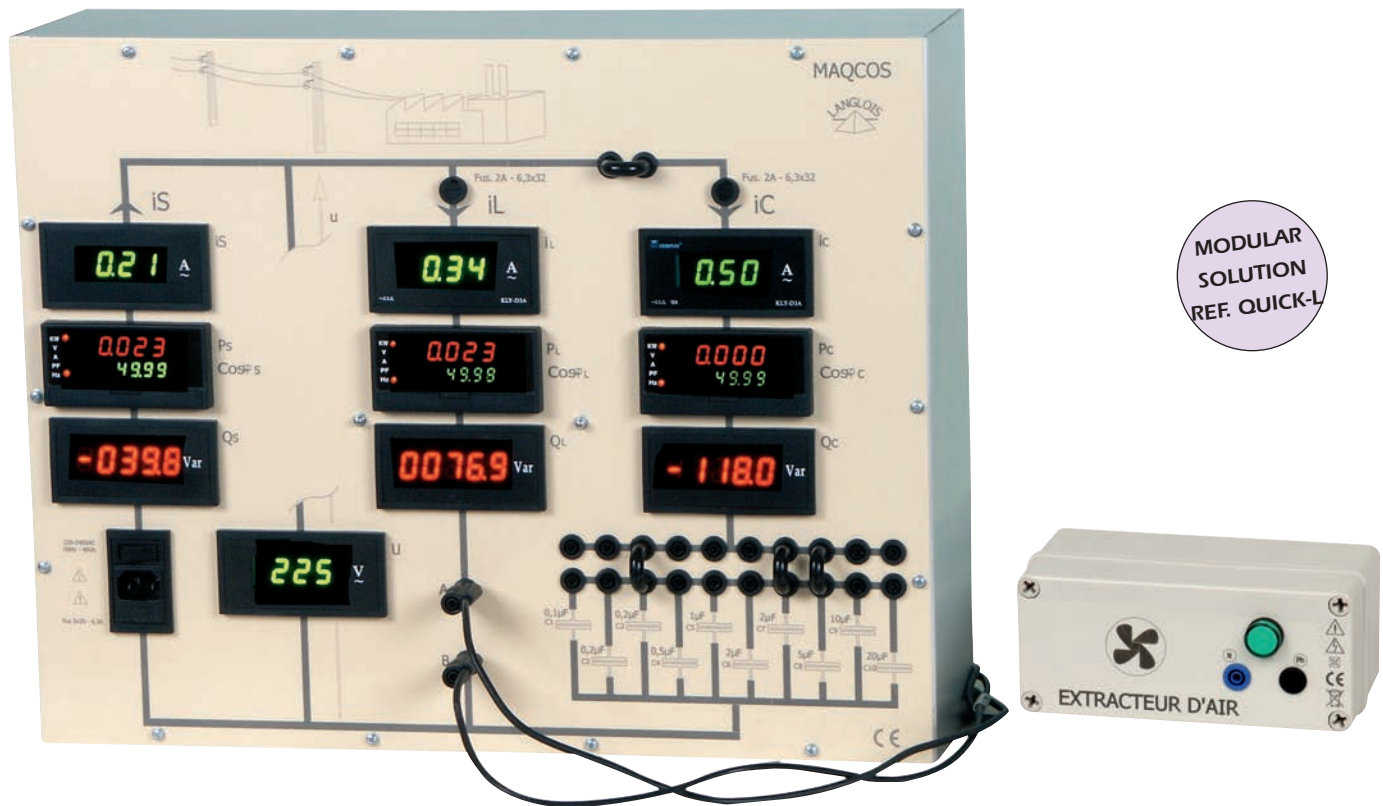


POWER FACTOR CORRECTION SYSTEM



ref. MAQCOS

EDUCATIONAL OBJECTIVES

- Studying the power factor & Demonstrating the interest of power factor corrector for the cost of the power (kWh)

USER'S MANUAL + 3 PRACTICAL WORKS

Proposed Practical Works

- studying of an industrial air extraction installation:
Current of branches – power of the transport line with and without power factor correction – Active and reactive power in the branches – Fresnel diagrams
- Study of the pure inductance of a plant in working in order to determine the capacitor bank necessary
Role of automatic compensation
- Study of 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 - 20µF
- Fuse protection
- Dimensions: 510 x 400 x 150 mm - Weight 8.2kg

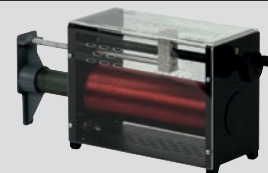
The MAQCOS model is designed for studying and rectifying power factors. It consists of three branches:

- 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.



ref. PSYJR2

VARIABLE INDUCTANCE OPTION

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.

CONVERSION TEST BENCH

RECTIFIER

SINGLE-PHASE / DIRECT CURRENT CONVERSION TEST BENCH

CO-1000 IS SUPPLIED WITH 4 MOVEABLE FRONT PANELS, INSTRUCTION BOOK INCLUDED TUTORIALS



SOME CO-1000 PRACTICES REQUIRE OPTIONAL ACCESSORIES

- | | | |
|--|------------------------------|--------------------------|
| Rheostat ECO1/2 10Ω
Réf. ECO1/2 10Ω | Variable coil
Réf. PSYJR2 | 90W motor
Réf. CO-110 |
|--|------------------------------|--------------------------|



- | | |
|-------------|--------------------------|
| Réf. CO-104 | Smoothing coil 40mH - 3A |
| Réf. CO-105 | Smoothing coil 20mH - 3A |
| Réf. CO-108 | Smoothing coil 60mH - 3A |
| Réf. CO-106 | 12V/24V Battery |

EDUCATIONAL OBJECTIVES

- Studying of the controlled, non-controlled and mixed rectification of the single-phase

TEACHING RESSOURCES + PRACTICAL WORKS

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 4 switches to change from the diode assembly to the rectifier assembly. The test bench is supplied with 4 moveable 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). 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

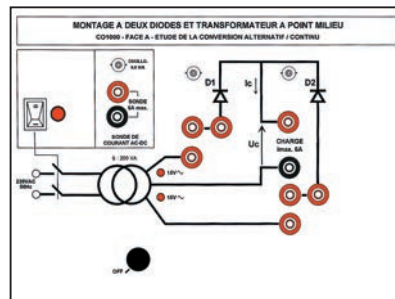
This probe consists of a Hall-effect sensor and is connected in series, like an ammeter. The current image is a voltage of 0.5 V/A available via BNC.

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

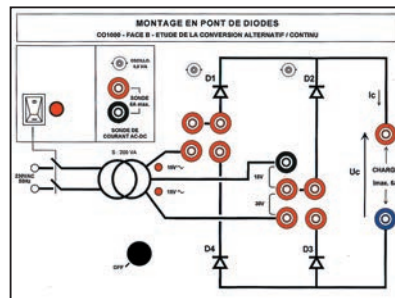
2 mid-point reactors: 2 x 15 Vrms
Power supply: 230VAC 50Hz 250VA
Dimensions: 670x370x170mm. Weight: 5.2kg



PANEL A: ASSEMBLY WITH TWO DIODES AND MID-POINT TRANSFORMER

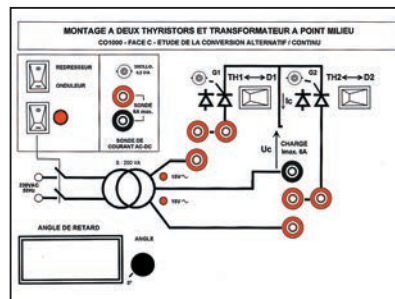
Return to single half-wave rectification and switching to double half-wave rectification by simply adding jumper straps.

- Experiment 1 Power flow on resistive load (R)
- Experiment 2 Power flow on inductive load (R,L)



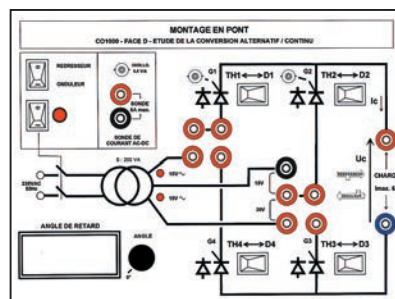
PANEL B: DIODE BRIDGE CIRCUIT ASSEMBLY

- 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 assembly
- Experiment 3 Power flow on active inductive load (E, R, L)
- Experiment 4 Application to a DC motor power supply (DCM)



CONVERSION TEST BENCH

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

SOME CO-1020 PRACTICES REQUIRE OPTIONAL ACCESSORIES

- | | |
|---|--|
| Ref. ECO1/2 10Ω | Rheostat ECO1/2 10Ω |
| Ref. ECO1/2 15Ω | Rheostat ECO1/2 15Ω |
| Ref. ECO1/2 22Ω | Rheostat ECO1/2 22Ω |
| Ref. ECO1/2 33Ω | Rheostat ECO1/2 33Ω |
| for an optimal use, low resistance loads are better | |
| Ref. PSYJR2 | Variable coil |
| Ref. CO-106 | 12V/24V Battery |
| Ref. CO-107 | Single-phase transformer 12V - 230V with its lamp 230V - 40W |
| Ref. CO-122 | Capacitor 22μF |

EDUCATIONAL OBJECTIVES

- Studying of a 24V single-phase inverter, in half bridge and in bridge

TEACHING RESSOURCES + PRACTICAL WORKS

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 ($I_{MAX} = 3A$) 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:

- Converter U/F constant
- SYMMETRICAL
- OFFSET
- BIPOLAR PWM - THREE-POLE PWM

A LED indicates which mode has been selected.

SELECTING ADJUSTMENT PARAMETERS:

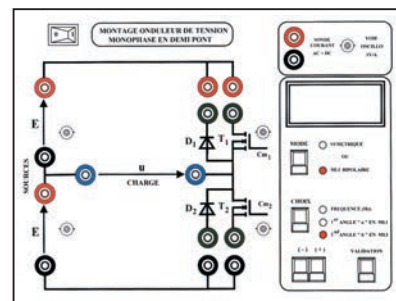
Adjustment parameters are selected by pressing the "SELECT" key:

- 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 (2 SWITCHES)"

The diode and power transistor operate by cross-barring

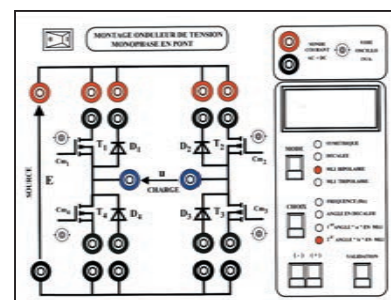
Presentation of symmetrical control

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 (4 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)

Experiment N°4: Application to induction heating

Experiment N°5: Application to a backup power supply

Using the CO-1000 test bench as a charger.