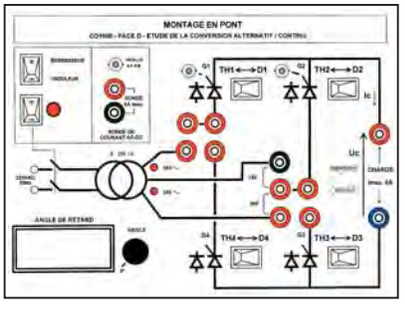
PANEL A: ASSEMBLY WITH TWO DIODES AND MID-POINT TRANSFORMER
Return to single half-wave rectification and switching to double half-wave rectification by simply adding jumper straps.
Experiment 1 Power flow on resistive load (R)
Experiment 2 Power flow on inductive load (R,L)



PANEL B: DIODE BRIDGE CIRCUIT ASSEMBLY
Experiment 1 Power flow on resistive load (R)
Experiment 2 Power flow on inductive load (R,L)
Experiment 3 Power flow on active load (E,R)
Experiment 4 Power flow on active inductive load (E,R,L)
Experiment 5 Application to a DC motor power supply
Any of these 4 diodes can be replaced by a rectifier at any time, simply by throwing the appropriate switch. This facilitates comparisons between all-diode, all-rectifier, symmetrical mixed, and asymmetrical mixed assemblies.



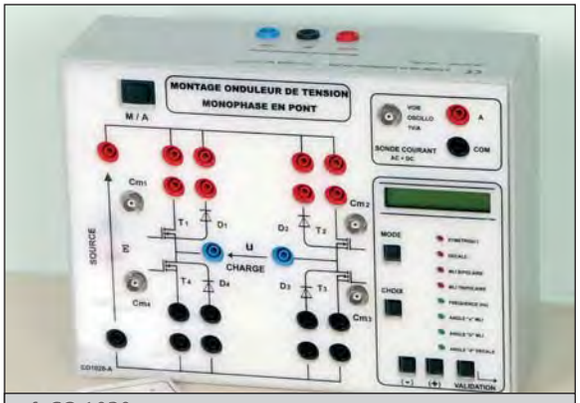
PANEL C: ASSEMBLY WITH TWO RECTIFIERS AND MID-POINT TRANSFORMER
Controlled single- and double-wave rectification.
The tests on panel A may be used again for comparison.



PANEL D: BRIDGE CIRCUIT ASSEMBLY (ALL RECTIFIERS OR MIXED)
Comparative studies of diode / rectifier / mixed assemblies
Experiment 1 Power flow on active inductive load (E, R, L)
Operates as a static convertor
Operates as a grid-interactive inverter
Experiment 2 Application to a DC motor power supply (DCM)
Mixed bridge-circuit ssembly
Experiment 3 Power flow on active inductive load (E, R, L)
Experiment 4 Application to a DC motor power supply (DCM)

INVERTER

SINGLE-PHASE CONTINUOUS/ALTERNATING CURRENT CONVERSION TEST BENCH
CO-1000 IS SUPPLIED WITH 2 MOVEABLE FRONT PANELS, INSTRUCTION BOOK INCLUDED TUTORIALS



ref. CO-1020

ACCESSORIES FOR CO-1020

Ref. ECO1/2 10Ω	Rheostat ECO1/2 10Ω (P.104)
Ref. ECO1/2 15Ω	Rheostat ECO1/2 15Ω (P.104)
Ref. ECO1/2 22Ω	Rheostat ECO1/2 22Ω (P.104)
Ref. ECO1/2 33Ω	Rheostat ECO1/2 33Ω (P.104)
for an optimal use, low resistance loads are better	
Ref. PSYJR	Variable coil (P.110)
Ref. CO-106	12V/24V Battery
Ref. CO-107	Single-phase transformer 12V - 230V with its lamp 230V - 40W
Ref. CO-109	load made up of a 40W machine with 12V/230V transformer

This bench is suitable for all types of tests on independent, single-phase static voltage converters. It has 2 detachable front panels, with holes forming a mask that reveals the layout diagram for the specific type of test to be carried out. The choice of layout (consisting of MOS power transistors) is thus determined by the front panel slotted into the casing:

PANEL A: "Single-phase, static, half-bridge voltage converter (two switches)"

PANEL B: "Single-phase, static, bridge voltage converter (four switches)"

The system includes a control panel offering the following options: (SYMMETRICAL, OFFSET, BIPOLAR PWM, and THREE-POLE PWM), a display (frequency and offset angles), indicator lights (control mode selection and adjustment parameters), and an AC+DC current probe for measuring and displaying all the current in the layout. It runs both on batteries and the laboratory continuous power supply and has reinforced safety systems (for reversed polarity and shutdown of unused transistors). The output (IMAX = 3A) is sufficient to run a motor of significant power and, in particular, to study the U/F control.

TRANSISTOR CONTROL PANEL:

This flexible, easy-to-use control panel is entirely managed by micro-controller and is capable of all variable frequency controls.

CONTROL MODE

The control mode is selected by pressing the "MODE" key:

- SYMMETRICAL
- OFFSET
- BIPOLAR PWM
- THREE-POLE PWM

A LED indicates which mode has been selected.

SELECTING ADJUSTMENT PARAMETERS:

Adjustment parameters are selected by pressing the "SELECT" key:

- FREQUENCY (Hz)
- OFFSET ANGLE
- 1st ANGLE "a" IN PWM
- 2nd ANGLE "b" IN PWM

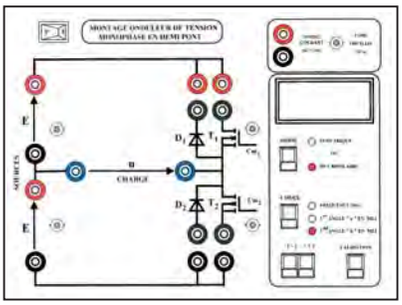
A LED indicates which parameter has been selected.

In PWM mode, the signal pattern is determined by the size of the angle (a, b) selected (which amounts to setting the pulse width).

Depending on the values of these angles, it is possible to eliminate the 3rd- and 5th-rank harmonics to obtain a spectrum with fewer harmonics, closer to the sinusoid curve.

CURRENT PROBE

This probe measures AC, DC, and AC + DC current and is connected in series, like an ammeter, in the circuit to be measured. A BNC terminal displays an image of the current intensity at a voltage of 1 V/A.



PANEL: A "SINGLE-PHASE, STATIC, HALF-BRIDGE VOLTAGE CONVERTER (TWO SWITCHES)"

The diode and power transistor operate by cross-barring

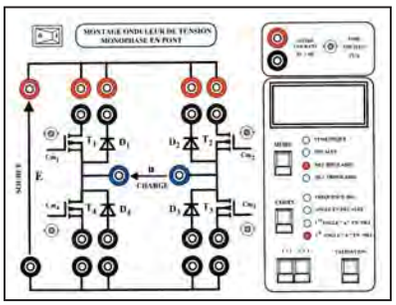
Presentation of symmetrical control

Presentation of the Pulse-Width Modulation control: Bipolar PWM wave

Experiment N°1: Throughput over resistive load (R)

Experiment N°2: Throughput over inductive load (R, L)

Experiment N°3: Throughput over resonant load (R, L, C)



PANEL B "SINGLE-PHASE, STATIC, BRIDGE VOLTAGE CONVERTER (FOUR SWITCHES)"

Presentation of offset control

Presentation of the Pulse-Width Modulation control: Three-pole PWM wave

Experiment N°1: Throughput over resistive load (R)

Experiment N°2: Throughput over inductive load (R, L)

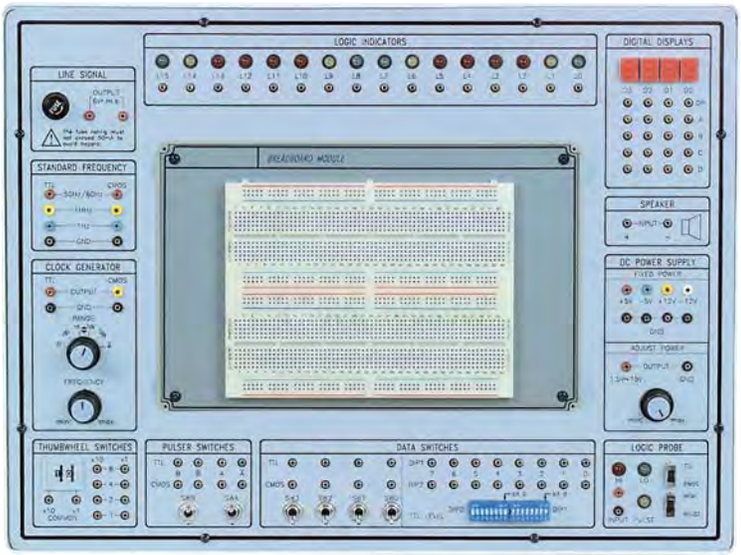
Experiment N°3: Throughput over resonant load (R, L, C)
Application to induction heating

Experiment N°4: Application to speed variations in an alternating current motor

Experiment N°5: Application to a backup power supply
Using the "C0-1000 alternating/continuous current converter" test bench as a charger.

Digital logic lab

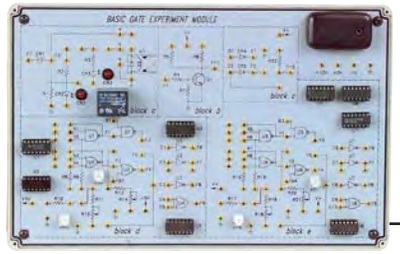
Digital logic lab equipped with a main unit and 13 experiment modules. Each module permits to realize several practical works. Supplied with leads and user's manual.

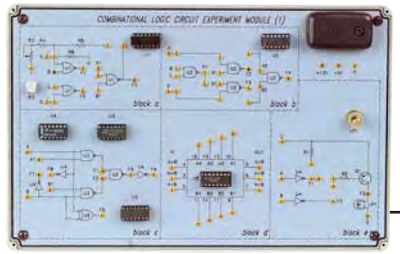


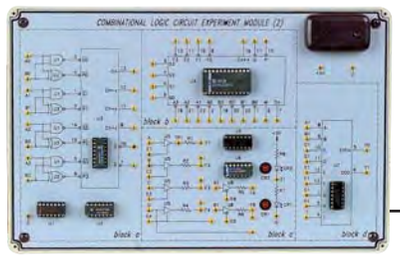
ref. PSY3101

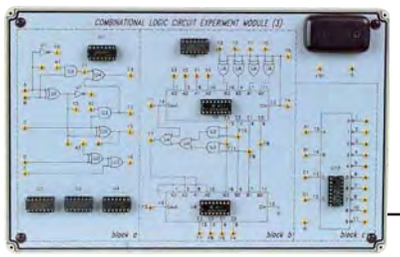
PSY3101 MAIN UNIT WITH:
4 fixed DC supplies with output overload protection
+5V -5V +12V -12V / 300mA on each output.
1 adjustable DC power supply with output overload protection:
from 1.5 to 15V / 500mA
3 fixed frequencies: 1Hz, 50Hz, 1MHz 0.01%, fanout : 10 TTL load
1 variable signal generator
6 ranges from Hz to 1MHz - Fanout: 10 TTL or CMOS load.
2 x 8 outputs, edge 0 ⌐ TTL level
4 outputs: edge 0 ⌐ TTL or CMOS level each with debounce circuit
1 fixed AC output - 6Vrms with overload protection
Thumbwheel switch, 2 digit, BCD code output, common point input.
16 x LED indicating high and low logic state
4 sets of independent 7-segment LED display, with BCD.
3 x LED functioning as a logic probe.
1 speaker with driver circuit.
Dimensions : 400 x 300 x 130 mm. Weight : 5.8kg

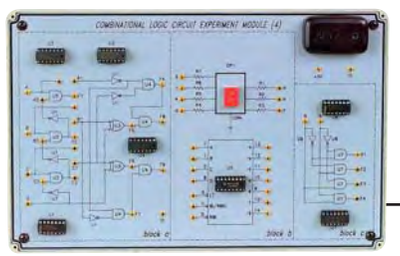
ACCESSORIES SUPPLIED
- 1680 tie-point breadboard which can be easily put into and taken off (permutable with the modules).
- jumpers, leads

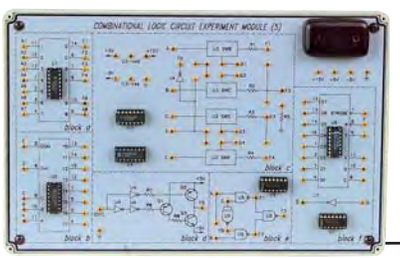


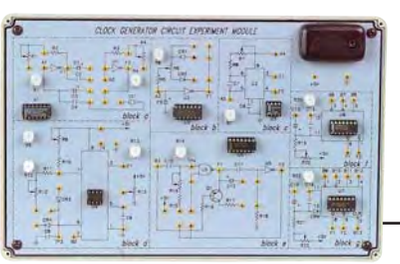












13 EXPERIMENT MODULES.
Designed with a 215 x 165 x 30mm solid body plastic housing, with electrical wiring printed on the front panel. An 8-bit DIP switch, located on the right top corner allows the user to simulate faults. Solution for faults are listed in the experiment manual for user's reference. Comprehensive experiment and instructor's manual are supplied with modules and contains theoretical drawings, wiring drawings. The experiment part has input signals, location of test points, tables to be filled up, comments and exercises.

Logic gates circuits, transistors, TTL and CMOS logic circuits. TTL/CMOS I/O voltage and current measurement experiments. Basic logic gate transmission delay measurement. AND, OR, NAND, NOR, XOR gate characteristics. Interface between TTL/CMOS and CMOS/TTL.

ref. DIGITAL1

NOR NAND XOR gate circuits, reverser, comparator circuit experiments, Schmitt trigger, open collector gate circuits.

ref. DIGITAL2

Three-state gate circuit. Adder.
Arithmetic logic unit.
Bit parity generator.

ref. DIGITAL3

Adder. Subtractor. 2 and 3 inputs reverser.
BCD code adder circuit.
Bit parity generator with XOR gate.
10 to 4 bit decoder with TTL IC.

ref. DIGITAL4

4 to 2 bit encoder. 4 to 2 bit decoder.
Decoder circuit experiments
(decoding 7-segment display with BCD code).

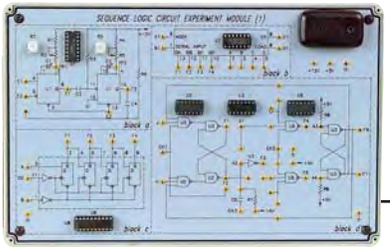
ref. DIGITAL5

10 to 4 bit encoder.
Multiplexer circuit experiments.
Digitally controlled analog
Multiplexer/demultiplexer circuits.
Bi-directional transmission with CMOS IC.

ref. DIGITAL6

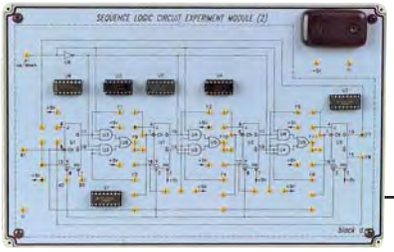
Oscillator circuit with basic logic gates, with Schmitt trigger. Voltage controlled oscillator circuit, with 555 trigger. Monostable multivibrator and synchronous astable multivibrator.

ref. DIGITAL7



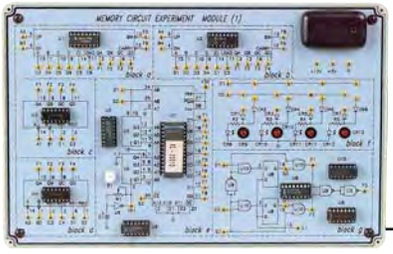
Variable duty ratio oscillator. RS, T, D, JK flip flop. Preset left/right shift register circuit.
Noise elimination circuit.

ref. DIGITAL8



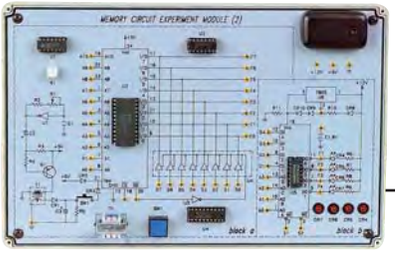
JK flip flop: asynchronous/synchronous, binaries up/down bi-directional counters.
Ring counter circuit, Johnson's counter circuit.

ref. DIGITAL9



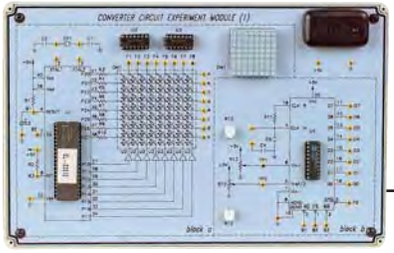
JK flip flop: asynchronous counter:
decimal, divide by N, preset synchronous binary/decimal.
Constructing ROM memories with diodes,
RAM memories with D flip flop. Constructing EPROM

ref. DIGITAL10



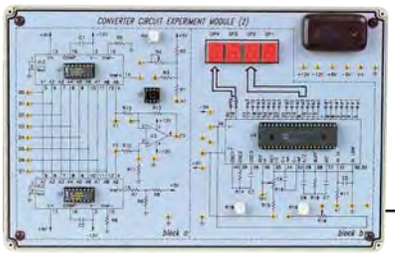
Constructing 64 bits RAM circuit.
Constructing Electronic EPROM circuit

ref. DIGITAL11



Construction dynamic scanning counter with single chip microprocessor. 8- bit analog/digital converter circuit.

ref. DIGITAL12

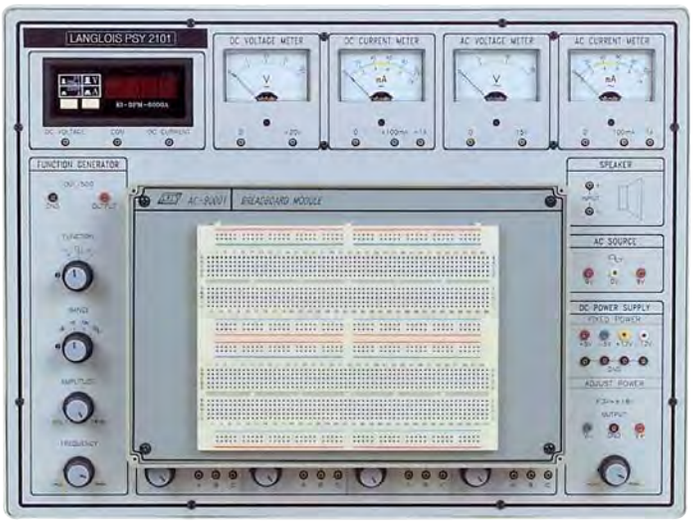


Digital/analog converter circuit, unipolar and bipolar.
3 digits analog/digital converter circuit.

ref. DIGITAL13

Analogue circuit lab

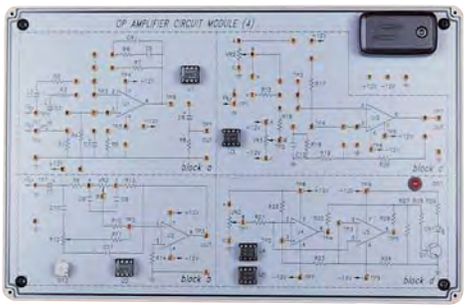
Analog circuit lab equipped with a main unit and 17 experiment modules.
Each module permits to realize several practical works.
Supplied with leads and user's manual.



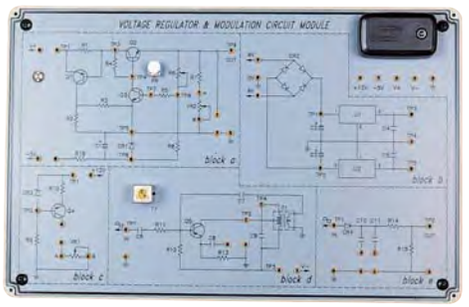
ref. PSY2101

MAIN UNIT WITH :
4 fixed DC supplies with output overload protection
+5V -5V +12V -12V / 300mA on each output.
Dual DC power supply with output overload protection
± 3V, ±18V / 1A continuously adjustable.
AC power supply with output overload protection
0-9VAC / 500mA
Signal generator
Sine, square and triangle 10Hz to 100kHz.
- 4 ranges 100Hz - 1 - 10 - 100 kHz
- Output impedance: 50Ω
- Output voltage : 9Vpp (with 50Ω load), 18Vpp (open loop).
3 1/2 digit digital voltmeter/ammeter
Range: 2V - 200V - accuracy 0.3%
Range 200µA - 2A - accuracy 0.5%
Analogue voltmeter/ammeter
0 to 20V DC - 0 to 100mA DC - 0 to 1A DC
0 to 15 V AC - 0 to 100mA AC - 0 to 1A AC
Speaker 8Ω, 0.25W with driver circuit.
0.25W potentiometers : 1kΩ, 10kΩ, 100kΩ, 1MΩ.
Breadboard: 1680 tie-point breadboard wich can be easily put into and taken off (permutable with the modules).
Dimensions : 400 x 300 x 130 mm. Weight : 5.8kg

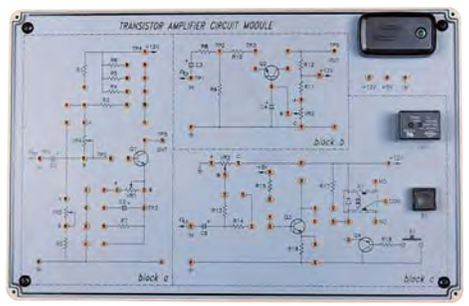
17 EXPERIMENT MODULES.
Designed with a 215 x 165 x 30mm solid body plastic housing, with electrical wiring printed on the front panel. An 8-bit DIP switch, located on the right top corner allows the user to simulate faults. Each analogue module is delivered with 2 experiment manuals.



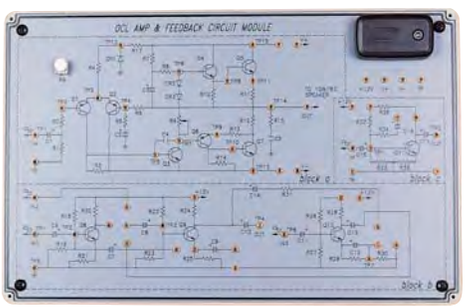
REF. ANALOG 1



REF. ANALOG 2



REF. ANALOG 3



REF. ANALOG 4

Silicium, Germanium, Zener, Photodiode and LED diode characteristics experiments.
Clipping and clamping circuits

ref. ANALOG1

Half wave and full wave rectifier circuit.
Bridge rectifier circuit.
Dual power rectifier circuit.
Voltage doubler & multiplier circuit.
RC direct current charge & discharge circuit.
Differentiator, integrator.
RL charge & discharge circuit.
NPN and PNP circuit. IE IB IC measurement

ref. ANALOG2

Transistor amplification circuit: common emitter circuit, common base, common collector.
Automatic and voltage divider bias point.
Feedback collector/base. Switching.
Switching type transistor circuit. Relay control.

ref. ANALOG3

Darlington's circuit.
Photoelectric control circuit.
Delay control circuit.FET measurement of IDSS, IGS, Vp.
MOSFET measurement of IDSS, Vp - FET and MOSFET amplifiers:common source, common drain.
Schemes
Automatic and voltage divider bias point

ref. ANALOG4

Two stage amplificator circuit, RC coupled
Direct coupled amplification circuit.
Transformer coupled amplification circuit.
Push-pull amplification circuit with impedance adapter transformer

ref. ANALOG5

Condenser coupling multi-stage amplification circuit.
OTL amplification circuit.
OCL amplification circuit.
IC amplification circuit.

ref. ANALOG6

Multistage amplifiers with direct coupling.
Transistor negative feedback circuit.
Serial voltage negative feedback circuit.
Parallel voltage negative feedback circuit.
Serial current negative feedback circuit.
Parallel current negative feedback circuit

ref. ANALOG7

Direct feedback circuits. Low frequency sine wave oscillating circuit (RC phase-shifting and Wien bridge oscillator circuit). High frequency sine wave oscillating circuit (Hartley oscillator circuit). Astable oscillating circuit with fixed or ajustable frequency and output on transformer.

ref. ANALOG8

Sine wave oscillating circuit (Colpitts).
Crystal.
Square generator with fixed variable frequency, flip-flop, timers, divider by Z.
Bistable, Intermittent oscillating circuit.

ref. ANALOG9

Schmitt's trigger circuit. Sawtooth wave oscillatingcircuit linear ramp generator. Regulated voltage/current circuit with zener diode/transistor. Regulated adjustable voltage. Current limiting.

ref. ANALOG10

Regulated voltage circuit with IC. Constant current circuit. Amplitude modulation circuit (AM).

ref. ANALOG11

Frequency modulation circuit (FM).
Transistor differential amplification.
Characteristics of OP amplifiers: input/output impedance, bandwidth, slew rate, offset voltage measurements for direct and inverse amplifier.

ref. ANALOG12

OP amplifier circuits: inverse and non inverse amplification, voltage follower, Difference amplification, Sum amplification, clipping circuit, constant voltage and current circuit, integrator circuit.

ref. ANALOG13

Montages à ampli op : amplificateur logarithmique, ampli exponentiel,
détecteur de valeur pic à AO et FET,
écrêteur de précision, régulateur de tension,
échantillonneur bloqueur.

ref. ANALOG14

OP amplifier : instrument amplification circuit, high pass, low pass and band pass amplification circuit.

ref. ANALOG15

Tone controller circuit. RIAA amplifier circuit.
Single power bias amplification circuit.
Positive feedback OP amplifier: comparator, Schmitt trigger, window type comparator.

ref. ANALOG16

Operational amplifier oscillators:
Monostable and astable multivibrator: square wave generator.
Sine wave: oscillation circuit:
RC oscillator, Wien oscillator.

ref. ANALOG17

STUDENT BOOK

(supplied with each module)

- A theoretic part, definitions, terminology, characteristics curves, schemas, theoretical schemas, and wiring diagrams with link slots. The functioning is explained in details.
- An experimental part to guide step by step the student to do practical works: choice of measurement appliances, settings, measurement to do, blank tables to be filled, curves to be drawn.
- Result commentaries, additional practical works

INSTRUCTOR BOOK

(supplied with each module)

- Practical works presentation: purposes, manipulation interpretation
- Switches position to simulate troubleshooting.
- Detailed and pedagogical solutions of practical works
- Calculation shown in extenso. Moreover, the instructor will find technical complements, which can be distributed to students without any modifications.

Electronic & electrical circuit lab

Electronic circuit lab equipped with a main unit and 11 experiment modules.
Each module permits to realize several practical work.
Supplied with leads and user's manual.

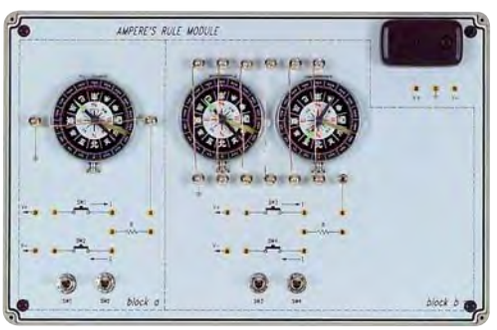
ref. PSY2101

MAIN UNIT PSY2101 INCLUDING

4 fixed DC supplies with output overload protection
+5V -5V +12V -12V / 300mA on each output.
Dual DC power supply with output overload protection
± 3V to ±18V / 1A continuously adjustable.
AC power supply with output overload protection
0-9VAC / 500mA
Signal generator
Sine, square and triangle 10Hz to 100kHz.
- 4 ranges 100Hz - 1 - 10 - 100 kHz
- Output impedance: 50Ω
- Output voltage : 9Vpp (with 50Ω load), 18Vpp (open loop).

3 1/2 digit digital voltmeter and ammeter
Range: 2V - 200V - accuracy 0.3%
Range 200µA - 2A - accuracy 0.5%
Analogue voltmeter and ammeter
0 to 20V DC - 0 to 100mA DC - 0 to 1A DC
0 to 15 V AC - 0 to 100mA AC - 0 to 1A AC
Speaker 8Ω, 0.25W with driver circuit.
0.25W potentiometers : 1kΩ, 10kΩ, 100kΩ, 1MΩ.
Breadboard : 1680 tie-point breadboard on top panel can be easily put into and taken off (permutable).
Dim: 400 x 300 x 130 mm. Weight: 5.8kg

11 EXPERIMENT MODULES.
Designed with a 215 x 165 x 30mm solid body plastic housing, with electrical wiring printed on the front panel. An 8-bit DIP switch, located on the right top corner allows the user to simulate faults. Each analogue module is delivered with 2 experiment manuals.



STUDENT BOOK
(supplied with each module)
A theoretic part, definitions, terminology,
characteristics curves, schemas, theoretical schemas, and wiring diagrams with link slots.
The functioning is explained in details.
An experimental part to guide step by step the student to do practical works: choice of measurement appliances, settings, measurement to do, blank tables to be filled, curves to be drawn.
Result commentaries, additional practical works

INSTRUCTOR BOOK
(supplied with each module)
Practical works presentation: purposes, manipulation interpretation
Switches position to simulate troubleshooting.
Detailed and pedagogical solutions of practical works
Calculation shown in extenso. Moreover, the instructor will find technical complements, which can be distributed to students without any modifications.

DC voltage and current measurement.
Ohm's law. Power in DC circuit.
Series – Parallel network and Kirchhoff's law.
Thevenin's and Norton's theorems.
Maximum power transfer theorem.
RC circuit and transient phenomena. AC voltage and current measurement. RC, RL, RLC circuits.
Transformer characteristics.
Series and parallel resonant circuits. LC filter.

ref. ELEC1

Magnetic devices. Magnetic field.

ref. ELEC2

Drawing magnetic curves. Magnetic field strength.
Lentz's and Faraday's laws.

ref. ELEC3

Ampere's rule

ref. ELEC4

Fleming's rule

ref. ELEC5

Self induction. Mutual induction.
Magnetic flux detection by sensor and amplifier

ref. ELEC6

Diode characteristics.
Rectifier circuit half and full wave.
Filter circuit.
LC filters and RC filters in π Zener diode characteristics. LED characteristics. Transistor characteristics
NPN PNP Vce IB. Multimeter functions.
FET characteristics.
Triac UJT characteristics.

ref. ELEC7

One stage transistor amplifier.
AB class Push-pull - Voltage regulator - SCR power dimmer - Two stages amplifier - Relay characteristics - Touch controller switch.

ref. ELEC8

Two stages amplifiers by transformers.
Coupling - Push-pull output on speaker
Wheatstone bridge.

ref. ELEC9

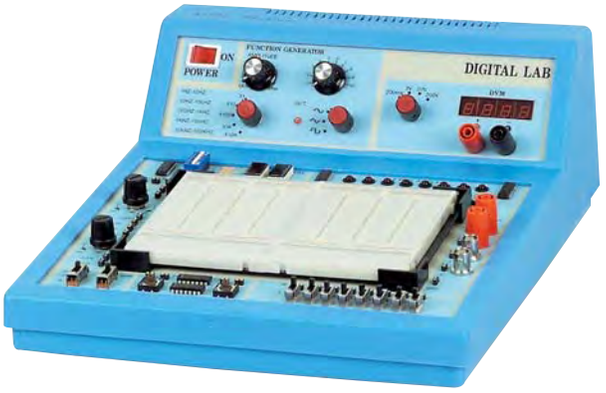
Photoresistor characteristics - Using a switch.
Thermistor characteristics. Wheatstone using.
Thyristor drived by thermistor.
3 stages amplifiers controled by microphone.

ref. ELEC10

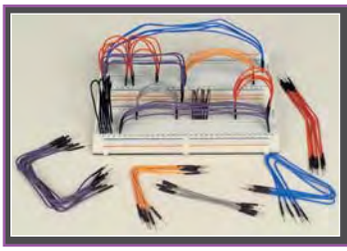
Blocking oscillator.
Blocking oscillator with speaker output.
Astable multivibrator. LC resonant circuit.
Electronic birdcall circuit

ref. ELEC11

Electronic test unit AT102



ref. AT102 NC, € HT



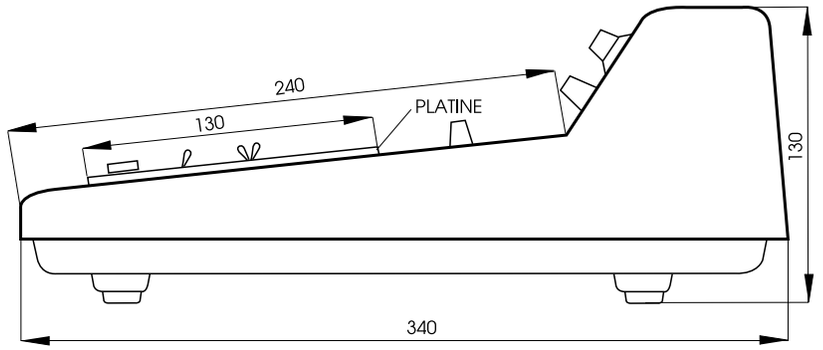
MICRO-LEADS
NOT SUPPLIED
SEE PAGE 202

ELEMENT OF REPLACEMENT

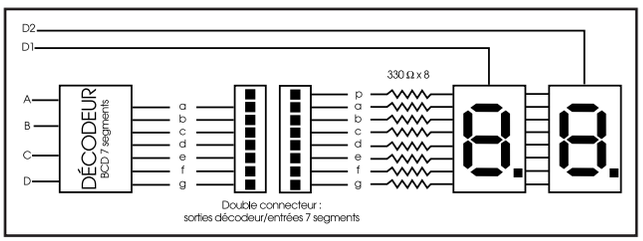
The central board.

ref. PR6

Designed for installation and rapid testing of prototypes and for practical experiments with analog and digital circuits. The contact board, which is hardwearing, is removable.
Dimensions: 340 x 265 x 130mm. Weight: 2.3kg.



The components are inserted on the contact board with the normal pitch spacing of 2.54mm.
There are 1580 contact points divided into:
12 contact points of supply lines
256 separate sets of 5 contact points receiving components and interconnetions.



4 SUPPLIES
Positioned in view immediately on the face, they are protected against short circuits
- Variable DC from 0 to +15V 300mA (ripple 30mV)
- Variable DC from 0 to -15V 300mA (ripple 30mV)
- Fixed DC +5V, 1A (100mV ripple)
- Fixed DC -5V, 1A (100mV ripple)

1 FUNCTION GENERATOR
From 1Hz to 100kHz in 5 ranges varied with a control dial. The output is protected against short circuits. - Sinewave, level variable from 0 to 10V peak-to-peak - Triangular wave, level variable from 0 to 6V peak-to-peak - Square wave, level variable from 0 to 8V peak-to-peak

2 DIGITAL DISPLAYS
7 segments and decimal point display. Switched by the inputs of D1 & D2.
- Direct control of each segment, a b c d e f
- Access to the input of the ABCD decoder IC

1 DC DIGITAL VOLTMETER
3 1/2 digits with a maximum reading of 2,000.
Ranges 200mV-2-20-200VDC. Input impedance 1MΩ

8 DIODE DISPLAY
Status from 0 to 7 with lamps to view logic levels.

10 LOGIC SWITCHES
- 8 with 2 positions giving a voltage a either 0 or 5V
- 2 with 3 positions giving voltages of -5V 0V +5V

2 LOGIC PUSHBUTTONS
2 anti-bounce outputs A and A (respectively B and B) supplying a level between 0 and 5V on the side of the unit.

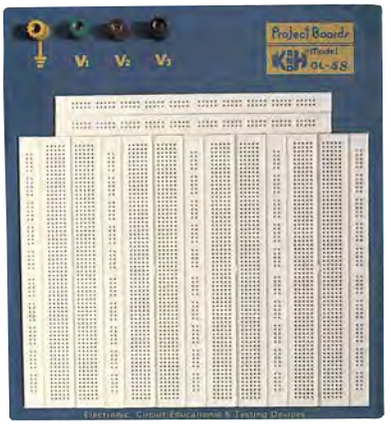
4 ADAPTERS
These adapters allow the unit to be connected to an external electronic unit.
- 2 banana inputs of 4mm diameter
- 2 inputs of female BNC connectors

Electronic test boards

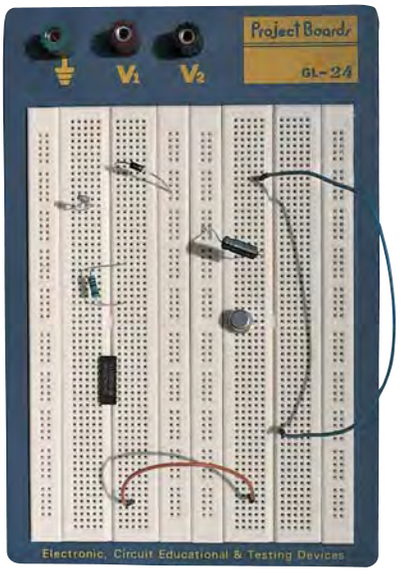
Contact boards for the design and rapid testing of circuits. The double reed contacts of these boards are in nickel plated bronze. They are pitched 1 inch/2.54 mm apart in an insulating ABS base. Contacts grouped in strips of 5 or 10, can be fully dismantled from the rear. Use components or leads with maximum diameter 0.6mm.

REF. PAL2420

REF. GL12



REF. GL48



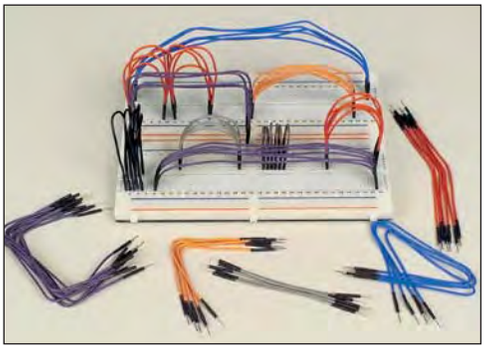
REF. GL24

Model with integrated power supply protected from short-circuits (PAL2420): 0 to +15V/500mA continuously variable ; 0 to -15V/500mA continuously variable ; +5V/1A fixed

Ref.	PAL2420	PAL2420S*	GL12	GL12S*	GL24	GL24S*	GL48	GL48S*
Nb of contacts	2420	2420	840	840	1680	1680	3260	3260
Dimensions mm	245 x 195	245 x 195	200 x 75	200 x 75	225 x 150	2250 x 150	260 x 240	260 x 240

** With safety sockets*

Micro-leads



Storage box for micro-leads

8 racks. Transparent plastic cover.
Total capacity of the box : 160 micro-leads.
Dimensions : 230 x 160 x 30mm.
Weight : 180g

ref. MICRO-B

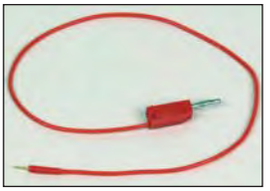
Ref.	M5	G7	O1	R10	N10	V1	B2
Lenght	50 mm	70 mm	100 mm	100 mm	100 mm	150 mm	200 mm
Colors obligatory	BROWN	GREY	ORANGE	RED	BLACK	VIOLET	BLUE

The flexible wire used for these leads is terminated at each end by a 0.6mm diameter nickel-plated plug.
The electrical contact is excellent.

INTERFACE LEAD

Special lead to connect the testing boards and any system in diameter 2mm.

Max current 500mA.



ref. INTER-2R
25cm Red color

ref. INTER-2N
25cm Black color