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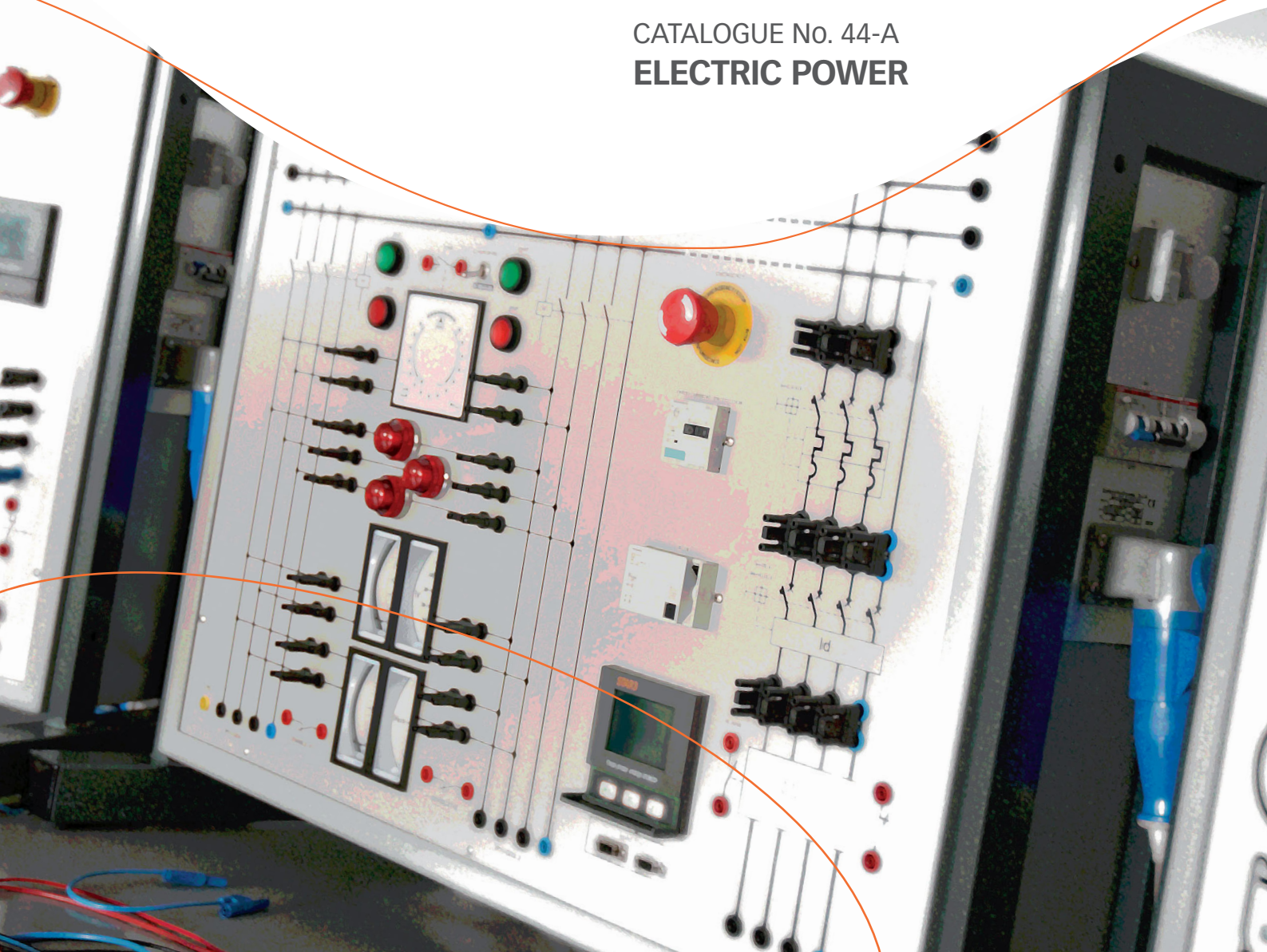
CATALOGUE No. 44-A

ELECTRIC POWER



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ELECTRIC POWER

Electric Power

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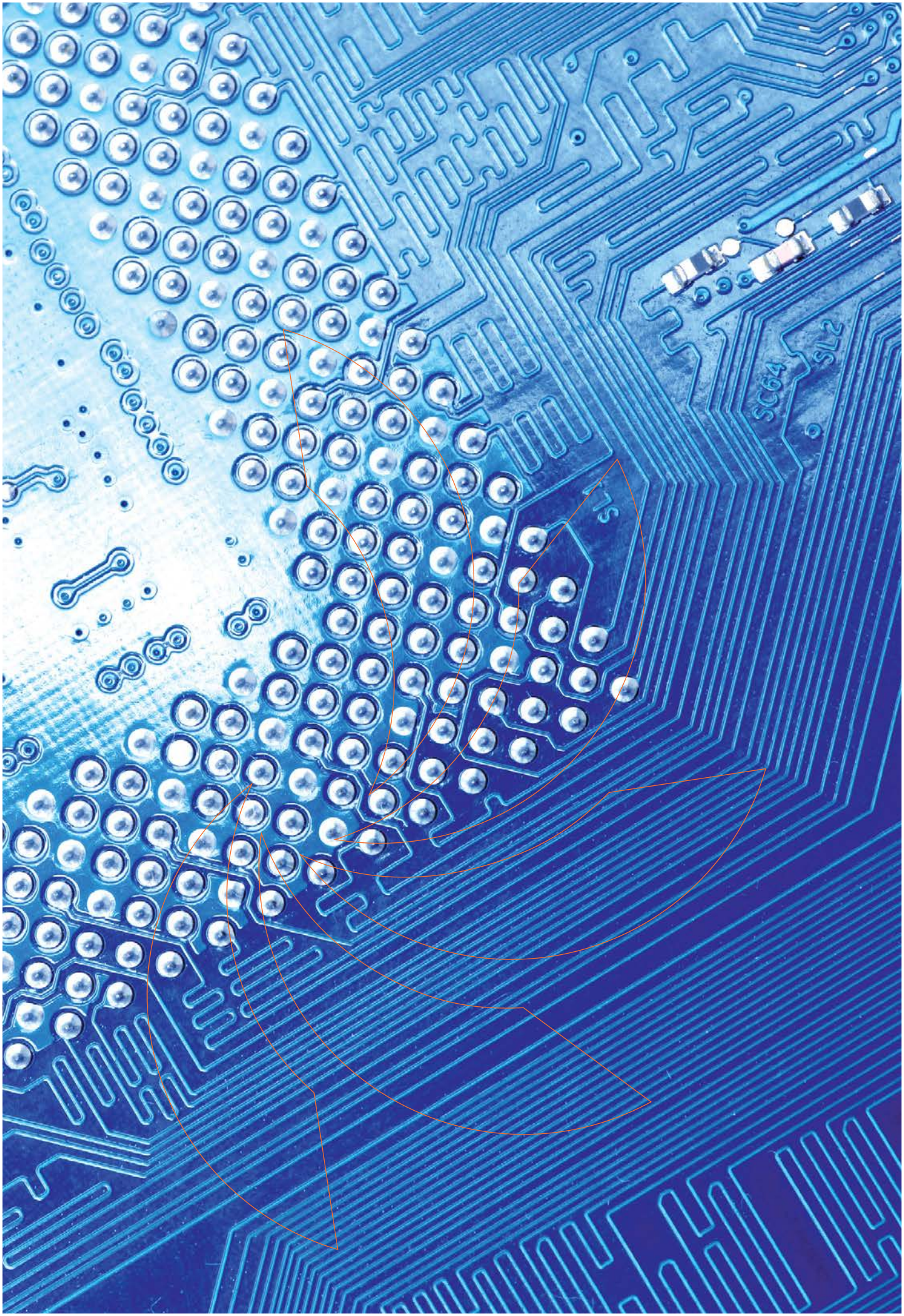
Rel. B16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ELECTRIC POWER
CATALOGUE No. 44-A

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ELECTRONIC DRIVES FOR AC/DC MOTORS

ED

INTRODUCTION

ADVANCED APPLICATIONS OF ELECTRIC POWER

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INTEGRATED SYSTEMS OF ELECTRIC POWER

ADVANCED GENERATION AND DOUBLE BUS BAR

Note: The catalog is constantly updated. Please send any suggestion you have to export@elettronicaveneta.com. We would also like to remind you that, due to the continuous technological upgrades, the described products may be subjected to design and/or technical modifications. Nevertheless, we guarantee that the educational content of our equipment remains unchanged.

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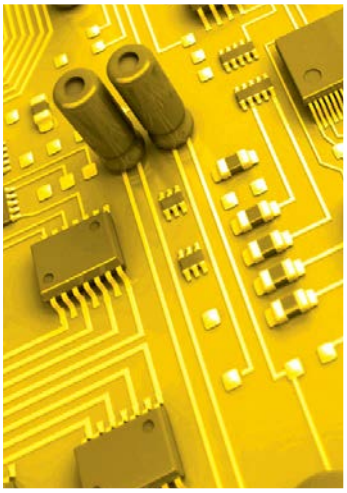
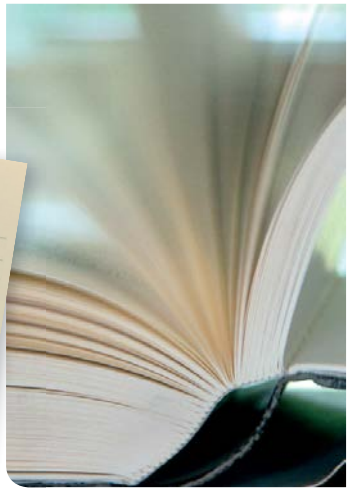
GENERAL INTRODUCTION



ELETTRONICA VENETA S.p.A. has been designing and manufacturing educational equipment since 1963. This equipment, covering the different fields of technology, fulfils two important educational objectives:

- to facilitate the learning process of the student by means of real systems which illustrate practically the important aspects of the theory learned in the classroom.
- to simplify the work of the teacher enabling the demonstration of the real, practical applications of the theory learned.

Increasing the efficiency of the didactic process improves and simplifies the integration of young students into the world of employment and justifies the material and human investments made in schools throughout the world.



ELETTRONICA VENETA S.p.A. operates on an international level and takes into consideration the training programmes and cultures of each specific country. In order to meet different requirements, we offer flexible systems which ensure maximum compliance with the latest technologies, technological advances and the professional profile requirements of local industry.

The proposed laboratories and training equipment are suitable for regular school education as well as ongoing post-diploma training courses and professional re-qualification.

Our training equipment covers most of the technological sectors included in the training programmes of vocational schools, technical institutes and universities, both national and international.

The integration of these efficient training systems into local school structures ensures high-quality, state-of-the-art training programmes which meet the diverse professional expectations of the student and the technological requirements of industry and research within their specific local contexts.

ELETTRONICA VENETA S.p.A. headquarters is located in the green fields of the Veneto region, not far from Venice, and constitute a centre for equipment design and development suited to the training needs of all professional and technical profiles. The modern premises integrates R&D laboratories, a production plant and a fully equipped teacher training centre.

The ISO 9001 (Quality System Certification) obtained in 1998 and updated in application of the latest edition of the International Standard, is further testament to the quality-driven organisation of **ELETTRONICA VENETA S.p.A.** aimed at providing top standard equipment, training and service.

PRESENTATION

Until some decades ago this branch of technology relied on mainly manual electromechanical techniques, but now electronic technology has deeply permeated the plants of production, control and distribution of electric power.

A new class of computer-assisted equipment, new control, management and supervision systems using microprocessors are integral parts of the new plants for production, distribution, control and use of electric power.

The need for a new knowledge, based on advanced components and technology, springs from this new reality involving the use of flexible and modular systems in training, able to be adapted to varying and continuously increasing needs.

ELETTRONICA VENETA S.p.a. has developed ideal environments and solutions for training and research, placing a set of apparatus designed for practical/experimental study of all the subjects referring to electric power, at learning structures' disposal.

This catalogue assembles high level subjects referring to power generation and its different transformations.

The last part of it includes real applications, such as the ones related to oil sector.

The subjects dealt with in this catalogue assume that students have an adequate background in general electronics, electric circuits and machines, as well as in the use of PC.

Specific users:

- Advanced university students in electrical engineering and industrial electronics
- Engineers and supervisors in activities requiring retraining in new technologies
- Engineers/technicians/operation-maintenance supervisors of power plants, military and civil ships, oil sector, civil defence, etc…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44-A

GENERATION, DISTRIBUTION AND CONSUMPTION OF ELECTRIC POWER

GD

Aim:

- Reproducing electric power production environment (Power Plant) in laboratory.
- Learning power production, Distribution and Control techniques
- Training engineers for management and maintenance of mobile plants (ships, oil platforms, civil defence, military)
- Learning diagnosis systems and maintenance techniques of electric networks
- Applying protection devices for safety of people and things

Equipment:

The proposal consists of a complete and modular laboratory including:

- Simulators of electric power plants and parallel of generators
- Control panels of power production and Transmission with professional equipment
- Panels for Simulating transmission lines
- Electric machines, protection equipment and devices used in the panels are industrial-type and professional

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44-A

GENERATION, DISTRIBUTION AND CONSUMPTION OF ELECTRIC POWER

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GENERATION, DISTRIBUTION AND CONSUMPTION OF ELECTRIC POWER

INTRODUCTION

This laboratory aims at training engineers for the management of power plants to meet the needs of:

- Engineers of power plants in remote places which are not connected with the mains (autonomous small and medium power plants),
- Training the future operators of big power plants connected with the mains,
- Training engineers for the maintenance and management of mobile power stations (ships, oil platforms, civil protection, military, etc…)

AIM OF THE LABORATORY

- Study of the typical configuration of power plants
- Management of power production and distribution plants.
- Study of protection devices and measuring instruments.
- Experimentation on models of high- and low-voltage electric installations.
- Diagnosis and maintenance of installations of power plants and of distribution systems
- Check of compliance with accident prevention and safety regulations.

MAIN CHARACTERISTICS OF THE LABORATORY

A) **COMPLETE LABORATORY** INCLUDING:

- Power generation.
- Distribution with high-voltage line simulators.
- Power demand and use.
- Power factor correction in high-voltage (synchronous compensator) and low-voltage (batteries of capacitors).
- Specific measuring instruments and protection devices for any phase.

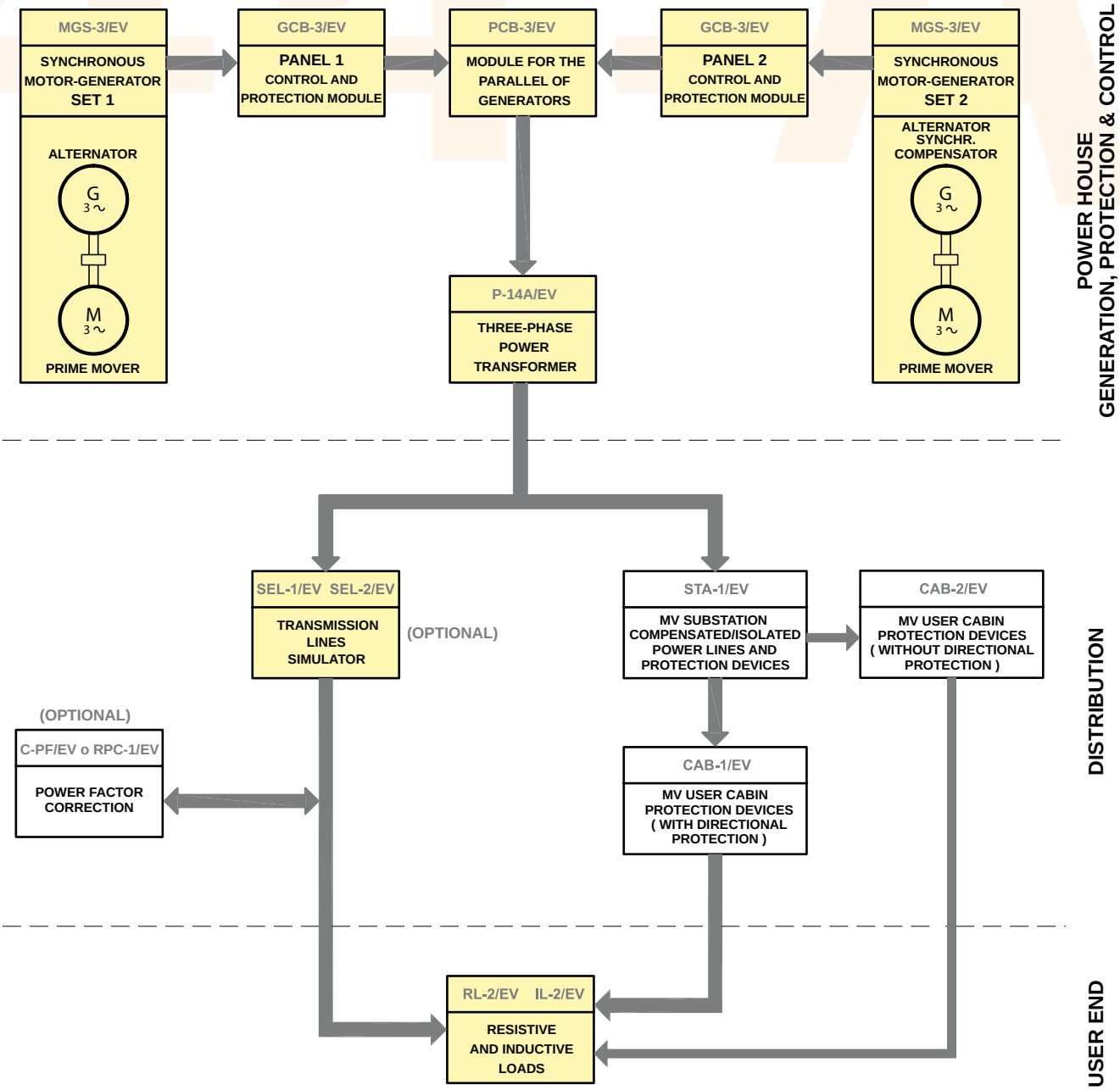
B) **WHOLLY MODULAR** LABORATORY:

- The laboratory consists of modules with silk-screen-printed electric diagrams. The modules contain the equipment and control devices. The modules are physically independent, movable and desk-type.
- The modules enable to deal with subjects separately, for example, seminars/specific courses may be realized on power production, on the parallel with the mains, on transmission lines, etc…
- Generator sets (synchronous alternators) are driven by DC motors with electronic drive.
- All the machines, instruments and the protection devices are industrial type.

C) **HIGH FLEXIBLE USE**:

- Modularity enables a high flexible use.
- Users may vary all the parameters to see the effects on the system and apply the relevant correcting actions.
- The system allows different configurations to widen the educational prospects. It is possible to add standard laboratory instruments or cut out some system instruments.
- The supervision of the electric parameters using digital analyzers with PC interface is provided
- Connections are made without the use of tools, by means of cables with safety plugs. This shortens the time of experimentation keeping a high level of safety for people and apparatuses.
- All protection and control devices of the electric machines are exactly the same as in industrial power stations. Hence, the sequence of actions for the management of a power station is exactly the same as in industrial power stations.

LABORATORY FOR STUDYING GENERATION, DISTRIBUTION AND CONSUMPTION OF ELECTRIC POWER



RELATED EQUIPMENT (OPTIONAL)

SRT-1/EV	PDG-R/EV	SEE-1/EV	SEE-2/EV	PRMCE-1/EV	HDPR/EV
SET OF PROTECTION RELAYS FOR HIGH AND LOW VOLTAGE NETWORKS	NEUTRAL POINT CONNECTION	ELECTRICAL POWER CYCLE SIMULATOR	ELECTRIC POWER GENERATION SIMULATOR	PAN. FOR THE STUDY OF THE MONITORING NETWORKS (SCADA) OF THE ELECTRIC POWER CONSUMP.	HIGH SPEED DISTANCE PROTECTIONRELAY SET

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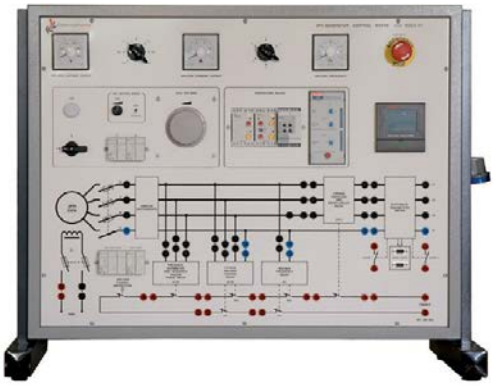
CONTROL AND PROTECTION MODULE
Mod. GCB-2/EV
SYNCHRONOUS MOTOR-GENERATOR SET
Mod. MGS-1/EV



INTRODUCTION

This control module contains all the supply and control devices for generator set mod. MGS-1/EV and enables students to learn and experiment with electric power production and the relevant protection systems, using real industrial components. The various installed electric devices, partially connected with each other and with safety terminals, are set at work with very simple and quick operations and they enable to create, modify and check the quality of the output power. All the protection and control devices of the electric machines used in the module are exactly the same as in industrial power plants. Hence, the sequence of management operations of this laboratory power station is exactly the same as necessary in industrial power plants. As this is a training and testing system, the starting operations of the generator set and the possible parallel with the mains are intentionally left to the operator, in order to let him understand the method. This generator set consists of a common base, that is a DC motor (which simulates a turbine or an endothermic engine) and a rotary-inductor synchronous generator connected with each other. The prime mover is provided with a tachometer to control and stabilize the speed of rotation.

PROTECTION AND CONTROL MODULE FOR MOTOR-GENERATOR SET Mod. GCB-2/EV

The fore panel is made of aluminium alloy, the apparatuses are represented with the international electric symbols and terminals with a high degree of protection against accidental contacts enable to assemble the circuit according to the represented diagram. The fore panel shows the classical sequence of power generation, but variants and different configurations from the proposed circuit are possible as well. Generator set mod. MGS-1/EV is connected via a synoptic panel available on a side of the module and the same principle can be followed to connect generator sets already existing in laboratories with power up to 3 kVA.

The control module includes a direct current drive to control the speed of prime mover and a variable power supply for the excitation circuit of the alternator. It includes also a voltmeter, an ammeter and a wide range frequency-meter to show immediately the electric parameters output by the alternator. There are also protection relays of phase sequence and symmetry, minimum and maximum voltage, minimum-maximum frequency and of overload-short circuit. Moreover there is a digital analyzer of electric power with RS485 interface to acquire the parameters of the output power on a personal computer.

TRAINING PROGRAM:

Training refers to the study of machines for power generation and to control and regulation devices. The range of application of these devices is related to both big high-voltage power plants and small autonomous and/or low-voltage co-generation plants.
Main subjects dealt with:

- Determination of resistance of the windings of a synchronous machine
- Detection of mechanical losses, iron losses, copper losses, etc…
- Determination of efficiency of a synchronous machine
- No-load characteristic or magnetization characteristic of an alternator
- Short circuit characteristic of an alternator
- Determination of synchronous impedance
- External characteristic of an alternator
- Control characteristic for different power factors
- V curves of a synchronous motor
- Using a synchronous motor as compensator for power factor correction

TECHNICAL CHARACTERISTICS:

PROTECTION AND CONTROL MODULE Mod. GCB-2/EV

The framework is made of chemically treated sheet steel, painted with many epoxy coats; the base is provided with rubber feet and it may be positioned on any working top. All the necessary electric components for the correct power supply of motor-generator set are included in the module.

Main installed components:

- 1 differential automatic magneto-thermal switch In =10 A Idn = 30 mA, A-type, with minimum-voltage releasing device and emergency pushbutton with mechanical holding
- 1 electronic drive for direct current motor with armature of160 Vdc max. 2kW, with separate excitation of 160 Vdc with feedback by a tachogenerator of 0.06 V/rev, or armature reaction.
- 1 voltage regulator 0-220 Vdc 2A for excitation of synchronous machine.
- 1 synoptic panel available on one side of the module to connect the motor-generator set with power up to 3 kVA.
- 1 wide range ammeter of 5 Aac, with switch for direct measurement of the current output or absorbed by the synchronous machine.
- 1 wide range voltmeter of 500 Vac, with switch for direct measurement of phase to phase, phase to neutral voltages output by the synchronous machine.
- 1 wide range frequency-meter 35-70 Hz.
- 5 breakable fuses for the protection of the synchronous machine.
- 1 relay of phase sequence and voltage asymmetry, for 400-V networks, asymmetry regulation range: 5-15 %; self-powered with 400 Vac
- 1 three-phase maximum-minimum voltage relay / N, control range ±10 %/ - 15 %, Ue 380-400-415 Vac, self-powered.
- 1 three-phase maximum-current and short-circuit relay; regulation range 1-5 A/5-25 Aac, auxiliary power supply: 230 V 50-60 Hz.
- 1 digital analyzer of electric power suit to balanced or unbalanced systems with neutral, for measurements of voltage, current, active, reactive and apparent powers, maximum active, reactive and apparent power peaks, counting of active and reactive energy, co-generation meters, two programmable relays with function of minimum and maximum alarm programmable between measured parameters, provided with RS485/232 interface for acquisitions on a personal computer.

Power supply: 230 Vac 50 Hz single-phase - 3 kVA
(Other voltage and frequency on request)
Dimensions: 840 x 450 x 680 mm
Net weight: 49 kg

TECHNICAL CHARACTERISTICS:

SYNCHRONOUS MOTOR-GENERATOR SET - Mod. MGS-1/EV

The set consists of a base and of the electric rotary machines, it may be positioned an any working top or close to the control module. The base is made of chemically treated sheet steel, painted with many epoxy coats; the base is provided with rubber feet and it enables to couple the machines in a very quick way.
It is also provided with safety covers to be put over the couplings so that moving parts become inaccessible, and it includes an accessory to lock the shaft of the machine for tests with locked rotor (short circuit).
The electric rotary machines have structural shape B3 and a protection degree IP 22.

Direct current motor:
Rated power = 1100 W
Armature voltage = 160 Vdc
Speed of rotation = 3000 rpm
Separate excitation
Tachogenerator of 0.06 Vdc/rev, coupled to the motor
Thermal protector integrated in the windings

Three-phase synchronous salient pole alternator:
Rated power = 1000 VA
Armature voltage = 3 x 230/400 Vac
Star delta connection
Speed of rotation = 3000 rpm
Separate excitation = 220 Vdc
Thermal protector integrated in the windings

Power supply: It is powered by control and protection module mod. GBC-2/EV
Dimensions: 1200 x 260 x 300 mm
Net weight: 65 kg

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- 1 single-phase power cord with plug IEC 309
- 1 set of 60 cables - jumpers with safety plug of 4 mm

OPTIONAL

SINGLE-PHASE - THREE-PHASE R-L-C LOAD MOD. RLC-2K/EV

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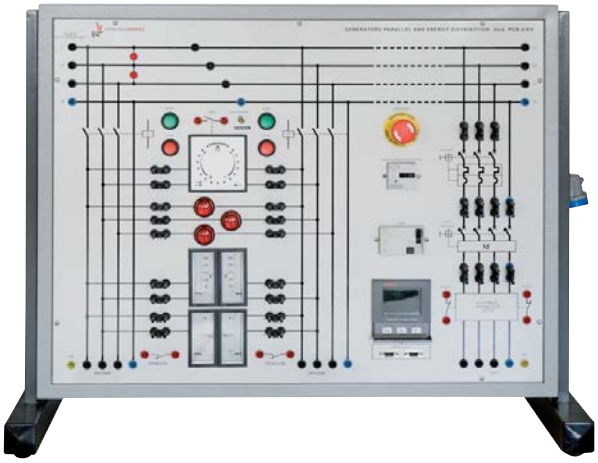
MODULE FOR PARALLEL OF GENERATORS

Mod. PCB-2/EV

INTRODUCTION

The module for the parallel of an alternator with a second alternator or with the mains, contains the control devices for the sets of three voltages and the actuators for the paralleling operation. It enables to learn and test the methodology for paralleling alternators, with actual industrial components.
The various installed devices, partially connected with each others and with safety terminals, are set at work with very simple and quick operations and they enable to modify the circuits at operator's discretion (connecting or disconnecting the devices).

The control devices of the sets of three voltages used in the panel are exactly the same as in industrial plants.
So the sequence of operations for the parallel is exactly the same as that necessary in industrial plants.
As this is a training system, the control and parallel operations with the mains are intentionally left to the operator so that he/she can understand the method.



MODULE FOR THE PARALLEL OF GENERATORS Mod. PCB-2/EV

The fore panel is made of aluminium alloy, the apparatuses are represented with the international electric symbols, and terminals with a high degree of protection against accidental contacts enable to assemble the circuit according to the represented diagram.
The fore panel represents a system of bars where the parallel of generators can be implemented with proper control devices and actuators. The bar system shows an output shunt for power distribution with protection against over-current and earth fault.
The control module includes a double voltmeter, a double frequency-meter and three lamps to indicate immediately the electric parameters of the sets of three voltage to be paralleled and a LED synchronoscope to point to the exact moment of parallel.
Moreover a digital power analyzer is available with interface RS485 to acquire the parameters on a personal computer.

TRAINING PROGRAM:

Training refers to the study of instruments and techniques for connecting alternators in parallel with one another and with the mains. The range of application of these devices is related to both big high-voltage power plants and to small autonomous and/or low-voltage co-generation plants.

Main subjects dealt with:

- regulation of prime mover to generate a compatible set of three voltages for the parallel with the mains,
- determination of the closing moment of the parallel device,
- synchronous machines in parallel with one another and with the mains,
- overload and loss of parallel of synchronous machines.

TECHNICAL CHARACTERISTICS:

Framework is made of chemically treated sheet steel, painted with many epoxy coats; the base is provided with rubber feet and it enables to couple the machines in a very quick way. All the necessary electric components for the proper operation of the module are included in the panel.

Main installed components:

- 1 differential automatic magneto-thermal switch In =10 A Idn = 30 mA, A-type, with minimum-voltage releasing device and emergency pushbutton with mechanical holding
- Single-phase output sockets for powering the power generation panels and various accessories.
- Double 500-Vac voltmeter for comparing the sets of three voltages having to be paralleled.
- Double 45-65 Hz (400 Vac) frequency-meter for comparing the frequencies of the sets of three voltages having to be paralleled.
- 1 LED synchronoscope of 400 V, 50-60 Hz.
- 1 three-lamp sequence indicator for voltage of 400 V
- Electromagnetic contactors of 25 A AC3, provided with start-stop buttons.
- 1 three-pole magneto-thermal automatic switch adjustable between 2.4 and 4 A
- 1 four-pole differential automatic switch In = 25 A Idn = 30 mA, A type.
- 1 Digital electrical power analyzer to be used with balanced or unbalanced systems with neutral, for measurement of voltages, currents, active, reactive and apparent power, peaks of maximum active, reactive and apparent power, active and reactive power counting, cogeneration counters. The analyzer includes a wide, high contrast, LCD display, five languages menu, organized in pages. Four pages can be programmed for a quick visualization of the preferred parameters. Complete with two programmable relays (for any parameter selected among any of the measured ones) with maximum and minimum alarm functions. The analyzer is provided with an interface RS485 for data acquisition with Personal Computer.

Power supply: 230 Vac 50 Hz single-phase - 3 kVA
(Other voltage and frequency on request)
Dimensions: 840 x 450 x 680 mm
Net weight: 38 kg

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- 1 single-phase power cord with plug IEC 309
- 1 set of 65 cables - jumpers with safety plug of 4 mm

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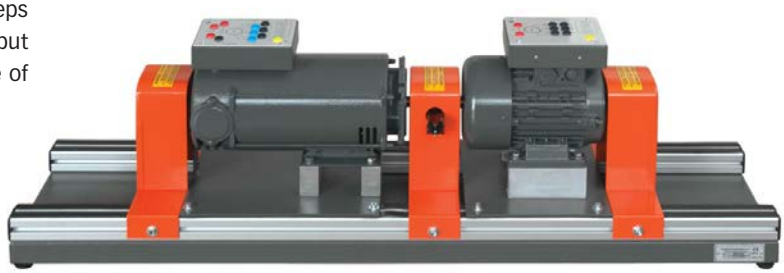
CONTROL AND PROTECTION MODULE
Mod. GCB-3/EV
SYNCHRONOUS MOTOR-GENERATOR SET
Mod. MGS-3/EV

INTRODUCTION

The Control Module contains all power supply and control devices of the generation set mod. MSG-3/EV and enables to learn and experiment, with real industrial components, on the power production and the related protection systems.
The different electrical devices, partially connected between them and to safety terminals, become operative with extremely simple and quick operations and give the possibility to create, change and check the quality of the generated power. All protection and control devices for the electrical machines used in the module are exactly like those installed in industrial control stations.
Consequently, the sequence of control procedures is exactly similar to those of the industrial power houses.
As this system is for training, the start up operations of the generator set and the parallel procedures with mains can be carried out MANUALLY (so the user can follow the steps sequence) or AUTOMATICALLY through the use of the output contact of the microprocessor-controlled synchronoscope of the Parallel Panel GCB-3/EV.
The generation set consists of a common base, a 3-phase squirrel cage motor (it is the prime mover and simulates the turbine or an endothermic motor) and a synchronous generator with rotating inductor coupled between them. The prime mover is provided with an electronic drive to control the rotation speed, and therefore, the frequency.



CONTROL AND PROTECTION MODULE FOR MOTOR–GENERATOR SET Mod. GCB-3/EV

The front panel is made in aluminum alloy. The equipment is represented using the international electrical symbols and the circuit can be set up following the shown diagram and using the standardized terminals with high protection degree against accidental contacts. The front panel represents the classical sequence of power generation, but variations and configurations
different from the suggested circuit are possible, too.
The provided generation set, mod. MSG-3/EV, is connected via a silk screen panel set on the side of the panel.
The control module includes a drive for the 3-ph motor (the prime mover) and a variable power supply for the alternator excitation circuit. It includes also a wide-scale voltmeter, ammeter and frequency-meter for immediate display of the electrical parameters provided by the alternator.
Protection relays are also included for sequence and phase symmetry, minimum-maximum voltage, minimum-maximum frequency and overload - short-circuit. Besides, there is also a digital analyzer for electrical power supplied with RS485 interface for data acquisition of the parameters of the power generated via personal computer. It is possible the connection of this instrument with similar ones (the other in the M-G control panel and the other of the Parallel Panel mod. GCB-3/EV).

TRAINING PROGRAM:

The training concerns the study of the machines for electric power generation and the control devices. The application field of such devices concerns big high voltage production plants as well as small low voltage autonomous and/or cogeneration plants.

Main treated subjects:

- Determination of the resistance of the synchronous machine windings
- Setting and operation of the protection relays
- Setting and use of the programmable multifunctional instrument
- No load or magnetization characteristic of the alternator
- External characteristic of the alternator
- Regulation characteristics for different power factors
- "V" curve of the synchronous motor
- Use of the synchronous motor as compensator for the power factor correction

TECHNICAL SPECIFICATIONS:

CONTROL AND PROTECTION MODULE Mod. GCB-3/EV

The structure is made in sheet steel chemically treated and painted with epoxy paint; the base is provided with rubber feet and can be laid over a work plane. All electrical components necessary for the motor-generator set operation are included in the module.

Main installed components:

- 1 Thermo-magnetic E.L.C.B. In = 10 A Idn = 30 mA, type A, with minimum voltage trip device and stop emergency pushbutton with mechanical interlock.
- 1 Electronic microprocessor-controlled drive for 3-ph squirrel cage motor (operational modes: V/f and vectorial); max 1.5 kW.
- 1 Voltage regulator 0-220 Vdc - 2 A for synchronous machine excitation.
- 1 Silk screen panel set on one side of the module to connect the motor-generator set.
- 1 Wide-scale analog ammeter 5 Aac with ammetric switch for direct measurement of the current supplied or absorbed by the synchronous machine.
- 1 Wide-scale analog voltmeter 500 Vac with voltmetric switch for direct measurement of the phase-phase voltage, neutral phase provided by the synchronous machine.
- 1 Wide-scale analog frequency meter 35-70 Hz for direct measurement of the frequency provided by the synchronous machine.
- 5 Sectionable fuses for synchronous machine protection.
- 1 Phase sequence and voltage asymmetry relay, for 400-V networks, asymmetry control range 5-15%, selfpowered 400V
- 1 Maximum and minimum voltage three-phase relay / N, control range +10% / -15%, Ue 380-400-415 Vac, selfpowered.
- 1 Maximum and minimum frequency relay, 50-60 Hz, control range ±10 %, self-powered 230 Vac.
- 1 Maximum current and short-circuit three-phase relay, control range 0-5 A / 5-25 A ac, auxiliary power supply 230 V 50-60 Hz.
- 1 Digital electrical power analyzer to be used with balanced or unbalanced systems with neutral, for measurement of voltages, currents, active, reactive and apparent power, peaks of maximum active, reactive and apparent power, active and reactive power counting, cogeneration counters. The analyzer includes a wide, high contrast, LCD display, five languages menu, organized in pages. Four pages can be programmed for a quick visualization of the preferred parameters. Complete with two programmable relays (for any parameter selected among any of the measured ones) with maximum and minimum alarm functions. The analyzer is provided with an interface RS485 for SCADA data acquisition.

Power supply: 230 Vca 50 Hz single-phase - 2 kVA
(Other voltage and frequency on request)
Dimensions: 840 x 450 x 680 mm
Weight: 49 kg

TECHNICAL SPECIFICATIONS:

SYNCHRONOUS MOTOR-GENERATOR SET Mod. MGS-3/EV

The set consists of a strong base where the electrical machines are coupled. The base is made in steel sheet, chemically treated and painted with epoxy paint; it is provided with rubber feet. All required safety covers for the mechanical couplings for the user' safety are also supplied.

Three-phase squirrel cage motor:
Nominal power = 1500 W
Voltage 230/400 Vca
Delta/star connection
Rotation speed = 3000 rev/min (2 poles)
Thermal protector integrated in the windings.

Synchronous three-phase alternator:
Nominal power = 1000 VA
Armature voltage = 3 x 230/400 Vca
Delta/star connection
Rotation speed = 3000 rev/min
Separated excitation = 220 Vcc
Thermal protector integrated in the windings

Power supply: From the control and protection module mod. GCB-3/EV
Dimensions: 1200 x 260 x 300 mm
Weight: 62 kg

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- 1 single-phase power cord with plug IEC 309
- 1 set of 60 cables - jumpers with safety plug of 4 mm

OPTIONAL

SINGLE-PHASE - THREE-PHASE R-L-C LOAD MOD. RLC-2K/EV

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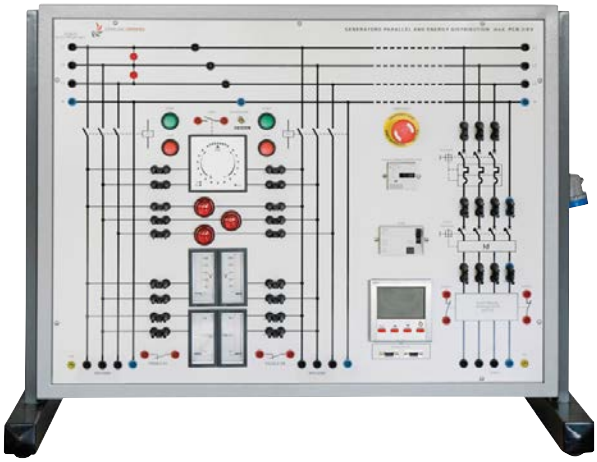
MODULE FOR THE PARALLEL OF GENERATORS
(WITH SCADA DATA ACQUISITION)
Mod. PCB-3/EV

INTRODUCTION

The module for the parallel of an alternator with a second alternator or with the public power network contains the control devices of the triads of voltage and the actuators for the parallel operation. It enables to learn and experiment, with real industrial components, on the methods for setting the alternators in parallel. The different electrical devices installed, partially connected between them and to safety terminals, become operative with extremely simple and quick operations and give the possibility to change the circuit at the user's need (to include or exclude the devices). The control devices of the voltage triads used in the panel are exactly like those installed in the industrial control stations. Consequently, the sequence of control maneuvers for the parallel is exactly like the one necessary in industrial central stations. As this system is for training, the start up operations of the generator set and the parallel procedures with the mains can be carried out MANUALLY (so the user can perform the steps sequence) or AUTOMATICALLY through the use of the output contact of the on-board microprocessor-controlled synchronoscope.



MODULE FOR THE PARALLEL OF THE GENERATORS Mod. PCB-3/EV

The front panel is made in aluminum alloy. The equipment is represented using the international electrical symbols and, the circuit can be set up following the represented diagram and with the standardized terminals having a high protection degree against accidental contacts. The front panel represents a bus bar system where the parallel of generators can be carried out with proper control instruments and actuators. The bus bar system shows an output shunt for power distribution with protection against over currents and the fault to ground.
The control module includes: a double voltmeter, a double frequency-meter, an electronic synchronoscope with LEDs and an auxiliary contact for the AUTOMATIC paralleling, plus three lamps for the immediate display of the electrical parameters of the triads to be set in parallel. Besides, it is included a digital power analyzer with RS485 interface for the data acquisition of the parameters of the power distributed with a personal computer. The panel is supplied with a RS485/USB converter and the software allows to visualize the data graphs that can be exported as EXCEL files. It is also possible to connect this instrument to the similar ones of the Control Panels of the motor-generator sets.

TRAINING PROGRAM:

The training concerns the study of the instruments and techniques for MANUAL or AUTO parallel connection of the alternators to the mains.

Main treated subjects:

- regulation of the prime mover in order to generate a triad of compatible voltage for the parallel with the line power
- determination of the parallel device closing in MAN/AUTO modes
- synchronous machines in parallel between them and with the line power
- overload of the synchronous machines and loss of the parallel

TECHNICAL SPECIFICATION:

The structure is made in sheet steel chemically treated and painted with epoxy paint; the base is provided with rubber feet and can be laid over a work plane. All electrical components necessary for the board operation are included in the module.

Main installed components:

- 1 Thermomagnetic E.L.C.B. In = 16 A Idn = 30 mA, type A, with minimum voltage trip device and stop emergency pushbutton with mechanical interlock.
- 3 Single-phase output sockets for power supply of the power generation panels and different accessories.
- 1 Double 500-Vac voltmeter for the comparison of the voltages of both voltages to be set in parallel.
- 1 Double frequency meter (45-55-65 Hz, 500 Vac) for the comparison of both frequencies to be set in parallel.
- 1 Syncronoscope, microprocessor controlled type, with synchronizing relay. Includes: 18 LEDs, two colors, with increased resolution closer to the synchronization speeds. Suitable for lines 3 x 400 V-50/60 Hz. With programmable voltage difference (1 to 10%), frequencies difference (2 to 20 electrical degrees) and delay time (0.1 to 1sec) for synchronizing.
- 1 Three-lamp sequence indicator for 400-V voltage.
- 2 contactors, 25 A AC3, with stop and run pushbuttons.
- 1 Three-pole T.M.C.B. In adjustable from 2.4 to 4 A
- 1 4-pole E.L.C.B. In = 25 A Idn = 30 mA.
- 1 Digital electrical power analyzer to be used with balanced or unbalanced systems with neutral, for measurement of voltages, currents, active, reactive and apparent power, peaks of maximum active, reactive and apparent power, active and reactive power counting, cogeneration counters. The analyzer includes a wide, high contrast, LCD display, five languages menu, organized in pages. Four pages can be programmed for a quick visualization of the preferred parameters. Complete with two programmable relays (for any parameter selected among any of the measured ones) with maximum and minimum alarm functions. The analyzer is provided with an interface RS485 for data acquisition with Personal Computer.
- **1 RS485/USB Converter and software for data acquistion with personal computer.**

Power supply: 230 Vca 50 Hz single-phase - 3 kVA
(Other voltage and frequency on request)
Dimensions: 840 x 450 x 680 mm
Weight: 38 kg

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- 1 single-phase power cord with plug IEC 309
- 1 set of 65 cables - jumpers with safety plug of 4 mm

AUTOMATIC VOLTAGE REGULATOR

Mod. AVR-E/EV

This electronic device makes possible the feeding of the alternators excitation, so to keep constant voltage output with great precision, under the following conditions:

- whatever the load (no-load, full load) and
- to supply the due excitation during the alternator start.

The unit is an option for the EV alternators of the MGS-1/EV, MGS-2/EV and MGS-3/EV series.

The connection to the a.m. alternators is as follows:

- connection of the alternator 3-ph output terminals as inputs of the AVR-E/EV unit
- remove the two jumpers of the alternator excitation and connect the DC output of the AVR-E/EV to the alternator excitation.

TECHNICAL FEATURES

- AVR: Automatic Voltage Control for the alternators excitation. Reliable, very compact electronic device.
- Totally included in a hard plastic box.
- All input & output terminals are 4 mm safety connectors.
- Transparent front cover, to visualize the controls and signaling spy lamps.
- Nominal Input: 100…490 VAC-50/60 Hz from the 3-ph output of the alternator
- Output: 100 VDC, 10 A max.
- Internal controls: voltage adjustment trimmer, stability control trimmer, frequency regulation trimmer, current regulation trimmer.
- External controls: precision voltage control potentiometer
- Protections: against over excitation in low frequency condition; overvoltage protection. One ultrafast fuse.
- Signaling LEDs: one LED for overvoltage protection; one LED for under frequency; one LED for Imax, one LED for overtemperature.

Dimensions: 220 x 170 x 110 mm
Weight: 1,5 kg

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

GENERATION EARTH LEAKAGE PROTECTION RELAY

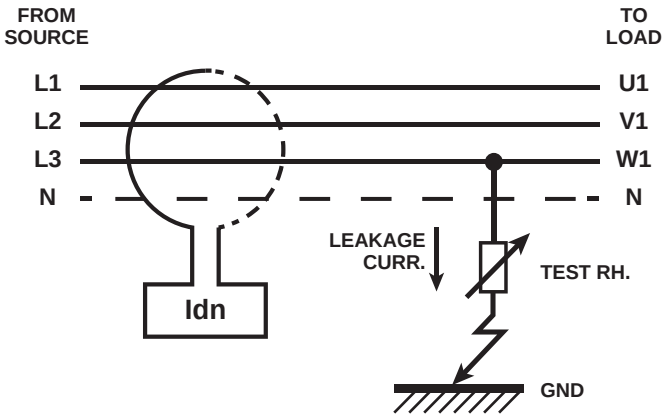
Mod. ETH-R/EV

INTRODUCTION

This optional module mod. ETH-R/EV includes a Earth Leakage Protection Relay **to be used together with the on-board protection relays of Panels GCB-3/EV and PGP-1/EV**. In the last case, only as a leakage current sensing relay.

It is an A-type differential relay with toroid transformer for the power cables, and adjustable current thresholds and trip times. The set includes also a rheostat to simulate the insulation failure to ground.

The toroid senses the vectors addition of the line currents, including the neutral wire, if present.
When the system is working properly, the magnetic effects of the currents compensate among them, and the vectors addition of all currents is zero.
When there is an insulation failure to ground, the vectors addition of all currents is not zero anymore, and there is the so called "leakage" or "differential" current.
This current builds up a proportional magnetic field in the toroid core; the field generates a voltage that is processed by the relay electronics so to provoke a mechanical action, like opening an automatic switch.



TECHNICAL CHARACTERISTICS:

Differential Relay

- A-type differential relay, with two adjustable trip times and currents, with toroidal transformer for the cables of the lines to be controlled.
- Measure and sensing the TRMS current
- Adjustable tripping currents, Idn selectable: 0,03 to 3 A
- Adjustable tripping times, selectable: 0.02 to 1 s (INS, SEL)
- Two independent programmable relays (C1: alarm, C2: tripping)
- Toroid transformer, DIAMETRO 30mm
- Display: 3 colored LEDs for ON, alarm and trip
- No. 2 output relay contact: 230 Vac, 6A
- Test and reset button + 4 programming pushbuttons

Test rheostat mod. RCD-1/EV

This table top rheostat, completely included in a painted metal container, allows to simulate an insulation leakage current in the range of 5 to 40 mA @ 3*400 V + N. All terminals are 4 mm safety type.

POWER SUPPLY:
230 Vac - 50-60 Hz

SUPPLIED WITH

OPERATIONAL HANDBOOK

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POWER TRANSMISSION LINES
Mod. SEL-1/EV

POWER TRANSFORMER
Mod. P-14A/EV

INTRODUCTION

The equipment reproduces two high voltage transmission lines with the possibility of varying the parameters. It enables to learn and test the characteristics and management of high voltage distribution networks, with small scale components. The electric various devices installed, partially connected with one another and with safety terminals, are set at work with extremely simple and quick operations and they enable to modify parameters and circuits at operator's discretion. The power transmission with insulated lines (IT system) is completed with a three-phase transformer with different possible connections with the primary and secondary circuits.

POWER TRANSMISSION LINES MOD. SEL-1/EV

The fore panel is made of aluminium alloy. Two models of high voltage power transmission lines are represented with the international electric symbols. Proper educational terminals and jumpers with a high degree of protection against accidental contacts allow to use the lines separately or in series/parallel connection. Electric parameters (resistance, inductance and capacitance) may be changed by means of lever selectors according to the different sections and length of line.
The presence of voltage is signalled by pilot lamps while protection against overloads relies on quick fuses.

TRAINING PROGRAM:

Training refers to the study of power transmission in medium-voltage high-voltage networks and to the study of three-phase transformers.

Main subjects dealt with:

- Models of power transmission lines with concentrated parameters
- Voltage drop and losses in power transmission lines
- Types of line (copper, aluminium)
- Parallel of power transmission lines
- Ideal transformer, real transformer
- No load, load and short-circuit tests of transformers, efficiency of a three-phase transformer
- Star, delta, zigzag connections and time index of three-phase transformers
- Protection devices of transformers

TECHNICAL CHARACTERISTICS:

SIMULATOR OF POWER TRANSMISSION LINES Mod. SEL-1/EV

Framework is made of chemically treated sheet steel, painted with many epoxy coats; the base is provided with rubber feet and it may be positioned on any working top. Lines are protected against overload and short circuit by quick blow fuses.

Main installed components:
Line 1
Modifiable parameter: Section (capacity in A)
Model of line used: PI
Simulated Un: 120 kV, operating Un 400V
Simulated Pn: 10 -15 - 20 MVA
Operating In: 1 A
Equivalent distributed R: 18 - 25 - 35 Ω
Distributed inductance and capacitance
equivalent to: 72 mH, 0.2 µF
Breakers of line start and end

Line 2
Modifiable parameter: length (km)
Model of line used: PI
Simulated Un: 120 kV, operating Un 400V
Simulated Pn: 20 MVA
Operating In: 1 A
Equivalent distributed R: 8.9 - 18 - 35 Ω
Distributed inductance equivalent to: 144 - 72 - 36 mH
Distributed capacitance equivalent to 0.1 - 0.2 - 0.4 µF
Breakers of line start and end

Possibility of using lines separately or in series/parallel connection.

Dimensions: 840 x 450 x 680 mm
Net weight: 35 kg

TECHNICAL CHARACTERISTICS:

THREE-PHASE POWER TRANSFORMER Mod. P-14A/EV

It is used as a step-up transformer at the output of the power plant, the output is connected with medium- high voltage transmission lines.

Power: 1500 VA
Primary voltage: 230/400 delta/star 50-60 Hz
Secondary voltage: 230/400 V with voltage variation ±5 %, + 10 %, + 15 %; phase variation between Primary and Secondary +/- 5 - 10 - 20 electrical degrees with zig-zag connection.

Protection: IP 22
Embedded thermal protector
Safety terminals with section 4 mm

Dimensions: 360 x 200 x 300 mm
Net weight: 19 kg

REQUIRED

UTILITIES (PROVIDED BY THE CUSTOMER)

- Power supply: 400 Vac 50 Hz three-phase - 1500 VA
  (Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:
- 1 set of cables - jumpers with safety plugs of 4 mm

OPTIONAL

RESISTIVE LOAD MOD. RL-2A/EV
INDUCTIVE LOAD MOD. IL-2/EV
CAPACITY LOAD MOD. CL-2/EV
SINGLE-PHASE - 3-PHASE R-L-C LOAD MOD. RLC-2K/EV

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SIMULATOR OF A POWER TRANSMISSION LINE

Mod. SEL-2/EV

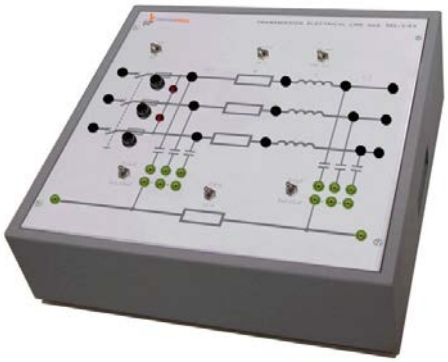
TECHNICAL CHARACTERISTICS:

- Desk-type box of chemically treated sheet steel, painted with epoxy coats.
- Side handles for easy transport.
- Fore panel of insulating material, with screen silk printed diagram of the components.
- All safety terminals ø 4 mm.

The simulator operates with Un: 3 x 220 V and it reproduces a 130-km long power transmission line of 77 kV, with the following characteristics:

- Rated voltage: 77 kV
- Rated current: 100 A
- Rated power: 13 MW
- Equivalent resistance: 3.5 Ω
- Concentrated equivalent capacitance: 10 μF
- Loop earth impedance: 0.8 Ω

The transmission line is protected against overload and short circuit by quick blow fuses.



COMPONENTS INSTALLED ON THE PANEL:

- Model of line: concentrated parameters, PI cell
- Simulated Un: 77 kV
- Operating Un: 3 x 220 V, 50 Hz
- Simulated Pn: MVA
- Simulated In: 100 A
- Operating In: 0.5 A
- Distributed equivalent R: 3 x 1.5 Ω or 3 x 23 Ω, selectable.
- Distributed equivalent L: 3 x 10 mH or 180 mH, selectable.
- Capacitors of line start and end: 3 x 2 μF or 3 x 0.22 μF, selectable. They may be connected in star, delta configuration, or earthed.
- Earth loop impedance: 0.8 Ω selectable.
- Three-pole switch of connection of the line.
- Fuse-holder with fuses: 6 x 30 In: 1 A

Possibility of using the line separately, or more lines series/parallel connected.

Dimensions: 415 x 400 x 150 mm
Net weight: 8 kg

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- 12 jumpers and 6 cables with safety terminals (ø 4 mm)

RESISTIVE, INDUCTIVE AND CAPACITIVE LOADS

SINGLE-PHASE - THREE-PHASE R-L-C LOAD Mod. RLC-2K/EV

GENERAL CHARACTERISTICS:

- Table-top metal container, with side handles.
- Fore panel of silk-screen-printed aluminium in lectern configuration.
- Terminals for safety plugs with 4 mm diameter
- 5 steps of single-phase/three-phase active power
- 5 steps of single-phase/three-phase inductive reactive power
- 5 steps of single-phase/three-phase capacitive power
- This load is also provided with technical manual and set of 14 cables with safety plugs.
- Dimensions and net weight: 530 x 520 x 330 mm - 38 kg

ELECTRICAL CHARACTERISTICS:

- It is suitable for single-phase supply voltage of 230 V and for three-phase supply voltage of 400 V, in star connection, and for three-phase voltage of 230 V, in delta connection.
- **Resistance section:** single-phase/three-phase active power of 1500 W, that can be shared by five steps consists of 3 resistances of 530 Ω - 220 Vdc/230 Vac.
- **Inductive section:** single-phase/three-phase inductive reactive power of 1500 VAr, that can be shared by five steps consists of 3 impedances with current of 0.43 A - 230 Vac - 50 Hz.
- **Capacitive section:** single-phase/three-phase capacitive reactive power of 1500 VAr that can be shared by five steps consists of 3 condensers with C of 6 µF - 0,43 A - 230 Vca - 50 Hz. Each sector has six terminals with 4 mm safety plugs allow the single-phase connection (parallel connection of the 3 phases), and the three-phase star/delta connection.
- 3 three-phase rotary switches for separate variation of R, L and C modules. Max. apparent power 2100 VA.

VARIABLE RESISTIVE LOAD Mod. RL-2A/EV

- Varnished desk-type metal boxes with fore panel of aluminium alloy and silk-screen-printed representation of the components.
- 3 separate ohmic sectors
- 21 values of single-phase or DC active power
- 7 values of three-phase active power
- Safety terminals and protection by fuses
- AC power supply: 230/400 V
- DC power supply: 220 V
- maximum active power: 1350 W
- This load is also provided with technical manual and set of 9 cables with safety plugs.

Dimensions and net weight: 525 x 500 x 200 mm - 22 kg

SINGLE-PHASE - THREE-PHASE R-L LOAD Mod. RL-2K/EV

GENERAL CHARACTERISTICS:

- Table-top metal container, with side handles.
- Fore panel of silk-screen-printed aluminium in lectern configuration.
- Terminals for safety plugs with 4 mm diameter
- 5 steps of single-phase/three-phase active power
- 5 steps of single-phase/three-phase inductive reactive power
- This load is also provided with technical manual and set of 14 cables with safety plugs.
- Dimensions and net weight: 530 x 520 x 330 mm - 35 kg

ELECTRICAL CHARACTERISTICS:

- It is suitable for single-phase supply voltage of 230 V and for three-phase supply voltage of 400 V, in star connection, and for three-phase voltage of 230 V, in delta connection.
- **Resistance section:** single-phase/three-phase active power of 1500 W, that can be shared by five steps consists of 3 resistances of 530 Ω - 220 Vdc/230 Vac.
- **Inductive section:** single-phase/three-phase inductive reactive power of 1500 VAr, that can be shared by five steps consists of 3 impedances with current of 0.43 A - 230 Vac - 50 Hz.
  Each sector has six terminals with 4 mm safety plugs allow the single-phase connection (parallel connection of the 3 phases), and the three-phase star/delta connection.
- 2 three-phase rotary switches for separate variation of R and L modules. Max. apparent power: 2100 VA.

VARIABLE INDUCTIVE LOAD Mod. IL-2/EV

- Varnished desk-type metal boxes with fore panel of aluminium alloy and silk-screen-printed representation of the components.
- 3 separate inductive sectors
- 21 values of single-phase reactive power
- 7 values of three-phase reactive power
- Safety terminals and protection by fuses
- Power supply: 230/400 V 50 Hz
- Max apparent power: 1350 VA
- This load is also provided with technical manual and set of 9 cables with safety plugs.

Dimensions and net weight: 525 x 500 x 200 mm - 85 kg

VARIABLE CAPACITIVE LOAD Mod. CL-2/EV

- Varnished desk-type metal boxes with fore panel of aluminium alloy and silk-screen-printed representation of the components.
- 3 separate capacitive sectors
- 21 values of single-phase reactive power
- 7 values of three-phase reactive power
- Safety terminals and protection by fuses
- Power supply: 230/400 V 50 Hz (Other voltage and frequency on request)
- Max apparent power: 1350 VA
- This load is also provided with technical manual and set of 9 cables with safety plugs.

Dimensions and net weight: 525 x 500 x 200 mm - 16 kg

44-A

PROTECTION, CONTROL AND MANAGEMENT OF ELECTRIC POWER

PC

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Aim:

- Reproducing the protection systems of high voltage and low voltage networks, in laboratory
- Learning control techniques of power factor correction
- Training engineers for the maintenance and management of distribution stations
- Learning designing standards for user cabins
- Applying protection devices for safety of people and things

Equipment:

The proposal consists of a complete and modular laboratory containing:

- Automatic control panels for power factor correction with professional equipment
- Panels with protection relays for medium voltage lines
- Panel for demonstrating the state of neutral conductor in TT, TN, IT systems
- Panels for simulation of MV lines with study of selectivity of protections, of coordination and current/time selectivity
- Panels for simulation of MV substations

Apparatuses, instruments and protection devices used in the panels are industrial type and professional.

44A-E-PC

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44-A

PROTECTION, CONTROL AND MANAGEMENT OF ELECTRIC POWER

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PROTECTION, CONTROL AND MANAGEMENT OF ELECTRIC POWER

INTRODUCTION

The line of panels forming the laboratory for the application and study of protection devices for user cabins and distribution stations enables to study and test protection devices used in medium voltage lines of 15 or 20 kV. Used components are actual microprocessor-controlled multi-function protection relays, interfaced with small-scale current and voltage transformers, and the study is carried out in low voltage of 380-400 V.

The strong metal desk-type framework that can easily be handled in laboratory, contains all the electric/electronic devices.

Synoptic panels are made of aluminium alloy and the necessary devices and connections for realizing standard configurations and/or any different configuration for experimental aims are clearly silk-screen-printed on the panel together with their international symbols.

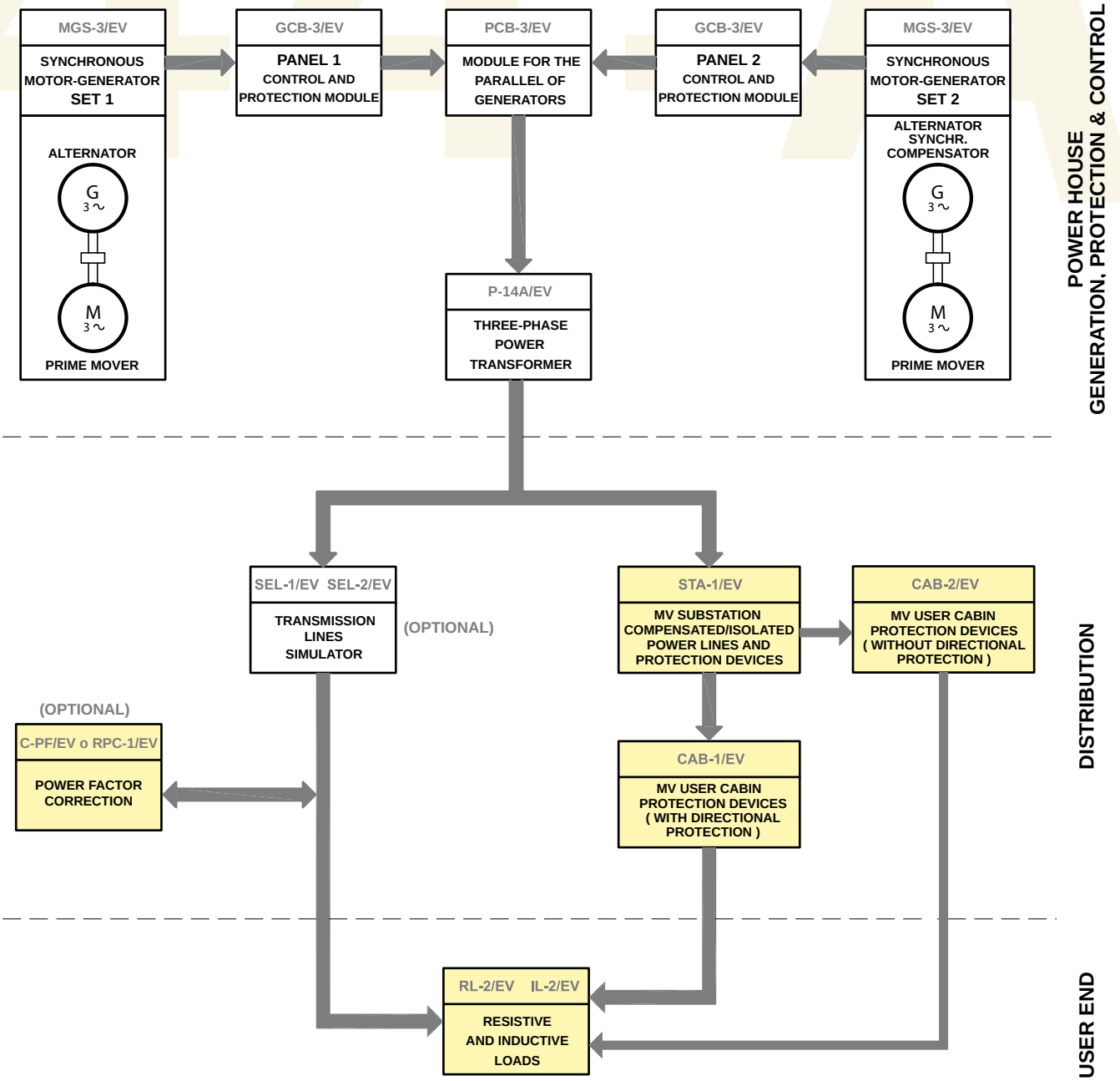
The connections for enabling the power section (MV line) are carried out on the fore panel via safety terminals and cables/jumpers with safety plugs of section 4 mm.

The rear panel is used for various configurations of the output relays of protections and of the wiring of the operation logic.

The functionality of the general protection is reproduced by a power contactor controlled by a PLC as regards the logic of interlocks.

Any breaker and earthing switches are reproduced by a rotary switch. The PLC controls the synoptic that monitors the state of the general device, of line breaker and of earthing switch, with LEDs.

LABORATORY FOR STUDYING
PROTECTION, MANAGEMENT AND CONTROL OF ELECTRIC POWER



ELECTRIC POWER

RELATED EQUIPMENT (OPTIONAL)

SRT-1/EV	PDG-R/EV	SEE-1/EV	SEE-2/EV	PRMCE-1/EV	HDPR/EV
SET OF PROTECTION RELAYS FOR HIGH AND LOW VOLTAGE NETWORKS	NEUTRAL POINT CONNECTION	ELECTRICAL POWER CYCLE SIMULATOR	ELECTRIC POWER GENERATION SIMULATOR	PAN. FOR THE STUDY OF THE MONITORING NETWORKS (SCADA) OF THE ELECTRIC POWER CONSUMP.	HIGH SPEED DISTANCE PROTECTIONRELAY SET

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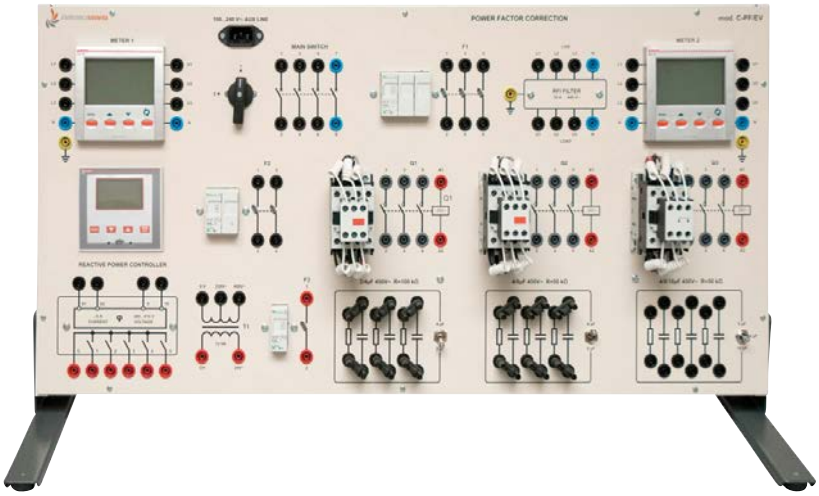
PANEL OF EXPERIMENTATION OF AUTOMATIC POWER FACTOR CORRECTION SYSTEMS

Mod. C-PF/EV



INTRODUCTION

This panel enables the experimentation on industrial installations with electronic devices for the control of power factor correction of electric low-voltage uses (voltage of 400 V). Automatic power factor correction circuits with different capacitive steps controlled by an electronic unit can be assembled on the panel. Two power analyzers measure voltages, currents, active, reactive and apparent powers and power factor.
The instruments are configured in 3 single-phase, three-phase systems with or without neutral; their use is free in the circuit: e.g.: in the feed line, in users or power consuming facility, in a capacitive battery, etc…

The panel is made of insulating material where components are represented with their international electric symbols; electric connections are easier via cables and jumpers with safety plugs of 4 mm; no tool is used.

The electric user with different values of apparent-active-inductive power is easily reproduced in laboratory with the combined help of variable resistive-inductive loads.
A value of active-reactive power ranging between 1300-1900 W + 1300 - 1900 Var, adjustable in 5..7 steps, is recommended for a very good experimentation.

Variable loads mod. RL-2/EV + IL-2/EV, or mod. RL-3/EV + IL-3/EV, or mod. RL-2K/EV, are recommended.

TRAINING PROGRAM:

- Measurements and relations between Apparent, Active, Reactive powers
- Located installation of power factor correction of single-phase power users
- Located installation of power factor correction of three-phase power users
- Discharge of the power stored in capacitors
- Central installations of automatic power factor correction with 1-2-3 equal steps
- Central installations of automatic power factor correction with 1-2-3 double steps
- Filtering of harmonic currents in capacitors

TECHNICAL CHARACTERISTICS:

- Varnished metal framework with fore panel of insulating material.
- Quick connections via safety terminals and cables Ø 4 mm
- 1 automatic microprocessor-controlled power factor regulator, with rated voltage 380-415 V 50-60 Hz
  - ammeter input with forward current up to 5 A (sensitivity range 0.125..6 A)
  - setting power factor 0.8 ind…0.8 cap, reconnection time 5…240 s
  - sensitivity range 5…600 s/step
  - 5 relay outputs with contacts 5 A - 250 Vac
  - manual setting of parameters by display-assisted keyboard
- 2 multi-function instruments, with auxiliary power supply of 115-230 V, 3 lines of three 7-segment displays of 13 mm with red LEDS
  - measures of voltages, currents, active-reactive-apparent powers and power factor in single-phase and three-phase systems
  - accuracy class for currents and voltages ± 1%
  - measuring range: 5 A - 850 V max
- operational four-pole rotary switch of 16 A - 400 V
- 1 set of three fuse holders with gl-type fuses 10.3 x 38 of 6 A
- 1 pair of fuse holders with gl-type fuses 10.3 x 38 of 2 A
- 1 fuse holder with gl-type fuse 10.3 x 38 of 4 A
- 1 noise suppressor for three-phase line with neutral - Un 440 V, In 10 A, inductance 0.4 mH, capacitance 0.1 µF.
- 3 three-pole contactors for power factor correction Ith (AC1) 25 A (7.5 kvar at 400 V) with transient limiting devices, insertion, excitation 24 Vac 50-60 Hz
- 1 single-phase transformer -primary 230-400, secondary 24 V, power of 72 VA
- 1 battery of three-phase capacitors of 450 V~ with selector between 2 and 4 µF and corresponding discharge resistors of 100 Ω - 5 W
- 1 battery of three-phase capacitors 450 V~ with selector between 4 and 8 µF and corresponding discharge resistors of 50 Ω - 10 W
- 1 battery of three-phase capacitors 450 V~ with selector between 4.8 and 16 µF and corresponding discharge resistors of 50 Ω - 10 W

All the batteries of capacitors can be connected in single-phase configuration or in three-phase star-delta configuration, they enable the development of automatic power factor correction systems up to 3 equal steps (4 + 4 + 4 µF), up to 3 double steps 2, 4, 8 µF, or of 4, 8, 16 µF; further combinations are possible from the parallel connection of the various batteries.

Dimensions: 805 x 405 x 100 mm
Net weight: 18 kg

OPTIONAL ACCESSORY:

Software and programming cable (having to be ordered separately).

Adding the programming software, via port RS232 (or USB with a converter) will enable to set and display (simultaneously) all the measures (current power factor, set power factor, average weekly power factor, voltage, current, reactive power of the installation) in the automatic power factor regulator in order to get a general view of power factor correction system. Moreover, the total time and the number of insertions performed from the start of the installation are shown for each step, for the preventive maintenance of contactors.

REQUIRED

UTILITIES (PROVIDED BY THE CUSTOMER)

- Auxiliary power supply: 230 Vac 50 Hz single-phase - 50 VA
- Power supply: 400 Vac 50 Hz three-phase - 3 kVA
  (Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- 1 set of 67 cables and 20 jumpers with safety plugs ø 4 mm

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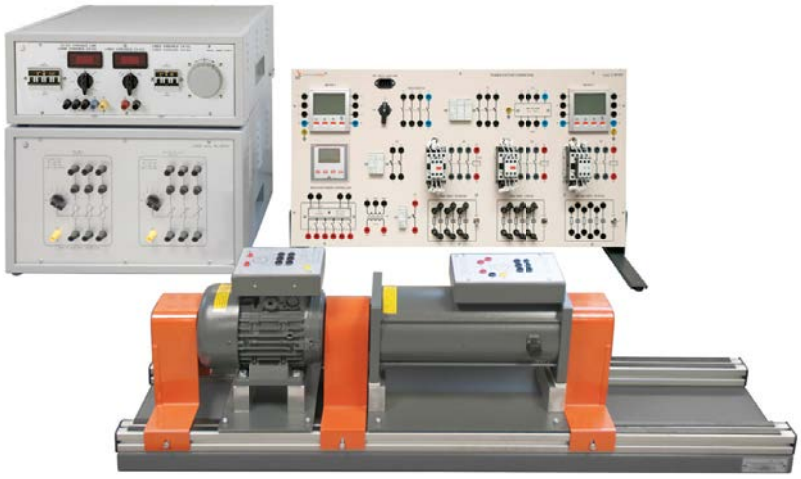
REACTIVE POWER COMPENSATION TRAINER

Mod. RPC-1/EV

INTRODUCTION

Reactive Power Compensation (RPC) is becoming an important topic in high-powered electrical installations. RPC is also known by its more popular name "Power Factor (or Cos Phi) Correction, hereinafter referred to as "PFC". Below are some reasons why RPC is important.



ECONOMICAL reasons:

1. When the Power Factor (PF) falls outside a specific range (usually above 0.9, such as 0.92 to 0.95) for a given period of time a considerable additional cost is applied to the consumer electricity bill.
2. When new equipment/components are added to an already existing electrical installation, the previously installed components such as distribution transformers can become overloaded. The first alternative one might consider is that of installing a new, more powerful transformer or to add another transformer in parallel with the existing ones. Another alternative, however - if the overload is due to Reactive Power - could be PFC. This alternative is usually cheaper than the previous ones and could also contribute to a decrease in the consumer's electricity bill (see ECONOMICAL 1).

TECHNICAL reasons:

3. Electrical loads are usually reactive or inductive with low power factor such as electrical motors, power transformers, fluorescent lamps, welding machines, induction furnaces etc. Low power factor means high reactive power (kVar), which translates into the need for additional excitation of the power house alternators. This excessive reactive power could even lead to the necessity of more alternators despite the fact that the active power (kW) might be low.
4. In addition to over-excitation of the alternators, **a low PF means higher currents for the same active power (kW)**. The energy loss in high voltage lines is proportional to the square of the current. Hence, any decrease in current will result in the reduction of the excitation requirements of the alternators as well as energy loss in the line.
5. It can be deduced from TECHNICAL 2 that correct power factor translates into less fossil fuel consumption, less air pollution (less greenhouse gas emissions) and longer life cycle of alternators, high voltage lines, switches and transformers.
6. Apart from maintaining the consumer's electricity bill as low as possible, the consumer also benefits from improved power factor as less current is consumed enabling the **electrical installation to operate with minimum stress**.

Elettronica Veneta Spa developed this Trainer for the exhaustive study of PFC tools and methods. It is a high level unit, and the suggested entrance level is a course in Electrical Laws and Electrical Machines.

EDUCATIONAL PROGRAM:

The Trainer has been developed for the theoretical-practical study of the different components, circuits and measurements of RPC techniques.

All the proposed components are real and totally operational. Instruments and electronic boards are of the most advanced available technology. The following RPC methods are theoretically explained in the manual. The student is then led to develop the different proposed circuits and to verify the theoretical concepts.

The following subjects are fully developed:

1. **the PF concept**: the shift angle between voltage and current.
2. **the S (kVA)- P (kW) - Q (kVAr)** power triangle
3. **theoretical fundamentals of PFC correction**, and the constancy of active power P (kW)
4. **the R-L loads** and the relative measurement of voltages, currents, active, reactive & apparent power. Measurement of PF using multifunctional instruments.
5. **the PF of a 3-ph asynchronous motor:** with no load and PF improving with load. Searching for the best capacitance and the possibility of PF over-compensation.

6. **PFC methods:** 1- static compensation (over the individual device); 2- centralized PFC; 3- the synchronous compensator.
7. **the automatic electronic control system:** description of a typical unit; use with a variable R-L load.
8. **the automatic PFC control system** in MAN/AUTO modes.
9. **the 3-ph synchronous compensator:** PFC related to the synchronous machine excitation.

TECHNICAL CHARACTERISTICS:

The Trainer consists of the following sub-units (for the complete details, pls see the specific brochure):

1- PANEL FOR THE AUTO/MAN PFC mod.C-PF/EV

- 1 automatic microprocessor-controlled power factor regulator, rated voltage 380-415 V 50-60 Hz; amps input: up to 5 A; settable PF0.8 ind…0.8 cap, reconnection time 5…240 s; 5 relay outputs with contacts 5 A - 250 VAC; manual setting of parameters by display-assisted keyboard
- 2 multifunctional instruments, auxiliary power supply 115-230 V, measurement of voltages, currents, active-reactive-apparent powers and power factor in single-phase and three-phase systems; range: 5 A - 850 V max. *Both instruments have free terminals for arbitrary connection.*
- 4-pole rotary switch, 16 A - 400 V
- 1 set of 3 fuse-holders with gG type fuses 10.3 x 38 of 6 A
- 1 pair of fuse-holders with gG type fuses 10.3 x 38 of 2 A
- 1 fuse-holder with gG type fuse 10.3 x 38 of 4 A
- 1 noise suppressor for 3-phase line with neutral - Un 440 V, In 10 A
- 3 three-pole contactors for PFC Ith (AC1) 25 A (7.5 kvar at 400 V) with transient limiting devices, insertion, excitation 24 VAC 50-60 Hz
- 1 single-phase control transformer: P= 230-400, S= 24 V; 72 VA
- 1 3-phase capacitor battery 450 V with selector 2 and 4 µF and discharge resistors 100 Ω - 5 W
- 1 3-phase capacitor battery 450 V with selector 4 and 8 µF and discharge resistors 50 Ω - 10 W
- 1 3-phase capacitor battery 450 V with selector 4.8 and 16 µF and discharge resistors 50 Ω - 10 W
- All capacitor banks can be connected in single-phase or 3-phase star-delta configuration. They enable the automatic PFC systems up to 3 equal steps (4 + 4 + 4 µF), up to 3 double steps 2, 4, 8 µF, or of 4, 8, 16 µF; further combinations are possible from the parallel connection of the various banks.

2- RESISTIVE-INDUCTIVE LOAD mod.RL-2K/EV

- suitable for single-phase 230 V and for 3-phase 400 V (star connection), and 230 V (delta connection). Max. apparent power: 2100 VA
- **Resistive section:** single-phase/three-phase active power, 1500 W, that can be divided into 5 equal steps. Each step consists of 3 resistances of 530 Ω - 220 VDC/230 Vac. Fuse protection against overloads and missing connections. Six terminals with 4 mm safety plugs enable single-phase connection (parallel connection of the 3 phases) and three-phase star/delta connection. One 3-phase rotary switch for independent variation of R section.
- **Inductive section:** single-phase/three-phase reactive power, 1500 Var, that can be divided into 5 equal steps. Each step consists of 3 impedances of 0.43 A - 230 V - 50 Hz. Fuse protection against overloads and missing connections. Six terminals with 4 mm safety plugs enable single-phase connection (parallel connection of the 3 phases) and three-phase star/delta connection. One 3-phase rotary switch for independent variation of L section.

3- SET OF ELECTRICAL MACHINES mod.P-4/EV + P-3/EV + BP/EV (v. cat. 23 - Electrical Engineering)

- the set includes a 3-phase squirrel cage asynchronous motor and a 3-phase alternator/synchronous motor. Both machines are mechanically coupled and mounted on a robust steel base.
- **the 3-phase squirrel cage asynchronous motor:** 1000 W; 230/400 V 50 Hz; 2900 rpm / 2 poles; delta-star connection; frame IM B3; protection: IP 44. Includes a thermal protector. Top terminal box, all connections via 4 mm safety connectors.
- **the 3-phase alternator / synchronous motor:** 1000 VA; 230/400 V 50 Hz; synchronous speed 3000 rpm / 2 poles; excitation voltage: 220 VDC. Also runs as synchronous motor with induction starting. Delta-star connection. Frame: IM B3; protection: IP 22. Includes a thermal protector. Top terminal box, all connections via 4 mm safety connectors.
- **the machines base:** for easy and quick coupling of the machines. Provided with safety covers that can be applied over the coupling joints to prevent access to moving parts.

4- VARIABLE VOLTAGES POWER SUPPLY mod. AMT-3/EV (v. cat. 23 - Electrical Engineering)

- Totally contained in a steel box; silk-screen-printed front panel of aluminium alloy and handles for transport.
- **3-phase voltage regulator** of 5 A, AC/DC selector
- **3-phase variable line of 0-430 V - 5 A (single-phase, 0-250 V),** protected by magneto-thermal circuit breaker, digital 3-digit voltmeter with voltmeter switch for phase-phase and phase-neutral connection, 4 mm safety terminals.
- **Variable line of 0-500 Vdc - 6 A** (three-phase voltage rectified by 6-diode bridge) ripple 4.2%; line protected by magneto-thermal circuit breakers, digital 3-digit voltmeter, safety terminals.

REQUIRED

UTILITIES (PROVIDED BY THE CUSTOMER)

- Power supply: 3*400 Vac 50 Hz three-phase - 5 kVA
  (Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES: 1 set of 60 cables

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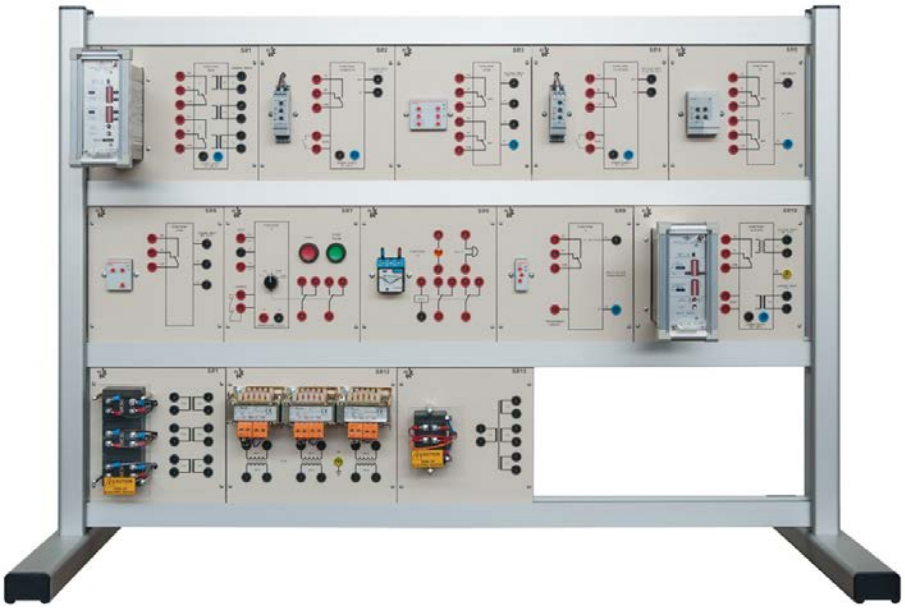
SET OF PROTECTION RELAYS FOR HIGH-VOLTAGE AND LOW-VOLTAGE NETWORKS

Mod. SRT-1/EV



STUDY AND APPLICATION OF PROTECTION RELAYS Mod. SRT-1/EV

This system has been designed to enable students to connect and apply a wide range of electric, electronic protection relays with circuits of increasing complexity, besides verifying their characteristics.
The training program is developed on interchangeable modules that enable to assemble the circuits with the mere connection of the modules via flexible leads of the equipment.
The modules are wholly made of insulating material, the graphic representation with international electric symbols and the educational safety terminals enable to assemble and test electric circuits in short time.

Main subjects dealt with:

- Study of the operational characteristics of protection relays.
- Typical applications of protection relays.
- Identification number of the protection function.
- Combination of more relays to attain specific protection goals.

TECHNICAL CHARACTERISTICS:

Set of modules for studying static protection relays and measuring transformers:

1 Module SR-1
1 three-phase maximum-current and short-circuit relay, adjustment range 0,5-2A/1-16 A ac, auxiliary power supply of 230 V 50-60 Hz.

1 Module SR-2
1 single-phase maximum or minimum current relay, adjustment range 0.1-5A/ 5-25 A ac/dc, auxiliary power supply of 230 V 50-60 Hz.

1 Module SR-3
1 three-phase maximum and minimum voltage relay /N, adjustment range +10% / -15%, Ue 380-400 Vac, self-powered.

1 Module SR-4
1 single-phase maximum or minimum voltage relay, adjustment range 2-500 Vac/dc, auxiliary power supply of 230 V 50-60 Hz.

1 Module SR-5
1 maximum and minimum frequency relay, 50-60 Hz, adjustment range + 10%, self-powered at 230 Vac.

1 Module SR-6
1 phase sequence and voltage asymmetry relay for networks of 400 V, asymmetry adjustment range: 5 -15%, self-powered at 400 Vac.

1 Modulo SR-7
1 auxiliary relay with two exchange contacts, driven by TTL/PLC signals / buttons of 24 Vdc for excitation, stop, start.

1 Module SR-8
1 auxiliary relay with two exchange contacts, excitation 24 Vdc, 1 optical acoustic indicator of 24 Vac/dc.

1 Module SR-9
1 timer relay with one exchange contact, multi-function, multi-range, multi-voltage, 24 Vac/dc

1 Module SR-10
directional overcurrent relay, 5 A - 400 V, auxiliary power supply of 230 Vac.

1 Module SR-11
3 wound-primary current transformers 10/5 A, performance 3 VA in cl. 0.5.

1 Module SR-12
voltage transformers 500/100 V, performance 10 VA in cl. 0.5.

1 Module SR-13
1 current step-up transformer 5 + 5 + 5/5 A, performance 8 VA in cl. 0.5.

TRAINING PROGRAM:

- Connections and study of the behaviour of a maximum-current relay in a three-phase network with different current values, verification of trip time.
- Connections and study of the behaviour of a short-circuit current relay in a three-phase network with different current values, verification of trip time.
- Connections and study of the behaviour of a single-phase maximum or minimum current relay, verification of trip time for maximum and minimum current.
- Connections and study of the behaviour of a maximum or minimum DC relay, verification of trip time for maximum and minimum current.
- Connections and study of the behaviour of a maximum and minimum voltage relay in a three-phase network with neutral, verification of trip time for maximum and minimum voltage.
- Connections and study of the behaviour of a single-phase maximum or minimum voltage relay, verification of trip time for maximum and minimum voltage.
- Connections and study of the behaviour of a maximum and minimum DC voltage relay, verification of trip time for maximum and minimum voltage.
- Connections and study of the behaviour of a maximum and minimum frequency relay, verification of its operation at maximum and minimum voltage.
- Connections and study of the behaviour of a phase sequence and voltage asymmetry relay in a three-phase network, verification of its operation with wrong sequence and in non-asymmetric conditions or missing phase.
- Connections and study of the behaviour of a maximum current directional relay in a three-phase network, verification of its operation with reverse current flow and as directional of maximum earth current (suitable for lines and generators).
- Use of auxiliary relays as interface of protection relays for controlling high power flows
- Use of auxiliary relays as interface for remote, optical/acoustic signalling of intervention of protection relays.
- Use of timers with various time functions to increase the functionality of protection relays
- Determination of the transformation ratio of a TA with various primary currents and influence of load on the secondary winding, performance tests.
- Connection of current transformers in three-phase networks.
- Measurement of zero sequence current in a three-phase system.
- Tests on a current step-up transformer.
- Demonstration of the differential protection principle.
- Determination of the transformation ratio of a TV with various primary voltages and influence of load on the secondary winding, performance tests.
- Connections of voltage transformers in three-phase networks.
- Connections of open-delta voltage transformers in three-phase networks.

Accessories supplied:
- 1 box for modules of aluminiun section and varnished sheet steel with transversal feet to lay on benches mod. TSI-2/EV
- 1 variable single/three-phase power supply of 0-430 Vac / 0-500 Vdc 5A for tests on voltage and current relays mod. AMT-3/EV
- 1 digital power analyzer suitable to balanced or unbalanced systems with or without neutral. Suitable to measure voltages, currents, apparent, active and reactive powers, maximum active, reactive and apparent power peaks, counting of active and reactive power, co-generation meters. The analyzer is provided with two programmable relays with minimum or maximum alarm functions between the measured parameters mod. AZ-VIP.
- 2 digital autorange multimeters
- 1 desk-type three-phase rheostat 3 x 500 W, 3 x 50, for tests on current relays.
- Set of 40 cables with safety terminals ø 4 mm

Frame - mod. TSI-2/EV - dimensions: 1160 x 500 x 810 mm
Net weight: 26 kg

SUPPLIED WITH
OPERATIONAL HANDBOOK WITH EXERCISES

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TRAINER WITH DIFFERENTIAL RELAY AND FUNCTIONALITY ANALYSIS INSTRUMENT

Mod. SR-14/EV

INTRODUCTION

This optional module of Set mod. SRT-1/EV includes a differential relay with adjustable trip times and currents and an instrument for analyzing the operation.

DIFFERENTIAL RELAY Mod. SR-14/EV

A-type differential relay, with adjustable trip times and currents, provided with a toroidal transformer crossed by the cables of the line to be controlled.

TECHNICAL CHARACTERISTICS:

- adjustable tripping current. Range: 0.3-0. 1-0.3-1-2-5 a
- adjustable tripping time: Range: 0.05-0.3-0.5-1-2-5 s
- LED for power supply and alarm
- test and reset button
- auxiliary power supply: 110 - 400 Vac, 50-60 Hz or 48 - 110 Vdc
- output relay contact: 10 A - 250 Vac
- indication of disconnected toroidal transformer
- toroidal transformer with cable entry diameter 29 mm

INSTRUMENT FOR TESTING DIFFERENTIALS:

- digital microprocessor-controlled instrument
- test 0 and 180°
- for AC-type and A-type differentials
- indication of correct connection with the circuit
- tripping currents selectable between 10-30-300-500 mA
- test ½ Idn, 1 Idn, 5 Idn
- automatic ramp mode
- maximum trip time:1000 ms with resolution of 1 ms

AUXILIARY POWER SUPPLY:
110-400 Vac - 50-60 Hz

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

CURRENT INVERSE TIME RELAY

Mod. SR-15/EV

TECHNICAL CHARACTERISTICS:

- Current and intervention time are controlled on the fore panel by two sets of 8 DIP switches
- 3 LEDs of state indication:
  1 green LED for line; 1 red LED indicating intervention for overload; 1 LED for overload memory
- Test pushbutton: it simulates the maximum regulated current twice to check relay intervention
- Switch for stopping relay intervention
- Relay intervention can be reset manually via the pushbutton of fore panel, manually via a remote pushbutton having to be connected with terminals, automatically (function is enabled via a jumper)
- Relay with NO/NC contact, rated current of 5 A
- Current input: 1 or 5 A

AUXILIARY POWER SUPPLY:
90-220 Vac/Vcc ± 20%

SUPPLIED WITH

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HIGH SPEED DISTANCE PROTECTION RELAY SET

Mod. HDPR/EV

Module SR-21 Module SR-16 Module SR-20

INTRODUCTION

The Impedance / Distance Relay (IR) is used in low, medium and high voltage lines, being one of the most important protection devices against shortcircuits. It is mainly used when the current overload relays do not provide adequate protection; the Impedance / Distance relays can work even when the short-circuit current is low and the overload relays could not operate safely. Additionally, the speed operation of the IR is independent from the short-circuit current value. Basically, it is a relay that senses the current and voltage of the protected line and calculates its impedance Z. This relay keeps record of the Z0 of the protected line under normal working conditions. It continuously compares the Z actual value with the recorded one; When the difference is under the preset limits (Z < Z0) the relay is activated and indicates the fault distance from the point where the relay is connected.

TECHNICAL CHARACTERISTICS:

The set includes:

1 module SR-16 - Distance Protection Relay

- Distance protection relay based on the Siemens SIPROTEC 4 7SA6
- For all voltages level
- High speed tripping time
- Protects even very short lines
- I (PH)= 1A; Ie= sensitive (min 30 mA)
- Auxiliary power supply: 24 to 48 VDC
- With 5 24VDC inputs + 9 relay outputs, 5 A DC
- Distance protection function: quadrilateral (Z<)
- Directional earth-fault protection, earthed networks
- Earth-fault detection compensated/isolated networks

Dimensions: 840 x 450 x 680 mm
Net weight: 33 kg

1 module SR-20 - Line Distance simulator

(to be used with the Module SR-16)

- HV line model: PI concentrated parameters
- Simulated distances: 25-50 and 100 km
- Simulated Un= 120 kV
- Simulated Pn= 20 MVA
- Working current: 1 A
- Distributed equivalent resistance (concentrated values) = 8.9-18-35 Ω
- Distributed equivalent inductance (concentrated values) = 144-72-36 mH
- Distributed equivalent capacitance (concentrated values) = 0.1-0.2-0.4 µF

Dimensions: 840 x 450 x 300 mm
Net weight: 15 kg

1 module SR-21 Isolation transformer

(to be used with the Module SR-16)

- Primary: 230/400 v - 50 Hz
- Sec. 1: 50/100 V - 8.6 A
- Sec. 2: 230/400 V - 2.17 A
- Power: 1500 VA
- For practical exercises on the shortcircuit

Dimensions: 360 x 200 x 300 mm
Net weight: 19 kg

SUPPLIED WITH

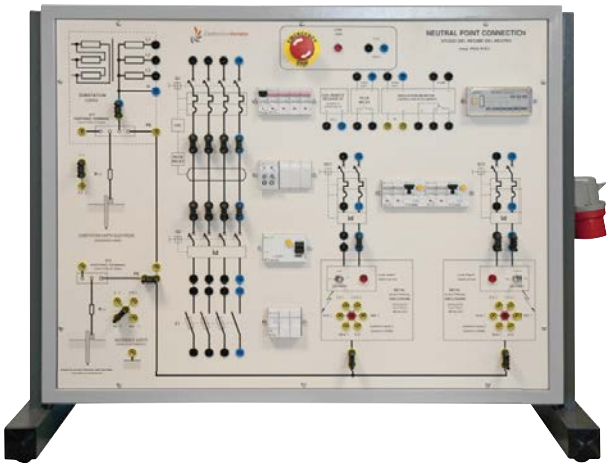
OPERATIONAL HANDBOOK WITH EXERCISES

PANEL FOR STUDYING AND TESTING DISTRIBUTION SYSTEMS (neutral point connection)

Mod. PDG-R/EV

INTRODUCTION

This panel enables teachers to develop an exhaustive class on the state of neutral conductor in distribution systems, so that students can easily learn and test this topic. The actual electric devices assembled in the panel and proper educational terminals with high protection degree against accidental contacts enable to assemble the various configurations, as well as a sight check of the operation: tests can be carried out with traditional instruments.



PANEL FOR STUDYING AND TESTING DISTRIBUTION SYSTEMS (neutral point connection) MOD. PDG-R/EV

Demonstration panel with electric components

The fore panel of insulating material is the support of the necessary devices for the development of the training program. The apparatuses are indicated on the panel with standard international symbols. The application field of these devices will cover installations of both civil and business and/or production (handicraft - industrial) sectors.

TRAINING PROGRAM:

This panel enables to study electric power distribution systems with reference to the following main topics:

- TT, RN and IT systems
- Protection against direct contacts
- Protection against indirect contacts by earthing, electric separation, automatic differential switch
- Protection against over-currents, selectivity in protection devices
- Earthing system and conductors
- Natural, artificial earth plates
- Checking the insulation resistance in systems insulated from earth (IT)
- Suitability of materials and of equipment
- Protections and breaking devices

Moreover, it is possible to carry out the following instrumental measurements and checks:

- Identification of neutral and ground conductors
- Measurement of insulation resistance
- Measurement of earth resistance
- Continuity tests of protection conductors
- Check of the operation of differential switches
- Check of the protection with automatic break
- Measurement of fault loop resistance / impedance
- Measurement of first earth fault in insulated systems

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TECHNICAL CHARACTERISTICS:

The framework is of chemically treated sheet steel, painted with several coats of epoxy paint. Its base is provided with rubber feet so that it can be positioned on any working top. The panel also includes all the necessary electrical components for a correct power supply of circuits.
The main components installed on the panel and accessible via safety terminals for plugs of Ø 4 mm, are:

- 1 three-phase insulation transformer of 230-400 V / 230-400 V 1500 VA
- 1 automatic magneto-thermal switch 4 x 6 A, C curve, with minimum-voltage releasing coil, emergency pushbutton with mechanical holding and warning light indicating panel in operation
- 1 power line of 230 Vac - 1 A for powering auxiliary devices
- 1 three-pole lever switch for inserting two different values of earth capacitance in IT line
- 1 simulation of cabin earth with resistance of 0.3 Ω, 1 Ω
- 1 simulation of earth plate with resistances of 2 Ω, 20 Ω, 200 Ω, 2 kΩ
- 2 simulators of electric uses with sinusoidal or one-way earth fault current, fault resistance of 50 kΩ, 15 kΩ, 5 kΩ, 1.5 kΩ, 500 Ω, no-resistance earth fault
- 1 monitor for insulation control in IT systems with regulation of the value of intervention sensitivity and scale for monitoring the instantaneous value of system insulation resistance
- 1 automatic differential magneto-thermal switch 4 x 2 A, C curve, class AC, possibility of using only the magneto-thermal switch without the differential section
- 1 four-pole differential circuit breaker of 25 A / 0.3 A, class A, "S" selective
- 1 set of three fuse holders, with breakable neutral conductor and fuses 10.2 x 38 of 1 A and 2 A
- 1 automatic magnetothermal differential switch 2 x 1 A, curve C, class AC, with possibility of using the only magnetothermal switch without the differential part
- 1 automatic magnetothermal differential switch 2 x 1 A, curve C, class A, with possibility of using the only magnetothermal switch without the differential part
- 1 differential relay coupled to a toroidal transformer with adjustable current Idn and intervention time

Dimensions of panel: 800 x 600 mm
Dimensions of framework: 840 x 450 x 680 mm
Net weight: 45 kg

REQUIRED

UTILITIES (PROVIDED BY THE CUSTOMER)

- Power supply: 400 Vac 50 Hz three-phase - 1500 VA
  (Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- Three-phase power cord of 5 m with EEC socket and plug
- 20 jumpers with safety plugs of Ø 4 mm for assembling various installation conditions
- Set of 20 various leads with safety plugs of Ø 4 mm

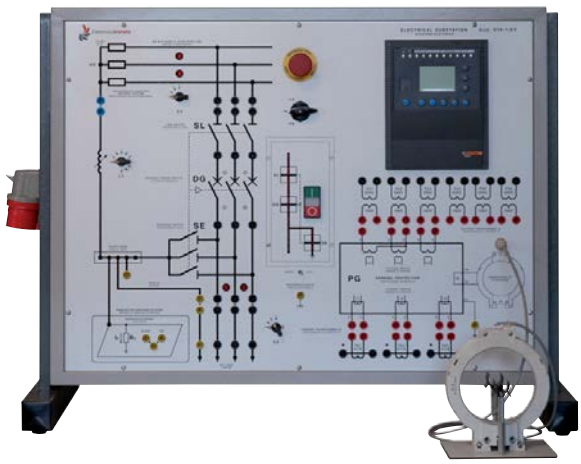
OPTIONAL

ACCESSORIES:

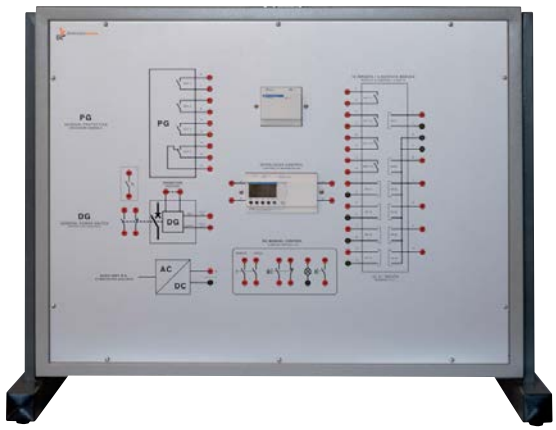
- Multifunction microprocessor-controlled instrument for electrical checks
- Digital ammeter for measuring rated and stray currents
- Autoranging digital multimeter

SUBSTATION PANEL

Mod. STA-1/EV



FORE VIEW



REAR VIEW

INTRODUCTION

Movable desk-type equipment with wide synoptic panel representing the parts of a medium voltage substation.
It uses professional components to reproduce the operating conditions and the rules for ensuring protection and safety in compliance with the standards in force applicable to the system typology, in laboratory.
The equipment has been conceived to allow a "tailored" configuration of the devices and test points prearranged in the panel, represented in silk-screen-printed diagrams with international symbols, thus enabling the separate study of the performance of each component, and their coordination.

Panel **mod. STA-1/EV** will output the Medium Voltage line; the capacitance parameters of this line can be modified, thus overhead and wired lines of different lengths can be reproduced. Furthermore the state of neutral conductor can be modified from insulated to compensated and the effect of compensation inductance will be demonstrated.

The possibility of using substation panel **mod. STA-1/EV** coupled to other panels such as user cabin panels **mod. CAB-1/EV** and **mod. CAB-2/EV** enables to carry out the coordination and study on ammeter and time selectivity of protection devices and to extend the applications with pilot wire logic selectivity.

This equipment consists of two panels to avoid errors during the practical experimentation: thus power circuits are kept separated from control circuits. Using safety terminals enables to assemble the power circuit (Medium Voltage circuit) quickly, on one side, via safety jumpers and/or cables with plugs Ø 4 mm.

The diagram silk-screen-printed on the panel supplies clear information on the typical connection of the devices, but connection points can also be modified at operator's will such as TA before or after the general device, 2 or 3 TV, toroidal TA connected in the reception point or in the output point of MV line, etc…

On the other side, using terminals and leads with plugs Ø 2 mm enables to assemble the control circuit for opening and closing the general protection, quickly.

The operation of the general device is reproduced by a power contactor controlled by a PLC for the logic of interlocks. The line breaker and the earthing switch are reproduced by a rotary switch. Moreover the PLC controls the LED synoptic diagram that displays the voltage available in the various points of the circuit, as well as the state of line breakers and of earthing switch.

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TRAINING PROGRAM:

This equipment including SEPAM S41 relay enables to define a typical electrical installation of a MV start point of the power distribution agency or of an arrival station owned by the customer connected with the Medium Voltage network. The topics that can be dealt with are:

- Insulated MV network, compensated MV network
- Overhead lines, cable lines with shield conductor
- Connection of TA and programming of the parameters for function 50 / 51 (maximum current)
- Connection of TA and programming of the parameters for function 50N / 51N (maximum earth current)
- Connection of TV and programming of the parameters for function 27 / 59 (minimum and maximum voltage)
- Programming of the parameters for function 81L / 81H (minimum and maximum frequency)
- Connection of toroidal TA and TV and programming of the parameters for function 67N (max. directional earth current)
- Programming of the parameters for current inverse time protection
- Configuring the outputs of general protection for the control of general device
- Configuring the inputs of general protection for the logic control of general device
- Pilot wire logic selectivity with other series-connected devices
- Measuring voltages, currents and powers
- Simple logic sequences for conditional validation and inhibition
- Substation earthing system, global earthing system combined with other earthing systems interconnected via the shields of MV cables.

The list of the topics is only indicative in consideration of the wide versatility of the used protection relay and of the possibility of realizing numberless connection diagrams.

TECHNICAL CHARACTERISTICS:

This unit is made of chemically treated sheet steel, painted with several coats of epoxy paint. Its base is provided with rubber feet so that it can be positioned on any working top.

Synoptic panels are made of aluminium alloy and they have been silk-screen printed with the international symbols; they show the necessary devices and connections for enabling standard configurations and/or any other configuration for experimental aims.

The connections on the fore panel (in three-phase voltage of 380-400 V) are carried out via terminals and leads/jumpers with safety plugs Ø 4 mm.

The connections on the rear panel (in extra low safety voltage of 24 Vdc) are carried out via terminals and leads with safety plugs Ø 2 mm.

Main components installed

- 3 single-phase transformers with primary winding of 230-400 V / secondary winding of 230 V, power of 500 VA, for assembling the HV / MV source.
- Automatic magneto-thermal 4-pole switch equipped with minimum voltage coil and emergency pushbutton, warning light indicating energized line, protection fuses of emergency stop circuit and transformers.
- Simulator of cabin earth resistance with value selectable between 0.3 and 1 Ω.
- General device reproduced with a 3-pole contactor In = 25 A
- Earthing switch reproduced by a rotary switch In = 32 A
- PLC-controlled logic of interlocks and LED synoptic panel that displays the availability of medium voltage in various points of the circuit, the state of general device, the state of line breaker, the state of earthing switch
- Pushbuttons for manual start/stop control of general device
- Modular PLC with display, 12 inputs of 24 Vdc / 8 outputs of 24 Vdc
- Regulated power supply of 24 Vdc 1.3 A
- 3 current step-down transformers 5 / 1 A
- 6 voltage step-down transformers 500 / 100 V
- Toroidal current transformer for detecting homopolar earth current
- SEPAM relay series 40 (model S41) provided with advanced dialogue interface with graphic LCD and keys for displaying measures and parametrizations
- Extension module of 10 inputs / 4 outputs applied to relay

Dimensions of operational panels: 800 x 600 mm
Dimensions of the framework: 880 x 450 x 680 mm
Weight: 42 kg

REQUIRED

UTILITIES (PROVIDED BY THE CUSTOMER)

- Power supply: 400 Vac 50 Hz three-phase - 1500 VA
  (Other voltage and frequency on request)

ACCESSORIES (NOT INCLUDED)

- **VARIABLE RESISTIVE LOAD - mod. RL-2/EV**
  Ideal tool for studying the effects of overcurrents and of earth faults.
- **SOFTWARE:**
  - Software kit (SFT 2841) for configuring SEPAM relay: it enables to display and control all the parameters. This software is available in Italian, English, French and Spanish and is provided with connection cable between PC and SEPAM series S 20, 40 and 80, as alternative to the programming keys of relay. This kit also includes Software SFT 2826 for transferring, displaying and analyzing turbo graphs (records of the event provoking an alarm condition) carried out by SEPAM relays. This software is available in Italian, English, French and Spanish.
  - PLC programming software Zelio SOFT SR2 SFT01 and USB cable (SR2CBL01) of PC-PLC connection for modifying the program of logic control of interlocks, as alternative to PLC programming keys. This software is available in Italian, English, French and Spanish.

Note: When using mod. STA-1/EV together with panels mod. CAB-1/EV and/or CAB-2/EV, it is enough to use only one computer with the above mentioned software and only one Resistive Load mod. RL-2/EV.

SUPPLIED WITH

OPERATIONAL HANDBOOK

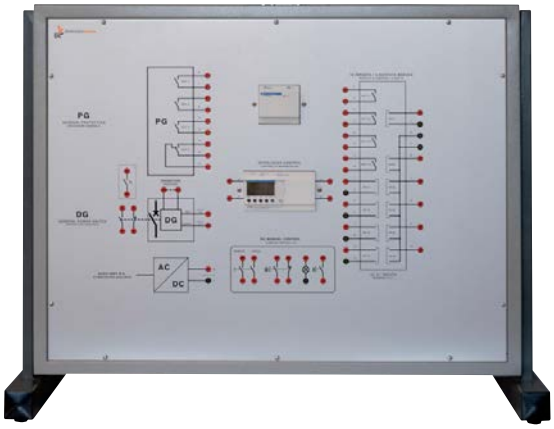
ACCESSORIES:

- 1 three-phase power cord of with (EEC) IEC 309 socket and plug
- 18 jumpers with safety plugs Ø 4 mm
- 46 leads of various lengths with safety plugs Ø 4 mm
- 18 leads of various lengths with safety plugs Ø 2 mm

USER CABIN PANEL I

Mod. CAB-1/EV

FORE VIEW



REAR VIEW

INTRODUCTION

Movable desk-type equipment with wide synoptic panel representing the parts of a medium voltage cabin. It uses professional components to reproduce the operating conditions and the rules for ensuring protection and safety in compliance with the standards in force applicable to the system typology, in laboratory.

The equipment has been conceived to allow a "tailored" configuration of the devices and test points prearranged in the panel, represented in silk-screen-printed diagrams with international symbols, thus enabling the separate study of the performance of each component, and their coordination.

The possibility of using user cabin panel **mod. CAB-1/EV** coupled to other panels such as user cabin panels and **mod. CAB-2/EV** and substation panel **mod. STA-1/EV** enables to carry out the coordination and study on ammeter and time selectivity of protection devices and to extend the applications with pilot wire logic selectivity.

This equipment consists of two panels to avoid errors during the practical experimentation: thus power circuits are kept separated from control circuits.

Using safety terminals enables to assemble the power circuit (Medium Voltage circuit) quickly, on one side, via safety jumpers and/or cables with plugs Ø 4 mm. The diagram silk-screen-printed on the panel supplies clear information on the typical connection of the devices, but connection points can also be modified at operator's will such as TA before or after the general device, 2 or 3 TA, TV before or after the general device, 2 or 3 TV, toroidal TA connected in the reception point or in the output point of MV line, etc…

On the other side, using terminals and leads with plugs Ø 2 mm enables to assemble the control circuit for opening and closing the **general protection**, quickly.

The operation of the **general device** is reproduced by a power contactor controlled by a PLC for the logic of **interlocks**.

The **line breaker and the earthing switch** are reproduced by a rotary switch. Moreover the PLC controls the LED synoptic diagram that displays the voltage available in the various points of the circuit, as well as the state of general device, of line breaker and of earthing switch.

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TRAINING PROGRAM:

This equipment including SEPAM S41 relay enables to define a typical electrical installation of a cabin owned by the customer connected with the Medium Voltage network. The topics that can be dealt with are:

- Connection of TA and programming of the parameters for function 50 / 51 (maximum current)
- Connection of TA and programming of the parameters for function 50N / 51N (maximum earth current)
- Connection of TV and programming of the parameters for function 27 / 59 (minimum and maximum voltage)
- programming of the parameters for function 81L / 81H (minimum and maximum frequency)
- Connection of toroidal TA and TV and programming of the parameters for function 67N (maximum directional earth current); cable lines with shield connected with cabin earthing system are considered
- Maximum inverse sequence current function 46
- programming of the parameters for current inverse time protection
- configuring the outputs of general protection for the control of general device
- configuring the inputs of general protection for the logic control of general device
- pilot wire logic selectivity with other series-connected devices
- measuring voltages, currents and powers
- control of delays to avoid simultaneous connections of two or more transformers with power exceeding 2 x 1600 kVA at 25 kV, or 2 x 2000 kVA at 20 kV (directive DK 5600 ENEL)
- simple logic sequenc. for conditional validation and inhibition
- earthing system of user cabin, global earthing system combined with other earthing systems interconnected via the shields of MV cables.

The list of the topics is only indicative in consideration of the wide versatility of the used protection relay and of the possibility of realizing numberless connection diagrams.

TECHNICAL CHARACTERISTICS:

This unit is made of chemically treated sheet steel, painted with several coats of epoxy paint. Its base is provided with rubber feet so that it can be positioned on any working top.

Synoptic panels are made of aluminium alloy and they have been silk-screen printed with the international symbols; they show the necessary devices and connections for enabling standard configurations and/or any other configuration for experimental aims.

The connections on the fore panel (in three-phase voltage of 380-400 Vac) are carried out via terminals and leads/jumpers with safety plugs Ø 4 mm.

The connections on the rear panel (in extra low safety voltage of 24 Vdc) are carried out via terminals and leads with safety plugs Ø 2 mm.

Main components installed:

- Simulator of cabin earth resistance with value selectable between 0.3 and 1 Ω.
- General device reproduced with a 3-pole contactor In = 25 A
- Line breaker and earthing switch reproduced by a rotary switch In = 32 A
- PLC-controlled logic of interlocks and LED synoptic panel that displays the availability of medium voltage in various points of the circuit, the state of general device, the state of line breaker, the state of earthing switch
- Modular PLC with display, 12 inputs of 24 Vdc / 8 outputs of 24 Vdc
- Regulated power supply of 24 Vdc 1.3 A
- 3 current step-down transformers 5 / 1 A
- 6 voltage step-down transformers 500 / 100 V
- Toroidal current transformer for detecting homopolar earth current
- SEPAM relay series 40 (model S41) provided with advanced dialogue interface with graphic LCD and keys for displaying measures and parametrizations
- Extension module of 10 inputs / 4 outputs applied to relay

Power supply: 230 Vac 50 Hz single-phase - 50 VA
(Other voltage and frequency on request)
Dimensions of operational panels: 800 x 600 mm
Dimensions of the framework: 880 x 450 x 680 mm
Weight: 27 kg

REQUIRED (NOT INCLUDED)

- **VARIABLE RESISTIVE LOAD - mod. RL-2/EV**
  Ideal tool for studying the effects of overcurrents and of earth faults.
- **SOFTWARE:**
  - Software kit (SFT 2841) for configuring SEPAM relay: it enables to display and control all the parameters. This software is available in Italian, English, French and Spanish and is provided with connection cable between PC and SEPAM series S 20, 40 and 80, as alternative to the programming keys of relay. This kit also includes Software SFT 2826 for transferring, displaying and analyzing turbo graphs (records of the event provoking an alarm condition) carried out by SEPAM relays. This software is available in Italian, English, French and Spanish.
  - PLC programming software Zelio SOFT SR2 SFT01 and USB cable (SR2CBL01) of PC-PLC connection for modifying the program of logic control of interlocks, as alternative to PLC programming keys. This software is available in Italian, English, French and Spanish.

Note: When using mod. CAB-1/EV together with panels mod. STA-1/EV and/or CAB-2/EV, it is enough to use only one computer with the above mentioned software and only one Resistive Load mod. RL-2/EV.

SUPPLIED WITH

OPERATIONAL HANDBOOK

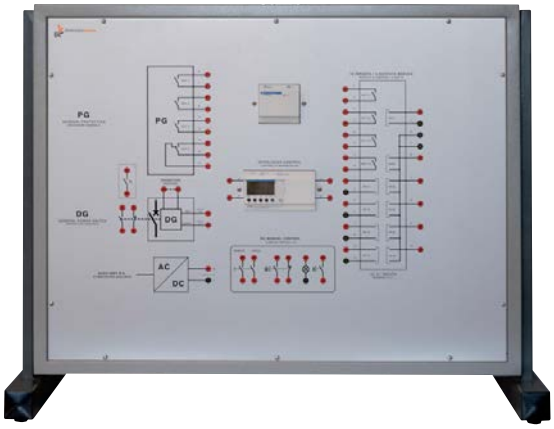
ACCESSORIES:

- 1 single-phase power cord
- 13 jumpers with safety plugs Ø 4 mm
- 47 leads of various lengths with safety plugs Ø 4 mm
- 18 leads of various lengths with safety plugs Ø 2 mm

USER CABIN PANEL II

Mod. CAB-2/EV

FORE VIEW



REAR VIEW

INTRODUCTION

Movable desk-type equipment with wide synoptic panel representing the parts of a medium voltage cabin. It uses professional components to reproduce the operating conditions and the rules for ensuring protection and safety in compliance with the standards in force applicable to the system typology, in laboratory.
The equipment has been conceived to allow a "tailored" configuration of the devices and test points prearranged in the panel, represented in silk-screen-printed diagrams with international symbols, thus enabling the separate study of the performance of each component, and their coordination.

The possibility of using user cabin panel **mod. CAB-2/EV** coupled to other panels such as user cabin panels and **mod. CAB-1/EV** and substation panel **mod. STA-1/EV** enables to carry out the coordination and study on ammeter and time selectivity of protection devices and to extend the applications with pilot wire logic selectivity.

This equipment consists of two panels to avoid errors during the practical experimentation: thus power circuits are kept separated from control circuits.

Using safety terminals enables to assemble the power circuit (Medium Voltage circuit) quickly, on one side, via safety jumpers and/or cables with plugs Ø 4 mm. The diagram silk-screen-printed on the panel supplies clear information on the typical connection of the devices, but connection points can also be modified at operator's will such as TA before or after the general device, toroidal TA connected in the reception point or in the output point of MV line, etc…

On the other side, using terminals and leads with plugs Ø 2 mm enables to assemble the control circuit for opening and closing the **general protection**, quickly.

The operation of the **general device** is reproduced by a power contactor controlled by a PLC for the logic of **interlocks**.

The line breaker and the earthing switch are reproduced by a rotary switch. Moreover the PLC controls the LED synoptic diagram that displays the voltage available in the various points of the circuit, as well as the state of general device and of earthing switch.

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TRAINING PROGRAM:

This equipment including SEPAM S20 relay enables to define a typical electrical installation of a cabin owned by the customer connected with the Medium Voltage network. The topics that can be dealt with are:

- Connection of TA and programming of the parameters for function 50 / 51 (maximum current)
- Connection of TA and programming of the parameters for function 50N / 51N (maximum earth current)
- Connection of toroidal TA and TV 67N (maximum earth current); cable lines with shield connected with cabin earthing system are also considered
- Programming of the parameters for current inverse time protection
- Configuring the outputs of general protection for the control of general device
- Configuring the inputs of general protection for the logic control of general device
- Pilot wire logic selectivity with other series-connected devices
- Measurements of currents
- Earthing system of user cabin, global earthing system combined with other earthing systems interconnected via the shields of MV cables.

The list of the topics is only indicative in consideration of the wide versatility of the used protection relay and of the possibility of realizing numberless connection diagrams.

TECHNICAL CHARACTERISTICS:

This unit is made of chemically treated sheet steel, painted with several coats of epoxy paint. Its base is provided with rubber feet so that it can be positioned on any working top.

Synoptic panels are made of aluminium alloy and they have been silk-screen printed with the international symbols; they show the necessary devices and connections for enabling standard configurations and/or any other configuration for experimental aims.

The connections on the fore panel (in three-phase voltage of 380-400 Vac) are carried out via terminals and leads/jumpers with safety plugs Ø 4 mm.

The connections on the rear panel (in extra low safety voltage of 24 Vdc) are carried out via terminals and leads with safety plugs Ø 2 mm.

Main components installed:

- Simulator of cabin earth resistance with value selectable between 0.3 and 1 Ω.
- General device reproduced with a 3-pole contactor In = 25 A
- Earthing switch reproduced by a rotary switch In = 32 A
- PLC-controlled logic of interlocks and LED synoptic panel that displays the availability of medium voltage in various points of the circuit, the state of general device, the state of line breaker, the state of earthing switch
- Pushbuttons of manual start/stop control of general device
- Modular PLC with display, 12 inputs of 24 Vdc / 8 outputs of 24 Vdc
- Regulated power supply of 24 Vdc 1.3 A
- 3 current step-down transformers 5 / 1 A
- Toroidal current transformer for detecting homopolar earth current
- SEPAM relay series 20 (model S20) provided with advanced dialogue interface with graphic LCD and keys for displaying measures (only currents) and parametrizations
- Extension module of 10 inputs / 4 outputs applied to relay

Power supply: 230 Vac 50 Hz single-phase - 50 VA
(Other voltage and frequency on request)
Dimensions of operational panels: 800 x 600 mm
Dimensions of the framework: 880 x 450 x 680 mm
Weight: 25 kg

REQUIRED (NOT INCLUDED)

- **VARIABLE RESISTIVE LOAD - mod. RL-2/EV**
  Ideal tool for studying the effects of overcurrents and of earth faults.
- **SOFTWARE:**
  - Software kit (SFT 2841) for configuring SEPAM relay: it enables to display and control all the parameters. This software is available in Italian, English, French and Spanish and is provided with connection cable between PC and SEPAM series S 20, 40 and 80, as alternative to the programming keys of relay. This kit also includes Software SFT 2826 for transferring, displaying and analyzing turbo graphs (records of the event provoking an alarm condition) carried out by SEPAM relays. This software is available in Italian, English, French and Spanish.
  - PLC programming software Zelio SOFT SR2 SFT01 and USB cable (SR2CBL01) of PC-PLC connection for modifying the program of logic control of interlocks, as alternative to PLC programming keys. This software is available in Italian, English, French and Spanish.

Note: When using mod. CAB-2/EV together with panels mod. STA-1/EV and/or CAB-1/EV, it is enough to use only one computer with the above mentioned software and only one Resistive Load mod. RL-2/EV.

SUPPLIED WITH

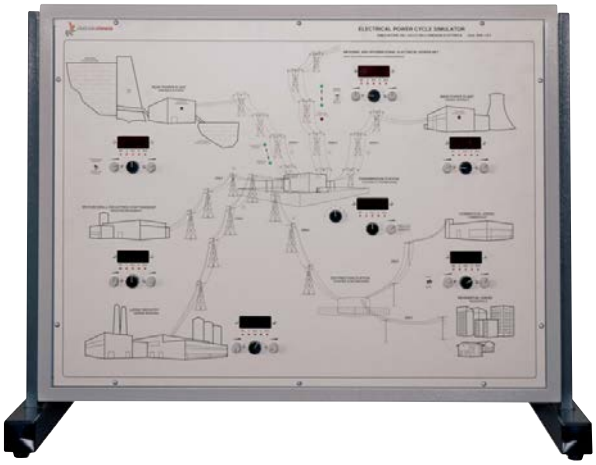
OPERATIONAL HANDBOOK

ACCESSORIES:

- 1 single-phase power cord
- 10 jumpers with safety plugs Ø 4 mm
- 31 leads of various lengths with safety plugs Ø 4 mm
- 18 leads of various lengths with safety plugs Ø 2 mm

SIMULATOR OF PRODUCTION, TRANSMISSION AND USE OF ELECTRIC POWER

Mod. SEE-1/EV



INTRODUCTION

The normal operation of a network of electric power transport and distribution must also program the use of some power plants that produce an almost constant quantity of energy; this energy is carried and distributed on the territory and most power is absorbed by the big industrial or craft businesses and a lower part by the commercial and housing sectors.
As consumption is not constant during a day, when there is a high energy demand, the power distribution agency must set some power plants at work to produce the power demanded and avoid catastrophic black-outs.
The plants enabling to satisfy the energy peaks during the day are generally of medium power and are arranged in the territory near the users with considerable consumptions, when possible; they must reach their full operation in short times (some tens of minutes).
The great thermoelectric or nuclear power plants are distributed and connected in parallel on the territory, so that they can meet the normal demand of electric power, whereas peak demands can be satisfied (where possible) by medium-power power plants of thermoelectric, hydroelectric type or using renewable energies (wind power, solar energy, etc...), managed by personnel, or wholly automated.

Great power plants satisfy the normal daily demand; during the peaks of demand they are "helped" or "relieved" by the plants of medium power. During the night, consumptions of production activities are reduced, and power availability is used in hydroelectric plants to pump water back into the upper basin (even water is not available forever), as reserve for future needs.

This simulator will cover the following topics:
Simulation of a (thermoelectric or thermonuclear) power plant for the production of electric energy, relieved (when necessary, according to the energy demand) by a hydroelectric plant using the water jump between two basins. Pumping water from the lower basin back into the upper basin (during the night), when the energy demand returns to normal standards.

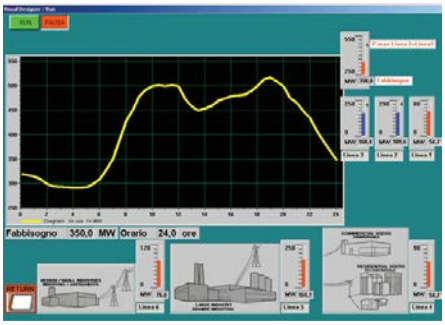
- Transmission on high voltage network, primary substation of high-medium voltage distribution
- Power-consuming facilities, users of electric energy such as big industry, small-size industry or handicraft, commercial and housing buildings.

Values are set by potentiometers on the synoptic panel and the energy flow of transmission network and of the various production and consumption centres can be seen on the display; the PC enables to display and delve into the specific technical notions of the components of electric power chain, such as:

- **Power plants**
- **Transmission of electric power**
- **Use of electric power**

SOFTWARE:

This simulator is provided with control software, when connected with a PC via USB port; it must be installed in PC with executive system WINDOWS XP (or higher versions).



Power supply: 230 Vac 50 Hz single-phase - 100 VA
(Other voltage and frequency on request)
Dimensions of demonstration panel: 800 x 600 mm
Dimensions of the framework: 840 x 450 x 680 mm
Net weight: 30 kg

REQUIRED (NOT INCLUDED)

- **PERSONAL COMPUTER**

SUPPLIED WITH

OPERATIONAL HANDBOOK

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SIMULATOR FOR THE PRODUCTION OF ELECTRIC POWER

Mod. SEE-2/EV

INTRODUCTION

This module will ensure a faithful simulation of an electric power generator set with adjustable parameters of voltage, frequency, correct/wrong cyclic sequence; that allows the "adjusting" operations that will lead to the closing of the parallel switch.

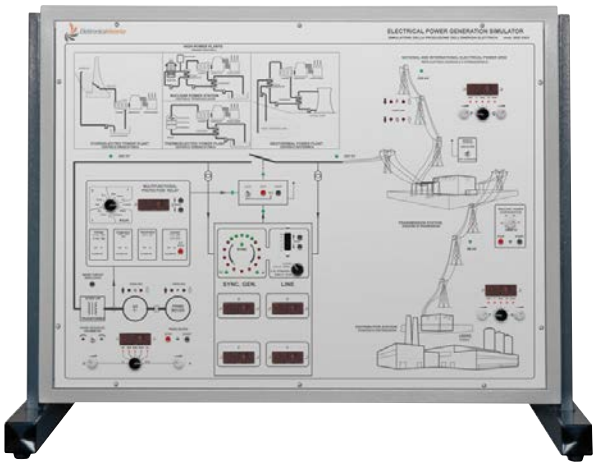
This simulator concerns a power distribution network (mains) where the parallel (paralleling operations) with the generator set is carried out; the mains has adjustable power parameters to show the need of paralleling the generator set.

Also the main protection relays of generators: relays of minimum/maximum voltage (function 27-59), of minimum/maximum frequency (function 81), definite-time overcurrent relays (function 51), relays of instantaneous short-circuit (function 50), of phase sequence and symmetry (function 47-60), are reproduced: the consensuses of these protection relays are the essential conditions to carry out the parallel; after paralleling the generator, if the set parameters are exceeded, they lead to the disconnection of the generator set from the parallel.

This simulator also reproduces the instruments of assistance to the parallel, that is 2 voltmeters, 2 frequency-meters and a synchronoscope; these instruments enable the operator to adjust the parameters output by the generator, properly, besides defining the ideal moment for closing the parallel switch enabling this operation. An alternative to the manual management of paralleling operations is represented by the automatic mode: in this case a sequence procedure is reproduced in the simulator: start of prime mover, control of frequency and voltage output as switch is closed automatically. However the generator set is checked by the protection relays. After the parallel has been implemented, modifying the control parameters of motor/generator set will enable to see the changes of the flow of produced/absorbed active and reactive power.

Electric load is reproduced faithfully: it is adjustable in both the modules of active power and of inductive reactive power, in order to load the distribution network and the generator in parallel and consequently to demonstrate the tripping of machine protections.

The phenomena described above are clearly demonstrated with the comparison of the readings of the three instruments (network, generator, load) equivalent to three energy analyzers that respectively indicate voltage, current, apparent power, active and reactive power with the sign (inlet/outlet active power and inductive/capacitive reactive power).



TECHNICAL CHARACTERISTICS:

Desk-type framework with silk-screen-printed schematic diagram including:

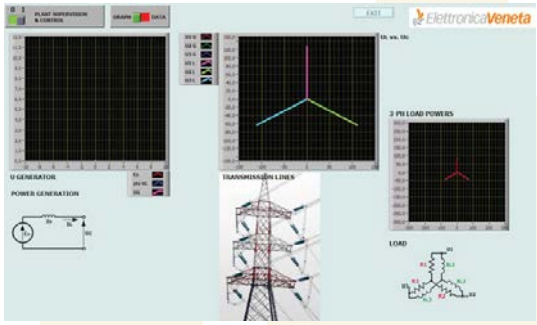
- Power distribution network with adjustable parameters that can be seen on the display
- Generator set with adjustable parameters that can be seen on the display
- Control of prime mover with adjustable output frequency / r.p.m. that can be seen on the display
- Bars, parallel switch provided with LED signaling open/closed condition
- Instruments of assistance to the parallel for a simultaneous monitoring of the 2 voltages/2 frequencies; these parameters can be seen on separate displays, LED signaling the moment of superposition of the two systems having to be paralleled
- Protection relay of voltage, frequency, current, phase sequence with adjustable tripping times and thresholds; the set values of threshold and time can be seen on display, indication of normal/anomalous condition by LED
- Load /user with adjustable parameters of absorbed power that can be seen on display.

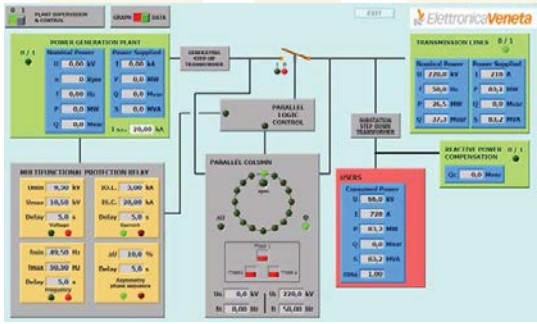
This simulator operates in connection with a PC and a specific software where all the control and measurement parameters dealt with in the class, are displayed at the same time.

Power supply: 230 Vac 50 Hz single-phase - 100 VA
(Other voltage and frequency on request)
Dimensions of demonstration panel: 800 x 600 mm
Dimensions of the framework: 840 x 450 x 680 mm
Net weight: 30 kg

TOPICS REPRODUCED ON THE SIMULATOR:

- Generator set with adjustable parameters
- Power distribution network with adjustable parameters of the carried power
- Protection relay of minimum/maximum voltage, of minimum/maximum frequency, of overcurrent and short-circuit, of phase sequence and symmetry, with indication of normal/anomalous condition
- Adjustment of energy demand with separate setup of active and reactive power
- Manual assistance to parallel with double voltmeter/frequency-meter and synchronoscope
- Automatic sequential control of parallel on overload condition
- Transfer of powers from overloaded line to parallel-connected generator





SOFTWARE:

This simulator is provided with control software that must be installed in a PC with executive system WINDOWS XP and USB port.

REQUIRED (NOT INCLUDED)

- **PERSONAL COMPUTER**

SUPPLIED WITH

OPERATIONAL HANDBOOK

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PANEL FOR THE STUDY OF THE MONITORING NETWORKS (SCADA) OF THE ELECTRIC POWER CONSUMPTION

Mod. PRMCE-1/EV

INTRODUCTION

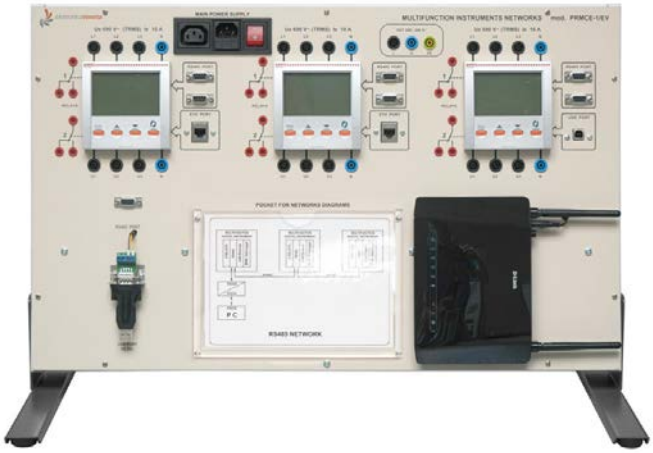
Panel specifically designed for the measuring and monitoring of electrical parameters (including consumption of electrical energy) with SCADA networks.
In this context, "electrical monitoring networks" describes the different modes the collected data can be transferred.
These networks can be used, for example, to differentiate between the consumption levels of different users (lighting, electrical power etc.) or between specific factory departments or laboratories. By so doing, it is possible to precisely cost each section derived from a global cost.
Another interesting application can be recording the active and reactive power trends, so as to correctly design the Power Factor correction units.

The present trend in electrical instruments is concentrating in a single box different "instruments". These new instruments are called "digital multifunctional instruments or "energy analyzers".
These instruments have many advantages if compared with traditional ones (analog and digital), where each one is dedicated to the measurement of only one parameter.
Some of the advantages are:

- they are microprocessor controlled digital instruments.
- they enable the measurement of a great number of electrical parameters with a minimum of cabling.
- they have displays that enable the simultaneous visualization of several parameters on a single screen.
- they usually are of a high precision class (0.5 ~ 0.2).

Referring to high end instruments, other extra features are included:

- the instruments include TRMS measurement and harmonic analysis.
- the instruments can be programmed according to user requirements.
- complex functions (Boolean) are available within the preset limits of the measured parameters.
- Possibility to configure alarms from the preset limits of the measured parameters and also from the Boolean functions.
- they usually include dry contacts, activated by the alarms.
- they have a wide range of additional accessories, such as different communication modules, memories to record and save the trend of the measured parameters which can subsequently be downloaded to a PC in the form of tables or graphs.



On the basis of above, the panel covers the following important subjects:

- the knowledge and programming of a high end multifunctional instrument
- the study of the communication networks that can be configured with such instruments
- Use of the supervision and energy management software for the monitoring and management of electrical parameters and energy consumptions of an electrical installation.

The instruments included in the panel are highly flexible and can be used in single and 3-ph lines, with/without neutral.

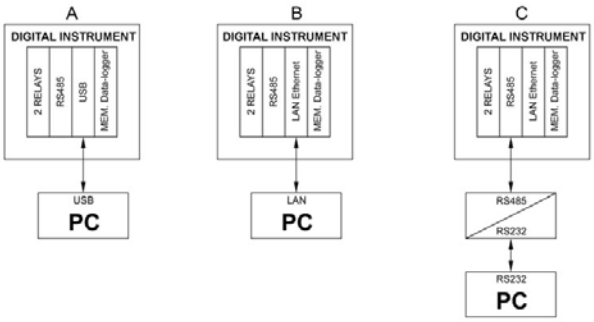
The proposed monitoring networks include RS485, LAN (Ethernet) and W-LAN (wireless / Wi-Fi).
The instruments are located on the front panel made of insulating material and representing the international electrical symbols. The instruments have free terminals that can be connected to real loads.
A holder containing the various synoptic diagrams of the different networks can also be found on the front panel.
The electrical power connections are carried out via cables (supplied in different colours and lengths) with 4 mm safety connectors. Network connections (RS485, Ethernet) are carried out via cables (also supplied) of different connector diameters.

To be noted that all exercises can be performed without the need of any tool.

EDUCATIONAL PROGRAMME & CONNECTING MODES:

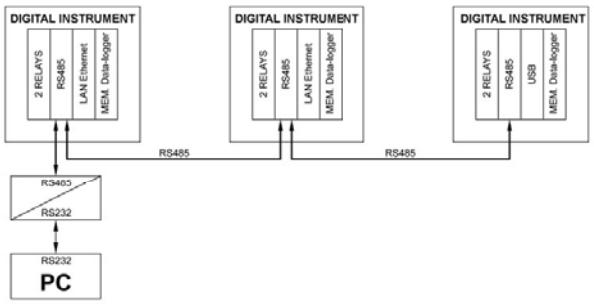
Connection of one instrument

A Connection of a digital instrument with a PC via USB port for data acquisition and specific control software.
B Connection of a digital instrument via LAN-Ethernet port for data acquisition and control software.
C Connection of a digital instrument with a remote PC via RS485 serial port and RS485/ RS232 interface.



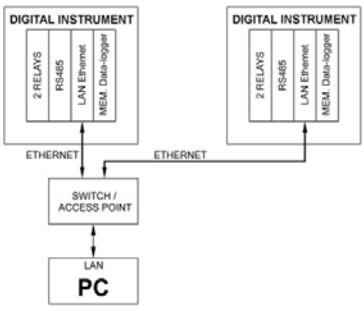
PC - Instrument local connections

D ***Connection of 3 digital instruments with a PC via RS485 serial port and RS485/ RS232 interface.***



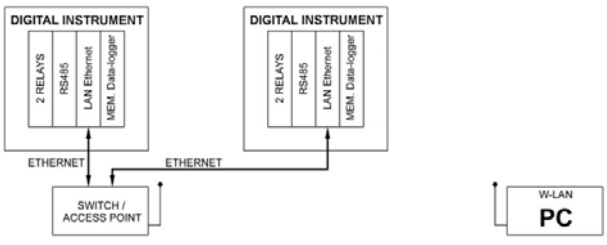
PC - Instruments RS485 connection

E1 ***Connection of 2 digital instruments with a switch / access point. Data access via PC.***



PC - Instruments LAN-Ethernet connection

E2 ***Connection wireless of 2 instruments to a remote PC.***



PC - Instruments W-LAN connection

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CONFIGURATION:

The Panel mod. PRMCE-1/EV includes:

- 3 high end digital multifunctional instruments for the analysis of electrical power.
- 1 interface RS485 / USB
- 1 Wireless Router
- 1 remote control & data-logger management software

Technical Characteristics - Digital instruments

- Digital instruments for single & 3-ph electrical parameters.
- Auxiliary feeding 110…250 VDC/VAC - 50-60 Hz.
- LCD graphic display, 128 x 80 pixel, backlit, 4 levels of grey.
- With 4 keys for visualizing and settings. Measurement of more than 300 TRMS electrical parameters in single and 3-ph systems: voltages, currents, active / reactive / apparent powers, power factor (cosϕ), frequency, harmonic analysis for voltages & currents up to the 31° harmonic, total and partial imported / exported active energy, total and partial inductive / capacitive reactive energy, total and partial apparent energy.
- Precision class for currents and voltages: ± 0,2 %. Range: 10 A (with 10/5 A internal CT) – max 830 V ph-ph – frequency range: 45…66 Hz.
- Possibility to create up to 4 programmable pages, each one with 4 selectable parameters.
- The instruments also include the following options:

INSTRUMENT/OPTION	LEFT	CENTER	RIGHT
OUTPUTS: 2 Relay	yes	yes	yes
Interface RS485	yes	yes	yes
ETHERNET Interface	yes	yes	---
USB Interface	---	---	yes
Memory + RTC	yes	yes	yes

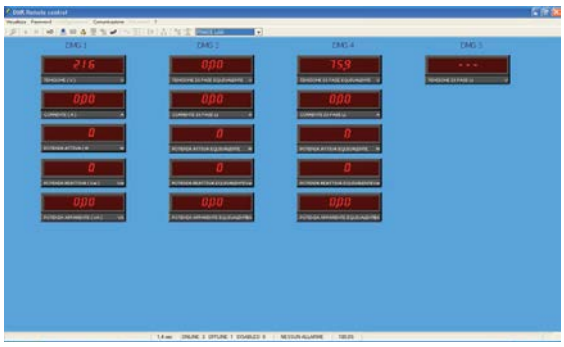
RS485 / USB interface to create the RS485 communication network

RS232 / RS485 interface to create the RS485 communication network.

Technical Characteristics - Wireless Router

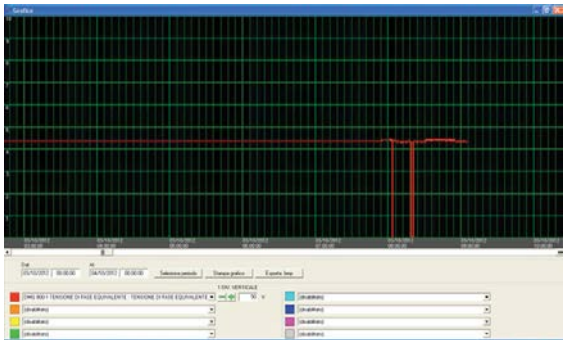
Switch 4 ports 100/10 Mbit Ethernet LAN to create the communication network with TCP/IP protocol and wireless connection.

DMK SW remote control software



With the remote control software it is possible:

- Visualize on the PC screen the measured values in virtual mode.
- Perform user defined measurements and save them in several formats (MS-Access, text ASCII, MS-Excel).
- Trace graphs of the desired parameters.
- Set alarm limits to the desired parameters.
- Save to disk the alarms and events sequence of the instruments network.
- Visualize and modify the set parameters, save, edit and print them.
- Visualize the harmonic content graph of voltage and current.
- Program the measurement pages, including flags associated to them, background images, labels and pushbuttons.
- Change the menus and command language (Italian, English, French, Spanish and Portuguese are available).



DMK SW 10 data-logger software

The DMK SW 10 data - logger software enables the configuration and management of the data collected in the memory module. Specifically, it is possible to:

- Set the desired parameters and the time elapsed for the data collection.
- Visualize the data from the DMK-DMG instruments in MS-Access format.
- Convert the MS-Access tables into ASCII text or MS-Excel formats.
- Trace graphs of the selected parameters.

System Requirements (PC NOT included)

PC Hardware

- CPU dual core, 2 GHz
- RAM 2GB
- Hard disk 60GB
- Ethernet RJ45 LAN board
- Communication Ports for the use with Ethernet, serial RS485, serial USB.

Operative Systems that can be used

- MS Windows XP SP3
- Windows Vista
- Windows 7 32/64bit
- Windows server 2003
- Windows server 2008.

Supported Browsers

- MS IExplorer 9 64bit edition
- MS IExplorer 10
- Google Chrome
- Apple Safari
- Mozilla FireFox
- Opera.

PC/SERVER Requirements

- CPU dual core, 2GHz
- RAM 2GB
- Hard disk 60GB (the disk capacity depends on the data to be memorized)
- SVGA 1024 x 768, color 16bit
- Communication Ports for the use with Ethernet, serial RS485, serial USB.

SUPPLIED ACCESSORIES:

- 1 USB cable, 2 m, with A / B connectors
- 3 Cable 1 m with 9 terminals connectors, for the RS485 connection.
- 3 Cables Ethernet RJ 45, 1 m cat. 5
- 16 Cables 1 m with 4 mm safety terminals for the power connections.
- 1 Polysnap feeder, input C14 connector, output C13 plug, and 2-pole switch and pilot light.
- 1 Cable single-ph with Unel male connector and C13 plug.
- 1 Cable single-ph with C14 male connector and C13 plug.
- Set of plastified synoptic diagrams of the proposed networks.

Dimensions: 650 x 400 x 120 mm
Net weight: 15 kg

SUGGESTED ACCESSORIES

To set and monitor variable electrical loads:

- 1 single/ 3-ph variable resistive load, mod. RL-2/EV
- 1 single/ 3-ph variable inductive load, mod. IL-2/EV

Alternatively:

- 1 single & 3-ph variable R-L load, mod. RL-2k/EV

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

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L1

44-A

SEMICONDUCTORS AND POWER ELECTRONICS

SP

Aim:

- Knowledge ad use of the devices of power electronics (DIODI, SCR, TRIAC, MOSFET, BJT, IGBT)
- Circuit configuration of the main diagrams of single-phase and three-phase rectification

Equipment:

- Complete solution for the set up of the laboratory of power electronics and Energy conversion
- Modular desk-type system with overlays
- Easy assembling of M1R, M2R, M3R, M4R, M5R and M6R circuits

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44-A

SEMICONDUCTORS AND POWER ELECTRONICS

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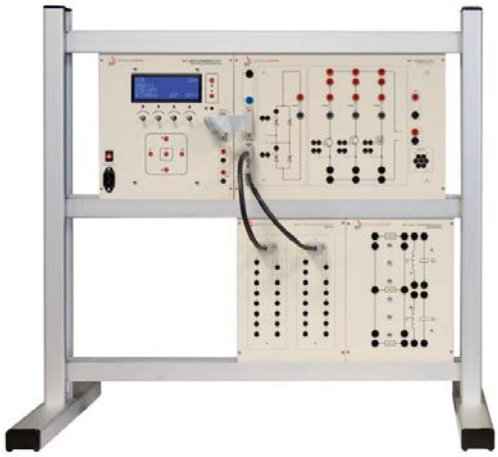
SEMICONDUCTORS AND POWER ELECTRONICS



INTRODUCTION

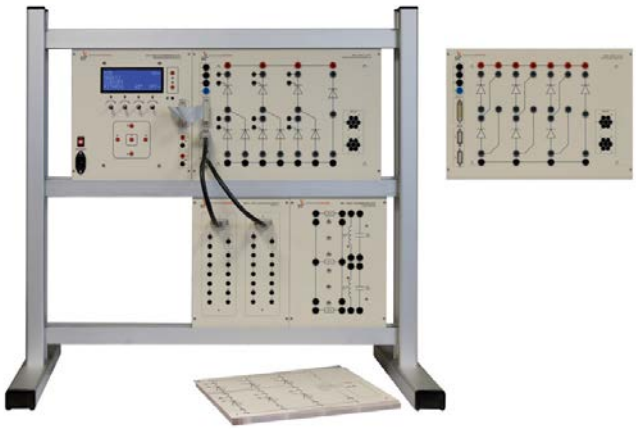
Power electronics represents the technology concerning the efficient conversion, control and modification of electric power starting from the available inlet to obtain the desired outlet.

Converters of power electronics are used in all the cases when the form of electric energy must be modified (for instance, for voltage, current or frequency modifications). Their power range can vary from some milliwatts (as in mobile phones) to hundreds of megawatts (as in HVDC transmission systems).

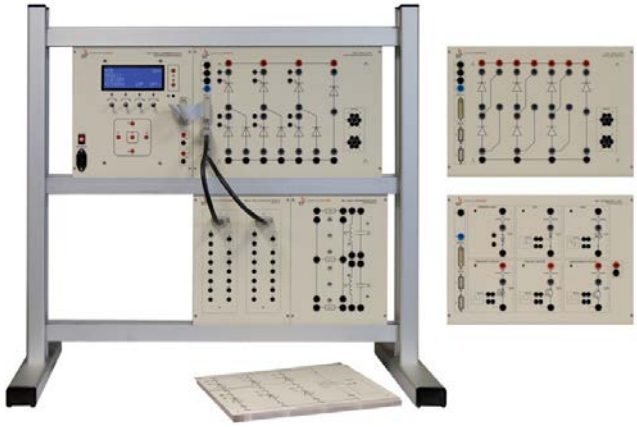
Electric current and voltage are used to carry the information, in general Electronics, whereas these quantities are used in power Electronics to transport the signal power.

The first components having been used in power electronics were mercury rectifiers. At present conversion is carried out with semiconductors such as DIODES, BJT, SCR, TRIAC, IGBT, MOSFET. The main aim of electronic systems consists in transmitting signals and data, whereas the most important thing in power electronics is the control of the sent electric power.

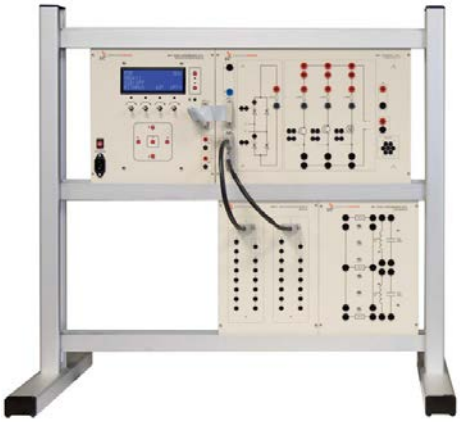
AC/DC converters (rectifiers) represent the commonest application of power electronics; in fact they can be found in a lot of electronic apparatuses such as television sets, personal computers, battery chargers, etc... The commonest industrial application is the speed regulator used to control motors.



BASIC LEVEL - USED MODULES								NECESSARY ACCESSORY
M1R	M2R	M3R	M4R	M5R	M6R	MB1	MDAQ	AEP-1
●	●	●				●	●	●



INTERMEDIATE LEVEL - USED MODULES								NECESSARY ACCESSORY
M1R	M2R	M3R	M4R	M5R	M6R	MB1	MDAQ	AEP-1
●			●			●	●	●



ADVANCED LEVEL - USED MODULES								NECESSARY ACCESSORY
M1R	M2R	M3R	M4R	M5R	M6R	MB1	MDAQ	AEP-1
				●	●	●	●	●

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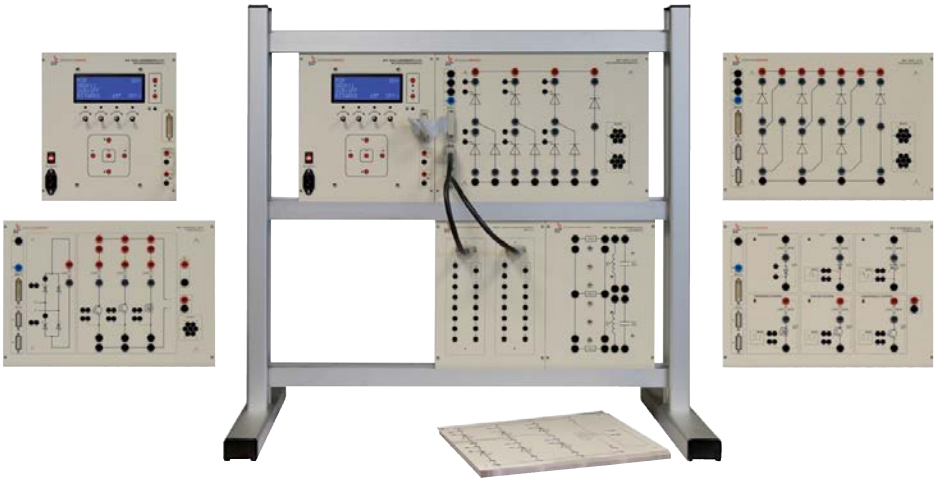
MODULAR SYSTEM FOR STUDYING POWER DEVICES AND RECTIFYING CIRCUITS

Mod. MRS-1/EV



INTRODUCTION

Power Electronics is related, among other topics, with the static power conversion and its applications. System mod. MRS-1/EV has been designed and manufactured with industrial components according to educational standards. It is the suitable tool for the theoretical-practical study of power devices, rectifying circuits and of control circuits of DC motors. The development of the exercises of the training program consists in fixing the units in the support mod. TSI-1/EV and placing over the due overlay for the exercise under test.

TRAINING PROGRAM:

Trainer mod. MRS-1/EV allows the theoretical-practical study of the following subjects:

Non-controlled Rectifiers (Basic Level)

E1UK-D	Single pulse rectifiers (direct polarization)
E1UK-I	Single pulse rectifiers (inverse polarization)
M2UK	Two pulse rectifiers - cathodes connected
M2UA	Two pulse rectifiers - anodes connected.
M3UK	Three pulse rectifiers - cathodes connected
M3UA	Three pulse rectifier - anodes connected
M6UK	Six pulse rectifier - cathodes connected.
B2U	Two pulse bridge rectifier
B6U	Six pulse bridge rectifier

Controlled Rectifiers (Basic Level)

E1CK-D	Single pulse converter (direct polarization)
E1CK-I	Single pulse converter (inverse polarization)
M2CK	Two pulse midpoint converter - cathodes connected
M2CA	Two pulse midpoint converter - anodes connected
M3CK	Three pulse midpoint converter - cathodes connected
M3CA	Three pulse midpoint converter - anodes connected
B2HK	Half controlled bridge
B2C	Fully controlled bridge
B6HK	Three-phase half controlled bridge.
B6C	Three-phase fully controlled bridge.

Power Devices (Intermediate Level)

- DIODE
- SCR
- TRIAC
- PWM MOSFET CHOPPER
- PWM IGBT CHOPPER
- LINEAR/PWM BJT CHOPPER

Power Circuits (Advanced Level)

BSP	Semi-controlled SCR single-phase bridge
BPC	Power control with **BJT**
IPC	Power control with **IGBT**
MPC	Power control with **MOSFET**

TECHNICAL CHARACTERISTICS:

Trainer mod. MRS-1/EV consists of the following units:

M1R	Basic & Intermediate Level - Microprocessor module
M2R	Basic Level - Diodes Base Module
M3R	Basic Level - SCR & diodes Module
M4R	Intermediate Level - Power devices
M5R	Advanced Level - Microprocessor module
M6R	Advanced Level - Power Circuits
MB1	R-L-C loads Module
MDAQ	Signals acquisition Module

M1R Basic & Intermediate Level - Microprocessor module

Control module **M1R** is connected with Modules **M2R** or **M3R** or **M4R** via a 25-pole connector to supply the due signals for controlling the different devices.
It includes a 4-line alphanumeric display to show various data, such as the codes of the module and of the connected overlay, the SCR firing angle etc...
The on-board pushbuttons enable the navigation inside the menu, the potentiometers allow to vary the selected parameters.
Two 0-10V analog inputs are also available to connect any source of external signals.

M2R Basic Level – Base Module of Diodes

Unit **M2R** allows the study of different non-controlled rectifiers by the use of 9 associated overlays that include:

E1UK-D	Single pulse rectifier (direct polarization)
E1UK-I	Single pulse rectifier (inverse polarization)
M2UK	Two pulse rectifier - cathodes connected
M2UA	Two pulse rectifier - anodes connected.
M3UK	Three pulse rectifier - cathodes connected
M3UA	Three pulse rectifier - anodes connected
M6UK	Six pulse rectifier - cathodes connected.
B2U	Two pulse bridge rectifier
B6U	Six pulse bridge rectifier

Connecting module **MDAQ** with the 15-pole connectors will supply the (opto-isolated) signals of voltages and currents available in the different exercises.
Connecting module **MB1** will enable to develop exercises with the ohmic, inductive and capacitive loads of the equipment.

M3R Basic Level – Base Module of SCR & diodes

Unit **M3R** allows the study of different controlled rectifiers by the use of 10 associated overlays that include:

E1CK-D	Single pulse converter (direct polarization)
E1CK-I	Single pulse converter (inverse polarization)
M2CK	Two pulse midpoint converter - cathodes connected
M2CA	Two pulse midpoint converter - anodes connected
M3CK	Three pulse midpoint converter - cathodes connected
M3CA	Three pulse midpoint converter - anodes connected
B2HK	Half controlled bridge
B2C	Fully controlled bridge.
B6HK	Three-phase half controlled bridge.
B6C	Three-phase fully controlled bridge.

Connecting module **MDAQ** with the 15-pole connectors will supply the (opto-isolated) signals of voltages and currents and of SCR firing available in the different exercises.
Connecting module **MB1** will enable to develop exercises with the ohmic, inductive and capacitive loads of the equipment.

M4R Intermediate Level – Power devices

Unit **M4R** allows the study of the following power devices:

- Diode
- SCR
- TRIAC
- PWM MOSFET CHOPPER
- PWM IGBT CHOPPER
- LINEAR/PWM BJT CHOPPER

Connecting module **MDAQ** with the 15-pole connectors will supply the (opto-isolated) signals of voltages and currents available in these power devices.
Connecting module **MB1** will enable to develop exercises with the ohmic, inductive and capacitive loads of the equipment.

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M5R Advanced Level - Microprocessor module

Control module **M5R** is connected with module **M6R** via the 25-pole connector to generate the signals for controlling the different power circuits. It includes a 4-line alphanumeric display to show different data, such as the codes of the module and of the connected overlay, the SCR firing angle, the frequency set for the operation of power devices and the selected duty cycle. It also includes a speed closed loop control that can be used if a DC motor and a tachogenerator (both not included) are connected with unit **M6R**. The on-board pushbuttons enable the navigation inside the menu, the potentiometers allow to vary the selected parameters.
Two 0-10V analog inputs are also available to connect any source of external signals.

MB1 Module of R-L-C loads

Module **MB1** includes the R, L and C loads available on safety terminals (Ø = 4 mm) for the exercises. It includes:

- three resistances of 100 Ω
- two coils of 50 mA 1A
- two capacitors of 8 µF 400V

Connecting the components in series and parallel will enable to obtain various loads.

M6R Advanced Level – Power Circuits

Unit **M6R** implements different circuits with power devices. The 4 associated overlays include:

BSP	Semi controlled SCR single-phase bridge
BPC	Power control with **BJT**
IPC	Power control with **IGBT**
MPC	Power control with **MOSFET**

Connecting module **MDAQ** with the 15-pole connectors will supply the (opto-isolated) signals of voltages and currents available in the circuit. Connecting module **MB1** will enable to develop exercises with the ohmic, inductive and capacitive loads of the equipment.
Two specific safety terminals Ø = 4 mm allow the connection of a tachogenerator for closed loop control: in fact connecting a DC motor coupled to a tachogenerator (not included) with the unit will enable to control speed.
The closed loop control is of PI-type (proportional-integral).

MDAQ Signal acquisition Module

This module supplies the signals of the connected unit (opto-isolated) on 30 safety terminals (Ø=2 mm).
The opto-isolated signals ensure electrical safe conditions for students when carrying out measurements: for instance, it is not necessary to use differential probes when using oscilloscope.

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OPTIONAL:

Trainer mod. MRS-1/EV allows to work with the machines and accessories of "Compact" line (300 W approx).

Accessories of "COMPACT" Line (300 W approx.)

Tachogenerator mod. M-16/EV

Output voltage: 0.06 V/rpm
RPM: 5000 max
Voltage of output 1: 300 Vdc @ 5000 rpm
Voltage of output 2: 10 Vdc @ 5000 rpm
Protection: IP44

Dimensions: 160 x 160 x 250 mm
Weight: 5 Kg

DC Generator/Motor with separate/ compound excitation mod. M-1/EV

Power: 300 W
Armature voltage: 220 Vdc
Field voltage: 220 Vdc
RPM: 3000 max
Frame: IM B3
Protection: IP 22
Embedded thermal protection

Dimensions: 44 x 160 x 250 mm
Weight: 15 Kg

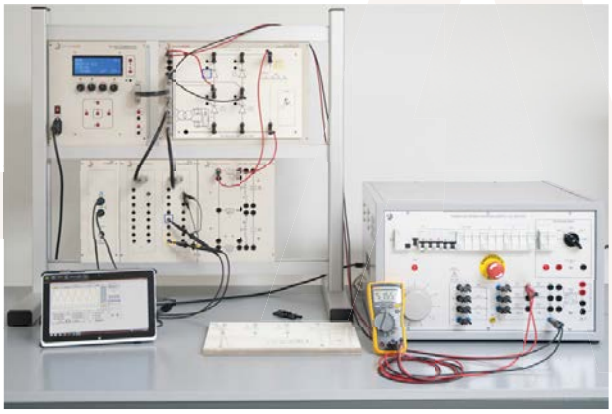
If user's own machines are used, they should have the following minimum features:
300W line: Power of 300W, armature voltage: 220 Vdc, field voltage: 220 Vdc, 3000 RPM

MPCQ – PC-controlled oscilloscope Module

Module MPCQ uses the PC calculating possibilities to visualize electrical signals.
It has a high graphic resolution , up to 0,15 mV, a wide bandwidth and a sampling frequence up to 1GHz.
A USB connection makes the connection fast and easy.
Particularly suitable to be used with LapTops to make signal measures on the terminals of the MDAQ module.

TECHNICAL SPECIFICATIONS:

- Input: 2 channels
- Input impedance: 1Mohm // 30pF
- Bandwidth: DC to 60 MHz ± 3dB
- Max input voltage: 30V (AC + DC)
- Inputs: DC, AC and GND
- Power Supply: from the USB port (500mA)
- Oscilloscope with USB connection.
- 2 x 60MHz probes for oscilloscope (PROBE60S)
- USB Cable
- CD with software



PC minimum requirements (PC not included):
- Operative System: Win 8.1
- port 2.0 or 3.0 USB
- CD Rom Reader

REQUIRED

POWER SUPPLY UNIT MOD. AEP-1/EV
- NOT INCLUDED -

AUXILIARY POWER SUPPLY:
230 Vac 50 Hz single-phase - 100 VA
(Other voltage and frequency on request)

SUPPLIED WITH

THEORETICAL-EXPERIMENTAL HANDBOOK
Introducing the trainer, guide to exercises and technical specs.

ACCESSORIES:
- 1 desk-type support for modules mod. TSI-1/EV with aluminium horizontal slides
- Set of safety jumpers Ø = 4 mm and Ø = 2 mm
- Connection cables

UNIVERSAL POWER SUPPLY UNIT FOR CIRCUITS OF POWER ELECTRONICS

Mod. AEP-1/EV

INTRODUCTION

This is the ideal desk-type power supply unit for powering the power section of single-phase and three-phase controlled and noncontrolled rectifiers. It also includes a DC variable output.

Power supply mod. AEP-1/EV outputs a continuously variable voltage of 0-400 Vac (three-phase) / 0-230 Vac (single-phase), with rated current of 5 A (7.5 A for 15 minutes. Variac output can be connected with an insulation transformer having a secondary voltage of 50-0-50 Vac, via some jumpers. It becomes a power supply with reduced variable voltage insulated from the mains. The secondary winding of the transformed can be connected in star or delta configuration. The star centre can be shifted to the centre of coils and the result will be a dual voltage. The two halves of the windings can be bridged to obtain a double output current.

The voltage output by variac can be connected with the three-phase Graetz bridge to obtain a variable direct current not insulated from the mains; interposing the insulation transformer will insulate the direct current output from the mains.

Another direct current output variable by steps between 160-180-200-220 V, with a current of 2 A, is also available to power excitation circuits of motors and of generators.

All the outputs are available on the safety terminals (with diameter of 4 mm) of the fore panel of aluminium alloy provided with international electric symbols.

This unit includes magnetothermal differential switch of 30 mA, emergency pushbuttom with rotation release. All outputs are protected against overload and short circuits by fuses.

TECHNICAL CHARACTERISTICS:

- Magnetothermal differential switch of 4 poles, In = 6 A, C curve, Idn 30 mA, class A
- Emergency pushbutton with mechanical holding and rotation release
- Minimum voltage coil for opening the main switch
- Three-phase variac of 400/0-400 V 5 A (7.5 A for 15 minutes) with safety terminals (Ø 4 mm) protected by fuses 10.3 x 38 In = 4 A
- Three-phase insulation transformer: primary winding of 3 x 230/400 V, secondary winding of 3 x 50-0-50 V - 5 a; power of 1500 VA
- Two separate outputs protected by two sets of three fuses 10.3 x 38 In = 4 A and safety terminals with safety plugs (Ø 4 mm)
- Three-phase bridge rectifier - Un = 600 V - In = 25 A; direct current output protected by fuses 10.3 x 38 In 8 A and safety terminals with safety plugs (Ø 4 mm)
- Output variable by steps 0-160-180-200-220 Vdc, with separator transformer of 500 VA, rotary selector, single-phase rectifier bridge Un 600 V - In 25 A, input and output protected by fuse 10.3 x 38 In 2 A and safety terminals with safety plugs (Ø 4 mm)

Dimensions: 525 x 500 x 297 mm
Net weight: 32 kg

REQUIRED UTILITIES (PROVIDED BY THE CUSTOMER)

- Power supply: 400 Vac 50 Hz three-phase - 3000 VA
  (Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK

ACCESSORIES:

- Three-phase power cord with IEC 309 plug
- 10 jumpers with safety plugs of 4 mm for quick connections

44-A


18
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44-A

ED

ELECTRONIC DRIVES FOR DC AND AC MOTORS

ED

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Aim:

- Learning the basic circuits and driving techniques of DC motors
- Learning the basic circuits and driving techniques of three-phase AC motors
- Troubleshooting and servicing practice of driving systems
- PI and PID r.p.m. control of AC and DC motors
- Tests of programming, data acquisition and supervision of servomechanisms

Equipment:

- Modular educational systems for learning devices and circuits of motor drives
- Actual professional driving systems for DC-shunt and DC permanent-magnet motors, provided with fault simulation, data acquisition and supervision
- Actual professional driving systems for asynchronous three-phase motors, provided with fault simulation, data acquisition and supervision
- Actual professional driving systems for brushless motors, provided with fault simulation, data acquisition and supervision

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44-A

ED

ELECTRIC POWER

ELECTRONIC DRIVES FOR DC AND AC MOTORS

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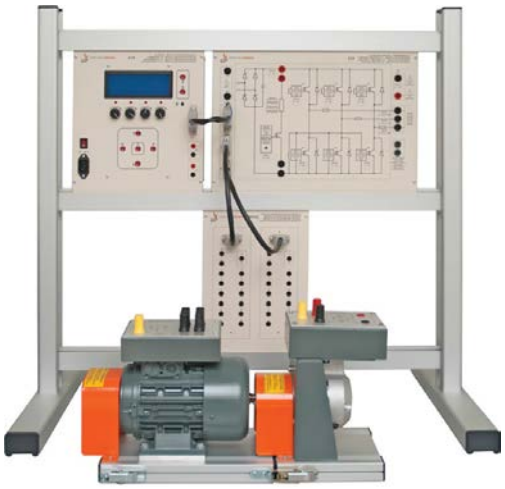
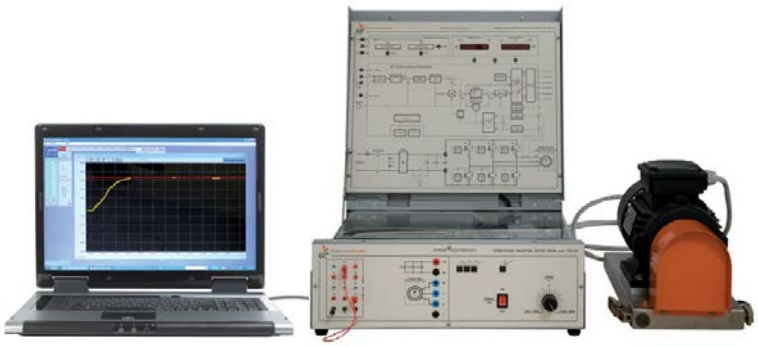
ELECTRONIC DRIVES FOR DC AND AC MOTORS





INTRODUCTION

An electric drive can be considered as a system that converts the electric power it receives at its input, into output mechanical power. Generally this conversion is carried out by circuits of power electronics.

Classification of electric drives according to motors.
Drives can be classified as:

- Direct current drives
- Alternating current drives.

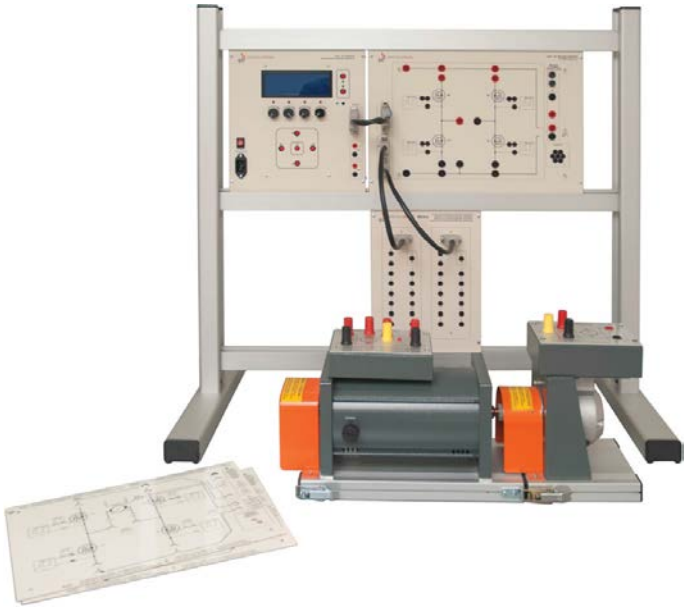
Then AC drives can be divided into:

- Drives with induction motors (asynchronous motors, generally cage motors)
- Drives with synchronous motors (or permanent-magnet or reluctance motors).

MODULAR EDUCATIONAL SYSTEMS FOR DRIVES OF DC MOTORS
Mod. ADC-1/EV

INTRODUCTION

Power Electronics is related, among other topics, with the static power conversion and its applications. System mod. ADC-1/EV has been designed and manufactured with industrial components according to educational standards. It is the suitable tool for the theoretical-practical study of DC motor drive.



TRAINING PROGRAM:

Trainer mod. ADC-1/EV allows the theoretical-practical study of the following subjects:

- Mechanical and electrical features of DC motors
- DC motor drives
- 2Q MOSFET drive (control and power circuits).
- 4Q MOSFET drive (control and power circuits).

TECHNICAL CHARACTERISTICS:

Trainer mod. ADC-1/EV consists of three units (with applicable overlays) for the exhaustive study of the industrial drive of a DC motor. These units are:

- **A1D DC DRIVE** - Microprocessor module
- **A2D DC MOTOR CONTROL** - Power circuit
- **MDAQ** - Data acquisition module

The development of the exercises of the training program consists in fixing the units in the support mod. TSI-1/EV, placing over the due overlay for the exercise under test and arranging the proper connections.
Each unit includes a panel of insulating material with Ø = 4 mm safety terminals, for connections.
Connecting module MDAQ will supply the (opto-isolated) signals of voltages and currents of unit A2D.

A1D DC DRIVE - Microprocessor module

Module **A1D** is connected with module **A2D** via a 25-pole connector and enables its operation by generating the necessary signals for control of power circuits.
It includes a 4-line alphanumeric display to show various data, such as the codes of the module and of the connected overlay, the set point value, the selected control mode (open or closed loop, with tachogenerator or armature voltage) etc... This Module includes a PID controller for the speed of the DC motor coupled to a tachogenerator (motor & tachogenerator are not included), connected with unit **A2D**.
It is possible to set the P, I and D values and the acceleration & deceleration ramps. The on-board pushbuttons enable the navigation through the menu, and the potentiometers allow to modify the selected parameters. Furthermore two other analog inputs of 0 to 10 V are available for the connection with any source of external signals.

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A2D DC MOTOR CONTROL – Power circuit

Unit A2D includes the power circuits for the DC motor. Two associated overlays are supplied, for the following power circuits:

2QC DC motor 2Q control
4QC DC motor 4Q control ("H" bridge configuration)

Two Ø = 4 mm safety terminals allow the connection with a tachogenerator for closed loop control. Other two Ø = 4 mm safety terminals are available for the control of motor overtemperature.
Connecting module MDAQ with 15-pole connectors will supply the (opto-isolated) signals of voltages and currents available in the two exercises.

MDAQ - Data acquisition module

Module **MDAQ** supplies the (opto-isolated) signals of the unit which it is connected with, on 30 safety terminals (Ø = 2 mm). The opto-isolated signals ensure electrical safe conditions for students when carrying out measurements: for instance, it is not necessary to use differential probes when using oscilloscope.

OPTIONAL ACCESSORIES:

Trainer mod. ADC-1/EV allows to work with the accessories of "Compact" line (300 W approx) or of "POWER" line (1000 W approx) according to customer's requirements.
Caution: *Components of these two lines CAN NEVER BE connected with each other*

Accessories of "COMPACT" Line (300 W approx.)

Tachogenerator mod. M-16/EV

Output voltage: 0.06 V/rpm
RPM: 5000 max
Voltage of output 1: 300 Vdc @ 5000 rpm
Voltage of output 2: 10 Vdc @ 5000 rpm
Protection: IP44
Dimensions: 160 x 160 x 250 mm
Weight: 5 Kg

DC Generator/Motor with separate/ compound excitation mod. M-1/EV

Power: 300 W
Armature voltage: 220 Vdc
Field voltage: 220 Vdc
RPM: 3000 max
Frame: IM B3
Protection: IP 22
Embedded thermal protection
Dimensions: 44 x 160 x 250 mm
Weight: 15 Kg

Experimental flywheel mod. VST-1/EV

Inertial flywheel for "M"series motors
Moment of inertia I: 0.0145 - 0.029 - 0.043 kgm^2
Max. speed of rotation: 4000 r.p.m.
Dimensions: 440 x 160 x 250 mm
Net weight: 25 kg

Accessories of "POWER" Line (1000 W approx.)

Tachogenerator mod. P-16/EV

Output voltage: 0.06 V/rpm
RPM: 5000 max
Voltage of output 1: 300 Vdc @ 5000 rpm
Voltage of output 2: 10 Vdc @ 5000 rpm
Protection: IP44
Dimensions: 200 x 200 x 300 mm
Weight: 10 Kg

DC Generator/Motor with separate/ compound excitation mod. P-1/EV

Power: 1000 W
Armature voltage: 220 Vdc
Field voltage: 220 Vdc
RPM: 3000 max
Frame: IM B3
Protection: IP 22
Embedded thermal protection
Dimensions: 500 x 200 x 300 mm
Weight: 48 Kg

Base for supporting and coupling the machines of "POWER" Line mod. BP/EV
If user's own machines are used, they should have the following minimum features:
300W line: Power of 300 W, armature voltage: 220 Vdc, field voltage: 220 Vdc, 3000 RPM
1000W line: Power of 1000 W, armature voltage: 220 Vdc, field voltage: 220 Vdc, 3000 RPM
Tachogenerator: voltage = 0.06 V/rpm, 5000 rpm, output voltage: 10 Vdc @ 5000 rpm.

REQUIRED

POWER SUPPLY UNIT MOD. AEP-1/EV
- NOT INCLUDED -

AUXILIARY POWER SUPPLY OF UNIT A1D:
230 Vac 50 Hz single-phase - 100 VA
(Other voltage and frequency on request)

SUPPLIED WITH

THEORETICAL-EXPERIMENTAL HANDBOOK
Introducing the trainer, guide to exercises and technical specs.

ACCESSORIES:

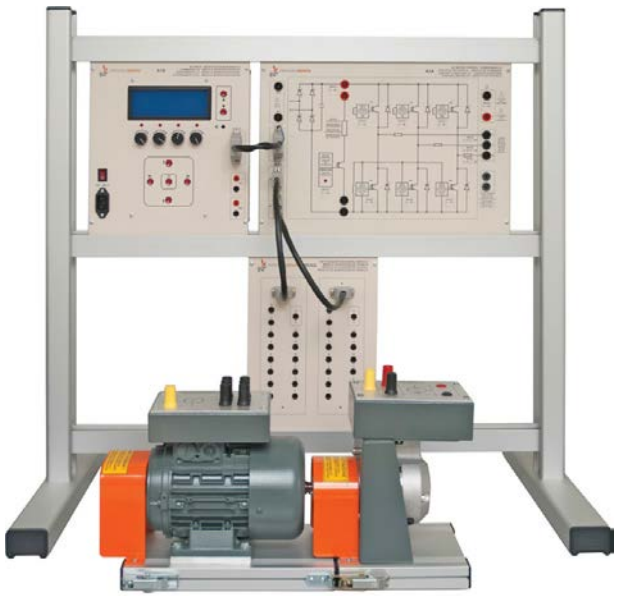
- 1 desk-type support for modules mod. TSI-1/EV with aluminium horizontal slides
- Set of safety jumpers Ø = 4 mm and Ø = 2 mm
- Connection cables

MODULAR EDUCATIONAL SYSTEMS FOR DRIVES OF AC MOTORS

Mod. AAC-1/EV

INTRODUCTION

Power Electronics is related, among other topics, with the static power conversion and its applications. System mod. AAC-1/EV has been designed and manufactured with industrial components according to educational standards. It is the suitable tool for the theoretical-practical study of AC motor drive.



TRAINING PROGRAM:

Trainer mod. AAC-1/EV allows the theoretical-practical study of the following subjects:

- Mechanical and electrical features of asynchronous three-phase motors. Motor equivalent circuit
- Electronic drives for asynchronous three-phase motors
- Modulation techniques for inverter
- Analysis of Pulse Width Modulation (PWM)
- FOC-type vector drive
- V/Hz scalar drive
- Acceleration and deceleration ramp
- PID control for drives

TECHNICAL CHARACTERISTICS:

Trainer mod. AAC-1/EV consists of three units for the exhaustive study of the industrial drive of an AC motor. These units are:

A1A AC DRIVE - Microprocessor module
A2A AC MOTOR CONTROL - Power circuit
MDAQ - Data acquisition module

The development of the exercises of the training program consists in fixing the units in the support mod. TSI-1/EV, placing over the due overlay for the exercise under test and arranging the proper connections.
Each unit includes a panel of insulating material with Ø = 4 mm safety terminals, for connections.
Connecting module MDAQ will supply the (opto-isolated) signals of voltages and currents of unit A2A.

A1A AC DRIVE – Microprocessor module

Module **A1A** is connected with module **A2A** via a 25-pole connector and enables its operation by generating the necessary signals for control of power circuits.
It includes a 4-line alphanumeric display to show various data, such as the codes of the module and of the connected overlay, the set point value, the selected control mode (open or closed loop, with tachogenerator or armature voltage) etc... This Module includes a PID controller for the speed of the AC motor coupled to a tachogenerator (motor & tachogenerator are not included), connected with unit **A2A**.
It is possible to set the P, I and D values and the acceleration & deceleration ramps. The on-board pushbuttons enable the navigation through the menu, and the potentiometers allow to modify the selected parameters. Furthermore two other analog inputs of 0 to 10 V are available for the connection with any source of external signals.

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A2A AC MOTOR CONTROL – Power circuit

Unit **A2A** includes the power circuits for the AC motor.

It consists of a VSI-type three-phase inverter whose control signals come from unit A1A. This three-phase inverter includes 6 IFBT transistors. The maximum power of motors that can be connected is of approximately 1000 W. A "Chopper"-type braking circuit is available and two Ø = 4 mm safety terminals enasble to control motor overtemperature. The DC power supply for the inverter comes from a Graetz bridge with capacitor filter. Three Ø = 4 mm safety terminals available on the panel enable to connect this unit with the three-phase motor. Other two specific Ø = 4 mm safety terminals allow the connection with a tachogenerator for closed loop control. Connecting module MDAQ with 15-pole connectors will supply the (opto-isolated) signals of voltages and currents available in the circuit.

MDAQ - Data acquisition module

Module MDAQ supplies the (opto-isolated) signals of the unit which it is connected with, on 30 safety terminals (Ø = 2 mm). The opto-isolated signals ensure electrical safe conditions for students when carrying out measurements: for instance, it is not necessary to use differential probes when using oscilloscope.

OPTIONAL ACCESSORIES:

Trainer mod. AAC-1/EV allows to work with the accessories of "Compact" line (300 W approx) or of "POWER" line (1000 W approx) according to customer's requirements.

Caution: *Components of these two lines CAN NEVER BE connected with each other*

Accessories of "COMPACT" Line (300 W approx.)

Tachogenerator mod. M-16/EV

Output voltage: 0.06 V/rpm
RPM: 5000 max
Voltage of output 1: 300 Vdc @ 5000 rpm
Voltage of output 2: 10 Vdc @ 5000 rpm
Protection: IP44
Dimensions: 160 x 160 x 250 mm
Weight: 5 Kg

Three-phase asynchronous motor mod. M-4/EV

Power: 500 W
voltage: 230/400 V - 50 Hz
RPM: 3000 - 2 poles
Frame: IM B3
Protection: IP 44
Embedded thermal protection
Dimensions: 440 x 160 x 250 mm
Weight: 10 Kg

Experimental flywheel mod. VST-1/EV

Inertial flywheel for "M"series motors
Moment of inertia I: 0.0145 - 0.029 - 0.043 kgm^2
Max. speed of rotation: 4000 r.p.m.
Dimensions: 440 x 160 x 250 mm
Net weight: 25 kg

Accessories of "POWER" Line (1000 W approx.)

Tachogenerator mod. P-16/EV

Output voltage: 0.06 V/rpm
RPM: 5000 max
Voltage of output 1: 300 Vdc @ 5000 rpm
Voltage of output 2: 10 Vdc @ 5000 rpm
Protection: IP44
Dimensions: 200 x 200 x 300 mm
Weight: 10 Kg

Three-phase asynchronous motor mod. P-4/EV

Power: 500 W
Voltage: 230/400 V - 50 Hz
RPM: 3000 - 2 poles
Frame: IM B3
Protection: IP 44
Embedded thermal protection
Dimensions: 440 x 160 x 250 mm
Weight: 10 Kg

Base for supporting and coupling the machines of "POWER" Line mod. BP/EV

If user's own machines are used, they should have the following minimum features:

500W line: Power of 500 W, voltage: 230/400 V - 50 Hz, 3000 rpm 2 poles
1000W line: Power of 1000 W, voltage: 230/400 V - 50 Hz, 3000 rpm 2 poles
Tachogenerator: voltage = 0.06 V/rpm, 5000 rpm, output voltage: 10 Vdc @ 5000 rpm.

REQUIRED

POWER SUPPLY UNIT MOD. AEP-1/EV
- NOT INCLUDED -

AUXILIARY POWER SUPPLY OF UNIT A1A:
230 Vac 50 Hz single-phase - 100 VA
(Other voltage and frequency on request)

SUPPLIED WITH

THEORETICAL-EXPERIMENTAL HANDBOOK
Introducing the trainer, guide to exercises and technical specs.

ACCESSORIES:

- 1 desk-type support for modules mod. TSI-1/EV with aluminium horizontal slides
- Set of safety jumpers Ø = 4 mm and Ø = 2 mm
- Connection cables

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UNIVERSAL POWER SUPPLY UNIT FOR CIRCUITS OF POWER ELECTRONICS

Mod. AEP-1/EV

INTRODUCTION

This is the ideal desk-type power supply unit for powering the power section of single-phase and three-phase controlled and noncontrolled rectifiers. It also includes a DC variable output.

Power supply mod. AEP-1/EV outputs a continuously variable voltage of 0-400 Vac (three-phase) / 0-230 Vac (single-phase), with rated current of 5 A (7.5 A for 15 minutes. Variac output can be connected with an insulation transformer having a secondary voltage of 50-0-50 Vac, via some jumpers. It becomes a power supply with reduced variable voltage insulated from the mains. The secondary winding of the transformed can be connected in star or delta configuration. The star centre can be shifted to the centre of coils and the result will be a dual voltage. The two halves of the windings can be bridged to obtain a double output current.

The voltage output by variac can be connected with the three-phase Graetz bridge to obtain a variable direct current not insulated from the mains; interposing the insulation transformer will insulate the direct current output from the mains.

Another direct current output variable by steps between 160-180-200-220 V, with a current of 2 A, is also available to power excitation circuits of motors and of generators.

All the outputs are available on the safety terminals (with diameter of 4 mm) of the fore panel of aluminium alloy provided with international electric symbols.

This unit includes magnetothermal differential switch of 30 mA, emergency pushbuttom with rotation release. All outputs are protected against overload and short circuits by fuses.

TECHNICAL CHARACTERISTICS:

- Magnetothermal differential switch of 4 poles, In = 6 A, C curve, Idn 30 mA, class A
- Emergency pushbutton with mechanical holding and rotation release
- Minimum voltage coil for opening the main switch
- Three-phase variac of 400/0-400 V 5 A (7.5 A for 15 minutes) with safety terminals (Ø 4 mm) protected by fuses 10.3 x 38 In = 4 A
- Three-phase insulation transformer: primary winding of 3 x 230/400 V, secondary winding of 3 x 50-0-50 V - 5 a; power of 1500 VA
- Two separate outputs protected by two sets of three fuses 10.3 x 38 In = 4 A and safety terminals with safety plugs (Ø 4 mm)
- Three-phase bridge rectifier - Un = 600 V - In = 25 A; direct current output protected by fuses 10.3 x 38 In 8 A and safety terminals with safety plugs (Ø 4 mm)
- Output variable by steps 0-160-180-200-220 Vdc, with separator transformer of 500 VA, rotary selector, single-phase rectifier bridge Un 600 V - In 25 A, input and output protected by fuse 10.3 x 38 In 2 A and safety terminals with safety plugs (Ø 4 mm)

Dimensions: 525 x 500 x 297 mm
Net weight: 32 kg

REQUIRED UTILITIES (PROVIDED BY THE CUSTOMER)

- Power supply: 400 Vac 50 Hz three-phase - 3000 VA
  (Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK

ACCESSORIES:

- Three-phase power cord with IEC 309 plug
- 10 jumpers with safety plugs of 4 mm for quick connections

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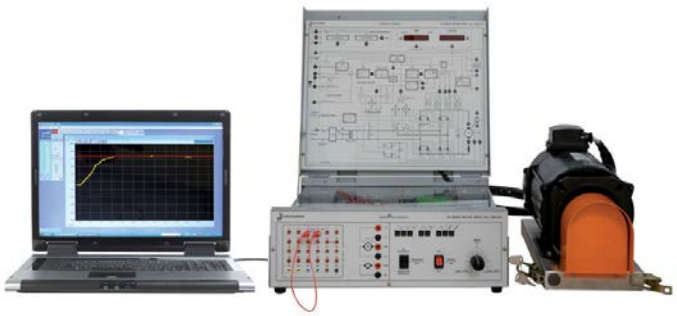
SERVOMECHANISM FOR DC-SHUNT MOTOR

Mod. DSD1/EV

The **DC-SHUNT** motor is a direct current motor in which the rotor field is generated by an external excitation circuit, in a way to obtain a constant or variable field. The DC-SHUNT motor drive proposed in the equipment **mod. DSD1/EV** is of the AC/DC type with thyristors (SCR).

This drive has been historically, the first one among the DC drives. Nevertheless, it is by no means obsolete; in fact, its robustness, its low cost in relation to the controlled power and the application fields make this mechanism an indispensable product for the industry. The system mod. DSD1/EV is, inside a laboratory of servomechanisms, the instrument necessary to the high level theoretical-practical study on the subjects concerning the thyristor AC/DC servomechanisms for DC-SHUNT motors. The power of the servomechanism, the circuit solutions and the employed components enable the development of the training program on a **totally industrial product and not on a simulator.**



SERVOMECHANISM FOR DC-SHUNT MOTOR mod. DSD1/EV

The system mod. DSD1/EV mainly consists of:

- **A bidirectional industrial servomechanism for DC SHUNT motor with separate excitation;**
- **An external unit consisting of a DC-SHUNT motor with separate excitation.**

The servomechanism is mounted on the EDUBOX structure, an innovative teaching presentation system combining the demonstration efficiency with the operative functionality. The compact unit includes:

- **An electronic circuit of the equipment;**
- **A silk-screen printed diagram with detailed block diagram;**
- **A panel with controls, indicators, test points;**
- **A non-destructive fault simulator.**

A tachogenerator directly mounted on the external unit together with the DC-SHUNT motor is providing the system's feedback. The servomechanism is connected to the external unit via an 8-pole cable. A dedicated electronic board, provided with the equipment mod. DSD1/EV, enables the PC interfacing, via USB/Bluetooth, during data acquisition and process supervision experiences. A fault simulation system enables the insertion of 8 different non-destructive faults by means of hidden switches; the inserted faults are the most common as concern the industrial use of the system. In this way, several exercises concerning the maintenance of the servomechanisms for industrial DC-SHUNT motor are allowed, enriching the professional background of the student.

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TRAINING PROGRAM:

- DC-SHUNT motor with separated excitation: electrical and mechanical characteristics;
- Structure of the bidirectional SCR servomechanism;
- Application range;
- Current and voltage waveforms of the motor;
- Speed control with tachogenerator;
- Speed control with inner current loop;
- PI regulators;
- Proportional action-speed controller calibration;
- Proportional action-current controller calibration;
- Integrative action;
- Set-point/ignition angle/SCR/speed ratio;
- Acceleration and deceleration ramps;
- Synchronism signal;
- Signal produced by the modulator;
- Dynamic response of the system;
- Analysis and use of the supervision software from PC in operations of speed setting / reading and speed / current graph plotting;
- Troubleshooting experiences in the servomechanism.

SOFTWARE:

Data acquisition and supervision:

- Interface card inside the equipment, complete with A/D and D/A converters;
- Connection to PC: USB/Bluetooth (PC not included);
- Graphic software running on Windows 7/8 or higher.

TECHNICAL SPECIFICATIONS:

- EDUBOX mounting structure;
- Silk screen printed diagram with the different circuit blocks of the system;
- Measurement test-points;
- 2 bar-graph indicators for speed and current;
- External control panel with switches and rotary potentiometer;
- Non-destructive fault simulator: possibility of insertion of 8 faults at max. with the same number of switches.

Power supply: 230 Vac 50 Hz single-phase - 1,5 kVA
(Other voltage and frequency on request)
Dimensions: 380 x 330 x 130 mm
Weight: about 10 Kg

SERVOMECHANISM CHARACTERISTICS:

- Speed set-point which can be fixed via potentiometer or PC;
- Speed regulation range: ±3000 rpm;
- Field voltage obtained inside and equal to 190 V;
- Single-phase controlled rectified power stage with 8 thyristors
- Ramp time: 5 s at max;
- Control: 4 Q bidirectional;
- LED diode diagnostics: power supply, current limit.

MOTOR UNIT CHARACTERISTICS:

- Metal base;
- Wounded rotor DC motor with separate excitation;
- Tachogenerator splined to the motor shaft;
- Nominal armature voltage: 160 V;
- Nominal power: 700 VA;
- Nominal speed: ±3000 rpm.

Dimensions: 400 x 120 x 170 mm
Weight: ca. 11 kg

REQUIRED

INSTRUMENTS - NOT INCLUDED -
- MULTIMETER
- OSCILLOSCOPE
- FUNCTION GENERATOR

SUPPLIED WITH

THEORETICAL-APPLICATION HANDBOOK OF THE MODULE WITH GUIDE TO THE APPLICATIONS.
INSTALLATION, USE AND MAINTENANCE HANDBOOK.

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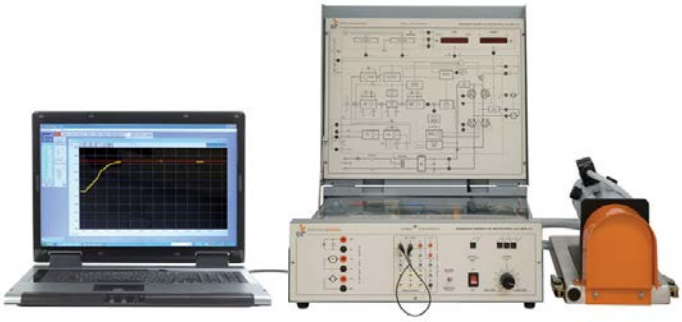
SERVOMECHANISM FOR PERMANENT MAGNETS DC MOTOR

Mod. MPD1/EV

Traditionally, the servomechanisms for permanent magnets DC motors have been employed in applications concerning speed and position control. Although recently the use of AC servomechanisms in these applications is greatly increased, DC servomechanisms are still used for their low starting cost and the excellent performances.

In this context, the suggested equipment **mod. MPD1/EV** represents the necessary instrument for the high level analytical-experimental study of subjects concerning **permanent magnets DC motors bidirectional servomechanisms, with PWM control techniques**. The power of the servomechanism, the circuit solutions, the used components cause the training program to be developed on **a totally industrial product and not on a reduced dimensions system**.



SERVOMECHANISM FOR PERMANENT MAGNETS DC MOTOR mod. MPD1/EV

The system mod. MPD1/EV mainly consists of:

- **A 4-quadrant industrial bidirectional servomechanism for permanent magnet DC motor;**
- **An external unit consisting of a permanent magnet DC motor.**

The servomechanism is mounted on the EDUBOX, structure, an innovative system for teaching presentation combining the demonstration effect with the operative functionality. The compact unit includes:

- **An electronic circuit of the equipment;**
- **A silk-screen printed diagram with detailed block diagram;**
- **A panel with controls, signaling, test points;**
- **A non-destructive fault simulator.**

Besides the DC motor, the external unit contains a tachogenerator for generating the feedback. The servomechanism is connected to the external unit via an 8-pole cable. A dedicated card, provided with the equipment mod. MPD1/EV, enables the PC interfacing, via USB/Bluetooth, for data acquisition and process supervision experiences. The training system is completed with a faults' simulation system allowing the insertion of 8 different non-destructive faults through hidden switches; the faults simulated are the most common ones occuring in the industrial use of the system. In this way, the experimentation is completed with exercises concerning the maintenance of DC industrial servomechanisms, enriching the professional background of the student.

TRAINING PROGRAM:

- Permanent magnet DC motor: electrical and mechanical characteristics;
- One-loop speed control with tachogenerator and armature feedback;
- Speed control with inner current loop;
- Structure of the 4-quadrant bidirectional servomechanism;
- Application range;
- Analysis of the power stage with bridge in "H" configuration;
- Zero adjustment;
- Maximum speed adjustment;
- PID controllers;
- Proportional-integrative gain regulation;
- Derivative action regulation;
- Set-point/duty-cycle/speed ratio;
- Dynamic response of the system;
- Analysis and use of the supervision software from PC in operations of speed setting/reading and speed/current graph plotting;
- Troubleshooting experiences in the servomechanism.

SOFTWARE:

Data acquisition and supervision:

- Interface card inside the equipment, complete with A/D and D/A converters;
- Connection to PC: USB/Bluetooth (PC not included);
- Graphic software running on Windows 7/8 or higher.

TECHNICAL SPECIFICATIONS:

- EDUBOX mounting structure;
- Silk-screen printed diagram with the different circuit blocks of the system;
- Measurement test-points;
- 2 bar-graph indicators for speed and current;
- External control panel with switches and rotary potentiometer;
- Non-destructive fault simulator: possibility of insertion of 8 faults at max with the same number of switches.

Power supply: 230 Vac 50 Hz single-phase - 1 kVA
(Other voltage and frequency on request)
Dimensions: 380 x 330 x 130 mm
Weight: about 10 kg

SERVOMECHANISM CHARACTERISTICS:

- Speed set-point which can be fixed via potentiometer or PC;
- Speed regulation range: ± 3000 rpm;
- Auxiliary voltages obtained with DC/DC converter inside the drive;
- "H" bridge power stage with 4 MOSFET power transistors;
- PWM modulation at high switching frequency;
- Control: 4-quadrant bidirectional;
- Reversible protection for over/under voltages;
- Irreversible protections for over temperature, short circuit, tachometric breaking;
- Single-phase rectifier bridge from network.

MOTOR UNIT CHARACTERISTICS:

- Metal base;
- Permanent magnet DC motor;
- Tachogenerator splined to the motor shaft;
- Nominal armature voltage: 80 Vac;
- Nominal armature current: 8Aac;
- Nominal speed: ± 3000 rpm

Dimensions: 400 x 120 x 170 mm
Weight: about 11 kg

REQUIRED

INSTRUMENTS - NOT INCLUDED -
- MULTIMETER
- OSCILLOSCOPE
- FUNCTION GENERATOR

SUPPLIED WITH

THEORETICAL-APPLICATION HANDBOOK OF THE MODULE WITH GUIDE TO THE APPLICATIONS.
INSTALLATION, USE AND MAINTENANCE HANDBOOK.

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INVERTER FOR THREE-PHASE ASYNCHRONOUS MOTOR

Mod. TID1/EV

The scalar V/Hz servomechanism for three-phase asynchronous motors is the most widely used in low and medium power range applications, due to their reduced price and good performances. The applications of such a servomechanism, for example, are: speed control of fans, compressors, pumps, electrical drilling machines.

In this context, the proposed equipment mod. TID1/EV, has been designed and carried out to enable deep theoretical/experimental study on **V/Hz scalar servomechanisms for three-phase asynchronous motors with sinusoidal PWM control**. The power of the servomechanism, the circuit solutions and the used components allow developing the educational program based on **a fully industrial product and not only on a reduced dimensions system**.

INVERTER FOR THREE-PHASE ASYNCHRONOUS MOTOR mod. TID1/EV

The system mod. TID1/EV mainly consists of:

- **A V/Hz industrial inverter for three-phase asynchronous motor;**
- **An external unit consisting of a three-phase asynchronous motor.**

The servomechanism is mounted on the EDUBOX structure, an innovative system for teaching presentation combining the demonstration effect with the operative functionality. The compact unit includes:

- **An electronic circuit of the equipment;**
- **A silk-screen printed diagram with detailed block diagram;**
- **A panel with controls, signaling, test points;**
- **A non-destructive fault simulator.**

The servomechanism is connected to the external unit via an 8-pole cable. A dedicated A/D & D/A card provided with the equipment mod. TID1/EV, enables the PC interfacing, via USB/Bluetooth, during data acquisition and process supervision experiences. A faults simulation system enables the insertion of 8 different non-destructive faults through hidden switches; the inserted faults are the most common accurring in the real world. In this way, the experimentation is completed with exercises concerning the maintenance of inverters for industrial three-phase asynchronous motors, enriching the professional background of the student.

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TRAINING PROGRAM:

- Asynchronous three-phase motor: electrical and mechanical characteristics;
- Equivalent circuits;
- Structure of the scalar V/Hz bidirectional servomechanism;
- Application range;
- Analysis of the IGBT three-phase inverter;
- Sine three-phase PWM modulation;
- Voltage wave-forms on the motor phases;
- Current wave-forms on the motor phases;
- Variation of the control frequency;
- Set-point/frequency/speed ratio;
- Acceleration/deceleration ramp;
- Dynamic response of the system;
- Analysis and use of the supervision software from PC in operations of speed setting / reading;
- Speed/current graph plotting;
- Troubleshooting experiences in the servomechanism.

SOFTWARE:

Data acquisition and supervision:

- Interface card inside the equipment, complete with A/D and D/A converters;
- Connection to PC: USB/Bluetooth (PC not included);
- Graphic software running on Windows 7/8 or higher.

TECHNICAL SPECIFICATIONS:

- EDUBOX mounting structure;
- Silk screen printed diagram with the different circuit blocks of the system;
- Measurement test-points;
- 2 bar-graph indicators for speed and current;
- External control panel with switches and rotary potentiometer;
- Non-destructive fault simulator: possibility of insertion of 8 faults at max with the same number of switches.

Power supply: 230 Vac 50 Hz single-phase - 0,5 kVA
(Other voltage and frequency on request)
Dimensions: 380 x 330 x 130 mm
Weight: about 10 kg

SERVOMECHANISM CHARACTERISTICS:

- Speed set-point which can be fixed via potentiometer or PC;
- Speed regulation range: ± 3000 rpm;
- Auxiliary voltages obtained with DC/DC converter inside the drive;
- Three-phase inverter with 6 IGBT transistors;
- Sine three-phase PWM modulation with programmable switching frequency;
- Rotation frequency programmable in the range: 0.1 ÷ 480 Hz;
- Control: bidirectional;
- Starting automatic Boost;
- Acceleration / deceleration times, programmable from 0.00 s to 99,99 s;
- Protections: over/under voltage, overcurrent, temperature, short-circuit;
- Single-phase rectifier bridge from network.

MOTOR UNIT CHARACTERISTICS:

- Metal base;
- Nominal phase voltages: 3 x 230 Vac;
- Three-phase asynchronous motor with squirrel cage rotor;
- Nominal speed: ± 3000 rpm.

Dimensions: 400 x 120 x 170 mm
Weight: about 10 kg

REQUIRED

INSTRUMENTS - NOT INCLUDED -
- MULTIMETER
- OSCILLOSCOPE
- FUNCTION GENERATOR

SUPPLIED WITH

THEORETICAL-APPLICATION HANDBOOK OF THE MODULE WITH GUIDE TO THE APPLICATIONS.
INSTALLATION, USE AND MAINTENANCE HANDBOOK.

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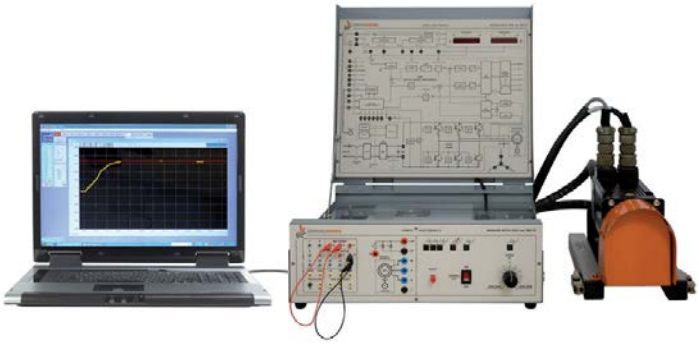
SERVOMECHANISM FOR BRUSHLESS MOTOR

Mod. BMD1/EV

Brushless motors are synchronous machines with rotor consisting in a permanent magnet and consequently without brushes. The mechanical and electrical characteristics of these motors are superior to those of traditional DC and AC motors.

Brushless motors are typically employed in power applications up to some kW such as: the control of computer peripherals, industrial automation, robots and variable speed servomechanisms for heat pumps. In this context, the suggested equipment mod. BMD1/EV, is the necessary instrument for a high level analytical-experimental study of the subjects concerning **electrical servomechanisms for brushless motors.** The power of the servomechanism, the circuit solutions, the used components, make the training program to be developed on a **totally industrial product and not on a symulated system**.



SERVOMECHANISM FOR BRUSHLESS MOTOR mod. BMD1/EV

The system mod. BMD1/EV essentially consists of:

- **An industrial bidirectional drive for AC brushless motor;**
- **An external unit consisting of an AC brushless motor.**

The servomechanism is mounted on the EDUBOX structure, an innovative system for teaching presentation combining the demonstration effect with the operative functionality.

The compact unit includes:

- **An electronic circuit of the equipment;**
- **A silk-screen printed diagram with detailed block diagram;**
- **A panel with controls, signaling, test points;**
- **A non-destructive fault simulator.**

Besides the brushless motor, the external unit contains a resolver-type position transducer. The servomechanism is connected to the external unit via an 8-pole cable. Besides, a dedicated card provided with the equipment mod. BMD1/EV, enables the PC interfacing, via USB/Bluetooth, during data acquisition and process supervision experiences. Then a simulation system enables the insertion of 8 different non-destructive faults via the same number of switches; the inserted faults are the most used as concern the industrial use of the system. In this way, the experimentation is completed with exercises concerning the maintenance of brushless industrial servomechanisms, enriching the professional background of the student.

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TRAINING PROGRAM:

- AC brushless motor: electrical and mechanical characteristics
- Position transducers: resolver
- Double-loop speed-current control
- Structure of the servomechanism
- Application range
- Analysis of the power stage with IGBT transistor
- Microcontroller architecture
- Acceleration and deceleration ramps
- Detection of the voltage and current wave-forms on the motor phases
- Changing of the control parameters
- Dynamic response of the system
- Analysis and use of the supervision software from PC in exercises of speed setting/reading
- Speed/current graph plotting
- Troubleshooting experiences in the servomechanism

SOFTWARE:

Data acquisition and supervision:

- Interface card inside the equipment, complete with A/D and D/A converters;
- Connection to PC: USB/Bluetooth (PC not included);
- Graphic software running on Windows 7/8 or higher.

TECHNICAL SPECIFICATIONS:

- EDUBOX mounting structure
- Silk screen printed diagram with the different circuit blocks of the system
- Measurement test-points
- 2 Bar-graph indicators for speed and current
- External control panel with switches and rotary potentiometer
- Non-destructive fault simulator: possibility of insertion of 8 faults at max with the same number of switches.

Power supply: 230 Vac 50 Hz single-phase - 2 kVA
(Other voltage and frequency on request)
Dimensions: 380 x 330 x 130 mm
Weight: about 6 kg

SERVOMECHANISM CHARACTERISTICS:

- Speed set-point which can be fixed via potentiometer or PC;
- Speed regulation range: ± 3000 rpm;
- Auxiliary voltages obtained with DC/DC converter inside the drive;
- 6 IGBT transistor power stage;
- Feedback with resolver;
- Control: 4-quadrant bidirectional with double speed-current loop;
- Acceleration / deceleration times, programmable from 0.00 s to 99,99 s;
- Protection for over/under voltages;
- Single-phase rectifier bridge from network.

MOTOR UNIT CHARACTERISTICS:

- Metal base;
- Permanent magnet brushless motor in neodymium-iron boron;
- Resolver splined to the motor shaft;
- Nominal armature voltage: 3 x 200 Vrms;
- Nominal armature current: 3 x 3.3 Arms;
- Nominal speed: ± 3000 rpm;
- Torque: 7.8 N·m.

Dimensions: 350 x 120 x 150 mm
Weight: about 5 kg

REQUIRED

INSTRUMENTS - NOT INCLUDED -
- MULTIMETER
- OSCILLOSCOPE
- FUNCTION GENERATOR

SUPPLIED WITH

THEORETICAL-APPLICATION HANDBOOK OF THE MODULE WITH GUIDE TO THE APPLICATIONS.
INSTALLATION, USE AND MAINTENANCE HANDBOOK.

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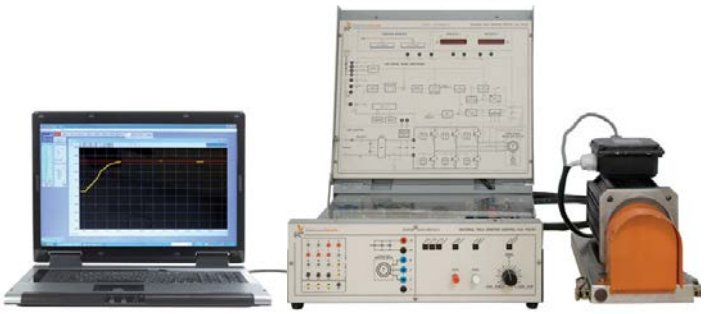
VECTORIAL FIELD-ORIENTED CONTROL SERVOMECHANISM FOR THREE-PHASES ASYNCHRONOUS MOTOR

Mod. FOC/EV

In AC servomechanisms of the last years, **the vectorial F.O.C. field- oriented control technology** is dominating. Used with three-phase asynchronous motors, they allow to reach torque and speed performances, superior to those obtained with traditional scalar technology.

The vectorial field-oriented control servomechanism for asynchronous three-phase motor mod. FOC/EV enables the student to learn, demonstrate and experiment the main concepts of field oriented control, enriching the personal theoretical background with the practical aspects of industrial design and maintenance. The power of the servomechanism, the circuit solutions, the used components, make the training program to be developed on a **totally industrial product and not on a simulator.**



VECTORIAL FIELD-ORIENTED CONTROL SERVOMECHANISM FOR ASYNCHRONOUS THREE-PHASE MOTOR mod. FOC/EV

Mainly consists of:

- **An industrial vectorial inverter for asynchronous three-phase bidirectional motor;**
- **An external unit consisting of a three-phase asynchronous motor.**

The available control modes are:

- **Field orientation with speed sensor;**
- **Field orientation without speed sensor (Sensorless);**
- **V/Hz control.**

The servomechanism is mounted on the EDUBOX structure, an innovative system for teaching presentation combining the demonstration effect with the operative functionality.

The compact unit includes:

- **An electronic circuit of the equipment;**
- **A silk-screen printed diagram with detailed block diagram;**
- **A panel with controls, signaling, test points;**
- **A non-destructive fault simulator.**

The servomechanism is connected to the external motor via an 8-pole cable. A dedicated electronic board, provided with the equipment mod. FOC/EV, enables the PC interfacing for data acquisition and process supervision experiences. The parametrization of the servomechanism is made with a keyboard with LCD display or via PC with dedicated software supplied with the system.

A faults' simulation system enables the insertion of 8 different non-destructive faults through switches; the faults simulated are typical cases verified in the industrial use of the system.

TRAINING PROGRAM:

- Asynchronous three-phase motor: electrical and mechanical characteristics;
- Vectorial field-oriented control (F.O.C.);
- Speed and torque control;
- Analysis of the IGBT three-phase inverter;
- "Space vector" vectorial modulation;
- Voltage/current wave-forms on the motor phases;
- Dynamic response of the system;
- Programming the servomechanism via keyboard or PC with dedicated software;
- Analysis and use of the data acquisition software from PC;
- Troubleshooting experiences in the servomechanism.

TECHNICAL SPECIFICATIONS:

- EDUBOX mounting structure;
- Silk screen printed diagram with the different circuit blocks of the system;
- Measurement test-points;
- External control panel with switches and rotary potentiometer;
- Non-destructive fault simulator: possibility of insertion of 8 faults at max with the same number of switches.

Power supply: 230 Vac 50 Hz single-phase - 1,5 kVA
(Other voltage and frequency on request)
Dimensions: 380 x 330 x 130 mm
Weight: about 10 kg

SOFTWARE:

Data acquisition and supervision:

- Interface card inside the equipment, complete with A/D and D/A converters;
- Connection to PC using the above mentioned interface (PC not included);
- Graphic software running on Windows 7/8 or higher.

SERVOMECHANISM CHARACTERISTICS:

- Speed set-point which can be fixed via potentiometer or PC;
- Speed regulation range: ± 3000 rpm;
- Auxiliary voltages obtained with DC/DC converter inside the drive;
- 6 IGBT transistor three-phase inverter;
- SVM (Space Vector Modulation) to keep the noise level to the minimum;
- Possibility of controls: sensorless, with encoder and V/Hz;
- Inverter programming via keyboard with back-lighted LCD display or PC with dedicated software and serial interface;
- Controls: speed and torque;
- Autotuning procedure for current, flow and range regulators;
- 8 inner speed references and 4 inner linear or "S" ramps;
- Digital inputs for encoder analog differentials;
- Outputs protected against the accidental grounding and phase short-circuit across the output and overload control;
- Alarm signaling on the keyboard display.

MOTOR UNIT CHARACTERISTICS:

- Metal base;
- Nominal phase voltages: 3 x 230 V;
- Three-phase asynchronous motor with squirrel cage rotor;
- Nominal speed: ± 3000 rpm.

Dimensions: 400 x 120 x 170 mm
Weight: about 10 kg

REQUIRED

INSTRUMENTS - NOT INCLUDED -
- MULTIMETER
- OSCILLOSCOPE
- FUNCTION GENERATOR

SUPPLIED WITH

THEORETICAL-APPLICATION HANDBOOK OF THE MODULE WITH GUIDE TO THE APPLICATIONS.
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LINEAR MOTOR TRAINER

Mod. LM-1/EV

44-A

INTRODUCTION

The **Linear Motor Trainer mod LM-1/EV** has been developed for teaching this special kind of electrical machines, that are becoming very important in automation systems. In fact, they compete advantageously with pneumatic / hydraulic devices in many industrial applications.

Today, linear motors (LM) are now cost-competitive with ball screws and belt drives and offer distinctly superior agility and bandwidth for advanced positioning applications.

Linear drives are increasingly replacing pneumatic / hydraulic cylinders, contributing reliability and controllability, free from the cost, noise and weight of air compressors or hydraulic power units and their pipings.

Additionally, linear motors drives are free of the classical problems related with the fluid compressibility (pneumatic drives) and temperature-sensitivity (that affect viscosity in hydraulic fluids).

Conventional positioning mechanisms are built up by lead screws, gear trains, belt drives and flexible couplings, which produce mechanical hysteresis, backlash and wear; positioners with LM are almost free of all these problems.

LM, as any modern electrical motor, are driven by electronic controllers; they should be tuned for the specific application for high gain loop, achieving wide bandwidth control, fast settling and recovering from transients.

LM are used today in several industrial applications. The positioning and the propulsion are among the most important. For the LM-1/EV it has been chosen the positioning application; it is the more interesting as it includes 3 nested control loops.

TRAINING PROGRAM:

- **The mechanical concept and their significance:** the classical concepts for rotational motors: torque, RPM, angular speed and angular positioning against their dual concepts for the LM: force, linear speed, linear acceleration and linear positioning. The relative formulas that link these parameters among them.
- **Types of LM:** operational principles and technical comparison among them regarding specific applications.
- **Constructional blocks of a LM system:** power and control signals flow.
- **Parameters to define a LM:** mechanical and electrical parameters according to the specific application.
- **The LM electronic drive:** the complete system description: motor- drive- sensors- data logger.

- **LM system connection and start up.**
- **The LM performance and measurements:** measurements of the combined mechanical parameters (acceleration, speed, force and positioning) against the electrical parameters (voltages, currents, power) with and without payload.

TECHNICAL SPECIFICATIONS:

The system includes two units (the Motor and the Controller), plus the accessories:

1- THE MOTOR

- Permanent magnet synchronous LM, including: the magnetic rod (dia. 25 mm). with 2 rod supports and sliding base for the forcer. Total rod lenght: 740 mm approx. Forcer free travel: 510 mm approx..
- Max stall force: 42 N approx @ 1.95 A (phases series connection).
- Force constant Kf: 22 / 11 N/A (series / parallel phases connections).
- Protection grade IP67. LOS
- Position feedback sensor, integrated with the forcer. Differential sinus/cosinus analog output type. It is the position feedback for the controller.
- External position sensor: mounted on the rod support,. It is the input for the supplied software.

2- THE CONTROLLER PANEL

- "Table-top" unit, completely contained in a robust metal box with long antitilting legs.
- LSM complete digital controller, microprocessor base, with 3 nested control loops: position, speed and current / torque.
- With 2 potentiometers, one for setting the forcer position, the second for setting the speed.
- Two signaling LEDs.
- Four figures display, that works with a 3-positions rotative selector to show position, speed, and current.
- Front keyboard, with 3 programming keys and display to visualize the parameters and the controller programming.
- All power terminals in 4 mm ø. Signal terminals in 2 mm ø.
- Possibility to connect an external function generator for continuous cycling.

3- ACCESSORIES TO BE SUPPLIED

- Set of connection cables with 4 mm safety connectors. Set of 2 mm cables.
- Function generator used as variable position generator. Output signals: sinusoidal, triangular, square, 0-10 Vpp. Feed by the Controller Panel.
- Data logger to process the signal coming from the distance sensor. With USB output to PC.
- Set of weights as motor payloads (2 x 1 kg + 1 x 2 kg) with stainless steel container. Therefore, 1-2-3-4 kg loads are available.
- Software: the unit is supplied with a specific software (Windows environment), that processes the data sent by the external distance sensor. It allows to calculate and graphically show the mechanical parameters (distance, speed, acceleration, force and power) under different loads.

Power supply: 230 Vac 50/60 Hz single-phase
(Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

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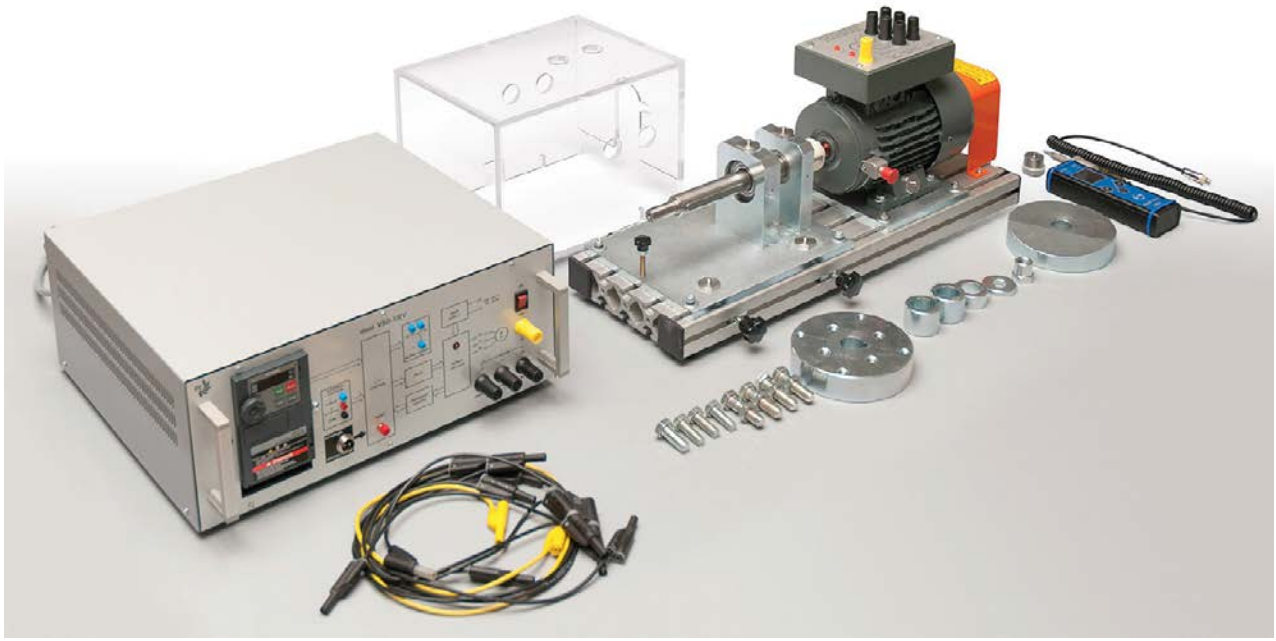
TRAINER FOR THE STUDY OF MECHANICAL VIBRATIONS

Mod. VBR-01/EV



INTRODUCTION

Vibration diagnosis is a technique for checking the condition of rotating machines (e.g. mechanical).
By performing this procedure regularly, you will be informed in advance about potential failures before the machine reaches the breakdown condition (that is, before having to apply corrective maintenance).
This is of a great advantage for large motors and generators, avoiding expensive overhauls. It is also very important for those critical machines (sometimes even low power machines) that can stop a complex and costly industrial process.
The periodical measurement, recording the values and evaluating the collected data performs one of the most important functions of PREVENTIVE MAINTENANCE.
Briefly, with the information supplied by this technique, you decide the optimum moment to stop the machine for repairs; you control the situation, instead of being "controlled" by the machine condition.

Vibration diagnostic measurements means:

- Diagnosis of bearings condition and their lubrication,
- Diagnosis of mechanical faults (axes misalignment, unbalance of rotating masses, detection of machine looseness and the dangerous mechanical resonances).

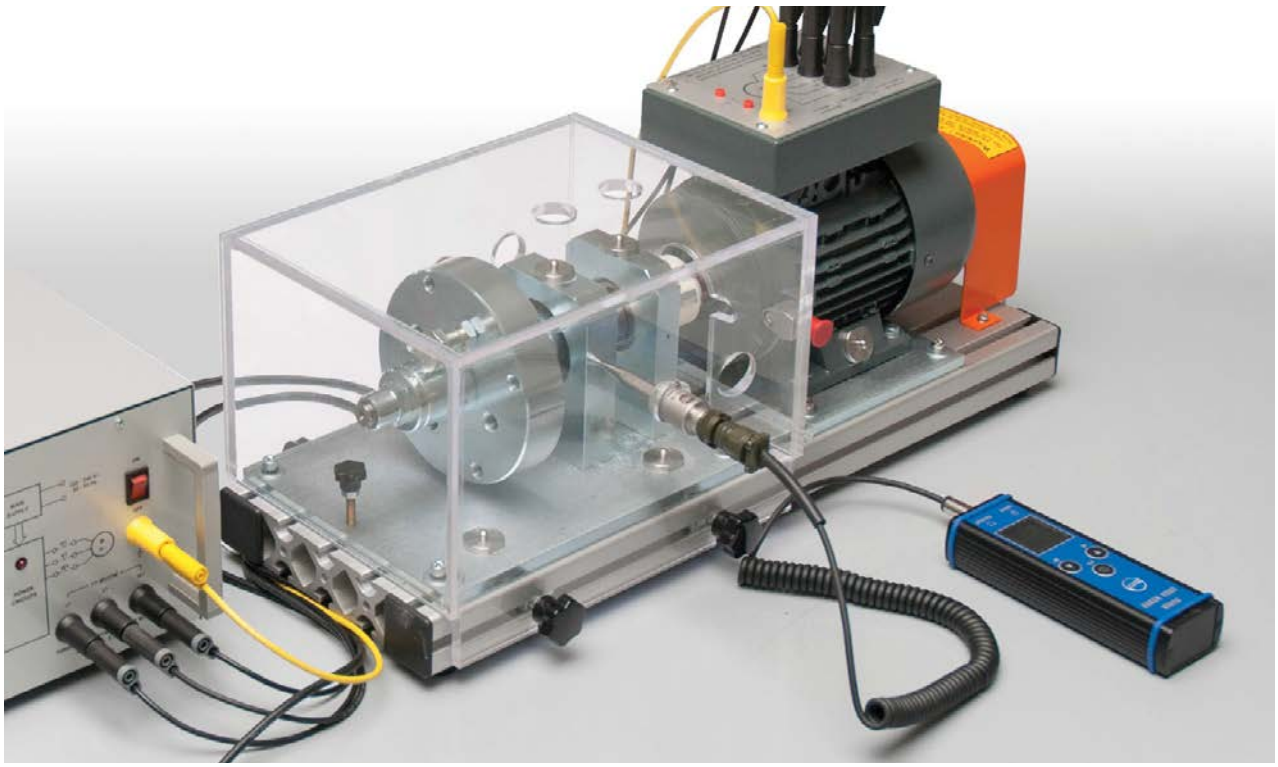
This technique can be applied in:

- The machine manufacturing stage, to check the design,
- Factories, at the production stage, to improve the performance of the rotating parts.
- Maintenance, to keep machines under control
- Workshops, to control the repaired rotating parts.

COMPOSITION:

The proposed system is composed by:

- A **Machines Set**, including:
  - A 3-ph asynchronous motor
  - An electronic drive for the motor, to vary the motor speed, and therefore, to examine the effect of this parameter over the vibration analysis.
  - A set of mechanical loads, modified to simulate the "failures" to be measured with the Vibration Measurement Instrument.
  - A support base for the motor and the mechanical load. The base has been designed to insert some "failures" to be measured with the Vibration Measurement Instrument.
  - The motor, the mechanical load, and the base includes the measuring points; these points are ready to apply the vibration sensor.
- A **Vibration Measurement Instrument.**



TRAINING PROGRAM:

- The importance of vibration measurement.
- Study of the factors that can cause vibration of the rotating parts.
- The vibration measuring parameters used in industry: overall RMS and PEAK velocity, overall RMS and PEAK acceleration, overall RMS and PEAK displacement, bearings fault detection, acceleration enveloping measurement.
- Influence of the RPM on the measured parameters.
- Selecting the optimum machine points for the vibrations checks.
- Preparing the surface of the measuring points. Precautions to be taken.
- The vibration measurement instrument: input sensors, outputs, measured parameters.
- Classical industrial measures on rotating machines related with mechanical vibrations: unbalanced masses, axis misalignment, machine looseness.
- Evaluation of the collected data and further actions to be taken.

TECHNICAL SPECIFICATIONS:

The MACHINES SET includes:

- 3-ph asynchronous motor with drive, with the following technical characteristics:
  - Motor: 3-phase squirrel-cage asynchronous motor; 3x230 V; synchronous speed: 3000 RPM (2 poles machine), power: 0.5 kW. Double end shaft, with orange safety cover in the back end.
  - Drive: microprocessor-controlled, bi-directional speed, for max. 0.75 kW 3-ph squirrel cage motor. Speed set-point through potentiometer. Digital display (7 segments, 4 figures) with programmable parameters. Power supply: 230 V single-phase. Max. power: 1.8 kVA. Freq. Limits: 0.5 to 400 Hz, with settable freq. limits. Power section: 3-phase inverter with 6 * IGBT transistors; sinusoidal PWM modulation. Control modes: V/f constant, variable torque, vectorial control, Programmable acceleration / deceleration ramp times (0 to 3600 sec).. Protections: over/under current, over temperature, short-circuit. Including the braking resistance and the respective clamping circuit. The drive has a safety control connected to the limit switch in the load support base.
- Set of Mechanical Loads, with the following technical characteristics:
  - One inertia heavy disk, to be coupled to the motor above. This disk has two concentric set of holes to screw bolts at different positions and angles to simulate low unbalances on a rotating mass.
  - One inertia heavy disk partially bevelled to simulate a heavy unbalanced load.
  - Support base, with the shaft to couple the heavy disks. The shaft is coupled to the motor. The base is ready to insert different "axes misalignments" between the motor and the mechanical Load.
  - Transparent, heavy plastic cover, with the holes to insert the instrument sensor. The safety limit switch placed in the base makes mandatory the use of this cover to run the motor drive.
  - The base includes the little metal pads to apply the instrument sensor.

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The VIBRATION MEASUREMENT INSTRUMENT:

- Instrument following ISO 10816 standard.
- It is a lightweight, manual portable instrument, designed to be a standard for plant engineers and maintenance staff.
- Despite being a powerful instrument, it is of easy use, a great advantage for educational purposes, mainly when dealing with beginners.
- The instrument automatically performs multiple measurements: determining the bearings condition, including insufficient lubrication; finding and measuring the level of rotating unbalanced masses, machine looseness and axis misalignment;
- **Measuring ranges:**

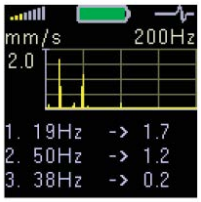
DETECTION	UNIT	FREQUENCY RANGE	DISPLAY
RMS	mm/s, ips	10-1000 Hz	0-999
PEAK	mm/s, ips	10-1000 Hz	0-999
RMS	g	500-16000 Hz	0-999
RMS	g	1500-16000 Hz	0-999
RMS	g	5000-16000 Hz	0-999
RMS	um, mil	2-200 Hz	0-999
PEAK u	m, mil	2-200Hz	0-999
Time Signal	g	500-16000 Hz	0-999
Spectrum (200 lines)	mm/s, ips	4-200Hz	0-999
Temperature	°C, °F		0-380°C (32-716°F)

- Display: color OLED display 128 x 128 pixels, diagonal 1.5" (38mm)
- Sensor: 1x external piezoelectric accelerometer; input: 60g PEAK with standard 100mV/g sensor
- Further functions: LED stroboscope (0.17 Hz – 300 Hz, equivalent to 10 RPM – 18000 RPM), LED torch
- Audible output: 1x AC signal 8 Ω / 0,5 W for external headphones.
- Power: 2 x AA 1.5V batteries (alkaline, NiMH, LiFe)
- Temp: Operating: -5 to 50, Storage: -20 to 65 (Degrees Celsius)
- Dimensions: 150 x 60 x 35 mm; Weight: 350 g including batteries (without cable, sensor and magnet). 540 g including batteries, cable, sensor and magnet
- Uses metric and English units.
- Only three keys for programming all the functions.

Some displays of the instrument

Overall RMS values

Overall PEAK values



Spectrum 200 Hz

Time signal for roller bearing diagnosis

SUPPLIED ACCESSORIES:

- For the machine set:
  - Set of 10 cables (different colors and lengths) with 4 mm safety connectors.
- For the instrument:
  - vibration sensor with coiled cable,
  - magnetic base,
  - earphones,
  - recording cable with 3.5 mm jacks,
  - measuring tip for manual pressure on the sensor,
  - 1.5V alkaline batteries, transport case, CD with the manual

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

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44-A

ADVANCED APPLICATIONS OF ELECTRIC POWER

AA

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ADVANCED APPLICATIONS OF ELECTRIC POWER

INTRODUCTION

This part of the catalogue includes some systems, as advanced application of Electric Power.
Then it is better to remind what "SYSTEM" means in this context:

A SYSTEM is a physical unit consisting of different parts linked by a functional relation and forming a whole where each part contributes to attain a common target that identifies the system.
An important characteristic of SYSTEMS is the total coherence established among its components, as all contribute to carry out the common target.

COMMON CHARACTERISTICS OF THESE SYSTEMS:

- They are **ACTUAL applications** of Electric Power, designed for **specific contexts**.
- They are assemblies of **higher level** where the **common function is complex**. Consequently, the Systems proposed in this section include components of high complexity. For instance, a PLC is considered as a component of the System.
- The interaction of various high complexity components requires a **high degree of automation**. In fact, the assembly is often controlled by PLCs.

NECESSARY KNOWLEDGE

What considered above leads to the statement that the study of the Systems included in this Section needs to know **sound fundamentals** of:

- Electric installations (particularly, of industrial type)
- Advanced electrc instruments
- Power protection devices, etc...
- Electric machines of any type
- Electronics: general electronics, PLC and, especially, Power Electronics
- Information Technology (use of PC, especially of EXCEL) and of Local Area Networks (LAN).

TARGET & USERS

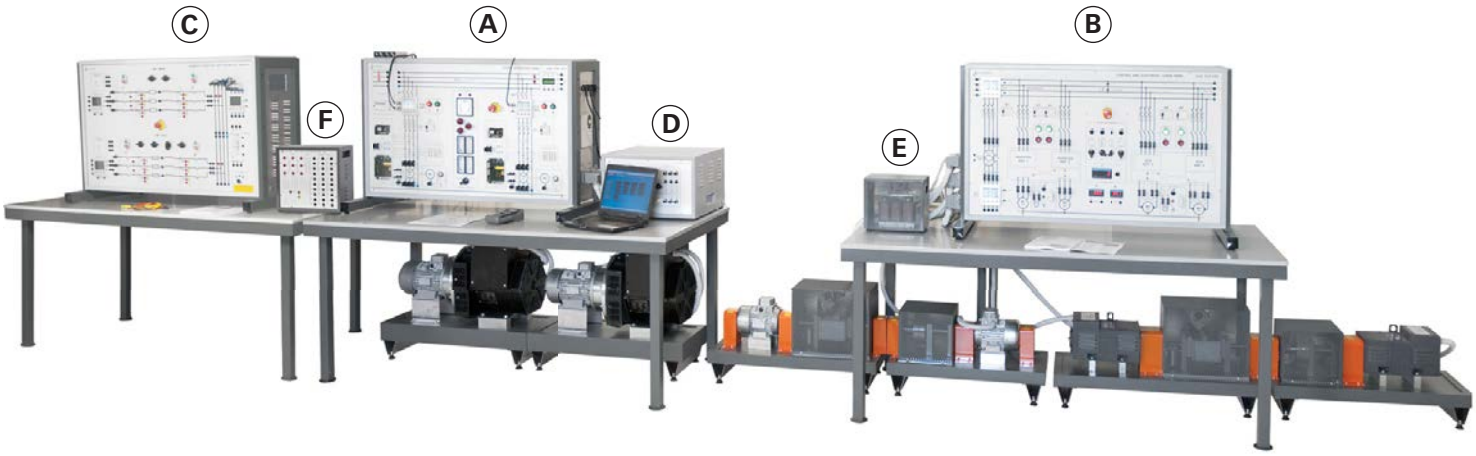
As these units offer a high educational level, the **preferential users** of these systems are:

- Universities: Electrical Engineering, last years of the faculty. Note that these systems are excellent, actual and operational examples, even for engineers who will not deal with these issues in future
- Updating courses for operators and maintenance technicians of power plants
- Specialized high schools for training engineers for Oil, Naval and Railway sectors.

THE SYSTEMS PROPOSED BY ELETTRONICA VENETA FOR THE STUDY OF THESE ADVANCED APPLICATIONS ARE:

- **INTEGRATED SYSTEMS OF ELECTRIC POWER**
- **ADVANCED GENERATION AND DOUBLE BUS BAR**

ELECTRIC POWER
ADVANCED APPLICATIONS



A = **GENERATION CONTROL AND PARALLEL PANEL + 2 MG**
Mod. PGP-1/EV

B = **PROPULSION DC AND AC MOTORS CONTROL PANEL**
Mod. CLP-1/EV

C = **DOUBLE-BUS BAR PANEL**
Mod. DBB-2E/EV

D = **SINGLE AND 3-PH RLC LOAD**
Mod. RLC-2K/EV

E = **3-PH SERVICES TRANSFORMER**

F = **3-PH POWER TRANSFORMER**
Mod. P-14A/EV

	REQUIRED UNITS						
Laboratory type	A	B	C	D	E	F	NOTES
GENERATION	X			X			
POWER ELECTRICAL PROPULSION / TRACTION		X					REQUIRED EXTERNAL 3-PH PWR SUPPLY
GENERATION + POWER ELECTRICAL PROPULSION / TRACTION	X	X		X	X		TYPICAL CONFIGURATION FOR: SHIPS, OIL DRILLING RIGS AND RAILWAYS LOCOMOTIVES
ELECTRICAL TRANSMISSION			X	X		X	REQUIRED EXTERNAL 3-PH PWR SUPPLY
GENERATION + ELECTRICAL TRANSMISSION	X		X	X		X	TYPICAL CONFIGURATION FOR: A GRID W/ DOUBLE BUS BAR AND AUXILIARY MGS
GENERATION + ELECTRICAL TRANSMISSION + POWER ELECTRICAL PROPULSION / TRACTION	X	X	X	X	X	X	TYPICAL CONFIGURATION OF ELECTRICAL SYSTEMS FOR LARGE SHIPS

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44-A

INTEGRATED SYSTEMS OF ELECTRIC POWER

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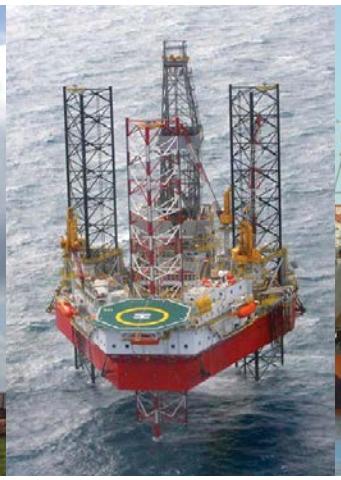
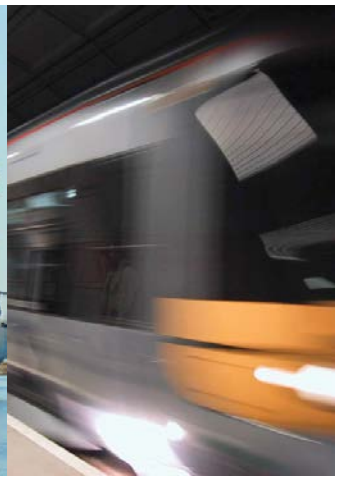
INTEGRATED SYSTEMS OF ELECTRIC POWER

INTRODUCTION

The **Integrated Systems of Electric Power** are those systems that include the whole cycle of electric energy: Production and Consumption.

Actual examples of these Systems are:





ON-SHORE | OFF-SHORE — OIL RIGS | NAVAL SYSTEMS | RAILWAYS

Some common characteristics of the Integrated Systems of Electric Power are summarized here below:

- In these Systems **almost all the power is electric**. Thus the importance of the technical training of the staff in charge of the System is emphasized.
- These **Systems are isolated from any external power source**. This is the reason why they are defined "integrated", that is they include Generation and Consumption.
- As they operate in isolation, these Systems must guarantee a **high reliability**, whether as regards their components, or the whole system level.
- Generally they have **a high degree of energy redundancy and management** to increase the reliability; this is the price imposed by isolation to reliability.
- The energy chain starts with the **primary machines of electric generation**. Generally they are Motor-Generator (MG) sets driven by big Diesel engines or by turbines. Therefore, as last resort, these systems depend on the fuel reserves for the primary machines.
- Most power produced is consumed in the **Traction / Propulsion** of the ship or of the drilling motors. The remaining power is consumed by the auxiliary services (lighting, heating / air conditioning, auxiliary motors, etc…).
- The motors applying electric Traction / Propulsion run at **extremely variable speed and load** (similar to those of the engine of a car). That provokes a strong electric and mechanical stress to the phase of generation. At present the large electric driving motors are powered by power semiconductor circuits controlled by microprocessors.
- Last, but not least, consider the **"administration" of power**. In fact, for economic reasons, the total installed power is generally lower than the total sum of consumptions. Consequently, service contemporaneity factors are carefully applied, and the hardware must include the logic and the safety devices to consider this situation. Of course the "tool" most frequently used for this function is the PLC.

UNITS PROPOSED FOR THE STUDY OF THE INTEGRATED SYSTEMS OF ELECTRIC POWER:

Mod. ODR-1/EV
Simulator for the study of the electric systems installed in oil rigs.

Mod. NEP-1/EV
Simulator for the study of electrically driven ships

Mod. ODR-2/EV
Integrated system of Generation - Propulsion equipped with Motor-Generator (MG) sets, brushless alternators and electric motor.

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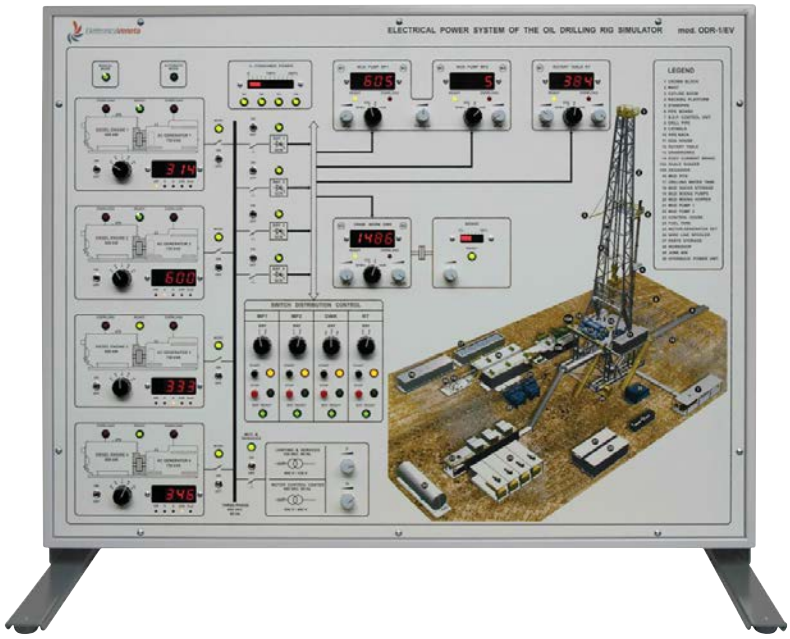
SIMULATOR FOR THE STUDY THE ELECTRIC SYSTEMS INSTALLED IN OIL RIGS

Mod. ODR-1/EV



INTRODUCTION

This table-top simulator is a preparatory panel for the training of maintenance technicians of (on-shore & off-shore) oil rigs.

Two targets are proposed:

- knowing the lay-out of a typical oil rig
- knowing the electric (generation and consumption) apparatuses and their instructions of use.

TRAINING PROGRAM:

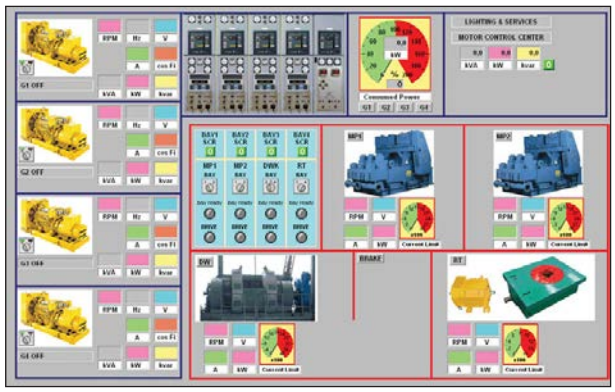
This Simulator enables students to learn:

- the lay-out of an oil rig
- the components of a typical electrical installation of an oil rig: alternators, Diesel engines, SCR drives, DC driving motors, Motor Control Center, etc...
- electrical installations of an oil rig
- the operations and procedures for managing the electric power, including the parallel of alternators
- the specific instruments for optimizing the performance of Diesel engines preventing them from wearing out, and for fuel saving
- the overloads of active power and of reactive power and neasures for preventing them.

TECHNICAL CHARACTERISTICS:

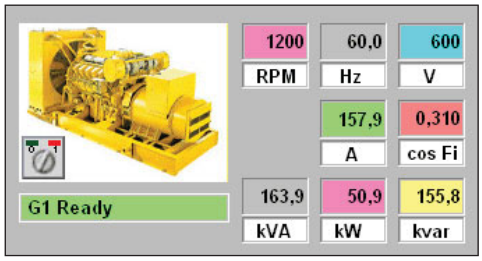
- This Simulator is used together with a Personal Computer.
- It consists of a vertical table-top panel reproducing the lay-out of a typical oil rig. A picture of an oil rig will help to understand the lay-out of the oil well.
- The panel reproduces the single line diagram of "National 1320 UE" system that is a typical electrical installation of an oil rig.
- It simulates 4 three-phase brushless alternators with their own main circuit breakers. Each alternator includes a display with selector for showing the active and reactive power consumed; two LEDs show the overload conditions of Diesel engine (active power) and of alternator (reactive power); another LED indicates the starting phase and the consensus for the parallel.
- Instrument with display for showing the % value of consumed power versus the instantaneous installed or available power, informing the driller of the need of connecting another generatr or of excluding it for energy saving.
- Two potentiometers allow to adjust the absorbed active and reactive power separately to simulate the load of the two three-phase transformers for the Motor Control Center and for the auxiliary services.

- DC motor - drive section simulates the large power consuming devices, such as mud pumps, winch, rotary table, eddy current brake. Two potentiometers and a display with selector enable to adjust the active and reactive power absorbed by each large power consuming device (load variation), separately.
- The "distribution control" section includes 4 selectors used to modify the association between drive and DC motor; some LEDs indicate their state
- This simulator is supplied with a software for the graphic analysis of the subjects described above; this software synthesizes and displays the values of electrical parameters on a PC (not included), besides allowing to simulate and show the electrical overloads of a complete oil rig.

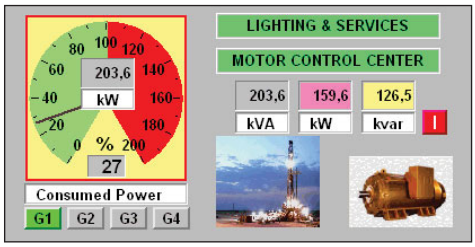


Graphic software

Power supply: 230 Vca 50 Hz single-phase - 100 VA
(Other voltage and frequency on demand)
Dimensions: 850 x 450 x 680 mm
Net weight: 25 kg



Display of measures for each motor-generator set



Instrument displaying the % value of consumed power

REQUIRED (NOT INCLUDED)

- **PERSONAL COMPUTER**

SUPPLIED WITH

OPERATIONAL HANDBOOK

ACCESSORIES:

- Single-phase power cord (1.5 m) with French-German plug
- USB connection cable

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SIMULATOR FOR THE STUDY OF ELECTRICALLY DRIVEN SHIPS

Mod. NEP-1/EV

ELECTRIC MARINE PROPULSION

At present most modern civilian vessels and warships are electrically driven for the several advantages offered by electric propulsion with respect to other systems.

The early electric propulsion systems used DC motors to drive the propellers, and DC generators to power the motors. A typical diagram was Ward Leonard connection (also used in railroads and in oil rigs).

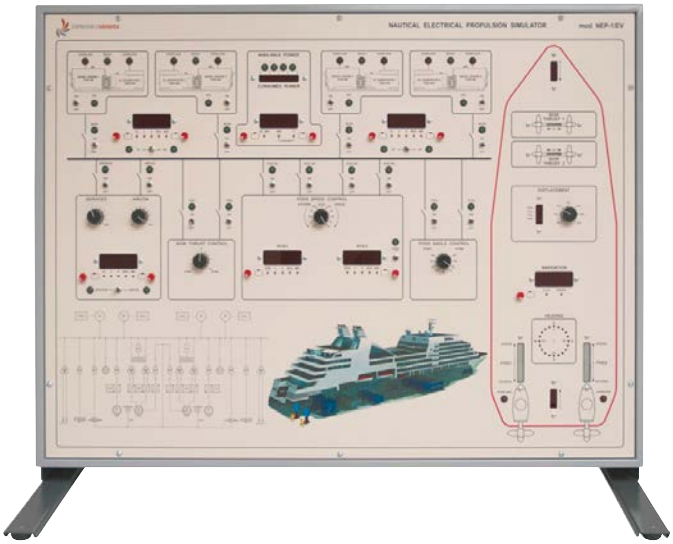
Then, when thyristor (SCR) AC-DC converters replaced DC generators, all the power consuming devices could be connected with a unique power supply unit, just like in a power station. In fact, the output power is three-phase alternating power part of which is shunted to the converters that drive the DC propulsion motors; the remaining power is used for the other services of the ship.

The servicing costs of DC motors are high. Therefore they have been replaced by (synchronous and asynchronous) three-phase AC motors powered by electronic drives, commonly known as inverters.

At present this last propulsion method is used in a lot of ships: big cruise ships, oceanographic research vessels, ice breaker ships, factory ships, oil rig platforms and vessels, vessels for laying gas / oil pipelines and cables; several types of warships, etc…

Electric propulsion offers a lot of advantages; in detail:

- it does not need the long, heavy and bulky shafts, supports, bearings, gearboxes, etc… which connect the prime mover with the propellers. In fact, the prime movers must be installed where required by the architecture of the ship, whereas propulsion motors are much smaller and lighter so that they can be installed near the propellers. Only flexible cables connect motors with the converters and inverters powering them.
- Electric propulsion enables to eliminate the rigid longitudinal shafts housed inside the hull of the ship. In fact, electric motors can be housed in pods outside the hull, with the possibility of rotation. Other motors are used for side propulsion and operation of the ship.
- What explained in the previous section leads to realize that the operation and dynamics of a modern ship are much more flexible (and complex) than those of mechanically driven vessels. This type of propulsion can be compared to that of VTOL aircrafts with respect to traditional take-off aircrafts.



- Modern electric propulsion enables a more accurate control of ship dynamics: in fact, even the propulsion mode (constant power or torque) can be chosen.
- Moreover noise level and vibrations will be reduced, especially at low speeds. This factor is very important in cruise ships for passengers' comfort.

AIM AND TRAINING PROGRAM:

This simulator is proposed as a **theoretical-practical introduction** to two basic topics of modern marine propulsion:

Study of electric marine propulsion systems:

- generation of electric power (prime movers, alternators),
- motors used in marine propulsion,
- electronic drives,
- accessory elements for the control of electric power,
- examples of circuit configurations according to the type of ship,
- examples of layout of the components inside the ship.

Study of ship dynamics:

- towrope resistance and its constituent factors;
- calculating the necessary power for propulsion;
- efficiency of energy chain;
- examples of movements of the ship according to the used drives.

TECHNICAL CHARACTERISTICS:

This simulator is a PC (not included)-aided vertical tabletop unit with a wide fore panel including silk-screen colour prints.
These silk-screen prints include: cross section of a ship showing the layout of propulsion elements, single-wire circuit of electric installation, the available controls and a view of the hull with the corresponding displays and controls for the movement of the ship.
The included software enables to display the parameters of the panel and the modification of the set values.

Power generation:

- 4 diesel generating sets of 7200 kVA. Each set includes 3 LEDs: a LED indicates READY and the two other LEDs signal the overload of diesel and of the alternator; they are provided with the corresponding switch for simulating the parallel of the alternator with bars;
- 2 displays indicate the parameters of alternators: Hz, V, A, kVA, kW; with 2 selectors: one for generators and the other for the parameters;
- instrument for determining the consumed power versus the available power; it includes a bargraph, 4 LEDs and a digital indicator.

Control of electrical consumptions:

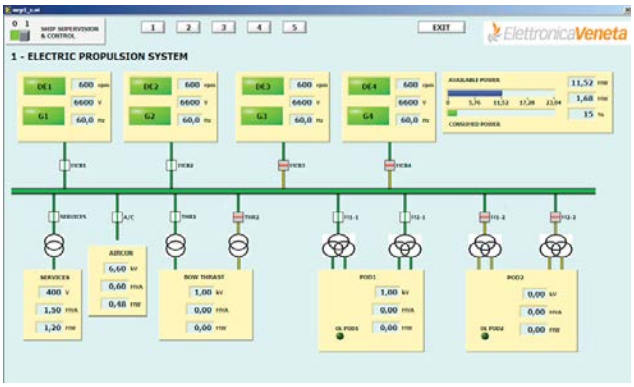
- Block of Services and Aircon: it includes 2 potentiometers of 0-100% to set the desired values of these loads and a digital indicator of the values of consumptions;
- Block BOW THRUST CONTROL: control of the two bow motors for side moves; it includes a bidirectional potentiometer for the drive in both directions of movement;
- Block PODS SPEED CONTROL: control of the propelllers of stern pods; step control of the speed in both rotation directions. Each POD can supply 50% or 100% of total rated power; this is the reason why 4 switches are included. Each POD is also provided with its own digital indicator;
- Block PODS ANGLE CONTROL: control of the angle of the pods of stern propellers. Both pods turn in parallel (same angle).

Indicators and blocks of ship movement:

These indicators are shown in the silk-screen print of ship outline.

- Indicator of towrope resistance: this is a red bargraph available at the bow of ship outline. It indicates the force opposing the movement of the hull; related with control DISPLACEMENT.
- Blocks BOW THRUST 1 and BOW THRUST 2: two green bargraphs placed perpendicularly to the longitudinal axis of the hull. The control of these motors is available in block BOW THRUST CONTROL.
- Block DISPLACEMENT: it includes a red bargraph and a potentiometer of 60-120%; it simulates the load of the ship (100% indicates the rated load) that defines the immersed part of the hull (called QUICKWORK). The Quickwork is the main component of towrope resistance.
- Block NAVIGATION: digital indicator of ship speed in KNOTS and in DEGREES (angle of longitudinal axis with respect to NORTH).
- Block HEADING: 20-LED digital indicator for the direction of movement of the ship. This is the graphical version of unit DEGREES of Block NAVIGATION.
- Blocks POD 1 and POD 2: two green bargraphs available at stern; they indicate the power output by each propulsion POD. Each POD is provided with a LED for overloads.
- Indicator of BACKWARD towrope resistance: red bargraph indicating the force opposing the movement of the hull; related with control DISPLACEMENT.

Power supply: 230 Vca 50 Hz single-phase - 400 VA
(Other voltage and frequency on demand)
Dimensions: 800 x 600 mm (panel)
840 x 450 x 680 mm (framework)
Weight: 35 kg



REQUIRED (NOT INCLUDED)

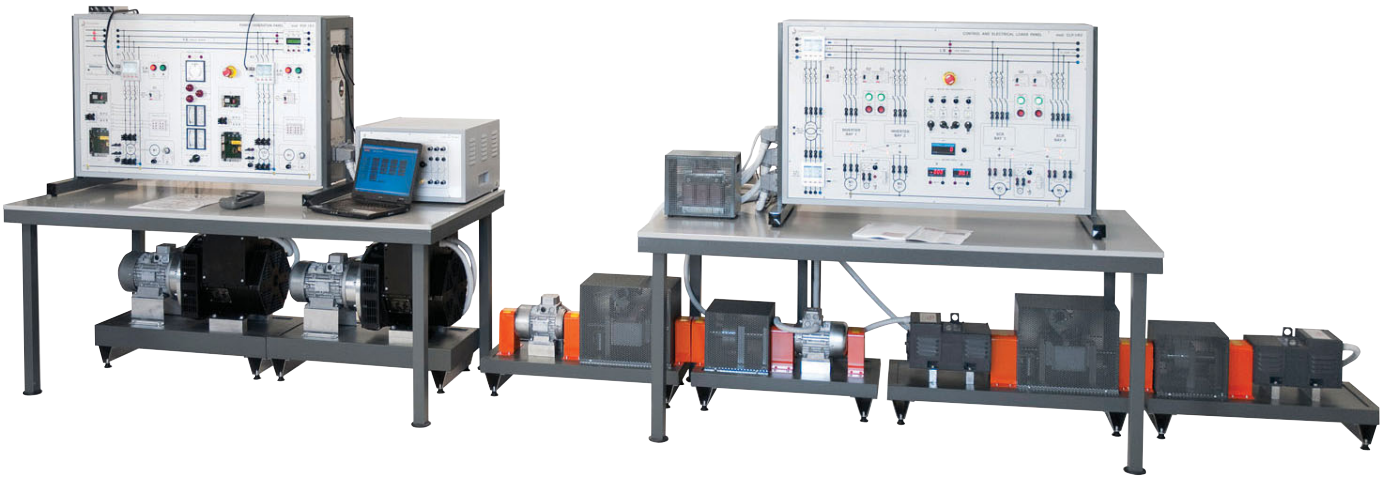
- **PERSONAL COMPUTER**

SUPPLIED WITH

THEORETICAL-EXPERIMENTAL HANDBOOK

INTEGRATED SYSTEM OF GENERATION-PROPULSION

Mod. ODR-2/EV



INTRODUCTION

Unit mod. ODR-2/EV is an **Integrated System of Electric Power**. This unit is a scale model, perfectly operating, of systems such as:

- **Locomotives**
- **Warships** and **merchant ships**
- On-shore and off-shore **oil rigs**

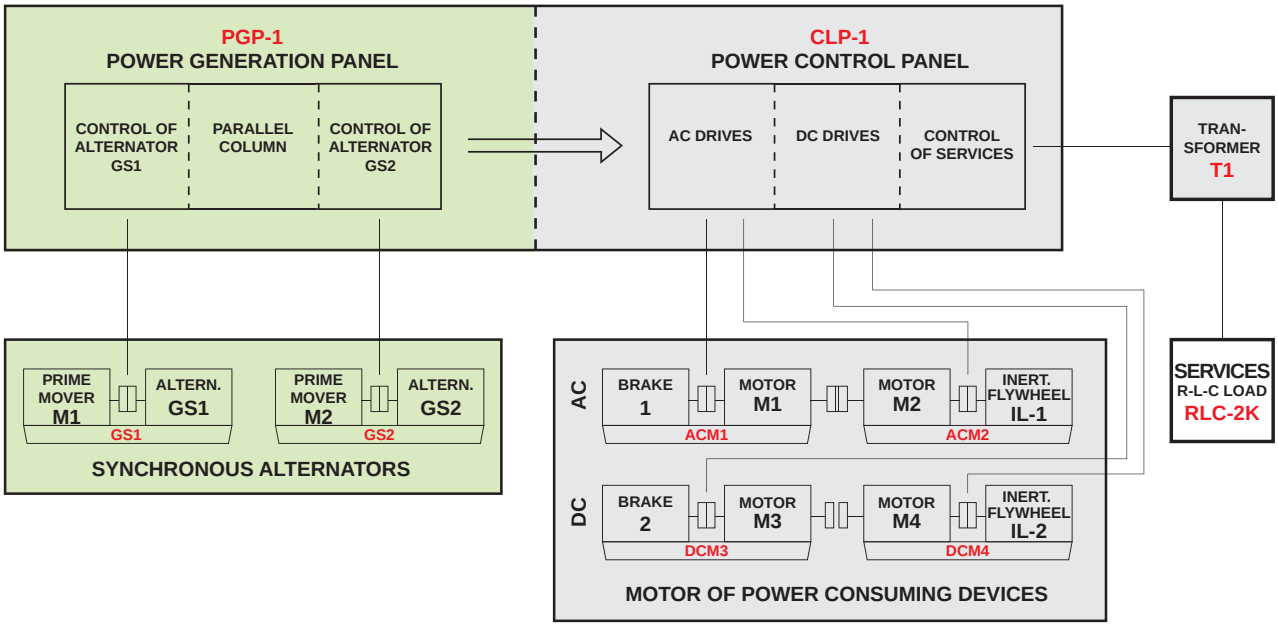
System mod. ODR-2/EV consists of two section well defined:

1- GENERATION:

- two Motor-Generator (MG) sets, with brushless alternators (as those usually included in the aforesaid systems) and electric motors as prime movers
- control of MG sets: it includes all the control and protection devices of both motor and alternator
- this system enables the manual and automatic parallel of two MG sets
- as the energy consumption varies versus the demand of system motors, the average consumed power must be approximately 80% of the installed power so that the performance of Diesel motors is optimized and they are also prevented from wearing out. Therefore the generators are connected/disconnected from the bars according to needs; operators are helped in this operation by a special instrument.

2- CONSUMPTION:

- Most electric power produced is consumed by Traction/ Propulsion motors; the remaining power is consumed by the auxiliary services
- Traditionally the big Traction/Propulsion motors were DC motors with electronic SCR drives, because the RPM of DC motors can be controlled more easily. But the maintenance of these motors is hard and they are inherently unsafe when they operate in dangerous environments (potentially explosive gases and/or powders, like in oil rigs)
- This is the reason why recently DC motors are replaced with three-phase squirrel-cage motors with electronic inverters controlled by microprocessors: these motors can be serviced easily and they can be used safely in hazardous environments, but their electronic control elements are complex and rather expensive
- If necessary, two or more three-phase transformers can be connected to adjust the output voltage (e.g.: 600 V) to the standardized voltage of auxiliary services (110 or 220 V for lighting; 400 or 480 V for powering motor control centres).



GENERAL DIAGRAM OF LABORATORY ODR-2/EV

CONFIGURATION OF SYSTEM Mod. ODR-2/EV:

The configuration indicated here below is carried out according to the concepts explained above and it includes:

SECTION GENERATION MOD. PGP-1/EV:

- 2 sets of motor - brushless alternator
- 1 control of the two MG sets

SECTION CONSUMPTION MOD. CLP-1/EV:

- 2 DC motors: one with flywheel and the other with variable brake. Motors with electronic SCR drive
- 2 AC three-phase squirrel-cage motors: one with flywheel and the other with variable brake. Motors with electronic drive controlled by microprocessor
- 1 control panel of the motors mentioned above and of the auxiliary services
- 1 three-phase transformer for powering the auxiliary services

Example of record of parameters during an exercise (starting, operation, overload, stop)

ACCESSORIES (NOT INCLUDED):

- 1 resistive-inductive-capacitive load mod. RLC-2K/EV, for simulating the auxiliary services
- 2 laboratory desks mod. TOP/EV
- 1 Personal Computer with 19" LCD screen
- 1 opto-isolated network analyzer mod. OMA-1/EV

The characteristics of the units mentioned above will be described in detail in the following pages.

IMPORTANT NOTE

Although units mod. PGP-1/EV and CLP-1/EV can operate separately, the typical phenomena of the Integrated Systems can be examined and checked only when these units operate jointly.

INTEGRATED SYSTEM OF GENERATION-PROPULSION
SECTION ELECTRIC GENERATION
Mod. PGP-1/EV

TRAINING PROGRAM:

- Example of an Integrated System of Generation-Propulsion: description of the electrical installation of an oil rig.
- Electrical installations in hazardous areas with risk of explosion
- Electric power generation:
  - motor-alternator sets used in the Integrated Systems of Generation-Propulsion
  - study of 3-phase brushless alternators
  - devices for controlling and regulating the output voltage
  - devices for controlling and regulating the reactive power and sharing of this power when the machines run in parallel
  - electronic relay for protection against overloads. Setting the relay parameters
  - electronic relay for protection against the max/min limits of the output voltage. Setting the relay parameters. Relation with alternator excitation
  - electronic relay for protection against the max/min limits of the frequency of output voltage. Setting the relay parameters. Relation with the RPM of the prime mover
  - electronic relay for protection against the wrong three-phase circuit sequence, missing phase and phase unbalance. Setting the relay parameters
  - action of the aforesaid safety devices on the main switch of M-G set
  - parallel procedure of alternators
  - instrument for measuring and optimizing the % value of the (active) power consumed versus the total available power on the bars. Utility and programming of this instrument
  - display of the output waveforms on the oscilloscope; effect of the different types of load
  - harmonic analysis of voltage and current versus the different types of load
  - study of 3-ph transformer in no-load and load conditions (transformer and load supplied separately)

TECHNICAL CHARACTERISTICS:

CONTROL PANEL OF THE GENERATION SECTION

- vertical panel wholly wired with components of industrial type
- fore side with devices and connections marked with their international symbols
- all connections are carried out exclusively via safety terminals, leads and jumpers with plugs of 4 mm
- multi-pole connectors for connecting prime movers and alternators are placed at the sides of the panel
- mushroom-head emergency pushbutton with mechanical holding.

The control panel includes:

- 2 microprocessor-controlled drives for the motors (prime movers), with possibility of selecting operational modes: V/f or vector, and of modifying ramp times, ON-OFF switch, potentiometer for speed control and stand-by switch.
- 2 Automatic Voltage Regulators (AVR) for the 3-ph alternator, with potentiometer for adjusting the output voltage
- 2 RPS (Reactive Power Sharing) for the 3-ph alternator operating in parallel
- 2 microprocessor-controlled multi-function instruments (one for each alternator), for measuring frequency, voltage (up to 850 V), current (up to 10 A), active, reactive and apparent power, phase and 3-ph. power factor, and for harmonic analysis of output energy. It is provided with communication RS485 port for data acquisition via PC (not included), and connections are carried out via safety terminals for plugs with diameter of 4 mm. They are provided with display to

show up to 4 electric parameters chosen by the user, simultaneously. Possibility of connection with other similar instruments in LAN

- 2 protection relays for control of min/max voltage, min/max frequency, correct phase presence, asymmetry and phase sequence, in the range 380-440 V 50-60 Hz. Regulation of voltage threshold Un between 80 and 115%, of frequency threshold f between ±1 and 10 % with delay time between 0.1 and 20 s, instantaneous intervention for wrong sequence or missing phase and with asymmetry over 30%. An exchange contact will signal abnormal condition, with automatic reset when normal conditions are restored

- 2 automatic switches with fixed magnetic threshold and adjustable thermal relay for protection of alternator against overload and short-circuit.
- 2 contactors for the parallel, with START/STOP pushbuttons and selector for starting the automatic parallel procedure.
- 1 double vertical voltmeter of 500 Vac + 1 double vertical frequency-meter of 45-65 Hz - 500 Vac for the parallel
- 1 electronic microprocessor-controlled synchronoscope, with relay of consensus for the automatic parallel. This instrument has some LEDs (18 LEDs, 2 colors) to indicate lead-lag and coincidence of the two 3-ph voltage circuits. Adjustment between 1 and 10 % of difference of two voltages, or between 2 and 20 degrees of difference of the two 3-ph voltage circuits; the delay time for closing the relay is selectable between 1 and 10 s
- 3 filament lamps of 400 V - 5 W for signaling the sequence of three-phase voltage circuits and helping the parallel
- 1 selector for connecting the instruments for parallel between bus-bars and alternators
- 1 digital instrument for showing the % value of the instantaneous absorbed power versus the power available on bus bars. This instrument includes 2 LEDs to indicate which and how many generators are connected with the bus bars (available power), another LED that blinks when load exceeds 80% of the available power, pushbuttons to display and program the values of the involved powers. A 3-ph active power converter for unbalanced loads will detect the instantaneous consumed power and sends its data to the instrument for % comparison.
- 1 general 4-pole magneto-thermal automatic switch with min.-voltage releasing coil, voltage pilot lamp
- 1 mushroom-head emergency pushbutton with mechanical holding.
- 2 universal single-ph 2-pin sockets Unel 230 V - 10, 16 A, for powering various apparatuses.

Power supply for the complete system mod. PGP-1/EV:
3 x 400 V - 50 Hz - 10 kVA
(other voltage and frequency on demand)
Dimensions of the panel: 1340 x 660 x 830 mm
Net weight: 73 kg

MOTOR - ALTERNATOR SETS:

- Prime mover: three-phase squirrel-cage asynchronous motor; power: 3 kW at 3000 r.p.m. - 2 poles, with microprocessor electronic drive
- Brushless 3-ph alternator of 400V; power: 2 kVA at 3000 RPM - 2 poles
- The machines are fixed onto a strong steel base with rubber feet and they are connected with the control panel via cables and multi-pole connectors, to simplify their installation.
- All the moving mechanical parts and couplings are protected with orange painted safety covers as it is stated by international standards.

Dimensions of each M-G set: 900 x 400 x 700 mm
Net weight: 177 kg

IMPORTANT NOTE

Although unit mod. PGP-1/EV can operate separately, the typical phenomena of the Integrated Systems can be examined and checked only when this unit operates jointly with unit mod. CLP-1/EV.

REQUIRED (NOT INCLUDED)

SINGLE-PHASE/THREE-PHASE R-L-C LOAD
Mod. RLC-2K/EV

SUPPLIED WITH

OPERATIONAL HANDBOOK
WITH EXERCISES

ACCESSORIES:

- Set of 4 cables and 22 jumpers, all with 4 mm safety plugs.
- RS485 - USB Converter and software for data acquisition from multifunction instruments
- Three-phase power cord of 5 m, with socket and plug IEC309, 5 poles, 400 V - 16 A

INTEGRATED SYSTEM OF GENERATION - PROPULSION
SECTION PROPULSION / CONSUMPTION
Mod. CLP-1/EV

TRAINING PROGRAM:

- Example of an Integrated System of Generation-Propulsion: description of the electrical installation of an oil rig.
- Electrical installations in hazardous areas with risk of explosion
- DC motor drives:
  - Study of DC motors. Example of big DC motors used in oil rigs
  - SCR control unit, components and devices of power control
  - Assignment logic of SCR control unit - motor
  - No-load test of DC motor
  - Test on DC motor loaded with inertial load, at different RPM
  - Test on DC motor loaded with variable load (eddy current brake), at different RPM
- AC motor drives:
  - Study of 3-ph asynchronous motors. Example of big AC motors used in oil rigs
  - PWM control units: devices and components of power control
  - Performance of 3-ph asynchronous motors when used with inverters
  - Inverter-motor assignment logic
  - Motor braking and energy saving circuits
  - No-load test of 3-ph asynchronous motor
  - Test on 3-ph asynchronous motor loaded with inertial load, at different RPM
  - Test on 3-ph asynchronous motor loaded with variable load (eddy current brake), at different RPM
- Test with combined drives of DC and AC motors:
  - with different loads and at different RPM
  - display (on the oscilloscope) of the deformation of the output voltage versus the load (system operating together with panel mod. PGP-1/EV).
  - diagrams of electric parameters versus the load (services, motors, combined operation with panel PGP-1/EV).
- Other power circuits:
  - Study of eddy-current brake

TECHNICAL CHARACTERISTICS

PROPULSION CONTROL PANEL:

- Vertical panel wholly wired with components of industrial type.
- Fore side with devices and connections marked with their international symbols.
- All connections are carried out via safety terminals, leads and jumpers with plugs of 4 mm.
- Multi-pole connectors for connecting motor-brake-flywheel sets are placed at the sides of the panel.

The control panel includes:

- 2 three-phase 4-quadrant electronic drives for DC motors, with power up to 1.5 kW, including automatic switch with fixed magnetic threshold and adjustable thermal relay for protection against overload and short circuit, contactor with start/stop pushbuttons.
- 2 three-phase microprocessor-controlled drives for 3-ph AC motors, with power up to 1.5 kW, including automatic switch with fixed magnetic threshold and adjustable thermal relay for protection against overload and short circuit, contactor with start/stop pushbuttons.
- 2 eddy-current brake drives, with excitation of 0-170 Vdc, controlled by potentiometer.
- 2 microprocessor-controlled multi-function instruments (one at panel input and the other for the measurement of auxiliary services) for measuring frequency, voltage (up to 850 V), current (up to 10 A), active, reactive and apparent power, phase and 3-ph. power factor, and for harmonic analysis of output energy. They are provided with RS485 communication port for data acquisition via PC (not included), and connections are carried out via safety terminals with diameter of 4 mm. They are provided with display to show up to 4 electric parameters chosen by the user, simultaneously. Possibility of connection with other similar instruments in LAN
- 1 digital voltmeter of 500 Vdc, 3 digits, accuracy rating of ±1%; free connection with the circuit via safety terminals for 4 mm plugs.
- 1 digital ammeter of 10 Adc, 3 digits, accuracy rating of ±1%; free connection with the circuit via safety terminals for 4 mm plugs.
- 1 digital tachogenerator of 4000 rpm. 4 digits, accuracy rating of ±1%, selector switch and connectors for 4 rpm-measuring sensors keyed in motor-brake-flywheel units.
- 1 console of system operator, including LEDs for signaling "drives ready", selectors and LEDs for indicating drive–motor assignments, potentiometers for separate motor RPM. control, and FOR/REV switches for each motor
- 1 PLC and contactors for a safe management of drive–motor assignment logics

Power supply for the complete system mod. CLP-1/EV:
230 Vca 50 Hz single-phase - 0,5 kVA
3 x 400 V - 50 Hz - 8 kVA
(other voltage and frequency on demand)

Dimensions and net weight of the panel:
1300 x 660 x 830 mm - 110 kg

DC MOTOR - FLYWHEEL (INERTIAL LOAD) UNIT

- DC motor, with power of 1.1 kW, armature voltage of 400 Vdc, separate excitation of 220 Vdc, 3000 RPM, embedded thermal protection against over-temperatures
- Inertia flywheel consisting of 3 heavy metal disks; 1, 2, 3 disks can be mounted to arrange different moments of inertia
- Reflection sensor for measuring motor RPM.
- Motor and flywheel are coupled to each other via a coupling and are fixed onto a strong steel base with rubber feet.
- Motor is connected with the control panel via leads and a multi-pole connector to simplify the installation.
- All the moving mechanical parts and the coupling are protected with orange painted safety covers as required by international standards.

Dimensions and net weight of DC motor-Flywheel unit:
910 x 400 x 450 mm - 104 kg

DC MOTOR - EDDY CURRENT BRAKE UNIT:

- DC motor, with power of 1.1 kW, armature voltage of 400 Vdc, separate excitation of 220 Vdc, 3000 RPM, embedded thermal protection against over-temperatures
- Bidirectional eddy current brake, with rated power of 1.1 kW, excitation of 0-220 Vdc.
- Reflection sensor for measuring motor RPM.
- Motor and brake are coupled to each other via a coupling and are fixed onto a strong steel base with rubber feet.
- Motor and brake are connected with the control panel via leads and a multi-pole connector to simplify the installation.
- All the moving mechanical parts and the coupling are protected with orange painted safety covers as required by international standards.

Dimensions and net weight of DC motor-Brake unit:
1030 x 400 x 580 mm - 103 kg

THREE-PHASE MOTOR - FLYWHEEL (INERTIAL LOAD) UNIT

- Three-phase asynchronous motor, with power of 1.1 kW, voltage of 400 Vac, 2850 RPM - 2 poles, embedded thermal protection against over-temperatures
- Inertia flywheel consisting of 3 metal disks; 1, 2, 3 disks can be mounted to arrange different moments of inertia.
- Reflection sensor for measuring motor RPM.
- Motor and flywheel are coupled to each other via a coupling and are fixed onto a strong steel base with rubber feet.
- Motor is connected with the control panel via leads and a multi-pole connector to simplify the installation.
- All the moving mechanical parts and the coupling are protected with orange painted safety covers as required by international standards.

Dimensions and net weight of AC motor-Flywheel unit:
830 x 400 x 450 mm - 74 kg

THREE-PHASE MOTOR - EDDY CURRENT BRAKE UNIT:

- Three-phase asynchronous motor, with power of 1.1 kW, voltage of 400 Vac, 2850 RPM - 2 poles, embedded thermal protection against over-temperatures
- Bidirectional eddy current brake, with rated power of 1.1 kW, excitation of 0-220 Vdc.
- Reflection sensor for measuring motor RPM.
- Motor and brake are coupled to each other via a coupling and are fixed onto a strong steel base with rubber feet.
- Motor and brake are connected with the control panel via leads and a multi-pole connector to simplify the installation.
- All the moving mechanical parts and the coupling are protected with orange painted safety covers as required by international standards.

Dimensions and net weight of AC motor-Brake unit:
930 x 400 x 580 mm - 74 kg

THREE-PHASE TRANSFORMER:

- Three-phase transformer separator, with power of 1500 VA
- star-connected primary winding of 400 V
- star/delta-connected secondary winding of 230/400 V
- it is equipped with automatic switch with fixed magnetic threshold and adjustable thermal relay for protection against overload and short circuit.

Dimensions and net weight: 320 x 320 x 300 mm - 17 kg

IMPORTANT NOTE

Although unit mod. CLP-1/EV can operate separately, the typical phenomena of the Integrated Systems can be examined and checked only when this unit operates jointly with unit mod PGP-1/EV.

REQUIRED (NOT INCLUDED)

SINGLE-PHASE/THREE-PHASE R-L-C LOAD
Mod. RLC-2K/EV

SUPPLIED WITH

THEORETICAL-EXPERIMENTAL HANDBOOK
OPERATIONAL HANDBOOK
WITH EXERCISES

ACCESSORIES:

- Set of 40 cables and 40 jumpers, all with 4 mm safety plugs.
- Three-phase power cord of 1.5 m, with French-German socket of 230 V - 16 A

ACCESSORIES
INTEGRATED SYSTEM OF GENERATION - PROPULSION

SINGLE-PHASE - THREE-PHASE R-L-C LOAD Mod. RLC-2K/EV

GENERAL CHARACTERISTICS:
- Table-top metal container, with side handles.
- Fore panel of silk-screen-printed aluminium in lectern configuration.
- Terminals for safety plugs with 4 mm diameter
- 5 steps of single-phase/three-phase active power
- 5 steps of single-phase/three-phase inductive reactive power
- 5 steps of single-phase/three-phase capacitive power
- This load is also provided with technical manual and set of 14 cables with safety plugs.
- Dimensions and net weight: 530 x 520 x 330 mm - 38 kg

ELECTRICAL CHARACTERISTICS:
- It is suitable for single-phase supply voltage of 230 V and for three-phase supply voltage of 400 V, in star connection, and for three-phase voltage of 230 V, in delta connection.
- **Resistance section:** single-phase/three-phase active power of 1500 W, that can be shared by five steps consists of 3 resistances of 530 Ω - 220 Vdc/230 Vac.
- **Inductive section:** single-phase/three-phase inductive reactive power of 1500 VAr, that can be shared by five steps consists of 3 impedances with current of 0.43 A - 230 Vac - 50 Hz.
- **Capacitive section:** single-phase/three-phase capacitive reactive power of 1500 VAr that can be shared by five steps consists of 3 condensers with C of 6 µF - 0,43 A - 230 Vca - 50 Hz. Each sector has six terminals with 4 mm safety plugs allow the single-phase connection (parallel connection of the 3 phases), and the three-phase star/delta connection.
- 3 three-phase rotary switches for separate variation of R, L and C modules. Max. apparent power 2100 VA.

WORKING TABLE MOD. TOP/EV

- Supporting frame and legs of tubular steel
- Feet of adjustable height
- Work-top of laminated wood with blunted edges
- All metal parts are stove enamelled with rustproof treatment.

Dimensions and net weight: 2000 x 1000 x 860 mm - 80 kg

SINGLE-PHASE - THREE-PHASE R-L LOAD Mod. RL-2K/EV

GENERAL CHARACTERISTICS:
- Table-top metal container, with side handles.
- Fore panel of silk-screen-printed aluminium in lectern configuration.
- Terminals for safety plugs with 4 mm diameter
- 5 steps of single-phase/three-phase active power
- 5 steps of single-phase/three-phase inductive reactive power
- This load is also provided with technical manual and set of 14 cables with safety plugs.
- Dimensions and net weight: 530 x 520 x 330 mm - 35 kg

ELECTRICAL CHARACTERISTICS:
- It is suitable for single-phase supply voltage of 230 V and for three-phase supply voltage of 400 V, in star connection, and for three-phase voltage of 230 V, in delta connection.
- **Resistance section:** single-phase/three-phase active power of 1500 W, that can be shared by five steps consists of 3 resistances of 530 Ω - 220 Vdc/230 Vac.
- **Inductive section:** single-phase/three-phase inductive reactive power of 1500 VAr, that can be shared by five steps consists of 3 impedances with current of 0.43 A - 230 Vac - 50 Hz. Each sector has six terminals with 4 mm safety plugs allow the single-phase connection (parallel connection of the 3 phases), and the three-phase star/delta connection.
- 2 three-phase rotary switches for separate variation of R and L modules. Max. apparent power: 2100 VA.

OPTO-ISOLATED NETWORK ANALYZER MOD. OMA-1/EV

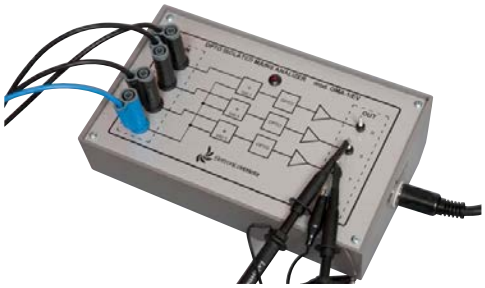


Table-top unit specifically designed to display the waveforms output by the alternators, on the oscilloscope (not included). This unit can also be used, with proper precautions, to observe the outputs of an inverter and of a DC drives towards the corresponding motors. The most important characteristic consists of its inputs (up to 500 Vrms of phase-to-phase voltage) that are opto-isolated from the output terminals, thus allowing to connect the oscilloscope probes with these last terminals in full safety.
- Input: 4 safety terminals of 4 mm; max. phase-to-phase voltage: 500 Vrms; the 3 phase terminals are black, the neutral terminal is blue.
- Output: 4 terminals of 2 mm (3 phases + N) - Each output is opto-isolated Vout = (1/100) Vin
- Power supply: separated from the source under test; power supply unit mod. PS3-C/EV: 110 to 240 Vac - 50/60 Hz
- This analyzer is provided with 4 cables with safety plugs.

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44-A

ELECTRIC POWER

ADVANCED GENERATION AND DOUBLE BUS BAR

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ADVANCED GENERATION AND DOUBLE BUS BAR

INTRODUCTION

Transmission and distribution of electric power is usually carried out over high-voltage (HV) and medium-voltage (MV) lines.

Several characteristics are involved in certifying an electric system as reliable and efficient (from both technical economical points of view); among these characteristics, we can mention **service continuity**, meaning the **number of blackouts per year, and their duration**. Both parameters are closely related to the concept of service reliability.

To improve **service continuity**, power consumers are usually powered by two or more lines (at times connected to different power sources) for a greater reliability of the electric service even in case of faults.

In this particular context, the **Double Bus Bar** offers the possibility of powering a user (or a certain geographical area) with several lines. This type of system must feature:

- A second line (or more lines) to power the user
- Control devices for the electricity flows (e.g.: power switches)
- Protection devices for the lines (relays)
- A system management "logic" that considers transients due to faults, as well a as safety and energy saving.

As implied in this description, **the target consists in optimizing the management of the system during anomalous (lines failures) or random events.**

ELETTRONICA VENETA HAS DESIGNED AND PRODUCED A UNIT FOR THE INTEGRAL STUDY OF THESE SYSTEMS: THE DBB-2E/EV PANEL.

This Panel includes:

- Two HV lines (featuring concentrated parameters); with two lines: a MAIN line and an AUXILIARY line
- Relays to protect the lines and detect their conditions.
- A PLC to manage the logic of the switches of these lines, and to control the Generation Panel PGP-1/EV

The MAIN LINE is usually powered by the mains, whereas the AUXILIARY LINE is powered by the MAINS (simulating a second Mains), or by one / two M-G set.

Under normal operation, the user is powered by the MAIN LINE, connected to the MAINS, and protected by the safety relays included in the system.

When a fault occurs in the MAIN LINE, the AUXILIARY LINE automatically guarantees the service continuity.

The switching between the MAIN and AUX lines is automatic and completely safe for the mains, for the user and for the M-G set, in case it is used.

Once the power is back on the main line, the M-G set is disconnected and the user is powered again from the mains.

The sequence of the AUXILIARY line begins with the automatic starting of an M-G set and its connection with the AUXILIARY LINE.

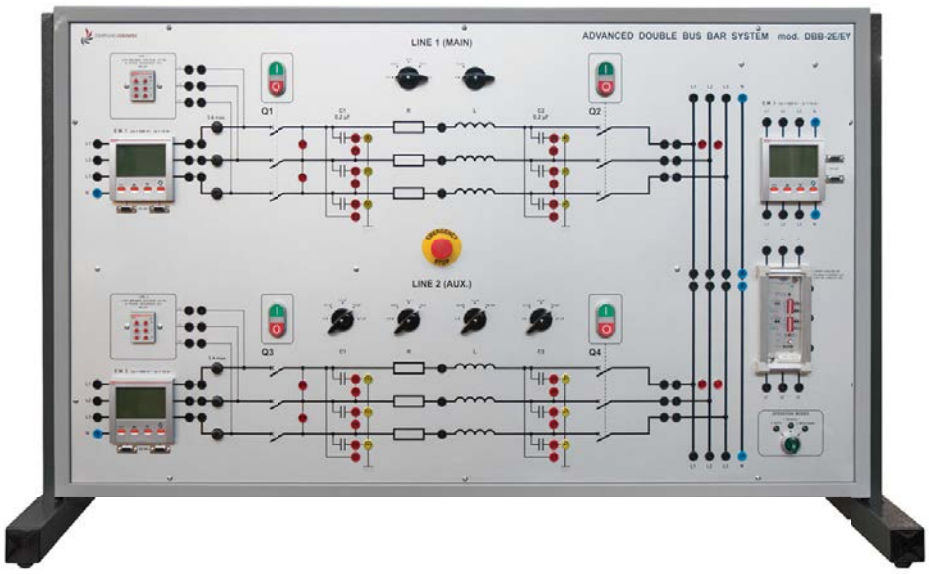
The AUX LINE can be supplied by:

- The mains
- One M-G set, manually started/stopped
- One/Two M-Gs, automatically started / stopped. The parallel of the second M-G is also automatic, and depends on the power requirements. *This operation is only possible when the DBB-2E/EV panel works together with the generation panel PGP-1/EV.*

IMPORTANT NOTE:
The system can be enhanced with the Power Factor Correction panel **C-PF/EV**.

DOUBLE BUS BAR SYSTEM

Mod. DBB-2E/EV



INTRODUCTION

Transmission and distribution of electric power is usually carried out over high-voltage (HV) and medium-voltage (MV) lines. Several characteristics are involved in certifying an electric system as reliable and efficient (from both technical economical points of view); among these characteristics, we can mention service continuity, meaning the number of blackouts per year, and their duration. Both parameters are closely related to the concept of service reliability.

To improve service continuity, power consumers are usually powered by two or more lines (at times connected to different power sources) for a greater reliability of the electric service even in case of faults.

The subject has been examined by Elettronica Veneta, and its traditional policy of design and development of educational units has led to this Panel that can satisfy the requirements of the most advanced courses of Electrical Engineering.

Switching among power lines is a complex process that must be carried out very precisely to avoid serious problems for the electrical grid.

In the past, these procedures were carried out manually by highly skilled qualified personnel. Nowadays, as networks are very complex, these processes are carried out by automatic systems.

The Panel includes:

- Two HV lines (featuring concentrated parameters): a MAIN line and an AUXILIARY line
- Relays to protect the lines and detect their conditions
- A PLC to manage the logic of the switches of these lines, and to control the Generation Panel PGP-1/EV.

PANEL OPERATING MODES:

The operating modes is a key concept. In fact, the user is able to work:

1) MANUAL MODE:

Both lines are totally under the user's control. Protection Relays and PLC are not operative. The switching between MAIN LINE and AUX LINE is performed by the user with the on-board pushbuttons. This Mode is used for the study of the Transmission Lines.

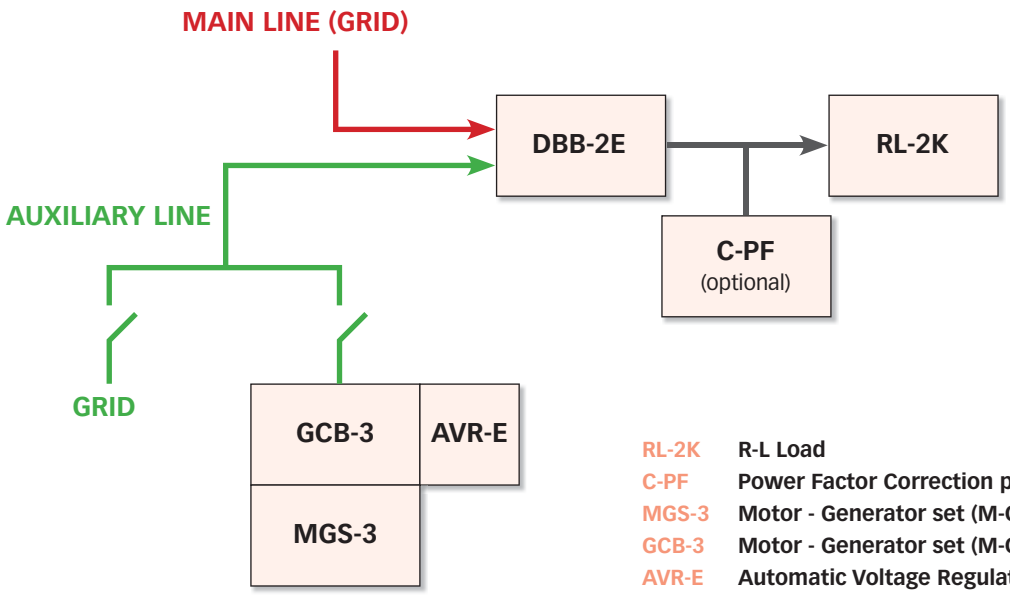
2) AUTO MODE:

In this mode switching between MAIN LINE and AUX LINE is performed automatically, under control of the protection relays and the PLC. Protection Relays are fully operative. The AUX LINE can be supplied from the Mains, or by one M-G set. THE OPERATION OF THE M-G SET IS MANUAL. A brief description of the operations is as follows:

- The MAIN LINE is powered by the mains, whereas the auxiliary line can be connected to the mains or to a M-G set.
- Under normal service conditions, the R-L load is powered by the mains, protected by the safety relays included in the panel.
- In case of fault (missing voltage) in the MAIN LINE, the AUX LINE will automatically guarantee the service continuity. Switching between the two lines is automatic and completely safe for the M-G set and for the load.
- When the MAIN LINE is powered again from the mains, the AUX LINE is disconnected and the load is powered again by the mains.
- In case a M-G set is used to feed the AUX LINE, the alternator should be equipped with an Automatic Voltage Regulator (AVR) to guarantee the voltage quality of the auxiliary line under any load condition.

Side view, PLC

THE R-L LOAD (mod. RL-2K/EV), THE POWER FACTOR CORRECTION PANEL (mod. C-PF/EV), THE M-G SET (mod. MGS-3/EV) AND ITS CORRESPONDING CONTROL PANEL (mod. GCB-3/EV + AVR-E/EV) ARE NOT INCLUDED IN THE SUPPLY OF mod. DBB-2E/EV AND ARE OFFERED SEPARATELY - A DETAILED DESCRIPTION OF THE CHARACTERISTICS OF THESE COMPONENTS IS AVAILABLE IN THE CORRESPONDING DATASHEETS.



RL-2K	R-L Load
C-PF	Power Factor Correction panel (optional)
MGS-3	Motor - Generator set (M-G)
GCB-3	Motor - Generator set (M-G) control panel
AVR-E	Automatic Voltage Regulator

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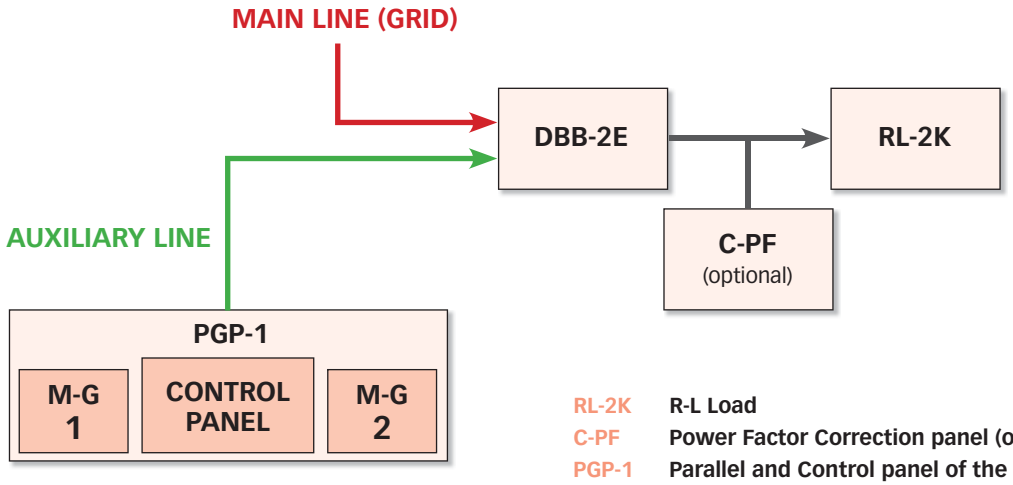
3) WITH GENS:

In this mode switching between MAIN LINE and AUX LINE is performed automatically, under control of the protection relays and the PLC. Protection Relays are fully operative. The AUX LINE is supplied from the Generation Panel PGP-1/EV panel **(this mode is ONLY operative for the system composed by DBB-2E/EV panel + PGP-1/EV panel)**.
When both panels work together, the DBB-2E/EV panel shows its full potential. A brief description of the operations is as follows:

- The MAIN LINE is powered by the mains, whereas the AUX LINE is connected to the Generation Panel PGP-1/EV.
- Under normal service conditions, the R-L load is powered by the mains, protected by the safety relays included in the panel.
- In case of fault (missing voltage) in the MAIN LINE, the AUX LINE will automatically guarantee the service continuity. Switching between the two lines is automatic and completely safe for the M-G set and for the load.
- The on-board PLC of the DBB-2E/EV orders the starting of the first M-G, and when all the safety conditions are satisfied, the alternator is automatically connected to the AUX LINE.
- In case a second M-G is required, the same PLC starts the second M-G, controls the safety conditions, and when the parallel requirements are satisfied, this second M-G supplies power to the load.
- When the MAIN LINE is powered again, the PLC will carry out the automatic disconnection of the AUX LINE; the disconnection and stop of both M-G sets. The system is again working under "normal conditions".

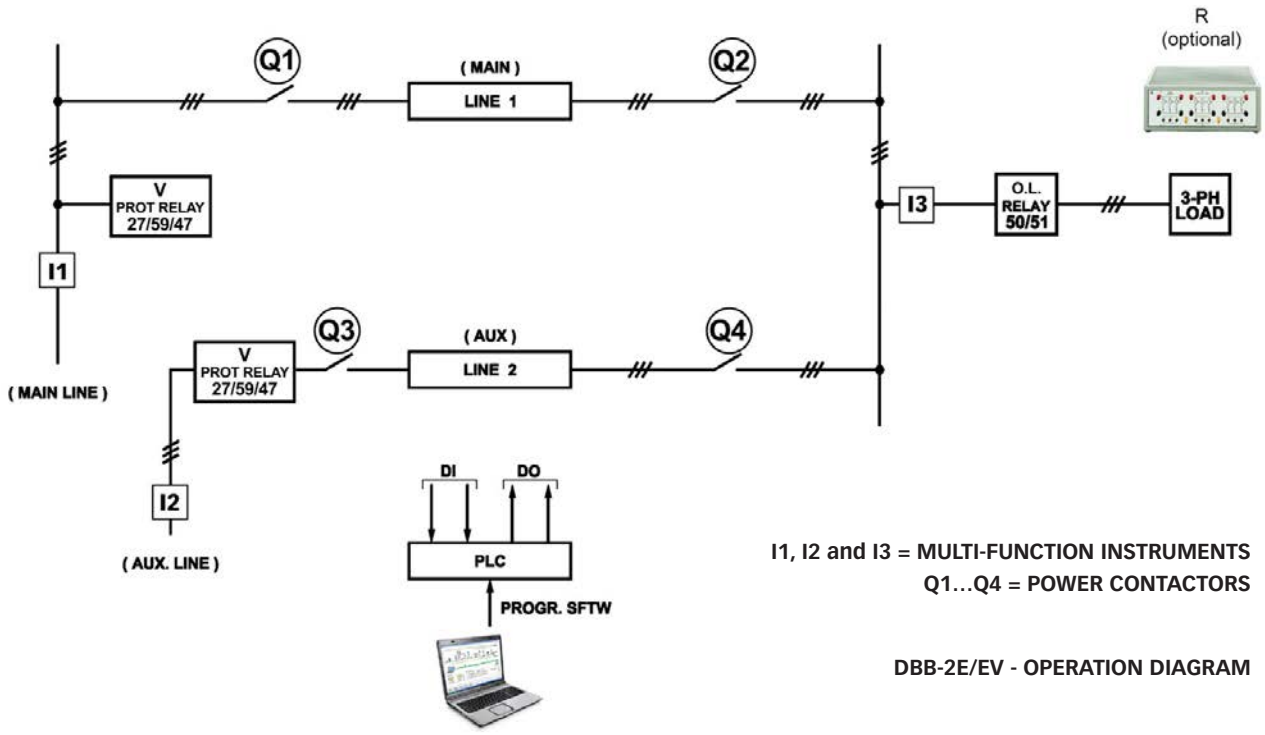
THE R-L LOAD (mod. RL-2K/EV), THE PANEL OF POWER FACTOR CORRECTION (mod. C-PF/EV) AND GEN PANEL mod. PGP-1/EV ARE NOT INCLUDED IN THE SUPPLY OF mod. DBB-2E/EV AND THEY ARE OFFERED SEPARATELY - A DETAILED DESCRIPTION OF THE CHARACTERISTICS OF THESE COMPONENTS IS AVAILABLE IN THE CORRESPONDING DATASHEETS.



RL-2K **R-L Load**
C-PF **Power Factor Correction panel (optional)**
PGP-1 **Parallel and Control panel of the 2 M-G sets**

TRAINING PROGRAM:

- **Electric generation:** three-phase alternators and prime movers, safety devices for alternators (specific protection relays), parallel of alternators: devices and conditions of parallel connection.
- **Double Bus Bar circuit:** MAIN line and AUXILIARY line.
- **Multifunction instruments:** functions, programming and use.
- **Power transmission lines:** study of HV transmission lines (featuring concentrated parameters), voltage drop versus section and length of conductors. Types of power lines: copper, aluminum. Power lines in series and in parallel.
- **PLC:** programming languages and structure, digital inputs and outputs and corresponding links with the field. Application of the software for developing programs via a PC. The DBB-2E/EV program as a case of study.
- **Protection relays:** study of 3 different protection relays (included in the panel): function of relays, main action, parameters to be set, connections with the system.
- **Automatic sequence to guarantee continuity of service:** starting, connection and parallel of auxiliary M-G sets.
- **Power Factor Correction** (Optional)



I1, I2 and I3 = MULTI-FUNCTION INSTRUMENTS
Q1...Q4 = POWER CONTACTORS

DBB-2E/EV - OPERATION DIAGRAM

TECHNICAL CHARACTERISTICS:

GENERAL CHARACTERISTICS

- Vertical tabletop metal panel, with solid framework of painted sheet steel, anti-tip legs with anti-slip rubber feet. Front panel silkscreen printed with the system layout marked with international symbols
- All terminals are 4 mm safety plugs.
- Indicator lamps for the operational states of the system.

The panel includes the following components:

THREE-PHASE HIGH-VOLTAGE LINES

Two three-phase lines of high voltage (exceeding 20 kV) for power transmission; these lines are simulated by model "ϖ" with concentrated parameters. Both lines can be used separately, connected in parallel, or in series. Power supply: 3 x 400 V (max.).

Line 1: the variable parameter is the section of cables and consequently the transmitted power capacity:

- Simulated distance: 50 km
- Transmitted power (MVA): 10-15-20, simulated by concentrated parameters
- Equivalent parameters: resistance: 18-25-35 Ω; inductance: 72 mH; distributed capacitance: 2 x 0.2 µF
- Circuit breakers at line beginning and end
- Protection by fuses

Line 2: the variable parameter is the distance (km):

- Length that can be selected among 25 -50 and 100 km
- Simulated voltage: 120 kV
- Transmitted power: 20 MVA
- Equivalent parameters: resistance: 9-25-35 Ω; inductance: 144 - 72 - 36 mH; distributed capacitance: 2 x 0.1 - 0.2 - 0.4 µF
- Circuit breakers at line beginning and end
- Protection by fuses.

SIGNALLING, PROTECTION AND CONTROL ELEMENTS

- 4 industrial contactors, with four NO power contacts. Auxiliary contacts: 1 NO + 1 NC. Coil: 24 Vdc.
- Four START/STOP buttons and indicator lamp
- EMERGENCY button
- 3-position selector for the operating modes
- 1 automatic thermo-magnetic 4-pole switch, 10 A, C curve, equipped with releasing remote coil (via emergency button)
- Voltage pilot lamps
- Power supply of power circuits: 3 x 400 V/N/PE - 10 A
- Power supply of control circuits: 24 Vdc - 2 A max.

PLC SYSTEM

- PLC by Siemens
- Power supply unit of 24 Vdc - 2 A, with electronic protection against overloads and short-circuits for the control of digital inputs and outputs
- 14 digital inputs: six of these inputs are used for the quick count
- 10 digital outputs of 24 Vdc with transistors
- RS-485 interface and adapter with USB cable for programming
- LED for the state of inputs and outputs

PROTECTION RELAYS

This system is provided with the three relays described here below:

- Overcurrent relay (protection functions 50/51): electronic three-phase maximum-current / short-circuit, adjustment range 1-5 / 5-25 A ac.
- N.2 MAX/MIN voltage relay (protection functions 27/59): electronic three-phase/N, voltage Ue selectable among 380-400-415 Vac; adjustment range +10% / -15% Ue.
- N. 2 PHASE SEQUENCE AND ASYMMETRY RELAY (protection functions 47/60): electronic device, 400 Vac, asymmetry selectable in the range: 5-15%.

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MULTI-FUNCTION AC INSTRUMENTS

N. 3 microprocessor-controlled multi-function instruments for power analysis. These three instruments have separate terminals for safety leads of 4 mm, for a totally free use.

- for measurements on balanced / unbalanced 3-ph systems, with or without Neutral, or of single-ph systems;
- these instruments enable to measure more than 300 parameters such as voltages and currents (in TRMS), active, reactive and apparent power, power factor, frequency, analysis up to the 31st harmonic of V and I, besides the total / partial active power, total / partial reactive power. Accuracy class of the instrument for V and I: 0.2%. Current up to 10 A (with internal CT 10/5) - max. phase-to-phase voltage of 830 V - 45…66 Hz.
- Auxiliary power supply: 110…240 Vac - 50-60 Hz
- Liquid-Crystal Display (LCD), 128 x 80 pixels with 4 grey levels
- With 4 pushbuttons to display and set measurement pages
- Four programmable pages among the most frequently used parameters (selectable among the measurement units).

Accessories supplied

- software for the configuration of the data detected by the instruments, setting the measures and the sampling time, graphic display of data versus time.

Overall dimensions of the panel: 1320 x 820 x 660 mm
Weight: 74 kg

Side view, Lines switches

REQUIRED

UTILITIES (PROVIDED BY THE CUSTOMER)

Power supply: 400 Vac 50 Hz three-phase - 6 kVA
(Other voltage and frequency on request)

SUPPLIED WITH

OPERATIONAL HANDBOOK WITH EXERCISES

ACCESSORIES:

- 40 jumpers of 4 mm
- 30 cables of different lengths and colours, with safety connectors of 4 mm;
- Three-phase power cord +N+PE.

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PRODUCTS INDEX
SORTED ALPHABETICALLY BY MODEL

ELECTRIC POWER
CATALOGUE No. 44-A

GD	GENERATION, DISTRIBUTION AND CONSUMPTION OF ELECTRIC POWER
PC	PROTECTION, CONTROL AND MANAGEMENT OF ELECTRIC POWER
SP	SEMICONDUCTOR AND POWER ELECTRONICS
ED	ELECTRONIC DRIVES FOR AC/DC MOTORS
AA	ADVANCED APPLICATIONS OF ELECTRIC POWER

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