



Configuration example of AEL-TI with AEL-TI-03 application included

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## INTRODUCTION

Petersen coils are used in three-phase system for limiting arc currents during earth-fault. When a phase-earth fault occurs on these systems, the phase voltage, in the damaged phase, is reduced to the earth potential while the capacitance of the defective line is discharged into the point of failure. The voltage of phase-earth of other two phases increases  $\sqrt{3}$ , as a result the fault current "IC" is three time the charge current of each phase to earth.

A modern Petersen coil consists of an inductance with iron core connected between the neutral of star of the transformer substation and earth in a three phase system. In case of failure, the fault current to ground capacitive (IC) now is neutralized by the current in the inductance, since it is equal in magnitude but lagged 180 degrees.



ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)



European Union Certificate (total safety)



Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)



"Worlddidac Quality Charter" and Platinum Member of Worlddidac

## GENERAL DESCRIPTION

The Arc Suppression Coil Application, "AEL-TI- 03", has been designed by Edibon to show the students how it is possible to neutralize an earth fault current with a Petersen Coil.

For this purpose, this application includes a Petersen Coil module with variable reactance so that it has resonance with the capacity of the line, previously chosen by the user.

In addition, this application has been designed to be combined with the rest of AEL-TI- and AEL-SST- applications in order to form a system in which the user can study concepts about generation, transmission, distribution and power consumption.

This application can work remotely through SCADA software AEL-TI-07/CCSOF included in the application of Transmission Application with Synchronous Generator, "AEL-TI-07".

The AEL-TI-03 application includes the following element:

- N-ASC. Arc Extinction Coil Module.

Required elements:

- N-RELT. Relay Test Module.
- AEL-TI-01. Analysis of Three-phase Power Lines Application.  
<http://www.edibon.com/en/files/equipment/AEL-TI-01/catalog>
- AEL-TI-07. Power Transmission Application with Synchronous Generator.  
<http://www.edibon.com/en/files/equipment/AEL-TI-07/catalog>

Recommended elements:

- AEL-TI-02. Distribution Transformer with Motor Regulation Application.  
<http://www.edibon.com/en/files/equipment/AEL-TI-02/catalog>
- AEL-TI-04. Underground Transmission Lines Application.  
<http://www.edibon.com/en/files/equipment/AEL-TI-04/catalog>
- AEL-TI-05. Parallel and Series Transmission Lines Application.  
<http://www.edibon.com/en/files/equipment/AEL-TI-05/catalog>
- AEL-TI-06. Analysis of Power Flows in Transmission Lines Application.  
<http://www.edibon.com/en/files/equipment/AEL-TI-06/catalog>
- AEL-SST-01. Switching in Transmission and Distribution Substations Application.  
<http://www.edibon.com/en/files/equipment/AEL-SST-01/catalog>
- AEL-SST-02. Switching Substation Protection Application.  
<http://www.edibon.com/en/files/equipment/AEL-SST-02/catalog>

The application AEL-TI-03 can be mounted on rack (option A) or on rail (option B):

Option A:

This application needs the following racks.

- N-RACK-B.

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

Option B:

This application can be mounted on rail.

Optionally the AEL-WBC. Electrical Workbench (Rail) can be supplied to mount the modules.

## SPECIFICATIONS

The AEL-TI-03 application includes the following element:

- **N-ASC. Arc Suppression Coil module.**

Nominal voltage: 230V.

Max. current: 1 A.

Coil: 0.5 to 1.5 H, 9 variable stages.



N-ASC

Required elements:

- **N-RELT. Relay test module.**

Power supply: 110-230V AC.

Frequency: 50/60Hz.

Start/stop pushbutton.

Display.

Operation pushbuttons:

Switch-on (it can be remote controlled).

Switch-off (it can be remote controlled).

Timer ON (relay test).

Contacts:

Voltage: 0...400 VAC/VDC.

Current: 0...20 A AC/DC.

3 operating contacts.

2 auxiliary contacts.



N-RELT

AEL-TI-01. Analysis of Three-phase Power Lines Application.

The AEL-TI-01 application includes the following elements:

- **N-AE1. Transmission Line Simulation Module.**

Four capacitors banks of 1  $\mu$ F by capacitor to simulate capacitance between lines.

Two capacitors of 1 and 2  $\mu$ F by phase to simulate capacitances between the line and earth.

Two resistors of 15 and 30 Ohm by phase.

One inductance by phase with 33, 78, 140, 193 and 236 mH terminals.

One neutral resistor of 10 Ohm.



N-AE1

- **N-REFT/3C. 3x300 W Three-Phase Configurable Resistors Module.**

Configurable Star and Delta connections.

Three banks with three three-phase resistors of 1600  $\Omega$ .

Nominal voltage: 400V AC.

Nominal power: 3 x (3 x 300) W.



N-REFT/3C

- **N-INDT/3C. 3x300 VAR Three-Phase Configurable Inductances Module.**

Configurable Star and Delta connection.

Three banks with three three-phase inductances of 5 H.

Nominal voltage: 400V AC.

Nominal power: 3 x (3x300) VAR.



N-INDT/3C

- **N-CAR19T/3C. 3x300 VAR Three-Phase Configurable Capacitors Module.**

Configurable Star and Delta connection.

Three banks with three three-phase capacitors of 2  $\mu$ F.

Nominal voltage: 400V AC.

Nominal power: 3 x (3 x 300) VAR.



N-CAR19T/3C

## Specifications

- N-EALD. **Network Analyzer Unit with Data Acquisition (2 units).**

ON-OFF switch.

Supply voltage: 400V AC.

Input terminals: Input connection with the measurement point.

Output terminals: Output connection with the measurement point.

Digital outputs: Three digital outputs are used for pulses or alarms, or for combining both.

RS-485 Communication port.

Fuses: 3 x 10 A.

Network Analyzer Display. It shows:

- Active, reactive and apparent power.

- Active, reactive and apparent energies.

- Lines and phase currents.

- Line and phase voltages.

- Frequencies.

- Power Factor.



N-EALD

- N-PSM. **Power Switch Module.**

Supply voltage: single-phase 230V AC.

Power terminals:

- Four power input terminals (3PH+N).

- Four power output terminals (3PH+N).

Auxiliary contacts:

- One "NO" contact.

- One "NC" contact.

Two push-buttons to open / close the power terminals and auxiliary contacts.

Two control contacts of 24V DC.

Two voltage supply outputs of 24V DC.



N-PSM

- N-RELO9. **Time Electronic Relay against Overcurrents (1.2 - 7 A).**

Electronic thermal relay.

Overload protection.

Range 1.2 – 7A.

Reset and test function.

1 NONC contact.

Temporization.



N-RELO9

Required element:

- N-VPS01. **AC 3PH Variable Power Supply.**

3PH+N+GND male connector with cable.

200V DC fixed output terminals.

0-200V DC variable output terminals.

230/400V AC fixed output terminals.

0-230/400V AC variable output terminals.

Three positions voltage regulation commutator: this commutator allows to control the AC and DC output voltage terminals with a motorized autotransformer. Central position keep actual voltage. Right position increase slowly the output voltage. Left position reduce slowly the output voltage up to zero volts. By releasing the commutator, it will return to its initial position.

ON/OFF switch.

DC Ammeter.

DC Voltmeter.

AC Ammeter.

AC Voltmeter.

Adjustable three phase thermal protection.

Fuses.

GND terminal.



N-VPS01

AEL-TI-07. Power Transmission Application with Synchronous Generator.

The AEL-TI-07 application includes the following elements:

- N-VPS01. **AC 3PH Variable Power Supply.**

3PH+N+GND male connector with cable.

200V DC fixed output terminals.

0-200V DC variable output terminals.

230/400V AC fixed output terminals.

0-230/400V AC variable output terminals.

Three positions voltage regulation commutator: this commutator allows to control the AC and DC output voltage terminals with a motorized autotransformer. Central position keep actual voltage. Right position increase slowly the output voltage. Left position reduce slowly the output voltage up to zero volts. By releasing the commutator, it will return to its initial position.

ON/OFF switch.

DC Ammeter.

DC Voltmeter.

AC Ammeter.

AC Voltmeter.

Adjustable three phase thermal protection.

Fuses.

GND terminal.



N-VPS01

- N-PSUB2. **Power Generation Substation Module 2.**

Supply voltage: 400V CA, 3PH+N+G

ON/OFF switch.

Power and signals connection:

Auxiliary connection.

Three-phase turbine supply hose with IP44 3PN+E 32A 400V connecting plug.

Three-phase generator supply hose with IP44 3PN+E 32A 400V connecting plug.

Three switches to choose between the different modes:

Local and remote control mode.

Manual and automatic speed control.

Manual and automatic excitation control

Three control switches to:

Start and stop the turbine.

Give permission to synchronize the generator with the grid.

Give permission to close 52NET circuit breaker.

Two potentiometers to regulate:

Turbine speed.

Generator excitation.

Emergency stop button.

Two circuit breakers for synchronization and stand-alone operations.

Different terminals to measure.

Ethernet connection: RJ45 communication port for SCADA remote control.



N-PSUB2

## Specifications

### • N-PPCM1. **Control and Protection of Turbine-Generator Group Module 1.**

Automatic speed and voltage controller (easygen):

Enables to connect up to 16 electric generators in parallel-island with distribution of active and reactive load and start/stop in function of the load demand.

Enables to connect a generator in parallel with the grid.

Enables different switches control modes, such as opening, closing and synchronization.

Analogical outputs to control voltage and frequency regulators.

Three-phase measurement of the grid and the generator voltage.

Three-phase measurement of the generator intensity and power.

Single-phase measurement of the grid intensity.

Protection system.

Generator:

Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), voltage asymmetry, detection of dead busbars, overvoltage (32), load unbalance (46), negative sequence power/reduced power (32R/F), overcurrent by defined curve (50/51), inverse time overcurrent (IEC255), measured ground fault (50N/51N), phase rotation, switches faults.

Network:

Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), vector jump, phase rotation.

Six alarms:

Alarm 1: Reverse power.

Alarm 2: Overcurrent.

Alarm 3: Over/undervoltage.

Alarm 4: Inverse Time Overcurrent.

Alarm 5: Over/under frequency.

Alarm 6: Shutdown Alarms.

Four operation signals:

Ready for operation.

Start request.

Synchronization conditions.

Permission for synchronization.

Back-up protections:

Current relay.

Reverse Power relay.

Ethernet connection: RJ45 communication port.



N-PPCM1

### • EMT6/1K. **1kW/1P Three-Phase Synchronous Generator.**

Nominal power: 1000 VA.

Power factor: 0.8

Nominal output voltage: 3x 400V AC.

Frequency: 50/60 Hz.

Speed: 3000 r.p.m.

Nominal output current: 0.8 A.

Nominal excitation current: 5 A.



EMT6/1K

## Specifications

- **SERV01. AC Servomotor 1.**

Nominal power: 2000 W.  
Nominal voltage: 400V AC.  
Nominal speed: 3000 r.p.m.  
Nominal current: 5A.



SERV01

- **N-EALD. Network Analyzer Unit with Data Acquisition.**

ON-OFF switch.  
Supply voltage: 400V AC.  
Input terminals: Input connection with the measurement point.  
Output terminals: Output connection with the measurement point.  
Digital outputs: Three digital outputs are used for pulses or alarms, or for combining both.  
RS-485 Communication port.  
Fuses: 3 x 10 A.  
Network Analyzer Display. It shows:  
Active, reactive and apparent power.  
Active, reactive and apparent energies.  
Lines and phase currents.  
Line and phase voltages.  
Frequencies.  
Power Factor.



N-EALD

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

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

### Manuals:

This unit is **supplied with the following manuals**: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

## EXERCISES AND PRACTICAL POSSIBILITIES

- 1.- Earth-fault on a line with point in isolated neutral.
  - 2.- Responses of the system against earth-fault on a line with earthed neutral.
  - 3.- Compensation of capacitive fault current on a line with resonant neutral.
  - 4.- Response of the system to earth-fault with earthed neutral.
- Other possibilities to be done with this application:
- 5.- Several students can see the results at the same time. A projector or electronic whiteboard can be used to see all the results in real time in class.
  - 6.- The Computer Control System with CCSOF allows a real simulation.
  - 7.- This application is completely safe since it has mechanical, electrical, electronic security devices and Software.
  - 8.- This application may be used to carry out applied research.
  - 9.- This application may be used for teaching training to industries, even to other institutions of Technical Education.
- Several other exercises can be done and designed by the user.

### REQUIRED SERVICES

- Electrical supply: three-phase, 380 V/50 Hz or 208 V/60 Hz, 3 kW.

### DIMENSIONS AND WEIGHTS

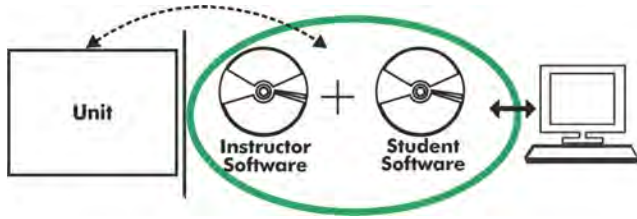
- AEL-TI-03:
- Dimensions: 600 x 300 x 350 mm approx.  
(23.62 x 11.81 x 13.77 inches approx.)
  - Weight: 15 Kg approx.  
(33 pounds approx.)

### AVAILABLE VERSIONS

- Offered in this catalogue:
- AEL-TI-03. Arc Suppression Coil Application.
- Offered in other catalogue:
- AEL-TI-01. Analysis of Three-phase Power Lines Application
  - AEL-TI-02. Distribution Transformer with Motor Regulation Application.
  - AEL-TI-04. Underground Transmission Lines Application.
  - AEL-TI-05. Parallel and Series Transmission Lines Application.
  - AEL-TI-06. Analysis of Power Flows in Transmission Lines Application.
  - AEL-TI-07. Power Transmission Application with Synchronous Generator.
  - AEL-SST-01. Switching and Distribution Power Substations Application.
  - AEL-SST-02. Switching Substation Protection Application.



**AEL-TI-03/ICAI. Interactive Computer Aided Instruction Software System:**



With no physical connection between unit and computer, this complete software package consists of an Instructor Software (EDIBON Classroom Manager -ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft -ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

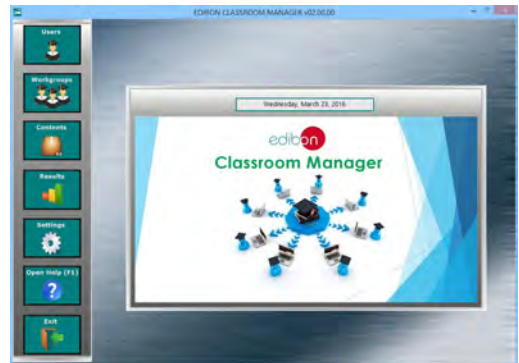
**Instructor Software**

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

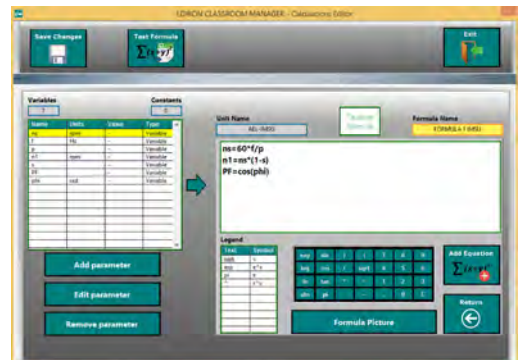
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual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

Innovative features:

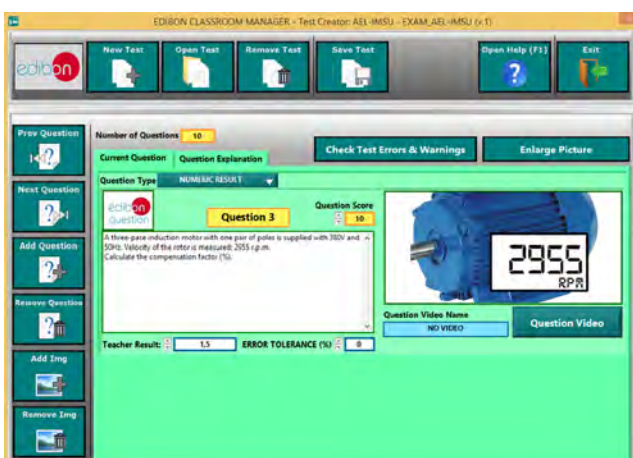
- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.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



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



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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



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

**Student Software**

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

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

Innovative features:

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

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

[www.edibon.com/en/files/expansion/ICAI/catalog](http://www.edibon.com/en/files/expansion/ICAI/catalog)



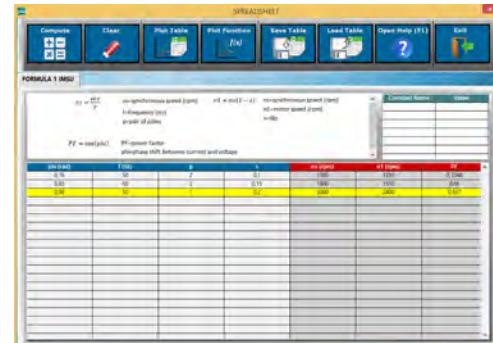
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

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



C/ Del Agua, 14. Polígono Industrial San José de Valderas.  
28918 LEGANÉS. (Madrid). ESPAÑA - SPAIN.  
Tel: 34-91-6199363 Fax: 34-91-6198647  
E-mail: edibon@edibon.com Web: [www.edibon.com](http://www.edibon.com)

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REPRESENTATIVE:

