

Pack EP 230

LV (300 W) CHOPPER / 1-/3-PHASE INVERTER

GENERAL CHARACTERISTICS

The EP230B, C, and S packs from the **Electrical Engineering** range include the EP230000 operations module, manual, a set of accessories and, depending on the version, the control software (for the C version) and simulation extension as well as implementation of new correctors (for the S version).

It enables the study of:

Choppers:

- Series
- Voltage reversible
- Current reversible
- Four quadrants
- Double nested series (+E /0 /-E)

Single-phase inverters:

- Full-wave shifted control, variable frequency
- PWM +E/-E, +E/0/-E, constant U/F

External control:

- Electronic editing $\pm 10 V_{DC}$ (static chopper or 1-phase inverter).

Three-phase inverters:

- PWM: variable modulation index, adjustable frequency
- Constant U/F ratio
- PWM +/-E, +E/0/-E, constant U/F

A setting software is provided (ref.: EP230100), the option EP231000 enables the functioning in autonomous mode.

TECHNICAL CHARACTERISTICS

Nominal characteristics

- Voltage range of the power supply: $60 V_{DC} \rightarrow 340 V_{DC}$ (LV)
- Maximum peak current in each static switch: 2 A.
- Frequency: 1 Hz \rightarrow 20 kHz
- Parametrizable acceleration ramp
- Duty cycle: 0% \rightarrow 100%
- Adjustable dead time
- Intersective commutation mode or state vector

Class illustration/demonstration:
The EP230 is also specially adapted to spot a particular phenomenon during a lecture *via* a video-projector (with the EP230100 software and a PC).

AREAS OF APPLICATION

Practical works:

Basic training:
Secondary & higher technical education.

- Prep school
- Vocational training in electrical engineering
- Institute of technology
- Engineering school & University

SAFETY DEVICES:

- Excitation current monitoring
- Short-circuit protections
- PTO (thermal protection)
- Power supply monitoring: min. $60 V_{DC}$ /max. $340 V_{DC}$ before switching on
- Control of the filtering capacity current when switching on
- Emergency stop if the reverse capacitor voltage exceeds $350 V_{DC}$
- Current monitoring within the discharge transistor
- Voltage monitoring of the reverse capacitor.

TECHNICAL GUIDE:

The EP 230 pack is provided with a commissioning and maintenance booklet indicating the general conditions of commissioning and use.

Under maximum supply voltage, protected against short-circuits.

PACKING:

Dimensions - net: 330x265x110 mm (l x w x h) - gross : 595x560x160 mm

Weight: Net 2 kg, Gross: 5

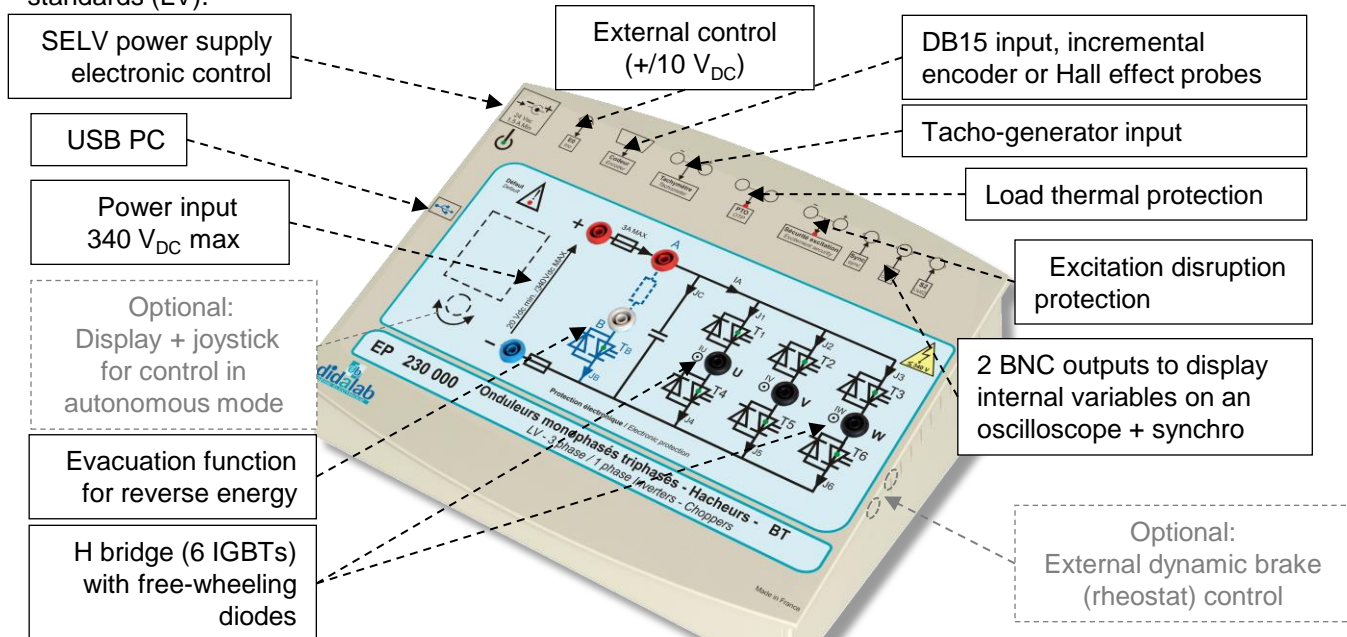


EP230000 – LV (300 W) chopper / 1-/3-phase inverter

Technical characteristics:

The EP230000 is composed of a PVC insulated frame with a front panel including operating diagrams, the device is suitable for table-top installation. The power supply unit is external (340 V_{DC} max, 2A). The adjustment control and choice is made by a PC due to the EP230100 software.

It is designed to be used from an adjustable continuous power supply in compliance with established safety standards (LV).



The EP230000 connects to the PC via USB, it can be operating in complete autonomous mode (option EP230100). The control board is based on a very high power level processor (ARM-M4), assisted with a 50,000-gate FPGA.

A control software under Windows (ref.: EP230100) enables to select the electronic configurations:

- Series chopper
- Reversible chopper in current, voltage
- 4-quadrant chopper
- Double nested series (0 +E 0 / 0 -E 0)
- Single-phase inverter with offset drive, PWM, constant U/F
- Three-phase inverter with offset drive, PWM, constant U/F

The operating parameters can be chosen (depending on the studied assembly):

- The operating frequency, the duty cycle
- The LF type and frequency (external by BNC or internal)
- The signals to be displayed on an oscilloscope by BNC or on a PC:
 - Current in one of the branch, current into the load
 - Voltage into a branch...

At any time, the module can be connected (depending on the software options) to a PC in order to:

- Display the time curves: voltage – current on a PC.
- Carry out practical works in speed/position servo-control of a DC motor (300 W).
- Create simulation models and new real-time correctors from the modelling software: *Scilab*.

EL331B: recommended load bench

BICMAC 300, Bench for Instrumentation of Charge for Machines Alternating & Continuous

Three-phase squirrel cage motor
Brushless motor
DC motor
(see documentation: **BICMAC 300**)

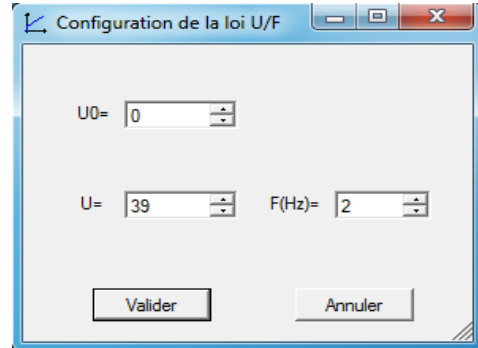
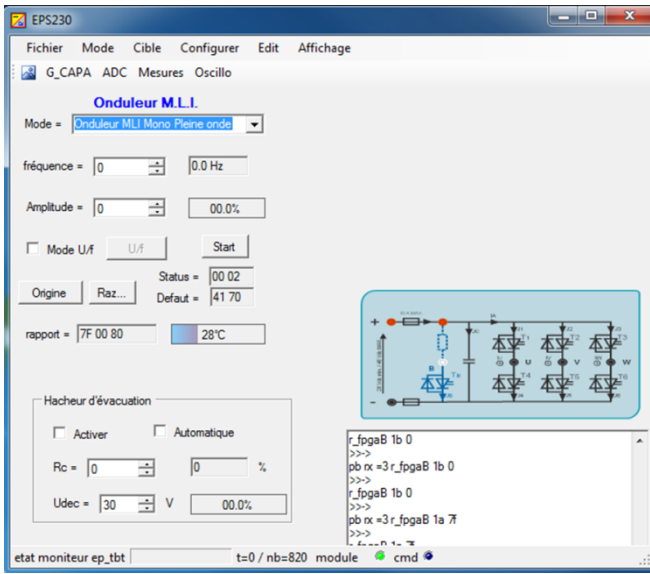


BICMAC 300:

- 300 W mechanical load generator 300W
- Measurements of speed/position, torque, mechanical power
- Choice of the type of load (constant, as function of the speed, square of the speed...)
- Connectable to a PC via USB...

EP230100: DRIVER AND ACQUISITION SOFTWARE

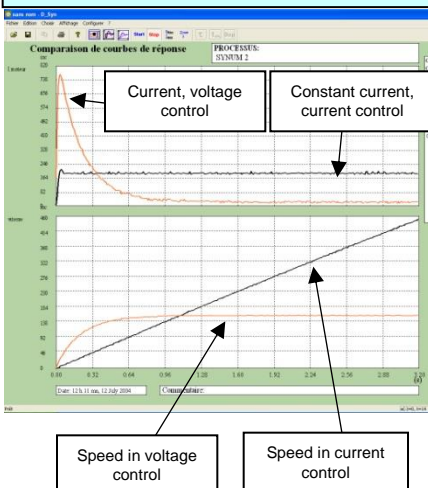
- It is operating under *Windows* environment and enables to drive the EP230 power bridge *via* USB.
- The students chooses the structure of the power bridge.
- They choose the values they want to display on the embedded oscilloscope
- They adjust the operating parameters, frequency, duty cycle ...



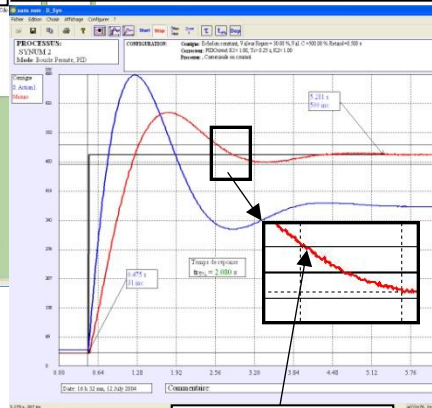
EP230200 : CONTROL COMMAND SOFTWARE « D_CCA »

- It is operating under *Windows* environment and enables to drive the EP230 power bridge *via* USB.
- Configuration of the system, *via* an ergonomic graphic interface:
 - selection of the system structure: speed or position open/closed loop.
 - selection of the control type, characteristic values: constant step, ramp, sine, trapezoid signals.,
 - selection of the corrector and its adjustments (P, PI, PID, Z corrector, fuzzy logic, tacho-generator feedback)
 - selection of the acquisition and recording parameters
 - selection of the measurements units (degree angle, radians, rotations)
- Structured processing for a series of experimental tests:
 - request for the displaying of a time response of one (or several) characteristic parameter(s): position, speed, acceleration, motor current – voltage, control signal, overflow, corrector output etc...
 - modification of the time diagram scales (zoom in X, or Y)
 - recording of the running test, comparison with the previous tests
 - determination of the automatic control characteristic values (time constants, response time at 5%, overflow amplitude, phase difference etc...)

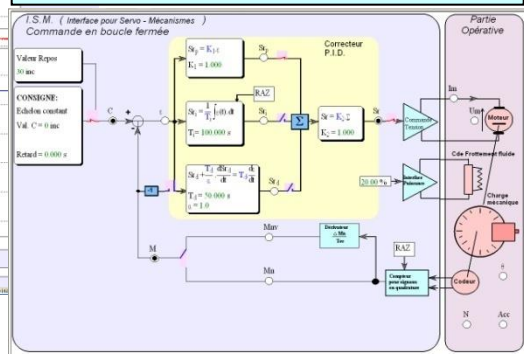
Comparison screen between OL responses in voltage control mode, and current mode, without friction disturbances.



Response in closed loop speed control, with automatic calculation of the reaching time in the 5% zone.



Parameter screen Example of speed control by PID single-loop corrector



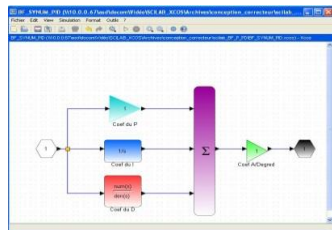
Automatic measurement of the response time at 5% on the feedback loop

EP230800 – Rapid prototyping software:

To emphasize the teaching qualities, even for research purpose, of the EPS230000 module, a software can be provided. It can synthesize any type of control (OL, CL, PI, PID, state feedback...) under *Scilab*® environment, then to generate the executable code that will be downloaded in the chopper/inverter enabling its real-time control. This graphical tool has the whole power from the simulation software *Scilab/Xcos* ; thus, the comparison between simulation and real behavior is possible in practical works (speed/position servo-control of a DC motor...).

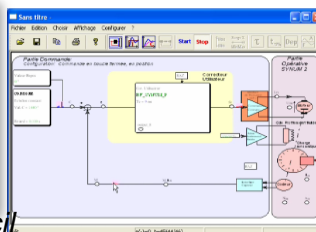
Example below:

From a simulation of the system in OL then in CL with the open-source software *Scilab/Xcos*®, the module *D_Scil* automatically generates the code which will be transferred into the chopper/inverter bridge then tested under the software *D_CCA* to compare results from simulation and experiments (cf.: *D_Scil* documentation).

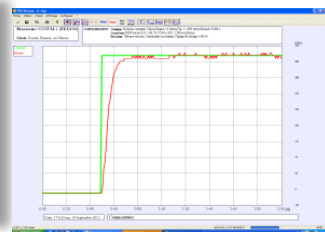


PID corrector under Xcos

Code generated via *D_Scil*



Implementation in *D_CCA*



Time response

Standard configurations:

EP230B: Basic package «STUDY OF A 1-2-/4-quadrant CHOPPER / 1-3-phase INVERTER 300 W (LV) », including:

Reference	Designation	Qty
EP230000	Safety LV module 300 W, 1-2-/4-quadrant chopper, 1-phase inverter 1-3-phase inverter full-wave, PWM +E/-E, +E/0-E, embedded current and voltage probes	1
EP230100	Driver and acquisition software	1
EGD000005	24 V _{DC} , 2.9 A Power supply with jack plug	1
EP2300010	User manual and technical guide	1
EGD000006	USB cable (AA-type)	1
EGD000018	Storage case	1

Optional: EP231000, TFT colour display (320x240) and digital potentiometer for autonomous control (without PC)

EP230C: Complete package « STUDY OF A 1-2-/4-quadrant CHOPPER / 1-3-phase INVERTER 300 W (LV), speed and position servo-control of DC motors » including:

Reference	Designation	Qty
EP230B	Basic package «STUDY OF A 1-2-/4-quadrant CHOPPER / 1-3-phase INVERTER 300 W (LV) »,	1
EP230200	Driving software for speed servo-control, response curves acquisition on a PC (<i>PC not included</i>)	1
EP230041	Teacher's manual "Study of the speed and position regulation on the EP230000 chopper"	1
EP230051	Student's manual "Study of the speed and position regulation on the EP230000 chopper"	1

EP230S: Complete and simulation package « STUDY OF A 1-2-/4-quadrant CHOPPER / 1-3-phase INVERTER 300 W (LV), speed and position servo-control of DC motors , with simulation» including::

Reference	Designation	Qty
EP230 C	Complete package « STUDY OF A 1-2-/4-quadrant CHOPPER / 1-3-phase INVERTER 300 W (LV), speed and position servo-control of DC motors »	1
EP230800	<i>D_Scil</i> , rapid prototyping under SCILAB/XCOS, graphical objects editor, real-time C-code generator.	1

Recommended accessories:

EM300000 : 3-phase (3x220V; 2A) & DC (340 V; 1.5A) power supply

EL331B: **BICMAC 300**, load bench with AC motor coupled with a programmable magnetic powder load.

EL050B: (3x) 320-W rheostat, 210 Ohms, 1.2 A, ELD102B : (3x) Inductive loads 35 mH, 5 A.

Accessories: 4-mm double sink leads, measuring instruments, PC.

Nota: for servo-control experiments on another bench, the group has to be equipped with an incremental encoder 5

V_{DC}.