Advanced AC Electrical Motors Application









INTRODUCTION

The use of AC motors is much more prevalent than DC motors due to several practical reasons. AC Motors are playing a vital role in daily life, right from pumping water to overhead tank to modern robotic arms for maneuvers. The main factor which leads to AC rotating machines adoption and wide use in various fields is its flexibility and its huge variety, which can be matched with almost any kind of demand.









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The Advanced AC Electrical Motors Application, "AEL-ACEMT", has been designed by Edibon to carry out electrical/mechanical test for a great variety of AC motors. Such tests allow obtaining the most significant electrical and mechanical characteristics of these motors .In addition, it is advisable to acquire the Control and Data Acquisition System Software for Electrical Machines, with SCADA, "EM-SCADA", with which the user will be able to obtain the characteristic curves for the tested electric motors and fulfill reports and comparisons of the obtained curves for each electric motor to study its advantages and application fields.

The "AEL-ACEMT" enables the user to learn in depth the behavior of a great range of AC motors, such as three-phase squirrel-cage induction motor, three-phase wound induction motor, three-phase squirrel-cage induction motor with two speeds, the Dahlander motor, the three-phase reluctance motor, the single-phase asynchronous motor with starting capacitor, the single-phase asynchronous motor with starting capacitor, the single-phase synchronous generator, etc.

For this purpose the application includes several elements such as a servomotor, single-phase and three-phase overcurrent relays and a series of measuring devices such as analog ammeters, a network analyzer, a multimeter and an optical speed meter. Dynamic braking tests can be carried out through the servomotor while parameters such as speed, electrical current, the voltage, the power factor or the active and reactive powers are measured.

For the fulfillment of electric motors advanced tests, it is advisable to acquire the Control and Data Acquisition System Software for Electrical Machines, with SCADA, "EM-SCADA". This advanced software allows monitoring the waveforms for current, voltage, torque and speed to study in depth the electric machines.

The AEL-ACEMT application includes the following elements:

- N-ALI01. Industrial Main Power Supply.
- N-REL09. Time Electronic Relay against Overcurrents (1, 2-7A).
- N-REL60. Single-phase Over/Undercurrent Relay.
- N-ARR12. Direct Starter Module.
- N-EALD. Network Analyzer with Computer Data Acquisition.
- N-MED09. AC Ammeter (0-2, 5 A).
- N-MED11. AC Ammeter (0-10 A).
- MED65.Digital Multimeter.
- TECNEL/TM. Hand Tachometer.
- N-SERV1K. 1 kW Servomotor Module.

Recommended elements:

- N-DMC01. Double Measurement and Control Module 1.
- N-VVCA. Advanced AC Motor Speed Controller.

Required elements. At least one is required:

ACEMT-K1: Asynchronous Three-Phase Motor of Squirrel Cage Kit.

- EMT7. Asynchronous Three-Phase Motor of Squirrel Cage.
- N-TRANS03. Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module.
- N-ARR01. Manual Star-Delta Starter.

ACEMT-K2: Asynchronous Three-Phase Motor of Wound Rotor Kit.

- EMT8. Asynchronous Three-Phase Motor with Wound Rotor.
- N-TRANS03. Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module.
- N-ARR01. Manual Star-Delta Starter.
- N-REFTI. Three-Phase Independent Resistor Module.

ACEMT-K3: Dahlander Three-Phase Motor Kit.

- EMT9. Dahlander Three-Phase Motor (two speeds).
- N-ARR07. Manual Dahlander Commutator, two speeds.

ACEMT-K4: Asynchronous Three-Phase Motor of two independent speeds Kit.

- EMT10. Three-Phase Asynchronous Motor of two independent speeds.
- N-ARR09. Manual Independent Windings Commutator, two speeds.

ACEMT-K5: Asynchronous Single-Phase Motor with Starting Capacitor Kit.

• EMT11. Asynchronous Single-Phase Motor with Starting Capacitor.

ACEMT-K6: Asynchronous Single-Phase Motor with Starting and Running Capacitor Kit.

• EMT16. Asynchronous Single-Phase Motor with Starting and Running Capacitor.

ACEMT-K7: Asynchronous Single-Phase Motor with split phase Kit.

• EMT20. Asynchronous Single-Phase Motor with Split Phase.

ACEMT-K8: Three-phase Reluctance Motor Kit.

• EMT21. Three-phase Reluctance Motor.

ACEMT-K9: Three-Phase Synchronous Generator Kit.

- EMT6. A.C Three-Phase Synchronous Motor-Alternator
- N-WCC/M. DC Motor Speed Controller (Intermediate option)).
- N-REFTI. Three-Phase Independent Resistor Module.

Recommended software:

• EM-SCADA. Control and Data Acquisition System Software for Electrical Machines, with SCADA.

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

Option A:

This application needs the following rack:

• N-RACK-A.

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

• N-MED09. AC Ammeter (0-2.5 A).

Measurement range: 0-2.5 A. Terminals: Measurement Terminals. Ground Terminal.

• N-MED11. AC Ammeter (0-10 A).

Measuring range: 0-10 A. Terminals: Measuring terminal. Ground terminal.

• MED65. Digital Multimeter.

This module has a digital multimeter of about 3 $^{1\!/_2}$ digits, with double-jack ending cables of about 4 mm to facilitate interconnections.

With this digital multimeter we will be able to measure:

- Voltage.
- Current.
- Resistance. Capacitors capacity.
- Temperature.

• TECNEL/TM. Hand Tachometer.

Two AA batteries. Three Positions switch to choice the measurement method. Speed recording push button. Speed measurement push button. Disassemble pieces for different shafts. Speed digital display.

• N-SERV1K. 1 kW Servomotor Module.

Dynamic and static four-quadrant operation. Speed and torque displays. Four-quadrant monitor. Thermal monitoring of the machine under test. Testing for the presence of a shaft cover. Connection voltage: 400 V. Frequency: 50 Hz. Maximum power output: 10 kVA. Maximum speed: 4000 r.p.m. Maximum torque 30 Nm. Temperature monitoring.

• N-TRANS03. Three-Phase Autotransformer 400/230 VAC, 1 kVA, Module.

Three-phase autotransformer. Nominal supply voltage: 400 VAC (3PH). Nominal output voltage: 3 x 230 VAC (3PH+N). Nominal power: 1 kVA. Transformer connection: YYO. Start/stop commutator for instantaneous connection/disconnection of the grid transformer. Fuses: 3 x 5 A.

• N-ARR01. Manual Star-Delta Starter.

Nominal voltage: 400 VAC. Maximum contacts current: 10 A. aStar-Delta three positions commutator: 0: Open circuit.

- Y: Star connection.
- Δ : Delta connection.







N-MED11



MED65



TECNEL/TM







N-TRANS03





Specifications

• N-ARR07. Manual Dahlander Commutator Module, 2 speeds.

Nominal voltage: 400 VAC. Maximum contacts current: 10 A.

Three positions commutator:

- 0: Open circuit.
- 1: Low speed.
- 2: High speed.

• N-ARR09. Manual Independent Windings Commutator Module, 2 speeds.

Nominal voltage: 400 VAC. Maximum contacts current: 10 A. Three positions commutator:

- 0: Open circuit.
- 1: Winding 1.
- 2: Winding 2.

• N-REFTI. Three-phase Independent Resistor Module.

Nominal voltage: 400 VAC. Resistor value: 3x150 Ohms. Nominal power: 3x352 W. Manual commutator to switch on/off the resistors. Fuses: 3x5 A. Terminals: Three input terminals (3PH). Three output terminals (3PH). Ground terminal.

 N-WCC/M. DC Motor Speed Controller (intermediate option). Supply voltage: 230 VAC. Variable output voltage: 0-300 VCC. Fuse: 2 A.

• N-DMC01. Double Measurement and Control Module 1.

Power supply: 230 VAC.

Analog inputs:

Torque signal: 0-10 VDC.

Speed signal: 0-10 VDC.

• EMT6. A.C. Synchronous Three-Phase Motor Alternator.

Nominal power: 250 W. Nominal output voltage: 3x 400 VAC. Frequency: 50/60 Hz. RPM:3000 r.p.m. Nominal output current: 1 A. Nominal excitation current: 0,25 A.

• EMT7. Asynchronous Three-Phase Motor of Squirrel Cage.

Nominal power: 370 W. Nominal voltage: 3x 230/400 VAC Δ/Y. Frequency: 50/60 Hz. Number of poles: 2. RPM: 2730 r.p.m. Nominal current: 1,67/ 0,97 A.







N-ARR09



N-REFTI





N-DMC01



EMT6



EMT7

Specifications

• EMT8. Asynchronous Three-Phase Motor of Wound Rotor.

Nominal power: 300 W. Nominal voltage: 3x 230/400 VAC Δ/Y. Frequency: 50/60 Hz. Number of poles: 2. RPM: 2870 r.p.m. Nominal current: 1/ 0,5 A.

• EMT9. Dahlander Three-Phase Motor (two speeds).

Nominal power: 370 W. Nominal voltage: 3x 400 VAC. Frequency: 50/60 Hz. Number of poles: 4. RPM: 1400/2800 r.p.m Nominal current: 1,2 / 1,55 A.

• EMT10. Asynchronous Three-Phase Motor with two independent speeds.

Nominal power: 240/370 W. Nominal voltage: 3x 400 VAC. Frequency: 50/60 Hz. RPM: 900/1420 r.p.m. Nominal current: 1,05 / 1,35 A.

• EMT11. Asynchronous Single-Phase Motor with Starting Capacitor.

Nominal power: 370 W. Nominal voltage: 3x 230 VAC. Frequency: 50/60 Hz. RPM: 2780 r.p.m. Nominal current: 2,53 A.

• EMT16: Asynchronous Single-Phase Motor with Starting and Running Capacitor.

Supply voltage: 110-220 V. Power: 370 W. Speed: 2780 r.p.m. Frequency: 50/60 Hz. Armature current: 1,85 A.

• EMT20. Asynchronous Single-phase Motor with split phase.

Supply voltage: 220 V. Power: 370 W. Speed: 2780 r.p.m. Frequency: 50 Hz. Armature current: 2,53 A.

• EMT21. Three-phase Reluctance Motor.

Nominal power: 300 W. Nominal voltage: 3x 400 VAC. Frequency: 50/60 Hz. RPM:3000 r.p.m. Nominal current: 1,4 A.

• 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.









EMT10



EMT11



EMT16



EMT20



EMT21

- ACEMT-K1: Asynchronous Three-Phase Squirrel Cage Motor Kit.
- 1.- Advanced frequency controller wiring and start-up. (Optional).
- 2.- Advanced frequency controller programming. (Optional).
- 3.- Three-Phase Asynchronous Squirrel Cage Motor speed control through the frequency controller. (Optional).
- Direct starting of the Three-Phase Asynchronous Motor of Squirrel Cage.
- 5.- Star-delta starting of the Three-Phase Asynchronous Motor of Squirrel Cage.
- 6.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Three-Phase Asynchronous Motor of Squirrel cage.
- Speed digital measurement of the Three-Phase Asynchronous Motor of Squirrel cage.
- 8.- Braking test with the servomotor for the Three-Phase Asynchronous Squirrel Cage Motor controlled by the frequency controller.
- 9.- Three-Phase ovecurrent protection calibration and testing.

ACEMT-K2: Asynchronous Three-Phase Motor of Wound Rotor Kit.

- 10.- Advanced frequency controller wiring and start-up. (Optional).
- 11.- Advanced frequency controller programming. (Optional).
- 12.- Three-Phase Asynchronous Motor of Wound Rotor speed control through the frequency controller. (Optional).
- Direct starting of the Three-Phase Asynchronous Motor of Wound Rotor.
- 14.- Star-delta starting of the Three-Phase Asynchronous Motor of Wound Rotor.
- 15.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Three-Phase Asynchronous Motor of Wound Rotor.
- 16.- Speed digital measurement of the Three-Phase Asynchronous Motor of Wound Rotor.
- Braking test with the servomotor for the Three-Phase Asynchronous Motor of wound rotor controlled by the frequency controller.
- 18.- Three-Phase ovecurrent protection calibration and testing.
- ACEMT-K3: Dahlander Three-Phase Motor Kit.
- 19.- Wiring of the Three-Phase Dahlander Motor and the manual commutator of two speeds.
- 20.- Direct starting of the Three-Phase Dahlander Motor.
- 21.- Manual change of the Three-Phase Dahlander Motor speed.
- 22.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Three-Phase Dahlander Motor.
- 23.- Speed digital measurement of the Three-Phase Dahlander Motor.

- 24.- Braking test with the servomotor for the Three-Phase Dahlander Motor.
- 25.- Three-Phase ovecurrent protection calibration and testing.

ACEMT-K4: Asynchronous Three-Phase Motor of two independent speeds Kit.

- 26.- Wiring of the Three-Phase Asynchronous Motor of two independent speeds and the independent windings manual commutator.
- Direct starting of the Three-Phase Asynchronous Motor of two independent speeds.
- Manual change of the Three-Phase Asynchronous Motor of two independent speeds speed.
- 29.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Three-Phase Asynchronous Motor of two independent.
- 30.- Speed digital measurement of the Three-Phase Asynchronous Motor of two independent speeds.
- Braking test with the servomotor for the Three-Phase Asynchronous Motor of two independent speeds.
- 32.- Three-Phase overcurrent protection calibration and testing.

ACEMT-K5: Asynchronous Single-Phase Motor with starting capacitor Kit.

- Wiring of the Single-Phase Asynchronous Motor with Starting Capacitor.
- Direct starting of the Single-Phase Asynchronous Motor with Starting Capacitor.
- 35.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Single-Phase Asynchronous Motor with Starting Capacitor.
- 36.- Speed digital measurement of the Single-Phase Asynchronous Motor with Starting Capacitor.
- 37.- Braking test with the servomotor for the Single-Phase Asynchronous Motor with Starting Capacitor.
- 38.- Single-phase overcurrent protection calibration and testing.

ACEMT-K6: Asynchronous Single-Phase Motor with starting and running capacitor Kit.

- Wiring of the Single-Phase Asynchronous Motor with Starting and Running Capacitor.
- Direct starting of the Single-Phase Asynchronous Motor with Starting and Running Capacitor.
- 41.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Single-Phase Asynchronous Motor with Starting and Running Capacitor.
- 42.- Speed digital measurement of the Single-Phase Asynchronous Motor with Starting and Running Capacitor.

Exercises and practical possibilities

- 43.- Braking test with the servomotor for the Single-Phase Asynchronous Motor with Starting and Running Capacitor.
- 44.- Single-phase overcurrent protection calibration and testing.
- ACEMT-K7: Asynchronous Single-Phase Motor with split phase Kit.
- 45.- Wiring of the Single-Phase Asynchronous Motor with split phase.
- 46.- Direct starting of the Single-Phase Asynchronous Motor with split phase.
- 47.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Single-Phase Asynchronous Motor with split phase.
- 48.- Speed digital measurement of the Single-Phase Asynchronous Motor with split phase.
- 49.- Braking test with the servomotor for the Single-Phase Asynchronous Motor with split phase.
- 50.- Single-phase overcurrent protection calibration and testing.
- ACEMT-K8: Three-Phase Reluctance Motor Kit.
- 51.- Wiring of the Three-Phase Reluctance Motor.
- 52.- Direct starting of the Three-Phase Reluctance Motor.
- 53.- Measuring of Voltages, Currents, Active Power, Reactive Power, Power Factor, etc. of the Three-Phase Reluctance Motor.
- 54.- Speed digital measurement of the Three-Phase Reluctance Motor.
- 55.- Braking test with the servomotor for the Three-Phase Reluctance Motor.
 - **REQUIRED SERVICES**
- Electrical supply: three-phase, 380V/50 Hz or 208V/60 Hz, 2 kW.

- 56.- Three-Phase ovecurrent protection calibration and testing.
- ACEMT-K9: Three-Phase Synchronous Generator Kit.
- 57.- Wiring of the Three-Phase Synchronous Generator.
- 58.- Analysis of the parameters to be controlled in an AC synchronous generator .
- 59.- Analysis of the speed vs voltage at the generator output with a constant excitation current.
- 60.- Analysis of the excitation current vs voltage at the generator output with constant frequency.
- 61.- Analysis of the voltage drop in the under loaded generator.

Practical exercises with the recommended Control and Data Acquisition System Software for Electrical Machines, with SCADA, "EM-SCADA":

- 62.- Real time torque measurement.
- 63.- Real time speed measurement.
- 64.- Real time current and voltage RMS values.
- 65.- Real time current and voltage waveforms measurement.
- 66.- Electrodynamical study of the motor.
- 67.- Obtaining characteristic curves (torque-speed curve, torquecurrent curve etc).
- 68.- Obtaining the saved results.
- 69.- Manual and automatic braking test and real time monitoring of the results.
- Several other exercises can be done and designed by the user.

DIMENSIONS AND WEIGHTS

AEL-ACEMT: -Dimensions: 1380 x 840 x 2010 mm approx. (54.33 x 33.07 x 79.13 inches approx.). -Weight: 80 Kg approx. (176 pounds approx.).

RECOMMENDED SOFTWARE

- EM-SCADA. Control and Data Acquisition System Software for Electrical Machines, with SCADA. (For more information see catalogue.Click on the following link: http://www.edibon.com/en/files/equipment/EM-SCADA/catalog

SOME REAL RESULTS OBTAINED WITH THE NETWORK ANALYSER



Representation of the torque-speed curve for the Three-Phase Asynchornous Squirrel Cage Motor.Notice that the motor nominal speed and the maximum torque can be appreciated.



Optional



AEL-ACEMT/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.



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



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



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

Optional

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



ERS. EDIBON Results & Statistics Program Package - Question Explanation



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



EPE. EDIBON Practical Exercise Program Package Main Screen

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



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