



Configuration example of AEL-TI with AEL-TI-06 application included

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INTRODUCTION

Transmission lines are an important part for the transport and distribution of electric power, because they are the physical environment through which the electricity is transported from power plants up to final consumer.

There is, however, a problem when several transmission lines are interconnected and form a complex network. If line impedances are very different, hence unbalance loads will be produced. This fact provokes low performance in networks.

One of the most efficient remedy for this problem is the use of Phase Shifting Transformers (PST). These transformers allow controlling the real power flow in the transmission lines, making possible the exploitation of the network infrastructure to get more transmitted/received power.



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 Analysis of Power Flows in Transmission Lines Application, "AET-TI-06", has been designed for the study of power flows in high voltage transmission lines via Phase Shifting Transformers (PST). For this purpose, this application includes a phase shifting transformer module, a transmission line module and a network analyser module. The phase shifting transformer module allows the user to control the voltage angle and the influence of this in the active power flow injected in the transmission line. The aerial transmission line module has terminals to configure the electrical parameters such as resistance, inductance, the capacitive effect between line to line and line to ground. The network analyser module allows the user to monitor the most important electrical parameters such as power factor, harmonics, drop voltages, powers, etc.

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-06 application includes the following elements:

- N-AE1. Transmission Line Simulation Module.
- N-PST/1K. 1 kVA Phase Shifting Transformer.
- N-EALD. Network Analyzer Unit with Data Acquisition.

Required elements:

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

<http://www.edibon.com/en/files/equipment/AEL-TI-01/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-03. Arc Suppression Coil Application.

<http://www.edibon.com/en/files/equipment/AEL-TI-03/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-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-06 can be mounted on rack (option A) or on rail (option B):

Option A:

This application needs the following racks.

- N-RACK-B (3 units).

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-06 application includes the following elements:

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

Four capacitors banks of 1 μ F by capacitor to simulate capacitance between lines.

Two capacitors of 1 and 2 μ 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-PST/1K. 1 kVA Phase Shifting Transformer.**

Input voltages: 3 x 400V.

Output voltage 1: 3 x 400V, 2 A.

Output voltage 2: 3 x 30V, 1.25A.

Power rating: 1 kVA.

Vector group: Dyn5.



N-PST/1K

- **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

Required elements:

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 μ F by capacitor to simulate capacitance between lines.

Two capacitors of 1 and 2 μ 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

Specifications

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

Configurable Star and Delta connections.

Three banks with three three-phase resistors of 1600 Ω .

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 μ F.

Nominal voltage: 400V AC.

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



N-CAR19T/3C

- **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

Specifications

- N-REL09. **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-REL09

Required 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.



N-VPS01

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.

- **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.- Measurement of the most important electrical parameters of parallel lines with equal length.
 - 2.- Measurement of the most important electrical parameters of parallel lines with different length.
 - 3.- Measurement of the most important electrical parameters of serial lines with equal length.
 - 4.- Measurement of the most important electrical parameters of serial lines with different length.
 - 5.- Measurement of the most important electrical parameters of parallel lines with equal impedance.
 - 6.- Measurement of the most important electrical parameters of parallel lines with different impedance.
 - 7.- Voltage angle influence in the active power injected in the line.
- Other possibilities to be done with this application:
- 8.- 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.
 - 9.- The Computer Control System with CCSOF allows a real simulation.
 - 10.- This application is completely safe since it has mechanical, electrical, electronic security devices and Software.
 - 11.- This application may be used to carry out applied research.
 - 12.- 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.

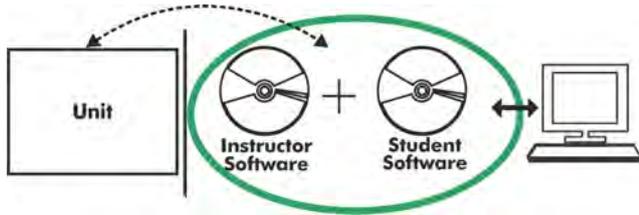
DIMENSIONS AND WEIGHTS

- AEL-TI-06:
- Dimensions: 600 x 300 x 700 mm approx.
(23.62 x 11.81 x 27.55 inches approx.)
 - Weight: 30 Kg approx.
(66 pounds approx.)

AVAILABLE VERSIONS

- Offered in this catalogue:
- AEL-TI-06. Analysis of Power Flows in Transmission Lines 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-03. Arc Suppression Coil Application.
 - AEL-TI-04. Underground Transmission Lines Application.
 - AEL-TI-05. Parallel and Series 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-06/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.

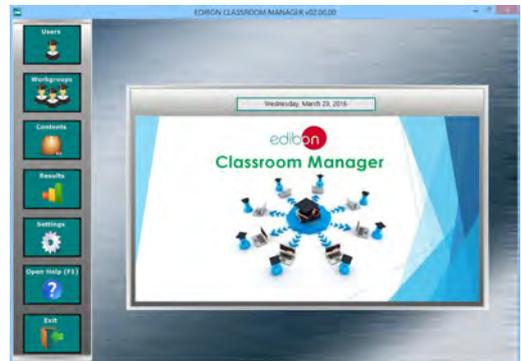
Instructor Software

- 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:

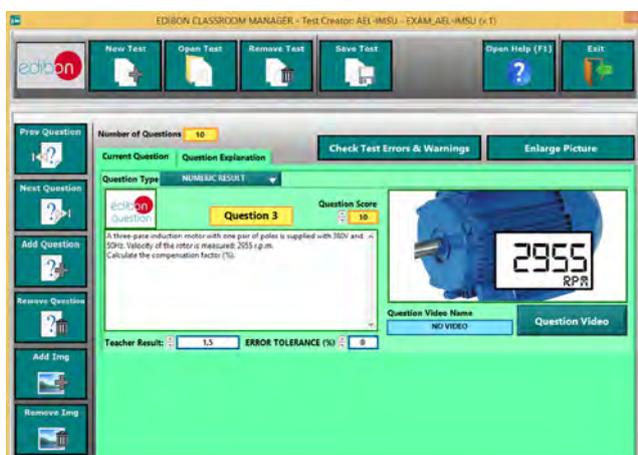
- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.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



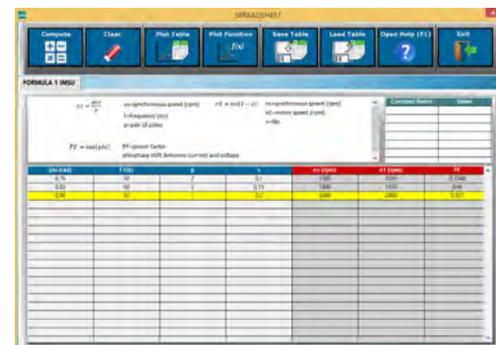
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



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.



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