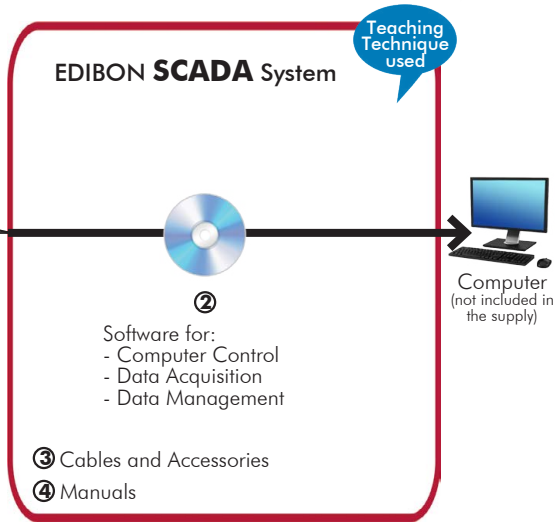
edibon

Engineering and Technical Teaching Equipment

Computer Controlled **Advanced Power Electronics Application,** with SCADA

AE-PEC

Configuration example of AE-PEC application with the required element N-DCAC



* **Minimum supply always includes: 1 + 2 + 3 + 4**
(Computer not included in the supply)

Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**
- **Capable of doing applied research, real industrial simulation, training courses, etc.**
- **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Designed and manufactured under several quality standards.**
- **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**
- **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

POWERED BY NATIONAL INSTRUMENTS LabVIEW

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↳PRODUCTS
↳2.- ELECTRONICS

For more information about Key Features, click here

Certificate of Approval of the Quality Management System

European Union Certificate (total safety)

UL and CSA Regulations (All our products are manufactured according to current UL and CSA regulations)

Certificate of Approval of the Environmental Management System

Worlddidac Association Certificate of Membership

INTRODUCTION

Nowadays, power electronics play an important role in controlling the flow of electrical energy. Power electronics is the technology behind switching power supplies, power converters, power inverters, motor drives and soft starters. In addition, power electronics is widespread in the field of smart grids, for example in back to back converters, PWM controllers, compensators (SVC and STATCOM), high voltage DC transmission systems (HVDC), etc.

The Computer Controlled Advanced Power Electronics Application, "AE-PEC", designed by EDIBON, is a modular solution created to provide comprehensive hands-on training in power electronics. This application is ideal for both training and research environments, offering a wide range of experiments and applications related to power supplies, digital metering, and power devices. This application allows students and instructors to gain practical experience and a deep understanding of the principles and applications of power electronics.

GENERAL DESCRIPTION

The Computer Controlled Advanced Power Electronics Application, "AE-PEC", includes various modules that allow exploration of different aspects of power electronics. The modular design of this application ensures flexibility and adaptability to various educational and research needs. Each module is equipped with the necessary components and detailed manuals to facilitate effective learning and the development of research projects.

The application is built with an intuitive interface that allows for easy integration and interaction between the different modules. Each module can be independently controlled and monitored, providing a dynamic environment for experimenting with power electronics circuits and concepts, as well as for advanced research in this field.

The "AE-PEC" application requires (at least one) of the following kits:

- DCDC-KIT. DC/DC Conversion Kit.
- ACDC/U-KIT. AC/DC Conversion Kit with Uncontrolled Rectification.
- ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.
- N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.
- ACAC-KIT. AC/AC Conversion Kit.
- ACDCAC-KIT. AC/DC/AC Conversion Kit (Frequency or Cycle Converter).
- CCR-DCM-KIT. AC/DC Conversion Kit with Controlled Rectification and DC/DC: DC Motor Control.
- C-ACM-KIT. AC/DC/AC Conversion Kit: Three-Phase AC Motor Control.

The educational and research objectives of each kit are described below:

- **DCDC-KIT. DC/DC Conversion Kit.**

  Allows the study of both isolated and non-isolated DC/DC conversion in direct current systems. This kit is composed of several elements:

  Isolated DC/DC Conversion Module (N-DCDC/I), which allows the study of isolated DC/DC conversion, composed of a bridge of 4 IGBT's, an HF transformer, 4 schottky diodes, a coil and a capacitor.

  Isolated DC/DC Conversion Module (N-DCDC/2T), based on a two-transistor branch, consisting of a bridge of 2 IGBT's, a coil and a capacitor.

  DC/DC Conversion Module with Transistor and Diode (N-DCDC/TD), based on one transistor and one diode branch, consisting of a bridge of one IGBT transistor and one schottky diode, one coil and one capacitor.

  IGBT Transistor Module (N-IGBT), to study the behavior of an IGBT in a power system and analyze its characteristics.

  MOSFET Transistor Module (N-MOSFET), to study the behavior of a MOSFET in a power system and analyze its characteristics.

  Transistor Module (N-BJT), to study the behavior of a BJT in a power system and analyze its characteristics.

  DIAC, TRIAC and SCR Module (N-DTS) independent of each other, to study their behavior in DC and obtain their characteristics.

  Single Phase Fixed Resistor Module (N-REF) and Single-Phase Variable Resistor Module (N-REV) to obtain consumptions and introduce load transitions.

- **ACDC/U-KIT. AC/DC Conversion Kit with Uncontrolled Rectification.**

  Designed to analyze uncontrolled rectification in three-phase and single-phase systems, covering both half-wave and full-wave rectification, including capacitor-based filtering. This kit is composed of several elements:

  AC/DC Conversion Module with Uncontrolled Rectification (N-ACDC/U), composed of 6 diodes independent of each other to form both a three-phase (6 diodes) and single-phase (4 diodes) full-wave rectifier; as well as a three-phase (3 diodes) and single-phase (1 diode) half-wave rectifier by joining them together using jumpers and wires.

  Capacitor Module (N-CAP) composed of two 1000 μF capacitors, to study the filtering of the alternating component coming out of the rectifier.

  Single Phase Fixed Resistor Module (N-REF) and Single-Phase Variable Resistor Module (N-REV), to obtain consumptions and introduce load transitions.

  Single-phase Inductance Module (N-IND) to load the rectifier inductively.

- **ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.**

  Facilitates the analysis of controlled rectification in three-phase and single-phase systems, including both half-wave and full-wave configurations. This kit is composed of several elements:

  AC/DC Conversion Module with Controlled Rectification (N-ACDC/C) composed of 6 SCRs independent of each other, to form both a three-phase (6 SCR) and single-phase (4 SCR) full-wave controlled rectifier; as well as a three-phase (3 SCR) and single-phase (1 SCR) half-wave controlled rectifier by linking them together using jumpers and cables. It also has a diode to connect in parallel and inverse for inductive loads.

  Heater Module with Temperature Sensor (N-HT) consisting of a 150Ω heating resistor with a temperature sensor. This module is used to check how the firing angle influences the output voltage and the output voltage influences the measured temperature.

  Single Phase Fixed Resistor Module (N-REF) and Single-Phase Variable Resistor Module (N-REV), to obtain consumptions and introduce load transitions.

  Single-phase Inductance Module (N-IND), to load the rectifier inductively.

- **N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.**

  Offers the ability to study various DC/AC conversion methods, such as phase shifting, square waves, and PWM, in both single-phase and three-phase configurations. This kit is composed of several elements:

  Single-phase and Three-phase AC/DC Conversion Module (N-DCAC) composed of 6 IGBT transistors, which allows the study of DC/AC conversion both single-phase (using 4 IGBT's), and three-phase (using 6 IGBT's) using the different modulations described above.

  Single Phase Fixed Resistor Module (N-REF) and Single-Phase Variable Resistor Module (N-REV), to obtain consumptions and introduce load transitions.

  Single-phase Inductance Module (N-IND) to load the rectifier inductively.

- **ACAC-KIT. AC/AC Conversion Kit.**

  Focuses on studying AC/AC conversion using a triac. It includes both basic applications of the triac and its implementation in a control circuit with dual time constants, allowing for adjustment of firing delay (angle) to control load power. This kit is composed of several elements:

  DIAC, TRIAC and SCR Module (N-DTS) independent of each other, to study their AC behaviors and obtain their characteristics.

  AC/AC Conversion Module with Dual Time Constant (N-ACAC), based on the control of a triac by double time constant.

  Two Lamp-holders + Incandescent Lamps Module (N-LAM08), to see the effect of the triac firing delay (angle) on the luminosity of the lamps, and therefore on the output voltage.

  Single Phase Fixed Resistor Module (N-REF) and Single-Phase Variable Resistor Module (N-REV), to obtain consumptions and introduce load transitions.

  Single-phase Inductance Module (N-IND), to load the rectifier inductively.

- **ACDCAC-KIT. AC/DC/AC Conversion Kit (Frequency or Cycle Converter).**

  This kit explores how to transform one AC voltage into another with a different frequency and amplitude by passing through an intermediate DC stage. This kit is composed of several elements:

  AC/DC Conversion Module with Uncontrolled Rectification (N-ACDC/U) composed of 6 diodes independent of each other, to form both a three-phase rectifier (6 diodes), and single-phase (4 diodes) full wave; as well as a three-phase rectifier (3 diodes) and single-phase (1 diode) half-wave joining them together using bridges and wires.

  Capacitor Module (N-CAP) composed of two 1000 μF, capacitors to study the filtering of the alternating component coming out of the rectifier.

  Single-phase and Three-phase AC/DC Conversion Module (N-DCAC) composed of 6 IGBT transistors, which allows three-phase DC/AC conversion (using 6 IGBT's) using PWM.

  3PH Commutable Resistor Load Module (N-REFT), to resistively load the inverter.

  Three-phase Commutable Inductive Load Module (N-INDT), to load the inverter inductively.

- **CCR-DCM-KIT. AC/DC Conversion Kit with Controlled Rectification and DC/DC: DC Motor Control.**

  Designed to study controlled AC/DC rectification and DC/DC conversion, applied to speed control of DC motors with voltages of 12V and 200V. This kit is composed of several elements:

  AC/DC Conversion Module with Controlled Rectification (N-ACDC/C) composed of 6 SCRs independent of each other, to form both a three-phase (6 SCR), and single-phase (4 SCR) full-wave controlled rectifier; as well as a three-phase (3 SCR) and single-phase (1 SCR) half-wave controlled rectifier by linking them together using jumpers and wires.

  DC/DC Conversion Module with Transistor and Diode (N-DCDC/TD) non-isolated, based on a branch of an IGBT transistor and a diode, consisting of a bridge of an IGBT transistor and a schottky diode, a coil and a capacitor.

  DC/DC Conversion Module with H-Bridge (N-DCDC/H) non-isolated, based on a bridge of 4 IGBT transistors and a diode.

  12 VDC Motor (EMT24).

  DC Shunt/Series/Compound Excitation Motor-Generator (EMT5) 200 VDC series/shunt excitation motor.

  Optical Sensor with 2500 Pulses per Revolution (OPTS).

- **C-ACM-KIT. AC/DC/AC Conversion Kit: Three-Phase AC Motor Control.**

  Enables the analysis of AC/DC/AC conversion, focusing on speed control of three-phase AC motors with a voltage of 220V. This kit is composed of several elements:

  AC/DC Conversion Module with Uncontrolled Rectification (N-ACDC/U) composed of 6 SCRs independent of each other, to form both a three-phase (6 diodes) and single-phase (4 diodes) full-wave controlled rectifier; as well as a three-phase (3 diodes) and single-phase (1 diode) half-wave rectifier controlled by linking them together using jumpers and wires.

  Single-phase and Three-phase AC/DC Conversion Module (N-DCAC) composed of 6 IGBT transistors, which allows the study of both single-phase (using 4 IGBT's) and three-phase (using 6 IGBT's) DC/AC conversion using the different modulations described above.

  Capacitor Module (N-CAP) composed of two 1000 μF capacitors, to filter the AC component coming out of the rectifier.

  3PH Squirrel-Cage Motor with "Y" connection (EMT17).

  Optical Sensor with 2500 Pulses per Revolution (OPTS).

The "AE-PEC" application includes the following elements:

- N-ALI01. Industrial Main Power Supply Module.
- N-ALI05. Fixed Voltage Supply Module 12+12 VAC and +5 VDC.
- N-ALI06. Fixed Voltage Supply Module 18+18 VAC and ±15 VDC.
- N-ALI07. Fixed Voltage Supply Module 18+18 VAC and adjustable from 0 to 30 VDC.
- N-SCN. Voltage and Current Monitoring Module with Converter Control.

Required elements (at least one) (Not included):

DCDC-KIT. DC/DC Conversion Kit.

- N-DCDC/I. Isolated DC/DC Conversion Module.
- N-DCDC/2T. DC/DC Conversion Module with 2 Transistors.
- N-DCDC/TD. DC/DC Conversion Module with Transistor and Diode.
- N-IGBT. IGBT Transistor Module.
- N-BJT. BJT Transistor Module.
- N-MOSFET. MOSFET Transistor Module.
- N-DTS. DIAC, TRIAC and SCR Module.

Required elements (at least one) (Not included):

- N-REF. Single Phase Fixed Resistor Module.
- N-REV. Single-Phase Variable Resistor Module.

ACDC/U-KIT. AC/DC Conversion Kit with Uncontrolled Rectification.

- N-ACDC/U. AC/DC Conversion Module with Uncontrolled Rectification.
- N-CAP. Capacitor Module.

Required elements (at least one) (Not included):

- N-REF. Single Phase Fixed Resistor Module.
- N-REV. Single-Phase Variable Resistor Module.
- N-IND. Single-phase Inductance Module.

ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.

- N-ACDC/C. AC/DC Conversion Module with Controlled Rectification.
- N-HT. Heater Module with Temperature Sensor.
- N-LAM36. 24V 15W Lamp Module.

Required elements (at least one) (Not included):

- N-REF. Single Phase Fixed Resistor Module.
- N-REV. Single-Phase Variable Resistor Module.
- N-IND. Single-phase Inductance Module.

N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.

Required elements (at least one) (Not included):

- N-REFT. 3PH Commutable Resistor Load Module.
- N-INDT. Three-phase Commutable Inductive Load Module.

ACAC-KIT. AC/AC Conversion Kit.

- N-ACAC. AC/AC Conversion Module with Dual Time Constant.
- N-DTS. DIAC, TRIAC and SCR Module.
- N-LAM08. Two Lamp Socket + Incandescent Lamps Module.

Required elements (at least one) (Not included):

- N-REF. Single Phase Fixed Resistor Module.
- N-REV. Single-Phase Variable Resistor Module.
- N-IND. Single-phase Inductance Module.

ACDCAC-KIT. AC/DC/AC Conversion Kit (Frequency or Cycle Converter).

- N-ACDC/U. AC/DC Conversion Module with Uncontrolled Rectification.
- N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.
- N-CAP. Capacitor Module.

Required elements (at least one) (Not included):

- N-REFT. 3PH Commutable Resistor Load Module.
- N-INDT. Three-phase Commutable Inductive Load Module.

CCR-DCM-KIT. AC/DC Conversion Kit with Controlled Rectification and DC/DC: DC Motor Control.

- N-ACDC/C. AC/DC Conversion Module with Controlled Rectification.
- N-DCDC/TD. DC/DC Conversion Module with Transistor and Diode.
- N-DCDC/H. DC/DC Conversion Module with H-Bridge.
- EMT24. 12 VDC Motor.
- EMT5. DC Shunt/Series/Compound Excitation Motor-Generator
- OPTS. Optical Sensor with 2500 Pulses per Revolution.

C-ACM-KIT. AC/DC/AC Conversion Kit: Three-Phase AC Motor Control.

- N-ACDC/U. AC/DC Conversion Module with Uncontrolled Rectification.
- N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.
- N-CAP. Capacitor Module.
- EMT17. 3PH Squirrel-Cage Motor with "Y" connection
- OPTS. Optical Sensor with 2500 Pulses per Revolution.

The application "AE-PEC" can be mounted on rack (option A) or on rail (option B):

Option A:

This application needs the following racks.

- N-RACK-A.
- N-RACK-B.

Optionally the AEL-WBR, Electrical workbench (rack) can be supplied to place the rack/s.

Option B:

This application can be mounted on rail.

Optionally the AEL-WBC, Electrical workbench (rail) can be supplied to mount the modules.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

With this unit there are several options and possibilities:
- Main items: 1, 2, 3 and 4.
- Optional items: 5, 6 and 7.

Let us describe first the main items (1 to 4):

① AE-PEC Application.

- N-ALI01. **Industrial Main Power Supply Module.**
  Supply voltage: 400 VAC, 3PH + N.
  ON / OFF removable key.
  Output voltage connections:
  Three-Phase + Neutral: 400 VAC.
  Single-Phase: 230 VAC.
  Three-Phase supply hose with IP44 3PN + E 32 A 400 V connecting plug.
  Differential magnetothermal 4 poles, 25 A, 300 mA AC 6 KA.
  Emergency stop push-button.

- N-ALI05. **Fixed Voltage Supply Module 12+12 VAC and +5 VDC.**
  AC Output: 12-0-12 VAC, 10 A.
  DC Output: 5 V, 3 A.

- N-ALI06. **Fixed Voltage Supply Module 18+18 VAC and ±15 VDC.**
  AC Output: 18-0-18 VAC, 10 A.
  DC Output: ±15 V, 2 A.

- N-ALI07. **Fixed Voltage Supply Module 18+18 VAC and adjustable from 0 to 30 VDC.**
  AC Output: 18-0-18 VAC, 10 A.
  DC Output: adjustable 0-30 V, 2 A.

- N-SCN. **Voltage and Current Monitoring Module with Converter Control.**
  Voltage Reference Generator:
  Range of continuous regulation reference signal: from -10 V to +10 V, from 0 to +10 V.
  Range of step reference signal: from -10 V to +10 V, from 0 to +10 V.
  Switch for selecting voltage range: between the 0 / ±10 V range and the 0 / +10 V range.
  Two Pulse Control Unit:
  Control voltage (U_c): 0 V to 10 V.
  Trigger angle: 180° to 0°.
  Number of outputs: 2 x 2.
  Inhibit voltage (U_INH): 15 V (open): Trigger pulses, 0 V: no trigger pulses.
  Six Pulse Control Unit:
  Control voltage (U_c): 0 to 10 V.
  Trigger angle: 180° to 0° (300°...120° / 60°...240°):
  Number of outputs: 3 x 2.
  Inhibit voltage (U_INH): 15 V (open): Trigger pulses, 0 V: no trigger pulses.
  PWM, Control Unit:
  Control voltage (U_c): 0 to 10 V.
  PWM: 20-200 Hz / 0.2-2 kHz / 2-20 kHz.
  Duty cycle (D): ton / T = 0-0.95.
  Number of outputs: 2 x 2, with LED indication of status.
  Output amplifier: Threshold voltage 5 V, short-circuit proof.
  Inhibit voltage (U_INH): 15 V (open): Trigger pulses, 0 V: ionger pulses at certain outputs only.
  Run-up Control Unit:
  Input signal range (U_i): -10 V to +10 V.
  Slew-rate fine adjustment: 0.5 to 50 V / s.
  Voltage gain fine adjustment: 0.1 to 1.
  Inhibit voltage (U_INH): 0 V: Zero output voltage, 15 V: normal operation.
  PID Controller:
  Signal voltage range: -10 V to +10 V.
  Controller parameters: Continuously adjustable.
  Proportional gain (K_p): 0 to 1000.
  Integral Time (T_I): 1 ms to 100s.
  Derivative Time (T_D): 0.2 ms to 20s.
  Integral controller reset input: Available.
  Error signal measurement terminal: Available.

Voltage and Current Measurement Modules for Data Acquisition:
Voltage-to-voltage gain: 0.01 V / V.
Current-to-voltage gain: 0.1 V / A.
Gain and Offset Adjust:
Input signal voltage interval: -50 V to +50 V.
Adjustable gain level: 0 to 1, 0 to 10, 0 to 100.
Pulse signal attenuation: Available.
Time constants: 0.1 to 10 ms; 10 to 100 ms.
Offset voltages: -10 V to +10 V.
Coarse setting: Through rotary switches.
Fine setting: Through potentiometer.
Data Acquisition Module: NI PCIe-6321:
Sample time: 250 Ksps.
Resolution: 16-bit.
Number of input channels: 16.
Number of output channels: 2.

Required elements (at least one) (Not included):

DCDC-KIT. DC/DC Conversion Kit.

- N-DCDC/I. **Isolated DC/DC Conversion Module.**
  Main input: one phase, fixed.
  Transformer ratio 1:1.
  Input and output with 16 A fuses.

- N-DCDC/2T. **DC/DC Conversion Module with 2 Transistors.**
  One branch of 2 transistors.
  Used semiconductor: IGBT:
  Collector-Emitter Voltage (V_CE): 600 V.
  Continuous Collector Current (I_C): 24 A at T_C = 25 °C
  Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  Gate-Emitter Voltage (V_GE): ±20 V.
  Power handling capacity: Up to 3 kW.
  Internal IGBT driver.
  Inductive loads supported (internal snubber in each transistor).
  One 33 μH inductor with current sensor for closed-loop control.
  One 1000 μF capacitor with voltage sensor for closed-loop control.
  Input and output with 16 A fuses.

- N-DCDC/TD. **DC/DC Conversion Module with Transistor and Diode.**
  One branch of one transistor and one diode.
  Used semiconductor: IGBT and diode:
  IGBT:
  Collector-Emitter Voltage (V_CE): 600 V.
  Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
  Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  Gate-Emitter Voltage (V_GE): ±20 V.
  Power handling capacity: Up to 3 kW.
  DIODE:
  Direct Average Current (I_FAV): 12 A.
  Direct Non-Repetitive Overload Current (I_FSM): 75A (tp = 10 ms).
  Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  Recovery Reverse Time (t_rr): 65 ns max.
  Power handling capacity: Up to 3 kW.
  Internal IGBT driver.
  Inductive loads supported (internal snubber in parallel with transistor).
  One 33 μH inductor with current sensor for closed-loop control.
  One 1000 μF capacitor with voltage sensor for closed-loop control.
  Input and output with 16 A fuses.

- N-IGBT. **IGBT Transistor Module.**
  Collector-Emitter Voltage (V_CE): 600 V.
  Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
  Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  Gate-Emitter Voltage (V_GE): ±20 V.
  Power handling capacity: Up to 3 kW.
  Input and output with 16 A fuses.

- N-BJT. **BJT Transistor Module.**
  Collector Current (I_c): 2.5 A.
  Collector-Emitter Voltage (V_CE): 30 V.
  Power handling capacity: Suitable for low-power triggering applications.
  Input and output with 16 A fuses.

- N-MOSFET. **MOSFET Transistor Module.**
  Drain-Source Voltage (V_DS): 400 V.
  Continuous Drain Current (I_D): 10 A.
  Drain-Source On-State Resistance (R_DS(on)): 0.55Ω.
  Gate-Source Voltage (V_GS): ±20 V.
  Power handling capacity: Up to 3 kW.
  Input and output with 16 A fuses.

- N-DTS. **DIAC, TRIAC and SCR Module.**
  SCR (Silicon Controlled Rectifier):
    Direct Average Current (I_TAV): 7.6 A max.
    True RMS Value of the Direct Current (I_TRMS): 12 A.
    Max. Repetitive Reverse Voltage (V_RRM): 800 V.
    Trigger Current (I_GT): 15 mA max.
    Trigger Voltage (V_GT): 1.5 V max.
    Power handling capacity: Up to 3 kW.
  DIAC (Diode for Alternating Current):
    Breakover Voltage (V_BO): 30 V to 40 V.
    Repetitive Peak On-State Current (I_TSM): 2 A.
    Power handling Capacity: Suitable for triggering TRIACs in low-power applications.
  TRIAC (Triode for Alternating Current):
    True RMS Value of the Direct Current (I_TAV): 8 A max.
    Non-Repetitive Peak Current (I_TSM): 70 A (50 Hz), 77A (60 Hz).
    Max. Repetitive Reverse Voltage (V_DRM): 800 V.
    Trigger Current (I_GT): 25 mA max. (all quadrants).
    Trigger Voltage (V_GT): 2.5 V max.
    State Keeping Current (I_H): 25 mA max.
    Power handling capacity: Up to 3 kW.

Required elements (at least one) (Not included):

- N-REF. **Single Phase Fixed Resistor Module.**
  Resistor value: 150 Ohm.
  Maximum power: 500 W.
  Selector:
    Position 0: Circuit opened.
    Position 1: Circuit closed.
  Fuse: 2 A.

- N-REV. **Single-Phase Variable Resistor Module. Variable resistor of 150 Ohm.**
  Maximum power: 500 W.
  Potentiometer.
  Terminals:
    Three terminals to choose all resistance or variable resistance.
  Fuse: 2 A.

ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.

- N-ACDC/U. **AC/DC Conversion Module with Uncontrolled Rectification.**
  Direct Average Current (I_FAV): 12 A.
  Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
  Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  Recovery Reverse Time (t_rr): 65 ns max.
  Power handling capacity: Up to 3 kW.

- N-CAP. **Capacitor Module.**
  Rated value: 2 x 1000 μF.
  Rated voltage: 385 V.
  Polarity inversion protection: Available.
  Discharge resistance: 330 kΩ (t = 330s).

Required elements (at least one) (Not included):

- N-REF. **Single Phase Fixed Resistor Module.**
  Resistor value: 150 Ohm.
  Maximum power: 500 W.
  Selector:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.

- N-REV. **Single-Phase Variable Resistor Module.**
  Variable resistor of 150 Ohm.
  Maximum power: 500 W.
  Potentiometer.
  Terminals:
  Three terminals to choose all resistance or variable resistance.
  Fuse: 2 A.

- N-IND. **Single-phase Inductance Module.**
  Inductance: 1.4 H.
  Switch:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.

ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.

- N-ACDC/C. **AC/DC Conversion Module with Controlled Rectification.**
  Direct Average Current (I_TAV): 7.6 A max.
  True RMS Value of the Direct Current (I_TRMS): 12 A.
  Max. Repetitive Reverse Voltage (V_RRM): 800 V.
  Trigger Current (I_GT): 15 mA max.
  Trigger Voltage (V_GT): 1.5 V max.
  Power handling capacity: Up to 3 kW.

- N-HT. **Heater Module with Temperature Sensor.**
  Resistance: 150Ω / 500 W.
  Temperature sensor: PT100:
  Temperature range: -50 to +500 °C.
  Internally conditioned to 0.05 V / °C.
  Output voltage from 0 to 10 V.
  Max. measurable temperature: 200 °C.

- N-LAM36. **24 V 15 W Lamp Module.**
  Nominal voltage: 24 VAC.
  Consumption: 15 W.

Required elements (at least one) (Not included):

- N-REF. **Single Phase Fixed Resistor Module.**
  Resistor value: 150 Ohm.
  Maximum power: 500 W.
  Selector:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.

- N-REV. **Single-Phase Variable Resistor Module.**
  Variable resistor: 150 Ohm.
  Maximum power: 500 W.
  Potentiometer.
  Terminals:
  Three terminals to choose all resistance or variable resistance.
  Fuse: 2 A.

- N-IND. **Single-phase Inductance Module.**
  Inductance: 1.4 H.
  Switch:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.

N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.

One-phase and three-phase DC-to-AC conversion supported.
Used semiconductor: IGBT:
Collector-Emitter Voltage (V_CE): 600 V.
Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
Gate-Emitter Voltage (V_GE): ±20 V.
Power handling capacity: Up to 3 kW.
Number of semiconductors: 6.
Internal IGBT driver.
Inductive loads supported (internal snubber in each transistor).
Input and output with 16 A fuses.

Required elements (at least one) (Not included):

- N-REFT. **3PH Commutable Resistor Load Module.**
  Nominal voltage: 400 VAC.
  Three-phase resistance: 3 x 150 Ohm.
  Nominal current: 1.6 A.
  Manual switch to turn activate/deactivate resistors.
  Fuses: 3 x 2 A.
  Terminals:
  Four input terminals (3PH + N).
  Four output terminals (3PH + N).

- N-INDT. **Three-phase Commutable Inductive Load Module.**
  Nominal voltage: 400 VAC.
  Inductance: 1.4 H.
  Nominal current: 1.6 A.
  Manual switch to turn activate/deactivate inductances.
  Fuses: 3 x 2 A.
  Terminals:
  Four input terminals (3PH + N).
  Four output terminals (3PH + N).

ACAC-KIT. AC/AC Conversion Kit.

- N-ACAC. **AC/AC Conversion Module with Dual Time Constant.**
  Used semiconductors: DIAC and TRIAC:
  DIAC (Diode for Alternating Current):
  Breakover Voltage (V_BO): 30 V to 40 V.
  Repetitive Peak On-State Current (I_TSM): 2 A.
  Power handling capacity: Suitable for triggering TRIACs in low-power applications.
  TRIAC (Triode for Alternating Current):
  True RMS Value of the Direct Current (I_TAV): 8 A max.
  Max. Repetitive Reverse Voltage (V_DRM): 800 V.
  Trigger Current (I_GT): 25 mA max. (all quadrants).
  Trigger Voltage (V_GT): 2.5 V max.
  State Keeping Current (I_H): 25 mA max.
  Power handling capacity: Up to 3 kW.
  Variable to control: Amplitude.
  Used technology: Double time constant.
  Input and output with 16 A fuses.

- N-DTS. **DIAC, TRIAC and SCR Module.**
  SCR (Silicon Controlled Rectifier):
  Direct Average Current (I_TAV): 7.6 A max.
  True RMS Value of the Direct Current (I_TRMS): 12 A.
  Max. Repetitive Reverse Voltage (V_RRM): 800 V.
  Trigger Current (I_GT): 15 mA max.
  Trigger Voltage (V_GT): 1.5 V max.
  Power handling capacity: Up to 3 kW.
  DIAC (Diode for Alternating Current):
  Breakover Voltage (V_BO): 30 V to 40 V.
  Repetitive Peak On-State Current (I_TSM): 2 A.
  Power handling capacity: Suitable for triggering TRIACs in low-power applications.
  TRIAC (Triode for Alternating Current):
  True RMS Value of the Direct Current (I_TAV): 8 A max.
  Non-Repetitive Peak Current (I_TSM): 70A (50 Hz), 77A (60 Hz).
  Max. Repetitive Reverse Voltage (V_DRM): 800 V.
  Trigger Current (I_GT): 25 mA max. (all quadrants).
  Trigger Voltage (V_GT): 2.5 V max.
  State Keeping Current (I_H): 25 mA max.
  Power handling capacity: Up to 3 kW.

- N-LAM08. **Two Lamp-holders + Incandescent Lamps Module.**
  Nominal voltage: 230 VAC (PH + N).
  Two bulbs:
  Consumption: 40 W each.
  Two terminals each one.

Required elements (at least one) (Not included):

- N-REF. **Single Phase Fixed Resistor Module.**
  Resistor value: 150 Ohm.
  Maximum power: 500 W.
  Selector:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.

- N-REV. **Single-Phase Variable Resistor Module.**
  Variable resistor of 150 Ohm.
  Maximum power: 500 W.
  Potentiometer.
  Terminals:
  Three terminals to choose all resistance or variable resistance.
  Fuse: 2 A.

- N-IND. **Single-phase Inductance Module.**
  Inductance: 1.4 H.
  Switch:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.

ACDCAC-KIT. AC/DC/AC Conversion Kit (Frequency or Cycle Converter).

- N-ACDC/U. **AC/DC Conversion Module with Uncontrolled Rectification.**
  Direct Average Current (I_FAV): 12 A.
  Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
  Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  Recovery Reverse Time (t_rr): 65 ns max.
  Power handling capacity: Up to 3 kW.

- N-DCAC. **Single-phase and Three-phase AC/DC Conversion Module.**
  One-phase and three-phase DC-to-AC conversion supported
  Used semiconductor: IGBT:
  Collector-Emitter Voltage (V_CE): 600 V.
  Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
  Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  Gate-Emitter Voltage (V_GE): ±20 V.
  Power handling capacity: Up to 3 kW.
  Number of semiconductors: 6.
  Internal IGBT driver.
  Inductive loads supported (internal snubber in each transistor).
  Input and output with 16 A fuses.

- N-CAP. **Capacitor Module.**
  Rated value: 2 x 1000 μF.
  Rated voltage: 385 V.
  Polarity inversion protection: Available.
  Discharge resistance: 330 kΩ (t = 330s).

Required elements (at least one) (Not included):

- N-REFT. **3PH Commutable Resistor Load Module.**
  Nominal voltage: 400 VAC.
  Three-phase resistance: 3 x 150 Ohm.
  Nominal current: 1.6 A.
  Manual switch to turn activate/deactivate resistors.
  Fuses: 3 x 2 A.
  Terminals:
  Four input terminals (3PH + N).
  Four output terminals (3PH + N).

- N-INDT. **Three-phase Commutable Inductive Load Module.**
  Nominal voltage: 400 VAC.
  Inductance: 1.4 H.
  Nominal current: 1.6 A.
  Manual switch to turn activate/deactivate inductances.
  Fuses: 3 x 2 A.
  Terminals:
  Four input terminals (3PH + N).
  Four output terminals (3PH + N).

CCR-DCM-KIT. AC/DC Conversion Kit with Controlled Rectification and DC/DC: DC Motor Control.

- N-ACDC/C. **AC/DC Conversion Module with Controlled Rectification.**
  Direct Average Current (I_TAV): 7.6 A max.
  True RMS Value of the Direct Current (I_TRMS): 12 A.
  Max. Repetitive Reverse Voltage (V_RRM): 800 V.
  Trigger Current (I_GT): 15 mA max.
  Trigger Voltage (V_GT): 1.5 V max.
  Power handling capacity: Up to 3 kW.
  A diode to connect in parallel and inverse for inductive loads.

- N-DCDC/TD. **DC/DC Conversion Module with Transistor and Diode.**
  One branch of one transistor and one diode.
  Used semiconductor: IGBT and diode:
  IGBT:
  Collector-Emitter Voltage (V_CE): 600 V.
  Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
  Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  Gate-Emitter Voltage (V_GE): ±20 V.
  Power handling capacity: Up to 3 kW.
  DIODE:
  Direct Average Current (I_FAV): 12 A.
  Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
  Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  Recovery Reverse Time (t_rr): 65 ns max.
  Power handling capacity: Up to 3 kW.
  Internal IGBT driver.
  Inductive loads supported (internal snubber in parallel with transistor).
  One 33 μH inductor with current sensor for closed-loop control.
  One 1000 μF capacitor with voltage sensor for closed-loop control.
  Input and output with 16 A fuses.

- N-DCDC/H. **DC/DC Conversion Module with H-Bridge.**
  H Bridge to control the polarity and the amplitude of the DC voltage.
  Used semiconductor: IGBT:
  Collector-Emitter Voltage (V_CE): 600 V.
  Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
  Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  Gate-Emitter Voltage (V_GE): ±20 V.
  Power handling capacity: Up to 3 kW.
  Number of semiconductors: 4.
  Internal IGBT driver.
  Inductive loads supported (internal snubber in each transistor).
  Input and output with 16 A fuses.

- EMT24. **12 VDC Motor.**
  Nominal power: 120 W.
  Rated voltage: 12 V.
  Speed: 10000 rpm.
  Rated current: 10 A.
  Shaft height: 71 mm.

- EMT5. **DC Shunt/Series/Compound Excitation Motor-Generator.**
  Nominal power: 300 W.
  Armature voltage: 200 VDC.
  Excitation voltage: 230 VDC.
  Armature current: 1.5 A.
  Excitation current: 0.4 A.
  Speed: 3400 / 7500 rpm.
  Shaft height: 71 mm.

- OPTS. **Optical Sensor with 2500 Pulses per Revolution.**
  Speed range: 0 – 6000 rpm.
  Accuracy class: 1.5.
  Resolution: 2500 pulses per revolution and position detection.
  Power supply: 5 V.

C-ACM-KIT. AC/DC/AC Conversion Kit: Three-Phase AC Motor Control.

- N-ACDC/U. **AC/DC Conversion Module with Uncontrolled Rectification.**
  Direct Average Current (I_FAV): 12 A.
  Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
  Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  Recovery Reverse Time (t_rr): 65 ns max.
  Power handling capacity: Up to 3 kW.

- N-DCAC. **Single-phase and Three-phase AC/DC Conversion Module.**
  One-phase and Three-phase DC-to-AC conversion supported.
  Used semiconductor: IGBT:
    Collector-Emitter Voltage (V_CE): 600 V.
    Continuous Collector Current (I_C): 24A at T_C = 25 °C.
    Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
    Gate-Emitter Voltage (V_GE): ±20 V.
    Power handling capacity: Up to 3 kW.
  Number of semiconductors: 6.
  Internal IGBT driver.
  Inductive loads supported (internal snubber in each transistor).
  Input and output with 16 A fuses.

- N-CAP. **Capacitor Module.**
  Rated value: 2 x 1000 μF.
  Rated voltage: 385 V.
  Polarity inversion protection: Available.
  Discharge resistance: 330 kΩ (t = 330s).

- EMT17. **3PH Squirrel-Cage Motor with "Y" connection.**
  Nominal power: 370 W.
  Nominal voltage: 3 x 400 VAC Y.
  Frequency: 50/60 Hz.
  Number of poles: 2.
  Speed: 2730 rpm.
  Nominal current: 0.97 A.
  Shaft height: 71 mm.

- OPTS. **Optical Sensor with 2500 Pulses per Revolution.**
  Speed range: 0 – 6000 rpm.
  Accuracy class: 1.5.
  Resolution: 2500 pulses per revolution and position detection.
  Power supply: 5 V.

- **All necessary cables to realize the practical exercises are included.**

The complete unit includes as well:

Advanced Real-Time SCADA.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

Capable of doing applied research, real industrial simulation, training courses, etc.

Remote operation and control by the user, as well as remote support from EDIBON technical support, are always included.

Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).

Designed and manufactured under several quality standards.

Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.

This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② **AE-PEC/CCSOF. Computer Control + Data Acquisition + Data Management Software:**

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

AE-PEC/CCSOF

③ **Cables and Accessories**, for normal operation.

④ **Manuals:**

This unit **is supplied with 7 manuals:** Required services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance & Practices manuals.

∗References 1 to 4 are the main items: AE-PEC + AE-PEC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

1.- Measurement of AC and DC voltages and currents: using digital voltmeters and ammeters to measure different voltage and current ranges.
2.- Characterization of power devices: Hands-on experiments with SCRs, MOSFETs, IGBTs, DIACs, TRIACs, UJTs, power transistors, and power diodes.
3.- Load testing: analysis of system behavior with different loads, including lamps, AC and DC motors.
4.- Firing control circuits: experiments with line synchronization, PWM control, and TRIAC firing control circuits.
5.- Power supply analysis: study of fixed AC and DC power supplies and their behavior under different load conditions.
6.- Implementation and testing of PWM firing control circuits with frequency adjustment.
7.- Measuring and calculating the efficiency of various power electronics components and circuits.
8.- Identifying and analyzing common faults in power electronics systems and learning troubleshooting techniques.
9.- Testing individual components like capacitors, inductors, and resistors mounted on the panels.
10.- Practical exercises in regulating voltage and current using different power electronics components.
11.- Studying the impact of temperature on the performance of power devices.
12.- Exploring the behavior of components in series and parallel configurations.
13.- Analyzing the dynamic response of power electronics systems to changes in load.
14.- Measuring and analyzing the harmonics in power electronics circuits.
15.- Observing and analyzing transient phenomena in power electronics circuits.
16.- Integrating and testing energy storage solutions like capacitors and batteries.
17.- Controlling the speed and direction of a DC motor using power electronics circuits.
18.- Simulation and modeling: using simulation tools to model and analyze power electronics circuits.
19.- Power factor correction: implementing and testing power factor correction techniques.
20.- Renewable energy integration: exploring the integration of renewable energy sources with power electronics systems.

Other possibilities to be done with this unit:

21.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
22.- Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
23.- The Computer Control System with SCADA allows a real industrial simulation.
24.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
25.- This unit can be used for doing applied research.
26.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
27.- Control of the AE-PEC unit process through the control interface box without the computer.
28.- Visualization of all the sensors values used in the AE-PEC unit process.

- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: three-phase, 380 VAC – 400 VAC/50 Hz or 190 VAC – 240 VAC/60 Hz, 1 kW.
- Computer.

DIMENSIONS AND WEIGHTS

AE-PEC:
- Dimensions: 1200 x 600 x 800 mm approx.
(47.24 x 23.62 x 31.50 inches approx.)
- Weight: 65 Kg approx.
(143.30 pounds approx.)

REQUIRED ELEMENTS (Not included)

Required (at least one):
- DCDC-KIT. DC/DC Conversion Kit.
- ACDC/U-KIT. AC/DC Conversion Kit with Uncontrolled Rectification.
- ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.
- N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.
- ACAC-KIT. AC/AC Conversion Kit.
- ACDCAC-KIT. AC/DC/AC Conversion Kit (Frequency or Cycle Converter).
- CCR-DCM-KIT. AC/DC Conversion Kit with Controlled Rectification and DC/DC: DC Motor Control.
- C-ACM-KIT. AC/DC/AC Conversion Kit: Three-Phase AC Motor Control.

SIMILAR UNITS AVAILABLE

Offered in this catalog:
- AE-PEC. Computer Controlled Advanced Power Electronics Application.

Offered in other catalogs:
- TECNEL. Computer Controlled Teaching Unit for the Study of Power Electronics (with IGBTS).
- TECNEL/B. Computer Controlled Basic Teaching Unit for the Study of Power Electronics (no IGBTS). (Converters: AC/DC+AC/AC).

Additionally to the main items (1 to 4) described, we can offer, as optional, other items from 5 to 7.
All these items try to give more possibilities for:

a) Technical and Vocational Education configuration. (ICAI)
b) Multipost Expansions options. (MINI ESN and ESN)

a) Technical and Vocational Education configuration

⑤ AE-PEC/ICAI. Interactive Computer Aided Instruction Software.

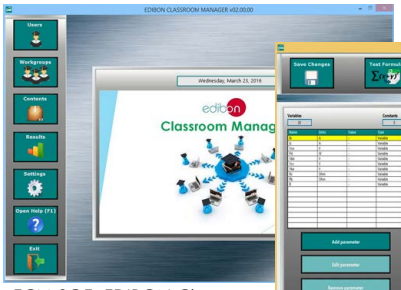
This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

This software is optional and can be used additionally to items (1 to 4).

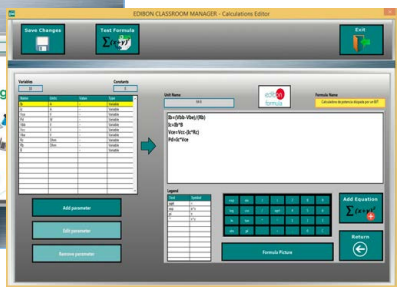
Instructor Software

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.



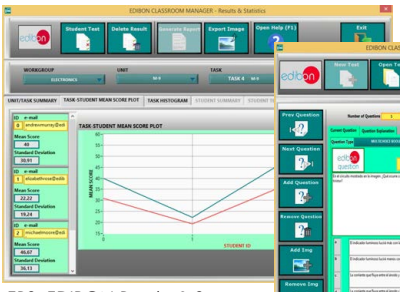
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



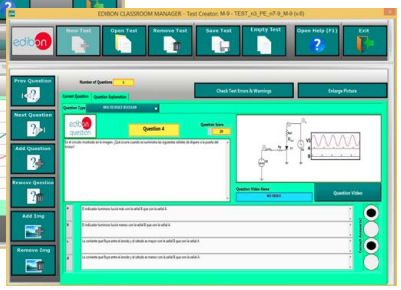
ECAL. EDIBON Calculations Program Package - Formula Editor Screen

Innovative features:

- **User Data Base Management.**
- **Administration and assignment of Workgroup, Task and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation System Solver Engine.**
- **Updatable Contents.**
- **Report generation, User Progression Monitoring and Statistics.**



ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram



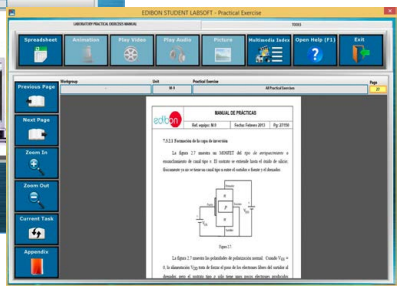
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

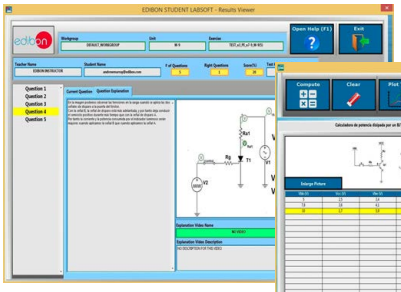
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



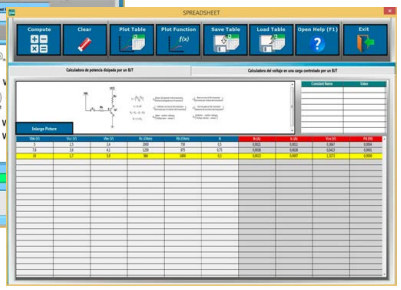
EPE. EDIBON Practical Exercise Program Package Main Screen

Innovative features:

- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge and progression.**
- **Test self-correction.**
- **Calculations computing and plotting.**
- **Equation System Solver Engine.**
- **User Monitoring Learning & Printable Reports.**
- **Multimedia-Supported auxiliary resources.**



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

For more information see **ICAI** catalogue. Click on the following link:

www.edibon.com/en/interactive-computer-aided-instruction-software

b) Multipost Expansions options

⑥ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

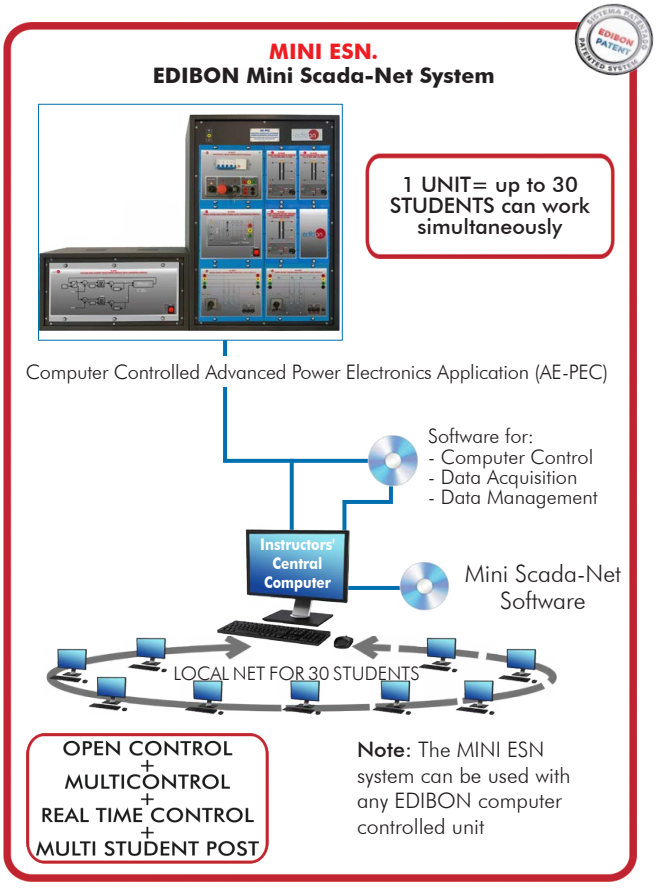
- **It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.**
- **Open Control + Multicontrol + Real Time Control + Multi Student Post.**
- **Instructor controls and explains to all students at the same time.**
- **Any user/student can work doing "real time" control/multicontrol and visualisation.**
- **Instructor can see in the computer what any user/student is doing in the unit.**
- **Continuous communication between the instructor and all the users/students connected.**

Main advantages:

- **It allows an easier and quicker understanding.**
- **This system allows you can save time and cost.**
- **Future expansions with more EDIBON Units.**

For more information see **MINI ESN** catalogue. Click on the following link:

www.edibon.com/en/edibon-scada-net



⑦ ESN. EDIBON Scada-Net Systems.

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

For more information see **ESN** catalogue. Click on the following link:

www.edibon.com/en/edibon-scada-net

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

①Unit: AE-PEC. Computer Controlled Advanced Power Electronics Application.

②AE-PEC/CCSOF. Computer Control + Data Acquisition + Data Management Software.

③Cables and Accessories, for normal operation.

④Manuals.

*IMPORTANT: Under AE-PEC we always supply all the elements for immediate running as 1, 2, 3 and 4.

Optional items (supplied under specific order)

a) Technical and Vocational Education configuration

⑤ AE-PEC/ICAI. Interactive Computer Aided Instruction Software.

b) Multipost Expansions options

⑥ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑦ ESN. EDIBON Scada-Net Systems.

①AE-PEC Application.

- N-ALI01. Industrial Main Power Supply Module.
  - Supply voltage: 400 VAC, 3PH + N.
  - ON / OFF removable key.
  - Output voltage connections:
    - Three-Phase + Neutral: 400 VAC.
    - Single-Phase: 230 VAC.
  - Three-Phase supply hose with IP44 3PN + E 32 A 400 V connecting plug.
  - Differential magnetothermal 4 poles, 25 A, 300 mA AC 6 KA.
  - Emergency stop push-button.
- N-ALI05. Fixed Voltage Supply Module 12+12 VAC and +5 VDC.
  - AC Output: 12-0-12 VAC, 10 A.
  - DC Output: 5 V, 3 A.
- N-ALI06. Fixed Voltage Supply Module 18+18 VAC and ±15 VDC.
  - AC Output: 18-0-18 VAC, 10 A.
  - DC Output: ±15 V, 2 A.
- N-ALI07. Fixed Voltage Supply Module 18+18 VAC and adjustable from 0 to 30 VDC.
  - AC Output: 18-0-18 VAC, 10 A.
  - DC Output: adjustable 0-30 V, 2 A.
- N-SCN. Voltage and Current Monitoring Module with Converter Control.
  - Voltage Reference Generator:
    - Range of continuous regulation reference signal: from -10 V to +10 V, from 0 to +10 V.
    - Range of step reference signal: from -10 V to +10 V, from 0 to +10 V.
    - Switch for selecting voltage range: between the 0 / ±10 V range and the 0 / +10 V range.
  - Two Pulse Control Unit:
    - Control voltage (U_c): 0 V to 10 V.
    - Trigger angle: 180° to 0°.
    - Number of outputs: 2 x 2.
    - Inhibit voltage (U_INH): 15 V (open): Trigger pulses, 0 V: no trigger pulses.
  - Six Pulse Control Unit:
    - Control voltage (U_c): 0 to 10 V.
    - Trigger angle: 180° to 0° (300°...120° / 60°...240°):
    - Number of outputs: 3 x 2.
    - Inhibit voltage (U_INH): 15 V (open): Trigger pulses, 0 V: no trigger pulses.
  - PWM, Control Unit:
    - Control voltage (U_c): 0 to 10 V.
    - PWM: 20-200 Hz / 0.2-2 kHz / 2-20 kHz.
    - Duty cycle (D): ton / T = 0-0.95.
    - Number of outputs: 2 x 2, with LED indication of status.
    - Output amplifier: Threshold voltage 5 V, short-circuit proof.
    - Inhibit voltage (U_INH): 15 V (open): Trigger pulses, 0 V: ionger pulses at certain outputs only.
  - Run-up Control Unit:
    - Input signal range (U_i): -10 V to +10 V.
    - Slew-rate fine adjustment: 0.5 to 50 V / s.
    - Voltage gain fine adjustment: 0.1 to 1.
    - Inhibit voltage (U_INH): 0 V: Zero output voltage, 15 V: normal operation.
  - PID Controller:
    - Signal voltage range: -10 V to +10 V.
    - Controller parameters: Continuously adjustable.
    - Proportional gain (K_p): 0 to 1000.
    - Integral Time (T_I): 1 ms to 100s.
    - Derivative Time (T_D): 0.2 ms to 20s.
    - Integral controller reset input: Available.
    - Error signal measurement terminal: Available.
  - Voltage and Current Measurement Modules for Data Acquisition:
    - Voltage-to-voltage gain: 0.01 V / V.
    - Current-to-voltage gain: 0.1 V / A.
  - Gain and Offset Adjust:
    - Input signal voltage interval: -50 V to +50 V.
    - Adjustable gain level: 0 to 1, 0 to 10, 0 to 100.
    - Pulse signal attenuation: Available.
    - Time constants: 0.1 to 10 ms; 10 to 100 ms.
    - Offset voltages: -10 V to +10 V.
    - Coarse setting: Through rotary switches.
    - Fine setting: Through potentiometer.
  - Data Acquisition Module: NI PCIe-6321:
    - Sample time: 250 Ksps.
    - Resolution: 16-bit.
    - Number of input channels: 16.
    - Number of output channels: 2.

Required elements (at least one) (Not included):

DCDC-KIT. DC/DC Conversion Kit.

- N-DCDC/I. Isolated DC/DC Conversion Module.
  - Main input: one phase, fixed.
  - Transformer ratio 1:1.
  - Input and output with 16 A fuses.
- N-DCDC/2T. DC/DC Conversion Module with 2 Transistors.
  - One branch of 2 transistors.
  - Used semiconductor: IGBT:
    - Collector-Emitter Voltage (V_CE): 600 V.
    - Continuous Collector Current (I_C): 24 A at T_C = 25 °C
    - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
    - Gate-Emitter Voltage (V_GE): ±20 V.
    - Power handling capacity: Up to 3 kW.
  - Internal IGBT driver.
  - Inductive loads supported (internal snubber in each transistor).
  - One 33 μH inductor with current sensor for closed-loop control.
  - One 1000 μF capacitor with voltage sensor for closed-loop control.
  - Input and output with 16 A fuses.
- N-DCDC/TD. DC/DC Conversion Module with Transistor and Diode.
  - One branch of one transistor and one diode.
  - Used semiconductor: IGBT and diode:
    - IGBT:
      - Collector-Emitter Voltage (V_CE): 600 V.
      - Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
      - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
      - Gate-Emitter Voltage (V_GE): ±20 V.
      - Power handling capacity: Up to 3 kW.
    - DIODE:
      - Direct Average Current (I_FAV): 12 A.
      - Direct Non-Repetitive Overload Current (I_FSM): 75A (tp = 10 ms).
      - Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
      - Recovery Reverse Time (t_rr): 65 ns max.
      - Power handling capacity: Up to 3 kW.
  - Internal IGBT driver.
  - Inductive loads supported (internal snubber in parallel with transistor).
  - One 33 μH inductor with current sensor for closed-loop control.
  - One 1000 μF capacitor with voltage sensor for closed-loop control.
  - Input and output with 16 A fuses.
- N-IGBT. IGBT Transistor Module.
  - Collector-Emitter Voltage (V_CE): 600 V.
  - Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
  - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  - Gate-Emitter Voltage (V_GE): ±20 V.
  - Power handling capacity: Up to 3 kW.
  - Input and output with 16 A fuses.
- N-BJT. BJT Transistor Module.
  - Collector Current (I_c): 2.5 A.
  - Collector-Emitter Voltage (V_CE): 30 V.
  - Power handling capacity: Suitable for low-power triggering applications.
  - Input and output with 16 A fuses.
- N-MOSFET. MOSFET Transistor Module.
  - Drain-Source Voltage (V_DS): 400 V.
  - Continuous Drain Current (I_D): 10 A.
  - Drain-Source On-State Resistance (R_DS(on)): 0.55Ω.
  - Gate-Source Voltage (V_GS): ±20 V.
  - Power handling capacity: Up to 3 kW.
  - Input and output with 16 A fuses.
- N-DTS. DIAC, TRIAC and SCR Module.
  - SCR (Silicon Controlled Rectifier):
    - Direct Average Current (I_TAV): 7.6 A max.
    - True RMS Value of the Direct Current (I_TRMS): 12 A.
    - Max. Repetitive Reverse Voltage (V_RRM): 800 V.
    - Trigger Current (I_GT): 15 mA max.
    - Trigger Voltage (V_GT): 1.5 V max.
    - Power handling capacity: Up to 3 kW.
  - DIAC (Diode for Alternating Current):
    - Breakover Voltage (V_BO): 30 V to 40 V.
    - Repetitive Peak On-State Current (I_TSM): 2 A.
    - Power handling Capacity: Suitable for triggering TRIACs in low-power applications.
  - TRIAC (Triode for Alternating Current):
    - True RMS Value of the Direct Current (I_TAV): 8 A max.
    - Non-Repetitive Peak Current (I_TSM): 70 A (50 Hz), 77A (60 Hz).
    - Max. Repetitive Reverse Voltage (V_DRM): 800 V.
    - Trigger Current (I_GT): 25 mA max. (all quadrants).
    - Trigger Voltage (V_GT): 2.5 V max.
    - State Keeping Current (I_H): 25 mA max.
    - Power handling capacity: Up to 3 kW.

Required elements (at least one) (Not included):
- N-REF. Single Phase Fixed Resistor Module.
  Resistor value: 150 Ohm.
  Maximum power: 500 W.
  Selector:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.
- N-REV. Single-Phase Variable Resistor Module. Variable resistor of 150 Ohm.
  Maximum power: 500 W.
  Potentiometer.
  Terminals:
  Three terminals to choose all resistance or variable resistance.
  Fuse: 2 A.

ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.
- N-ACDC/U. AC/DC Conversion Module with Uncontrolled Rectification.
  Direct Average Current (I_FAV): 12 A.
  Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
  Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  Recovery Reverse Time (t_rr): 65 ns max.
  Power handling capacity: Up to 3 kW.
- N-CAP. Capacitor Module.
  Rated value: 2 x 1000 μF.
  Rated voltage: 385 V.
  Polarity inversion protection: Available.
  Discharge resistance: 330 kΩ (t = 330s).

Required elements (at least one) (Not included):
- N-REF. Single Phase Fixed Resistor Module.
  Resistor value: 150 Ohm.
  Maximum power: 500 W.
  Selector:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.
- N-REV. Single-Phase Variable Resistor Module.
  Variable resistor of 150 Ohm.
  Maximum power: 500 W.
  Potentiometer.
  Terminals:
  Three terminals to choose all resistance or variable resistance.
  Fuse: 2 A.
- N-IND. Single-phase Inductance Module.
  Inductance: 1.4 H.
  Switch:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.

ACDC/C-KIT. AC/DC Conversion Kit with Controlled Rectification.
- N-ACDC/C. AC/DC Conversion Module with Controlled Rectification.
  Direct Average Current (I_TAV): 7.6 A max.
  True RMS Value of the Direct Current (I_TRMS): 12 A.
  Max. Repetitive Reverse Voltage (V_RRM): 800 V.
  Trigger Current (I_GT): 15 mA max.
  Trigger Voltage (V_GT): 1.5 V max.
  Power handling capacity: Up to 3 kW.
- N-HT. Heater Module with Temperature Sensor.
  Resistance: 150Ω / 500 W.
  Temperature sensor: PT100:
  Temperature range: -50 to +500 °C.
  Internally conditioned to 0.05 V / °C.
  Output voltage from 0 to 10 V.
  Max. measurable temperature: 200 °C.
- N-LAM36. 24 V 15 W Lamp Module.
  Nominal voltage: 24 VAC.
  Consumption: 15 W.

Required elements (at least one) (Not included):
- N-REF. Single Phase Fixed Resistor Module.
  Resistor value: 150 Ohm.
  Maximum power: 500 W.
  Selector:
  Position 0: Circuit opened.
  Position 1: Circuit closed.
  Fuse: 2 A.
- N-REV. Single-Phase Variable Resistor Module.
  Variable resistor: 150 Ohm.
  Maximum power: 500 W.
  Potentiometer.
  Terminals:
  Three terminals to choose all resistance or variable resistance.
  Fuse: 2 A.

- N-IND. Single-phase Inductance Module.
  - Inductance: 1.4 H.
  - Switch:
    - Position 0: Circuit opened.
    - Position 1: Circuit closed.
  - Fuse: 2 A.

N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.
- One-phase and three-phase DC-to-AC conversion supported.
- Used semiconductor: IGBT:
  - Collector-Emitter Voltage (V_CE): 600 V.
  - Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
  - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
  - Gate-Emitter Voltage (V_GE): ±20 V.
  - Power handling capacity: Up to 3 kW.
- Number of semiconductors: 6.
- Internal IGBT driver.
- Inductive loads supported (internal snubber in each transistor).
- Input and output with 16 A fuses.
- Required elements (at least one) (Not included):
  - N-REFT. 3PH Commutable Resistor Load Module.
    - Nominal voltage: 400 VAC.
    - Three-phase resistance: 3 x 150 Ohm.
    - Nominal current: 1.6 A.
    - Manual switch to turn activate/deactivate resistors.
    - Fuses: 3 x 2 A.
    - Terminals:
      - Four input terminals (3PH + N).
      - Four output terminals (3PH + N).
  - N-INDT. Three-phase Commutable Inductive Load Module.
    - Nominal voltage: 400 VAC.
    - Inductance: 1.4 H.
    - Nominal current: 1.6 A.
    - Manual switch to turn activate/deactivate inductances.
    - Fuses: 3 x 2 A.
    - Terminals:
      - Four input terminals (3PH + N).
      - Four output terminals (3PH + N).

ACAC-KIT. AC/AC Conversion Kit.
- N-ACAC. AC/AC Conversion Module with Dual Time Constant.
  - Used semiconductors: DIAC and TRIAC:
    - DIAC (Diode for Alternating Current):
      - Breakover Voltage (V_BO): 30 V to 40 V.
      - Repetitive Peak On-State Current (I_TSM): 2 A.
      - Power handling capacity: Suitable for triggering TRIACs in low-power applications.
    - TRIAC (Triode for Alternating Current):
      - True RMS Value of the Direct Current (I_TAV): 8 A max.
      - Max. Repetitive Reverse Voltage (V_DRM): 800 V.
      - Trigger Current (I_GT): 25 mA max. (all quadrants).
      - Trigger Voltage (V_GT): 2.5 V max.
      - State Keeping Current (I_H): 25 mA max.
      - Power handling capacity: Up to 3 kW.
  - Variable to control: Amplitude.
  - Used technology: Double time constant.
  - Input and output with 16 A fuses.
- N-DTS. DIAC, TRIAC and SCR Module.
  - SCR (Silicon Controlled Rectifier):
    - Direct Average Current (I_TAV): 7.6 A max.
    - True RMS Value of the Direct Current (I_TRMS): 12 A.
    - Max. Repetitive Reverse Voltage (V_RRM): 800 V.
    - Trigger Current (I_GT): 15 mA max.
    - Trigger Voltage (V_GT): 1.5 V max.
    - Power handling capacity: Up to 3 kW.
  - DIAC (Diode for Alternating Current):
    - Breakover Voltage (V_BO): 30 V to 40 V.
    - Repetitive Peak On-State Current (I_TSM): 2 A.
    - Power handling capacity: Suitable for triggering TRIACs in low-power applications.
  - TRIAC (Triode for Alternating Current):
    - True RMS Value of the Direct Current (I_TAV): 8 A max.
    - Non-Repetitive Peak Current (I_TSM): 70A (50 Hz), 77A (60 Hz).
    - Max. Repetitive Reverse Voltage (V_DRM): 800 V.
    - Trigger Current (I_GT): 25 mA max. (all quadrants).
    - Trigger Voltage (V_GT): 2.5 V max.
    - State Keeping Current (I_H): 25 mA max.
    - Power handling capacity: Up to 3 kW.
- N-LAM08. Two Lamp-holders + Incandescent Lamps Module.
  - Nominal voltage: 230 VAC (PH + N).
  - Two bulbs:
    - Consumption: 40 W each.
    - Two terminals each one.

Required elements (at least one) (Not included):
- N-REF. Single Phase Fixed Resistor Module.
  - Resistor value: 150 Ohm.
  - Maximum power: 500 W.
  - Selector:
    - Position 0: Circuit opened.
    - Position 1: Circuit closed.
  - Fuse: 2 A.
- N-REV. Single-Phase Variable Resistor Module.
  - Variable resistor of 150 Ohm.
  - Maximum power: 500 W.
  - Potentiometer.
  - Terminals:
    - Three terminals to choose all resistance or variable resistance.
  - Fuse: 2 A.
- N-IND. Single-phase Inductance Module.
  - Inductance: 1.4 H.
  - Switch:
    - Position 0: Circuit opened.
    - Position 1: Circuit closed.
  - Fuse: 2 A.

ACDCAC-KIT. AC/DC/AC Conversion Kit (Frequency or Cycle Converter).
- N-ACDC/U. AC/DC Conversion Module with Uncontrolled Rectification.
  - Direct Average Current (I_FAV): 12 A.
  - Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
  - Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  - Recovery Reverse Time (t_rr): 65 ns max.
  - Power handling capacity: Up to 3 kW.
- N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.
  - One-phase and three-phase DC-to-AC conversion supported
  - Used semiconductor: IGBT:
    - Collector-Emitter Voltage (V_CE): 600 V.
    - Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
    - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
    - Gate-Emitter Voltage (V_GE): ±20 V.
    - Power handling capacity: Up to 3 kW.
  - Number of semiconductors: 6.
  - Internal IGBT driver.
  - Inductive loads supported (internal snubber in each transistor).
  - Input and output with 16 A fuses.
- N-CAP. Capacitor Module.
  - Rated value: 2 x 1000 μF.
  - Rated voltage: 385 V.
  - Polarity inversion protection: Available.
  - Discharge resistance: 330 kΩ (t = 330s).

Required elements (at least one) (Not included):
- N-REFT. 3PH Commutable Resistor Load Module.
  - Nominal voltage: 400 VAC.
  - Three-phase resistance: 3 x 150 Ohm.
  - Nominal current: 1.6 A.
  - Manual switch to turn activate/deactivate resistors.
  - Fuses: 3 x 2 A.
  - Terminals:
    - Four input terminals (3PH + N).
    - Four output terminals (3PH + N).
- N-INDT. Three-phase Commutable Inductive Load Module.
  - Nominal voltage: 400 VAC.
  - Inductance: 1.4 H.
  - Nominal current: 1.6 A.
  - Manual switch to turn activate/deactivate inductances.
  - Fuses: 3 x 2 A.
  - Terminals:
    - Four input terminals (3PH + N).
    - Four output terminals (3PH + N).

CCR-DCM-KIT. AC/DC Conversion Kit with Controlled Rectification and DC/DC: DC Motor Control.
- N-ACDC/C. AC/DC Conversion Module with Controlled Rectification.
  - Direct Average Current (I_TAV): 7.6 A max.
  - True RMS Value of the Direct Current (I_TRMS): 12 A.
  - Max. Repetitive Reverse Voltage (V_RRM): 800 V.
  - Trigger Current (I_GT): 15 mA max.
  - Trigger Voltage (V_GT): 1.5 V max.
  - Power handling capacity: Up to 3 kW.
  - A diode to connect in parallel and inverse for inductive loads.

- N-DCDC/TD. DC/DC Conversion Module with Transistor and Diode.
  - One branch of one transistor and one diode.
  - Used semiconductor: IGBT and diode:
    - IGBT:
      - Collector-Emitter Voltage (V_CE): 600 V.
      - Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
      - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
      - Gate-Emitter Voltage (V_GE): ±20 V.
      - Power handling capacity: Up to 3 kW.
    - DIODE:
      - Direct Average Current (I_FAV): 12 A.
      - Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
      - Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
      - Recovery Reverse Time (t_rr): 65 ns max.
      - Power handling capacity: Up to 3 kW.
  - Internal IGBT driver.
  - Inductive loads supported (internal snubber in parallel with transistor).
  - One 33 μH inductor with current sensor for closed-loop control.
  - One 1000 μF capacitor with voltage sensor for closed-loop control.
  - Input and output with 16 A fuses.
- N-DCDC/H. DC/DC Conversion Module with H-Bridge.
  - H Bridge to control the polarity and the amplitude of the DC voltage.
  - Used semiconductor: IGBT:
    - Collector-Emitter Voltage (V_CE): 600 V.
    - Continuous Collector Current (I_C): 24 A at T_C = 25 °C.
    - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
    - Gate-Emitter Voltage (V_GE): ±20 V.
    - Power handling capacity: Up to 3 kW.
  - Number of semiconductors: 4.
  - Internal IGBT driver.
  - Inductive loads supported (internal snubber in each transistor).
  - Input and output with 16 A fuses.
- EMT24. 12 VDC Motor.
  - Nominal power: 120 W.
  - Rated voltage: 12 V.
  - Speed: 10000 rpm.
  - Rated current: 10 A.
  - Shaft height: 71 mm.
- EMT5. DC Shunt/Series/Compound Excitation Motor-Generator.
  - Nominal power: 300 W.
  - Armature voltage: 200 VDC.
  - Excitation voltage: 230 VDC.
  - Armature current: 1.5 A.
  - Excitation current: 0.4 A.
  - Speed: 3400 / 7500 rpm.
  - Shaft height: 71 mm.
- OPTS. Optical Sensor with 2500 Pulses per Revolution.
  - Speed range: 0 – 6000 rpm.
  - Accuracy class: 1.5.
  - Resolution: 2500 pulses per revolution and position detection.
  - Power supply: 5 V.

C-ACM-KIT. AC/DC/AC Conversion Kit: Three-Phase AC Motor Control.

- N-ACDC/U. AC/DC Conversion Module with Uncontrolled Rectification.
  - Direct Average Current (I_FAV): 12 A.
  - Direct Non-Repetitive Overload Current (I_FSM): 75 A (tp = 10 ms).
  - Repetitive Peak Reverse Voltage (V_RRM): 1000 V.
  - Recovery Reverse Time (t_rr): 65 ns max.
  - Power handling capacity: Up to 3 kW.
- N-DCAC. Single-phase and Three-phase AC/DC Conversion Module.
  - One-phase and Three-phase DC-to-AC conversion supported.
  - Used semiconductor: IGBT:
    - Collector-Emitter Voltage (V_CE): 600 V.
    - Continuous Collector Current (I_C): 24A at T_C = 25 °C.
    - Collector-Emitter Saturation Voltage (V_CEsat): 1.8 V typical at I_C =15 A.
    - Gate-Emitter Voltage (V_GE): ±20 V.
    - Power handling capacity: Up to 3 kW.
  - Number of semiconductors: 6.
  - Internal IGBT driver.
  - Inductive loads supported (internal snubber in each transistor).
  - Input and output with 16 A fuses.
- N-CAP. Capacitor Module.
  - Rated value: 2 x 1000 μF.
  - Rated voltage: 385 V.
  - Polarity inversion protection: Available.
  - Discharge resistance: 330 kΩ (t = 330s).
- EMT17. 3PH Squirrel-Cage Motor with "Y" connection.
  - Nominal power: 370 W.
  - Nominal voltage: 3 x 400 VAC Y.
  - Frequency: 50/60 Hz.
  - Number of poles: 2.
  - Speed: 2730 rpm.
  - Nominal current: 0.97 A.
  - Shaft height: 71 mm.

- OPTS. Optical Sensor with 2500 Pulses per Revolution.
  Speed range: 0 – 6000 rpm.
  Accuracy class: 1.5.
  Resolution: 2500 pulses per revolution and position detection.
  Power supply: 5 V.

• All necessary cables to realize the practical exercises are included.

The complete unit includes as well:

Advanced Real-Time SCADA.
Open Control + Multicontrol + Real-Time Control.
Specialized EDIBON Control Software based on LabVIEW.
Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
Capable of doing applied research, real industrial simulation, training courses, etc.
Remote operation and control by the user, as well as remote support from EDIBON technical support, are always included.
Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
Designed and manufactured under several quality standards.
Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

②AE-PEC/CCSOF. Computer Control +Data Acquisition+Data Management Software:

The three softwares are part of the SCADA system.
Compatible with the industry standards.
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
Management, processing, comparison and storage of data.
It allows the registration of the alarms state and the graphic representation in real time.
Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

③Cables and Accessories, for normal operation.

④Manuals:

This unit is supplied with 7 manuals: Required Services, Assembly and Installation Control Software, Starting-up, Safety, Maintenance & Practices Manuals.

Exercises and Practical Possibilities to be done with the Main Items

1.- Measurement of AC and DC voltages and currents: using digital voltmeters and ammeters to measure different voltage and current ranges.
2.- Characterization of power devices: Hands-on experiments with SCRs, MOSFETs, IGBTs, DIACs, TRIACs, UJTs, power transistors, and power diodes.
3.- Load testing: analysis of system behavior with different loads, including lamps, AC and DC motors.
4.- Firing control circuits: experiments with line synchronization, PWM control, and TRIAC firing control circuits.
5.- Power supply analysis: study of fixed AC and DC power supplies and their behavior under different load conditions.
6.- Implementation and testing of PWM firing control circuits with frequency adjustment.
7.- Measuring and calculating the efficiency of various power electronics components and circuits.
8.- Identifying and analyzing common faults in power electronics systems and learning troubleshooting techniques.
9.- Testing individual components like capacitors, inductors, and resistors mounted on the panels.
10.- Practical exercises in regulating voltage and current using different power electronics components.
11.- Studying the impact of temperature on the performance of power devices.
12.- Exploring the behavior of components in series and parallel configurations.
13.- Analyzing the dynamic response of power electronics systems to changes in load.
14.- Measuring and analyzing the harmonics in power electronics circuits.
15.- Observing and analyzing transient phenomena in power electronics circuits.
16.- Integrating and testing energy storage solutions like capacitors and batteries.
17.- Controlling the speed and direction of a DC motor using power electronics circuits.
18.- Simulation and modeling: using simulation tools to model and analyze power electronics circuits.
19.- Power factor correction: implementing and testing power factor correction techniques.
20.- Renewable energy integration: exploring the integration of renewable energy sources with power electronics systems.

Other possibilities to be done with this unit:

21.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
22.- Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
23.- The Computer Control System with SCADA allows a real industrial simulation.
24.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
25.- This unit can be used for doing applied research.
26.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
27.- Visualization of all the sensors values used in the AE-PEC unit process.
- Several other exercises can be done and designed by the user.

a) Technical and Vocational Education configuration

⑤ AE-PEC/ICAI. Interactive Computer Aided Instruction Software.

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc...so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

b) Multipost Expansions options

⑥ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.

Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing “real time” control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:

This system is used with a Computer Controlled Unit.

- Instructor’s computer.
- Students’ computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

✱ Specifications subject to change without previous notice, due to the convenience of improvement of the product.

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