

**AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer**



**AEL-FUSG-LO. Smart Grid Loads**

**Static Loads**



**Dynamic Loads**



**Key features:**

- **Managing real Smart Grid devices used by prestigious utilities.**
- **Learning about what are the operations between the utilities and the final user.**
- **Real time monitoring, remote management and verification of the network quality.**
- **Bidirectional communication between the Utility (the student) and the Smart Meter.**
- **Possibility to use additional smart meters and optional accessories.**
- **This Trainer may be expanded with: AEL-FUSG-E. Final User Smart-Grid - Smart Energy Trainer and/or AEL-FUSG-N. Final User Smart-Grid - Net Metering Trainer.**



ISO 9000: Quality Management  
(for Design, Manufacturing,  
Commercialization and After-sales service)



European Union Certificate  
(total safety)



Certificates ISO 14000 and  
ECO-Management and Audit Scheme  
(environmental management)



Worlddidac Quality Charter  
Certificate and  
Worlddidac Member

## INTRODUCTION

Nowadays, the main goal of all major electric utilities is to achieve a perfect synchronization between power generation and consumption. For that purpose, some activities, such as real-time remote management and monitoring of the energy consumption and bidirectional communication with smart meters, are indispensable.

To understand how current utilities work in the Electrical Grids, EDIBON offers the Final User Smart Grid - Smart Meter Trainer (AEL-FUSG-M), a real Smart Grid System where the user can manage an actual Smart Meter.

## GENERAL DESCRIPTION

The Final User Smart Grid - Smart Meter Trainer (AEL-FUSG-M) is a trainer that reflects the real operation of current Smart Grids. The purpose of the AEL-FUSG-M is to make the user understand how utilities work in a real smart grid environment.

The complete system consists of:

- a) AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.
- b) Required accessories.
- c) Optional accessories.

- a) AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer, consist of the following modules:

N-ALI01. Industrial Power Supply.

This module is used to simulate the electrical grid and supply the data concentrator (N-CTT) and other possible elements.

N-CTT. Data Concentrator Module.

This module is a communications concentrator that belongs to a remote management system with automatic meter reading (AMR). The reading is performed through the power line (power line communication or PLC).

This module can communicate with one or more smart meters. Once the user is communicating with the smart meter from the data concentrator, a platform web can be open. The platform web is integrated in the data concentrator and we can see all electrical parameters of the smart meters that are connected to the power line. It is an important advance, because we can monitor in real time the behaviour of the loads like the utilities do. Besides we can meter the most important electrical parameters, for example: voltages, currents, positive active power, negative active power, positive reactive power, negative reactive power, power factors, positive and negative active energy, positive and negative reactive energy...

N-SM. Smart Meter Module.

This "smart" meter let us know which the consumption of the final customer is at any time. This meter is similar to conventional meters but has the advantage that can send all the electrical parameters of the load (customer) to the utility (data concentrator) in real time. Thus, the utility can know exactly the energy needs of each customer at all times.

Configuration and control software (platform web).

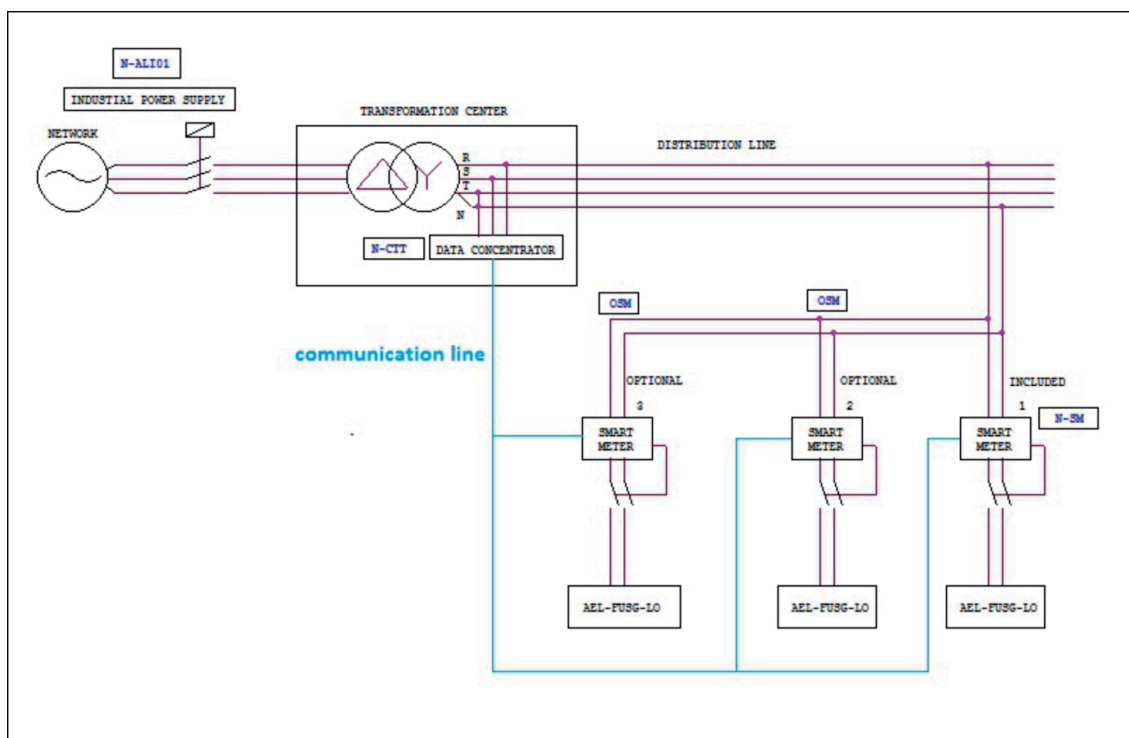
The N-CTT module includes a platform web to control the Smart Meter.

So, the user can perform the following functions:

Real time monitoring, remote management and verification of the network quality.

Relay breaker to limit the maximum consumed power by the final user.

Bidirectional communication between the Utility (the student) and the Smart Meter: the student can control and monitoring the loads state and limit the maximum power required.



Continue...

b) Required accessories:

In order to simulate different real consumptions and to carry out all the practical possibilities proposed AEL-FUSG-M trainer requires a set of static and dynamic loads. The following loads must be acquired:

AEL-FUSG-LO. Smart Grid Loads, formed by:

Static Loads:

N-REV. Variable Resistor.

This module is used to limit the torque of the universal motor (EMT12).

N-LAM16. Halogen Lamp.

N-IND. Variable Inductance Load with commutator.

This module is used to simulate a reactive energy consumption.

N-CAR19. Single-Phase Commutable Capacitor Load.

This module is used to simulate a reactive energy compensation.

N-LAM32. LED Lamp.

This module is used to simulate a low consumption light.

N-WCC/M. DC Motor Speed Controller.

N-REF. Resistor Load with commutator. (4 units)

Dynamic Loads:

EMT12. Universal Motor.

This motor is used to simulate a washing machine together the eddy current brake.

FRECP. Eddy Current Brake.

This brake is used to reduce the EMT12 speed and to increase the energy consumed by him.

EH. Electric Heating Module.

This module is used to simulate a conventional electric heating.

c) Optional accessories:

For AEL-FUSG-M. Final User Smart Grid-Smart Meter Trainer:

OSM. Additional Smart Meter with AEL-FUSG-LO. Smart Grid Loads.

For AEL-FUSG-LO. Smart Grid Loads:

AEL-APFC. Single-phase Automatic Power Factor Compensation.

The complete system consists of:

- a) AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.
- b) Required accessories.
- c) Optional accessories.

- a) **AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer**, consist of the following modules:

#### N-ALI01 . Industrial Power Supply.

This module is used to simulate the electrical grid and supply the data concentrator (N-CTT) and other possible elements.

Three-phase differential protection.

Three-phase output: 380 Vac.

Single-phase output: 230 Vac.

Safety key.

Emergency stop button.

Required power supply: three-phase 380 Vac.

#### N-CTT. Data Concentrator Module.

The communications concentrator consists of:

- A metering system formed by a number of smart meters (on our case, there is one residential smart meter). The data concentrator communicates with the smart meter by means of a power line.
- Remote control System. It is a web platform that let us have access to the data concentrator, visualize all the smart meters connected to the power line and configure different parameters, visualize all the electrical parameters of the load connected to each smart meter, etc.

Configuration and control software (platform web).

The N-CTT module includes a platform web to control the Smart Meter.

So, the user can perform the following functions:

Real time monitoring, remote management and verification of the network quality.

Relay breaker to limit the maximum consumed power by the final user.

Bidirectional communication between the Utility (the student) and the Smart Meter: the student can control and monitoring the loads state and limit the maximum power required.

#### N-SM. Smart Meter Module.

The N-SM Module can carry out the following measurements and controls:

- Current measurements.
- Voltage measurements.
- Active and reactive power measurement in four quadrants.
- Bidirectional measurements of the active and reactive energy in four quadrants.
- Power factor measurements.
- Smart Relay to be controlled from the data concentrator platform web.



Smart Meter ID	Name	Status	Power	Energy	Voltage	Current	Power Factor	Relay	Daily Energy	Daily Power	Daily Current
60	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
61	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
62	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
63	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
64	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
65	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
66	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
67	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
68	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
69	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
70	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
71	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3
72	40-40-22-10-10-10	A	1000	1000	230	4.3	0.95	ON	1000	1000	4.3

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

**Manuals.**

Continue...

b) Required accessories:

In order to simulate different real consumptions and to carry out all the practical possibilities proposed AEL-FUSG-M trainer requires a set of static and dynamic loads that represent different consumption generally used at home, industries and other places.

The following loads must be acquired:

**AEL-FUSG-LO. Smart Grid Loads:**

It is formed by:

N-REV. Variable Resistor.

Nominal current: 2 A.

Nominal power: 500 W.

N-LAM16. Halogen Lamp.

Input voltage: 2 terminals of 230Vac.

Power: 60W.

N-IND. Variable Inductance Load with commutator.

Nominal current: 2 A.

Inductance: 33 mH; 78 mH; 140 mH; 236 mH.

Commutator.

N-CAR19. Single-Phase Commutable Capacitor Load.

Nominal voltage: 230 Vac.

Capacitance: 7  $\mu$ F; 14  $\mu$ F; 21  $\mu$ F; 28  $\mu$ F; 35  $\mu$ F.

Commutator.

N-LAM32. LED Lamp.

Nominal voltage: 230 Vac.

N-WVCC/M. DC Motor Speed Controller.

Adjustable voltage: up to 320 Vdc.

Maximum current: 2 A.

N-REF. Resistor Load with commutator. (4 units)

Nominal current: 2 A.

Nominal power: 500 W.

EMT12. Universal Motor.

Power: 230 W.

Speed: 5000/9000 r.p.m.

Frequency: 50Hz/60Hz.

V.Armatu.: 230 V.

FRECP. Eddy Current Brake.

FRECP is an unit designed to work as a magnetic brake by means of the induction of Foucault's parasitic currents.

The FRECP is similar to an electrical motor, since it has a stator winding, the inductor, that we will feed with a DC voltage. We will change the braking torque by means of this direct voltage.

The breaking torque is proportional to the current injected.

Nominal current: 1.67 A.

Maximum current: 1.8 A.

Maximum braking torque: 1.4 Nm.

Bench - support.

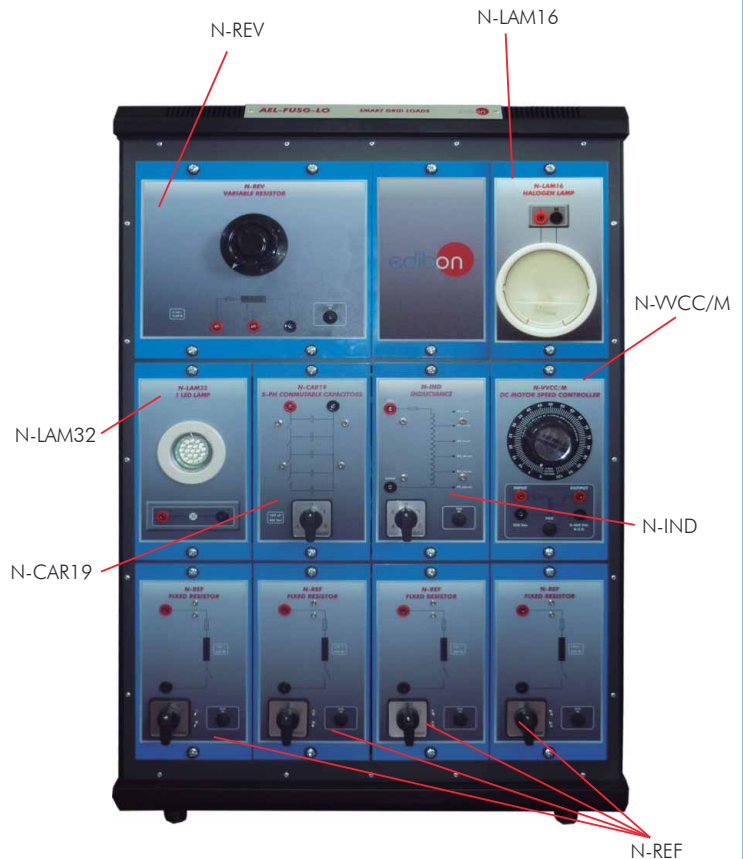
DC power supply.

EH. Electric Heating Module.

This module can be used for different purposes.

Load purpose: this module is used like a resistive load of 700 W.

**IMPORTANT!** These loads can be used simultaneously with AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer, AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer and AEL-FUSG-N. Final User Smart Grid-Net Metering Trainer.



EMT12 + FRECP



EH

c) Optional accessories:

For AEL-FUSG-M. Final User Smart Grid-Smart Meter Trainer:

OSM. Additional Smart Meter with AEL-FUSG-LO. Smart Grid Loads.

For AEL-FUSG-LO. Smart Grid Loads:

AEL-APFC. Single-phase Automatic Power Factor Compensation.



## SOME SOFTWARE SCREENS

Measurement details, load profiles, monthly billing, immediate profiles, daily billing.

CCT											
CCT cycles											
Configuration											
Statistics											
Apply Save Clear statistics Reboot Refresh											
#	serial	mac	present	ARG	Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
58	40.40.22.10.1f.d6	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
59	40.40.22.10.1f.d7	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
60	40.40.22.10.1f.d8	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
61	40.40.22.10.1f.d9	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
62	40.40.22.10.1f.da	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
63	40.40.22.10.1f.db	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
64	40.40.22.10.1f.dc	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
65	40.40.22.10.1f.dd	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
66	40.40.22.10.1f.de	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
67	40.40.22.10.1f.df	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
68	40.40.22.10.1f.e0	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
69	40.40.22.10.1f.e1	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
70	40.40.22.10.1f.e2	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
71	40.40.22.10.1f.e3	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events
72	40.40.22.10.1f.e4	A	yes		Details	Profiles	Monthly billing	Immediate profiles	Daily billing	Daily absolutes	Events

Instantaneous measurements, power demand threshold.

CCT  
CCT cycles  
Configuration  
Statistics  
Apply  
Save  
Clear statistics  
Reboot  
Refresh

### CCT meter details

updated at 2015/07/14 11:55:06 [Update values](#)

**ZIV0034603144**

Clock: 20150714 11:55:07 [set](#)

Firmware ver: V0019

VL1: 224 V

CL1: 0 A

VL2: 0 V

CL2: 0 A

VL3: 0 V

CL3: 0 A

CTOT: 0 A

P+: 0 kW

P-: 0 kW

Q+: 0 kVar

Q-: 0 kVar

PF: 0

A+: 0 kWh

A-: 0 kWh

RH: 0 kWh

RC+: 0 kWh

RL: 0 kWh

RC-: 0 kWh

Active Threshold: 2

Dem. Threshold 1: 15000 [W](#) [set](#)

Dem. Threshold 2: 15000 [W](#) [set](#)

Disconnect: Connected [Disconnect](#) [Connect](#)

Disconnect: Connected [Disconnect](#) [Connect](#)

[Return to list](#) [Reload](#)

## EXERCISES AND PRACTICAL POSSIBILITIES

- 1.- Communication process with the data concentrator.
- 2.- Remote control of the smart meter relay.
- 3.- Real time monitoring of the energy consumed by the loads.
- 4.- Power factor comparison with different load combinations using the data concentrator web server.
- 5.- Comparison of the energy consumption from the utility point of view (with the platform integrated in the data concentrator) and from the final user point of view (using the smart meter display).
- 6.- Power factor correction using capacitor banks. The student can configure different loads and analyze the quality of energy in real time.
- 7.- Instantaneous measurement of the current, voltage, active power and power factor.

NOTE: All practical exercises can be done remotely, as actual utilities do with real Smart Grids.

### REQUIRED SERVICES

- Electrical supply: single phase, 220 V./50 Hz. or 110 V./60 Hz.
- Computer (PC).
- AEL-FUSG-LO. Smart Grid Loads.

### DIMENSIONS & WEIGHTS

AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer:

-Dimensions: 640 x 320 x 670 mm. approx.  
(25.19 x 12.59 x 26.37 inches approx.)

-Weight: 20 Kg. approx.  
(44 pounds approx.)

Required accessory:

AEL-FUSG-LO. Smart Grid Loads:

Static Loads in Rack: -Dimensions: 640 x 320 x 920 mm. approx.  
(25.19 x 12.59 x 36.22 inches approx.)

-Weight: 30 Kg. approx.  
(66 pounds approx.)

EMT12: -Dimensions: 285 x 250 x 260 mm. approx.  
(11.22 x 9.84 x 10.24 inches approx.)

-Weight: 8 Kg. approx.  
(17.6 pounds approx.)

FRECP: -Dimensions: 285 x 250 x 270 mm. approx.  
(11.22 x 9.84 x 10.63 inches approx.)

-Weight: 8.25 Kg. approx.  
(18.2 pounds approx.)

EH: -Dimensions: 450 x 340 x 300 mm. approx.  
(17.71 x 13.38 x 11.81 inches approx.)

-Weight: 4 Kg. approx.  
(8.81 pounds approx.)

### ADDITIONAL TRAINERS

- AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.

The user can increase the knowledge about the influence of the load demand through smart devices.

Management of a real Home Energy Management System.

Development of different automation programs to get an efficient consumption.

- AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.

The user will learn different simulations, such as selling electricity to the grid, Net Metering and measuring the input and output power flows generated by the Renewable Energy simulator.

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



C/ Del Agua, 14. Polígono Industrial San José de Valderas.  
28918 LEGANÉS. (Madrid). SPAIN.

Phone: 34-91-6199363 FAX: 34-91-6198647

E-mail: [edibon@edibon.com](mailto:edibon@edibon.com) WEB site: [www.edibon.com](http://www.edibon.com)

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REPRESENTATIVE:

