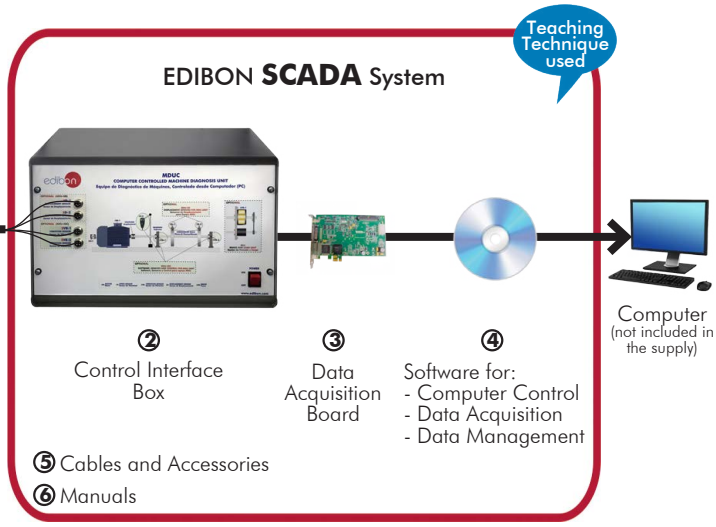
edibon

Engineering and Technical Teaching Equipment

Computer Controlled **Machine Diagnosis Unit,** with SCADA

MDUC

① Unit: MDUC. Computer Controlled Machine Diagnosis Unit



* Minimum supply always includes: 1 + 2 + 3 + 4 + 5 + 6
(Computer not included in the supply)

Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**
- **Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**
- **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**
- **Capable of doing applied research, real industrial simulation, training courses, etc.**
- **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Designed and manufactured under several quality standards.**
- **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**
- **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

POWERED BY NATIONAL INSTRUMENTS LabVIEW

www.edibon.com
PRODUCTS
7.- MECHANICS

For more information about key features, click here

Certificate of Approval of the Quality Management System

European Union Certificate (total safety)

UL and CSA Regulations (All our products are manufactured according to current UL and CSA regulations)

Certificate of Approval of the Environmental Management System

Worlddidac Association Certificate of Membership

INTRODUCTION

To extend the operation time of a machine, prevent serious damage and correctly perform the maintenance tasks, it is essential to know the machine state.

In general, the state of a machine or its parts can be measured by analyzing the type and magnitude of the vibrations generated.

With the recommended additional elements is possible to simulate certain faults and study the effects caused in the vibration spectrum.

GENERAL DESCRIPTION

The Computer Controlled Machine Diagnosis Unit, "MDUC", of EDIBON, allows you to perform vibration measurement practical exercises, measuring the displacement, velocity and acceleration of vibrations in the time-frequency range.

The Computer Controlled Machine Diagnosis Unit, "MDUC", includes the following elements:

1. The MDU Base Unit, "MDU-UB".
2. The Software, Sensors and Control for MDU Unit, "MDU-SSC".
3. Displacement Sensors for MDU Unit, "MDU-SD".

MDUC detail

1. MDU-UB. MDU Base Unit.

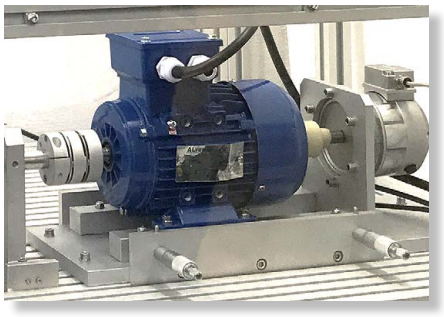
The MDU Base Unit, "MDU-UB", components are mechanical elements such as: flexible couplings for compensating misalignments, bearings with easily removable roller bearings, two rotor shafts of different lengths, two flywheels with replaceable counterweights and an asynchronous drive motor connected to a frequency converter and a tachometer generator.

All the elements can be mounted on an aluminum frame of 1100 x 770 mm with longitudinal grooves for displacement. They can be easily adjusted using screws.

The unit electronic console makes it possible to show on digital displays the speed and power of the motor, to adjust the motor speed using a potentiometer, and to select the direction of rotation of the motor.

The drive motor is mounted on a sliding carriage that includes two micrometer for precise alignment.

Specific cases of machine faults may be studied with the additional recommended elements, such as: shaft bending vibrations, shaft fissures, roller bearing faults, coupling vibrations, belt drive vibrations, gear faults, pump cavitation, blower vibration, and electromechanical vibrations. Furthermore, with the Bread and Load Unit, "MDU-BLU", ranges of two loading moments may be generated as well as two speed ranges.


MDUC detail

The MDU Base Unit, "MDU-UB", requires the following to be assembled:

- Mobile Structure for MDU, "MDU-MLB", or
- Top Table Structure for MDU, "MDU-SM".

2. MDU-SSC. Software, Sensors and Control for MDU Unit.

The Software, Sensors and Control for MDU Unit, "MDU-SSC" allows to perform all measurements and analyze vibrations.

The aim of the vibration analyzer is to assess the machine diagnosis testing with the different sets related to the vibration interface technology.

The system consists of two acceleration sensors, a speed sensor, a measuring amplifier with adjustable amplification degree, a USB box and the analysis software.

The analysis software has the following features: two-channel oscilloscope (studies in the time domain), two-channel spectrum analyzer (studies in the frequency domain), vibration intensity gauge, analysis of shock effects and damage in roller bearings, filter for acceleration curve recording, orbit representation and module for 1 or 2 plane balancing of rigid rotors in operation.

Thanks to the software, it is possible to compare the effectiveness of vibration signals by applying various analysis methods and by determining the advantages and disadvantages of different techniques. Each connection unit includes a 1x, 10x, 100x amplifier, with 16 analog input channels, 4 analog output channels, 4 digital input channels and 4 output channels, which will make possible the coupling of the sensors.

The optional connection of the additional recommended element, the Displacement Sensors for MDU Unit, "MDU-SD".

This unit is connected via USB.

It can be used both in a laptop or a computer.

Computer controlled motor control (MDU-UB) and brake control (MDU-BLU) are optional.

3. MDU-SD. Displacement Sensors for MDU Unit.

Two displacement sensors which, together with the Set of Elastic Shaft ,"MDU-SES", and the Software, Sensors and Control for MDU Unit, "MDU-SSC", allow you to represent subcritical and supercritical shaft orbits in resonance.

Required elements (only one) (Not included):

- **MDU-MLB. Mobile Structure for MDU.**

The Mobile Structure for MDU, "MDU-MLB", is a robust structure designed to quickly and easily assemble the various elements of the MDU Base Unit, "MDU-UB" or the Computer Controlled Machine Diagnosis Unit, "MDUC", and thus assemble a mobile test bench for machine diagnosis.

This structure consists of a slotted table with anodized aluminum frames of 1100 x 770 x 820 mm.

It has three levels, where the two shelves at the bottom can be used to support the electronic unit and other accessories.

It also has four steering wheels for easy movement, with brakes on two of them and a transparent protective cover that protects against the rotating parts and allows us to observe the different experiments. The cover includes a safety switch for automatic stop if opened.

Mobile Structure for MDU, "MDU – MLB" includes:

MDU-SM. Top Table Structure for MDU.

TF-WLB. Wheeled Laboratory Bench.

- **MDU-SM. Top Table Structure for MDU.**

Bench-top frame consisting of a slotted table with anodized aluminum profiles measuring 1100 x 770 x 820 mm.

It has a transparent protective cover that protects against the rotating parts and allows us to observe the different experiments. The cover includes a safety switch for automatic stop if opened.

Additional recommended elements (Not included):

- **MDU-BLU. Break and Load Unit.**

The Break and Load Unit, "MDU-BLU", of EDIBON is a magnetic particle brake, a display unit and an electrical control. It is possible to precisely adjust the braking moment. The excitation current is used as a measurement of the braking moment and it can be displayed through a console.

The braking unit consists of an integrated drive belt and a second projecting shaft, thus it has two speed ranges and two moment ranges.

The power generated is converted into heat by the brake and evacuated to the outside through a fan.

- **MDU-SES. Set of Elastic Shaft.**

The Set of Elastic Shaft, "MDU-SES", of EDIBON allows to study the behavior of an elastic rotor subjected to imbalance and balance of elastic rotors in operation. It is possible to study the resonance and the phenomena occurred in subcritical and supercritical regimes with the Displacement Sensors for MDU Unit, "MDU-SD".

The Set of Elastic Shaft, "MDU-SES", includes some oscillating ball bearings that guarantee the total shaft movement, and the protective bearings limit the amplitude in areas close to the resonance to non-hazardous values.

- **MDU-SRS. Set of Rotating Shaft with Crank.**

It is important that fissures resulting from material fatigue in rotating machines are detected in good time before the breakage occurs, which usually leads to fatal consequences.

The Set of Rotating Shaft with Crank, "MDU-SRS", consists of two shafts with different lengths, the short shaft simulates a projecting shaft end and the load is transmitted with the belt drive of the Set of Belt Drive, "MDU-SBD", whereas the long shaft is used with a protective bearing of the Set of Elastic Shafts, "MDU-SES", and a flywheel in order to study a shaft fissure in the case of an elastic rotor.

With the Set of Rotating Shaft with Crank, "MDU-SRS", a fissure with very close to real behaviors is simulated. By clamping the flange joint tightly with different forces, small temporary openings in the joint are achieved.

- **MDU-SRBF. Set of Roller Bearings with Faults.**

To determine the remaining life cycle of a roller bearing and decide on its replacement, the slow variation of the vibration spectrum is analyzed. The spectral distribution will enable to draw accurate conclusions about the type of defect and its location.

The Set of Roller Bearings with Faults, "MDU-SRBF", has six roller bearings with which to check and explain several faults in roller bearings, such as: damaged outer ring, damaged inner fault, damaged rolling element, combined damage, very used and new and non-faulty.

The radial bearing load may be adjusted within certain limits through the Set of Belt Drive, "MDU-SBD".

- **MDU-SCO. Set of Couplings.**

The Set of Couplings, "MDU-SCO", allows to compare the properties of different couplings such as curved tooth, bolt, flange and claw couplings.

The vibrational behavior of the different types of couplings is important to draw conclusions about faults or defects in the manufacturing or assembly of rotating machines. The usual faults are eccentricity, oscillation and pitch errors.

The Set of Couplings, "MDU-SCO", consists of different couplings to make shaft connections, allowing the study of different types of couplings, faulty and non-faulty.

- **MDU-SBD. Set of Belt Drive.**

The belt drives are noiseless drive devices, have a long life and require little maintenance provided that its design, assembly and adjustment are correct. The Set of Belt Drive, "MDU-SBD", allows to study the conditions that cause vibrations or slip in belts.

The set consists of three belts, three pulleys and a set of tensioning rollers and a belt pre-tension meter.

- **MDU-SSDG. Set to Study Damage in Gears.**

The Set to Study Damage in Gears, "MDU-SSDG", allows to study the vibrational behavior of gears with typical defects. For that purpose, gears with tooth defects and gears without defects are included, so a comparative study can be carried out. The gears included in the set are helical and straight-toothed gears. Due to the importance of lubrication in the vibrational signal of the unit, this may be lubricated with grease and gear oil.

The system allows to vary the gear distance and clearance between the teeth.

Assembly of the Set to Study Damage in Gears "MDU-SSDG" in the Computer Controlled Machine Diagnosis Unit "MDUC" with Break and Load Unit "MDU-BLU"

- **MDU-SCM. Set of Crank Mechanism.**

The compressors and pumps frequently use crank and connecting rod mechanisms. The force and mass oscillations cause vibrations in the units.

The Set of Crank Mechanism, "MDU-SCM", allows to adjust the stroke, mass compensation and bearing clearance, as well as the speed, to simulate vibrations.

The load is exerted by springs.

When you want to simulate the force obtained by a gas compression, a higher torque is required, for which it is recommended to use the Set of Belt Drive, "MDU-SBD", or the Set to Study Damage in Gears, "MDU-SSDG".

- **MDU-SSCP. Set to Study Cavitation in Pumps.**

Pump cavitation is produced when steam cavities are created within a fluid in which forces act responding to the pressure differences. Cavitation causes noise, damage to components and loss of performance.

The Set to Study Cavitation in Pumps, "MDU-SSCP", allows to produce the cavitation phenomenon and study its vibrational response.

The Set to Study Cavitation in Pumps, "MDU-SSCP", consists of a single-stage centrifugal pump connected to flexible tubes with a tank. It is possible to adjust different operating conditions with valves and manometers. Furthermore, it is possible to observe the inside of a pump in operation through the plastic casing.

The pump can be driven directly through an elastic coupling or the Set of Belt Drive, "MDU-SBD".

- **MDU-SSVF. Blower Vibration Set for MDU.**

In the Blower Vibration Set for MDU, "MDU-SSVF", the vibrations are magnetically induced. It is possible to study three impellers with a different number of movable vanes. It is also possible to study the gyroscopic effect by mounting the flywheel plate at an oblique angle. A regular fault in the rotation of the roller is induced by the action of a magnet.The blower can be driven directly through an elastic coupling or the Set of Belt Drive, "MDU-SBD".

- **MDU-SEV. Set of Electromechanical Vibrations.**

Among the drive systems are the asynchronous motors, which generate vibrations in machines.

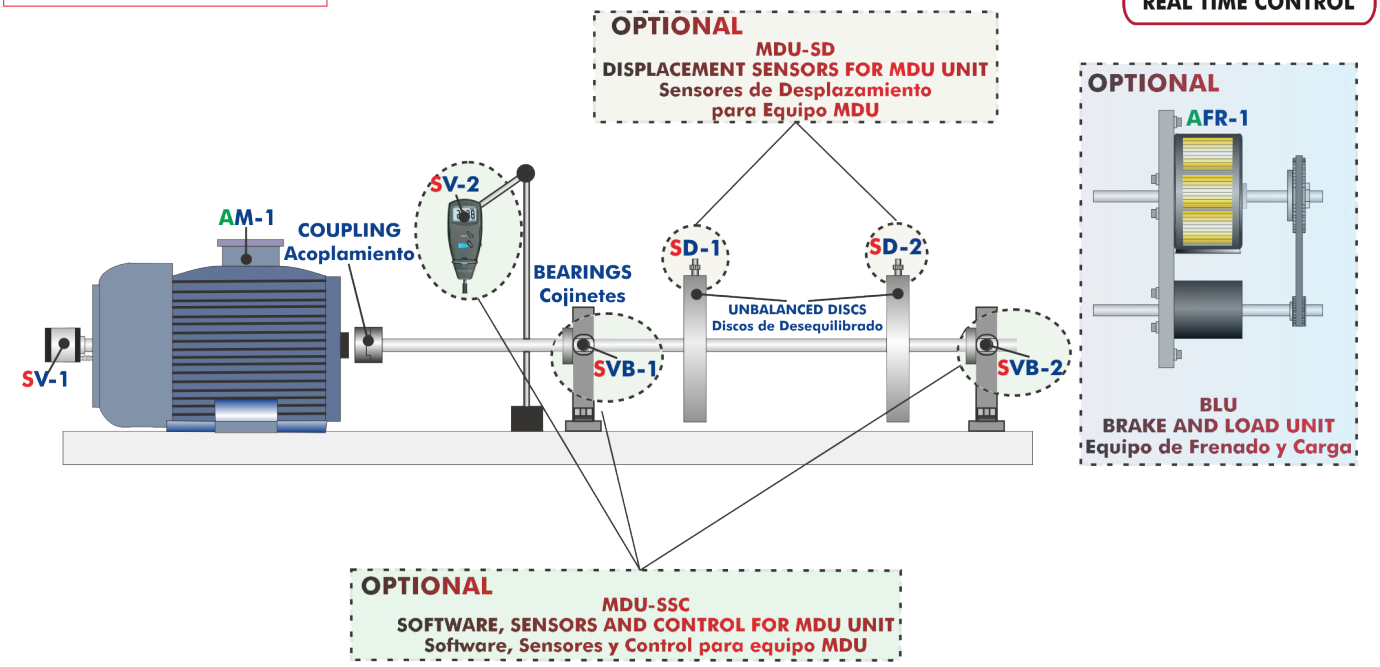
This is the case with an asymmetric air gap (space between rotor and stator), in which the magnetic vibrational forces induce torsional and bending vibrations. In the event of a partial failure of the electrical windings, mechanical vibrations are produced in the asymmetrical magnetic field.

The Set of Electromechanical Vibrations, "MDU-SEV", is an adjustable unit that allows to adjust an asymmetric air gap or to disconnect a winding, generating an electromagnetic asymmetry and thus it is possible to study its vibrational behavior.

Assembly of Set of Electromechanical Vibrations, "MDU-SEV", in the MDU Base Unit, "MDU-UB", with the Break and Load Unit, "MDU-BLU".

2 actuators and 6 sensors controlled from any computer, and working simultaneously

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL



AM- MOTOR Motor
SV- SPEED SENSOR Sensor de Velocidad
SVB- VIBRATION SENSOR Sensor de Vibración
SD- DISPLACEMENT SENSOR Sensor de Desplazamiento
AFR- BRAKE Freno

With this unit there are several options and possibilities:
- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10 and 11.

Let us describe first the main items (1 to 6):

① MDUC Unit.

The Computer Controlled Machine Diagnosis Unit, "MDUC", includes the following elements:
- The MDU Base Unit, "MDU-UB".
- The Software, Sensors and Control for MDU Unit, "MDU-SSC".
- Displacement Sensors for MDU Unit, "MDU-SD".

- MDU-UB. MDU Base Unit.

Main metallic elements made of stainless steel.

Asynchronous motor with frequency variator, with sliding support and two micrometres:
- Drive power: 0.37 kW.
- Nominal speed: 2800 rpm.
- Adjustable power and speed.

Two shafts:
- Short, diameter: 20 mm, length: 300 mm.
- Long, diameter: 20 mm, length: 500 mm.

Three flexible motor-shaft couplings in order to compensate possible misalignments.

Two bearing sawhorses:
- Ball bearings 6204 – SKF.

Two unbalanced flywheels with removable counterweights (screws), thus allowing the balancing in 1 or 2 planes:
- Diameter: 150 mm, 1700 g each.

Tachometer for recording the speed.

Toolkit and screws for assembly of all components.

Storage case.

Electronic console:
- Metal box.
- Main switch.
- Speed sensor connector.
- Motor connector.
- Motor start switch.
- Motor stop switch.
- Motor rotation switch.
- Motor controller by potentiometer.
- Digital display for motor speed.
- Digital display for motor power.

Unit: MDUC

- MDU-SSC. Software, Sensors and Control for MDU Unit.

Two acceleration sensors for recording oscillation travel, oscillation speed and acceleration:
- Frequency range: 1 – 10 kHz, sensitivity: 100 mV/g.
- Resonance frequency of about 32 kHz.

Optical tachometer sensor:
- Range: 100 – 60000 rpm.
- Optical range: up to 2 m.
- Class 2 laser of 675 nm.

USB connection.

MDU-SSC

- MDU-SD. Displacement Sensors for MDU Unit.

Two inductive displacement sensors:
- Range: 1 – 10 mm.

MDU-SD

The complete unit includes as well:

Advanced Real-Time SCADA.
Open Control + Multicontrol + Real-Time Control.
Specialized EDIBON Control Software based on LabVIEW.
National Instruments Data Acquisition board (250 KS/s, kilo samples per second).
Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.
Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
Capable of doing applied research, real industrial simulation, training courses, etc.
Remote operation and control by the user and remote control for EDIBON technical support, are always included.
Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
Designed and manufactured under several quality standards.
Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

Required elements (only one) (Not included):
- MDU-MLB. Mobile Structure for MDU, or
- MDU-SM. Top Table Structure for MDU.

Additional recommended elements (Not included):
- MDU-BLU. Break and Load Unit.
- MDU-SES. Set of Elastic Shaft.
- MDU-SRS. Set of Rotating Shaft with Crank.
- MDU-SRBF. Set of Roller Bearings with Faults.
- MDU-SCO. Set of Couplings.
- MDU-SBD. Set of Belt Drive.
- MDU-SSDG. Set to Study Damage in Gears.
- MDU-SCM. Set of Crank Mechanism.
- MDU-SSCP. Set to Study Cavitation in Pumps.
- MDU-SSVF. Blower Vibration Set for MDU.
- MDU-SEV. Set of Electromechanical Vibrations.

② MDUC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.
Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.
All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output.
Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.
Single cable between the control interface box and computer.
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.
Simultaneous visualization in the computer of all parameters involved in the process.
Calibration of all sensors involved in the process.
Real time curves representation about system responses.
Storage of all the process data and results in a file.
Graphic representation, in real time, of all the process/system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
All the actuators and sensors values and their responses are displayed on only one screen in the computer.

MDUC/CIB

Shield and filtered signals to avoid external interferences.
Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.
Real time computer control for pumps, compressors, heating elements, control valves, etc.
Real time computer control for parameters involved in the process simultaneously.
Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

PCI Express Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI Express.

Analog input:

Number of **channels= 16** single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536.

Sampling rate up to: 250 KS/s (kilo samples per second).

Input range (V)=±10 V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.

Analog output:

Number of **channels=2**. **Resolution=16 bits**, 1 in 65536.

Maximum output rate up to: 900 KS/s.

Output range (V)=±10 V. Data transfers=DMA, interrupts, programmed I/0.

Digital Input/Output:

Number of **channels=24 inputs/outputs**. D0 or DI Sample Clock frequency: 0 to 100 MHz.

Timing: Number of **Counter/timers=4**. Resolution: Counter/timers: 32 bits.

The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

DAB

④ MDUC/CCSOF. Computer Control + Data Acquisition + Data Management Software:

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

Sampling velocity up to 250 KS/s (kilo samples per second).

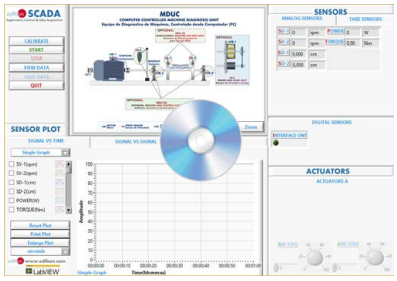
Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.



MDUC/CCSOF

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

This unit is **supplied with 8 manuals**: Required services, Assembly and Installation, Interface and Control software, Starting-up, Safety, Maintenance, Calibration & Practices manuals.

∗References 1 to 6 are the main items: MDUC + MDUC/CIB + DAB + MDUC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

Required elements (only one) (Not included)

MDU-MLB. Mobile Structure for MDU

Mobile table for the MDU Base Unit, "MDU-UB" or for the Computer Controlled Machine Diagnosis Unit, "MDUC", with the dimensions of 1100 x 770 x 820 mm.

The Mobile Structure for MDU, "MDU-MLB", includes:

- MDU-SM. Top Table Structure for MDU:
  - Anodized aluminum frames.
  - Aluminum frame assembly without mechanization.
  - Transparent protective cover with safety switch.
  - Diagram in the front panel with distribution of the elements similar to the real one.
- TF-WLB. Wheeled Laboratory Bench.
  - Anodized aluminum frames.
  - Aluminum frame assembly without mechanization.
  - Four steering wheels with brakes on two of them.
  - Two shelves for the accessories.

MDU-SM. Top Table Structure for MDU

Anodized aluminum frames.

Aluminum frame assembly without mechanization.

Transparent protective cover with safety switch.

Diagram in the front panel with distribution of the elements similar to the real one.

Additional recommended elements (Not included)

MDU-BLU. Break and Load Unit

The set consists mainly of:

- Magnetic particle brake (adjustment and measurement of the braking torque):
  - Speed range: 200 – 2000 rpm.
  - Braking torque: 10 Nm.
- Adjustment and measurement of the braking torque.
- Integrated belt drive for the second speed range and the moment range:
  - Gear ratio between brake shafts: i = 3.
  - Speed range: 600 – 6000 rpm.
  - Braking torque: 3.3 Nm.
- Axial fan for heat discharge.
- Electric protection against superheating
- Electronic console:
  - Main switch.
  - Brake switch.
  - Brake controller.
  - Digital display of brake excitation current.

Additional recommended elements (Not included)

MDU-SES. Set of Elastic Shaft

This set consists primarily of:

- Two elastics shafts made of high-grade steel (long length and small diameter):
  - Diameter: 10 mm.
  - Length: 550 mm.
  - Nominal length between bearings: 450 mm.
- Three bearings with holes for sensor housing.
- Two bearing supports with oscillating ball bearings.
- Vibration amplitude limitation bearing, diameter: 20 mm.
- Storage case.

Required elements (Not included):

- MDU-SD. Displacement Sensors for MDU Unit.

MDU-SRS. Set of Rotating Shaft with Crank

The set consists mainly of:

- Taker-in plate.
- Flange with short shaft (additional recommended element Set of Belt Drive, "MDU-SBD"):
  - Diameter: 90 mm.
- Flange with long shaft (for flywheel).
  - Diameter: 90 mm.
- Six screws:
  - Hexagon head screw for flange M8 x 20.
- Clamping kit.
- Two shafts:
  - Diameter: 20 mm.
  - Short shaft for "projecting shaft end" simulation:
    - Length: 85 mm.
    - Max. allowable bending moment: 15.9 Nm.
  - Long shaft for "elastic rotor" simulation:
    - Length: 200 mm.
    - Max. allowable bending moment: 3.9 Nm.
  - Centering mandrel for shaft alignment during the test assembly.

Required elements (Not included):

- MDU-SES. Set of Elastic Shaft.

and

- MDU-SBD. Set of Belt Drive.

MDU-SRBF. Set of Roller Bearings with Faults

The set consists mainly of:

- Six oscillating ball bearings:
  - Inner diameter: 20 mm.
  - Outer diameter: 47 mm.
  - Width: 14 mm.
  - Number of balls: 12.
  - Bearings:
    - Bearing with damaged outer ring.
    - Bearing with damaged inner ring.
    - Bearing with damaged rolling element.
    - Bearing with combined damage.
    - Widely used bearing.
    - New and non-faulty bearing
- Roller bearing bracket.
- Retaining rings.
- Tool for retaining rings.

Additional recommended elements (Not included):

- MDU-SBD. Set of Belt Drive.

Additional recommended elements (Not included)

MDU-SCO. Set of Couplings

The set consists mainly of:
- Curved tooth coupling.
- Non-faulty flange coupling.
- Flange coupling with eccentricity fault:
  - Eccentricity fault (non-centering): 0.2 mm.
- Flange coupling with oscillation fault:
  - Oscillation fault: 0.4 ± 0.1 mm.
- Bolt coupling with variable pitch fault:
  - Non-eccentric bolt.
  - Eccentric bolt:
    - Bolt eccentricity: 1 mm.
  - Max. pitch error: 180° ± 1.909°.
- Four stars for claw coupling:
  - 98 Shore A (red).
  - 92 Shore A (yellow).
  - 64 Shore D (green).
  - 80 Shore A (blue).
- Roller bearing bracket with elastic support.

Additional recommended elements (Not included):
- MDU-BLU. Break and Load Unit.

MDU-SBD. Set of Belt Drive

The set consists mainly of:
- Rubber V-belt:
  - SPX profile, approx. 10 mm wide.
  - Belt length: 915 mm.
- Damaged rubber V-belt:
  - SPX profile, approx. 10 mm wide.
  - Belt length: 915 mm.
- Small drive pulley:
  - Diameter: 63 mm.
- Small pulley with eccentricity fault for the V-belt:
  - Diameter: 63 mm.
- Large pulley:
  - Diameter: 125 mm.
- Distance between shafts: 300 mm.
- Clamping kit.
- Belt pre-tension meter: 0 – 150 N.
- Belt tensioning device.
- Individually adjustable tensor rollers.
- V-belt tension adjustment.

Required elements (Not included):
- MDU-BLU. Break and Load Unit.

MDU-SSDG. Set to Study Damage in Gears

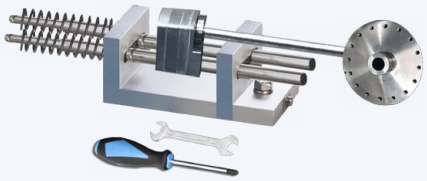
The set consists mainly of:
- Transparent box cover to observe the gear in operation.
- Holes for vibration sensors.
- Sets of straight-toothed gears, with fault:
  - Sprocket wheel: 75 teeth each, m= 2.
  - Pinion: 25 teeth each, m= 2.
- Sets of straight-toothed gears, without fault:
  - Sprocket wheel: 75 teeth each, m= 2.
  - Pinion: 25 teeth each, m= 2.
- Sets of helical-toothed gears, with fault:
  - Sprocket wheel: 75 teeth each, m= 2.
  - Pinion: 25 teeth each, m= 2.
- Sets of helical-toothed gears, without fault:
  - Sprocket wheel: 75 teeth each, m= 2.
  - Pinion: 25 teeth each, m= 2.
- Gear fixing shafts.
- Variable wheelbase.
- Motor oil SAE 10 W – 40, 1 l for lubricating the gears.
- Storage case.

Required elements (Not included):
- MDU-BLU. Break and Load Unit.

Additional recommended elements (Not included)

MDU-SCM. Set of Crank Mechanism

The set consists mainly of:
- Crank and connecting rod mechanism with adjustable stroke:
  - Stroke: 50 – 75 – 100 mm.
- Two balance weight masses: Total 490 g, designed to operate with a 50 mm stroke.
- Bearing set adjustment:
  - Bearing clearance: 0 – 1 mm.
- Two pressure springs:
  - Length without tension: 170 mm.
  - Spring ratio: R = 0.55 N/mm.



Additional recommended elements (Not included):
- MDU-SBD. Set of Belt Drive.

or
- MDU-SSDG. Set to Study Damage in Gears.

MDU-SSCP. Set to Study Cavitation in Pumps

The set consists mainly of:
- Centrifugal pump:
  - Max. flow rate: 17 l/min (3300 min^{-1}).
  - Max. lift height: 12 m (3300 min^{-1}).
  - Three-vane impeller.
  - Minimum speed for cavitation: 2240 min^{-1} approx. (choked suction side).
- Two manometers:
  - Pressure side: 0 – 4 bar.
  - Suction side: -1 – 1.5 bar.
- Casing cap.
- Knurled screw to open the casing cap.
- Suction side tube.
- Two ball valves.
- Set of flexible tubes.
- Tank:
  - Material: HDPE.
  - Capacity: 20 l.

Additional recommended elements (Not included):
- MDU-SBD. Set of Belt Drive.

MDU-SSVF. Blower Vibration Set for MDU

The set consists mainly of:
- Steel plate impeller with three movable vanes:
  - Diameter: 204 mm.
  - Max. speed: 3000 min^{-1}.
- Steel plate impeller with five movable vanes:
  - Diameter: 204 mm.
  - Max. speed: 3000 min^{-1}.
- Steel plate impeller with seven movable vanes:
  - Diameter: 204 mm.
  - Max. speed: 3000 min^{-1}.
- Flywheel plate to simulate axial forces.
- Protective cover.
- Roller bearing bracket.
- Aluminum protective plate, diameter: 220 mm.
- Permanent magnet.

Additional recommended elements (Not included):
- MDU-SBD. Set of Belt Drive.

Additional recommended elements (Not included)

MDU-SEV. Set of Electromechanical Vibrations

The set consists mainly of:

Asynchronous motor with variable speed:

Drive power: 0.37 kW.

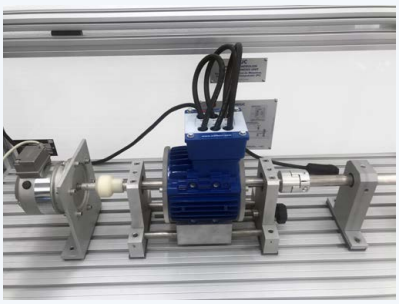
Nominal speed: 2800 rpm.

Adjustable power and speed.

Variable air gap due to stator displacement.

Winding disconnect switch.

Current clamp. Adjustable magnet-vane distance.



Required elements (Not included):

- MDU-BLU. Break and Load Unit.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

1.-Assessment of the vibration state of a machine.

2.-Measuring the vibrations caused by unbalanced operation of rigid rotors in 1 and 2 planes.

3.-Study of the basic essentials of the vibration measurement in shafts and bearings.

4.-Study of the basic magnitudes and parameters.

5.-Use of measuring sensors and instruments.

6.-Understanding the influence of speed and shaft and recorder arrangements.

7.-Learning to balance rigid shafts in operation and alignment between motor and bearing.

8.-Understanding and interpreting the frequency spectra.

9.-Learning about the different vibration signals.

10.-Applying the FFT analysis correctly.

11.-Measuring the speed, oscillation travel, oscillation speed and acceleration.

12.-Learning about the effects of alignment on different types of couplings.

13.-Learning about the effects of speed on vibration behavior.

14.-Learning about the effects of the balanced and unbalanced elastic rotor (MDU-SES kit is required).

15.-Study of the variation of a typical vibration behavior (vibration velocity, frequency, amplitude, and phase) due to a fissure (MDU-SRS kit is required).

16.-Identifying cracks and fissures in shafts through acceleration curves and order analysis (MDU-SRS is required).

17.-Identifying a fissure through the variation of a vibration spectrum (MDU-SRS is required).

18.-Estimating the life cycle of a roller bearing (MDU-SRBF is required).

19.-Identifying faulty roller bearings (MDU-SRBF required).

20.-Checking the effects of roller bearing faults on outer and inner ring, or the roller bearing body on the vibration spectrum (MDU-SRBF is required).

21.-Understanding the effect of ring gear hardness on claw couplings (MDU-SCO is required).

22.-Comparing the curved tooth, bolt, flange or claw couplings (MDU-SCO is required).

23.-Understanding the importance of belt tension in vibration behavior (MDU-SBD is required).

24.-Checking the effect of the eccentricity in pulleys and the speed in vibration behavior (MDU-SBD is required).

25.-Comparison between defective and non-defective belts (MDU-SBD is required).

26.-Understanding and interpreting the frequency spectra in order to differentiate between defective and non-defective belts (MDU-SBD is required).

27.-Identifying defects in the gears according to their vibration behavior (MDU-SSDG is required).

28.-Learning about the effect of the toothed gear, the lubrication used and the wheelbase and the backlash (MDU-SSDG is required).

29.-Identifying wear on the rod and piston (MDU-SCM is required).

30.-Learning about the effect of bearing clearance and impacts (MDU-SCM is required).

31.-Study of the vibrations of a centrifugal pump in operation (MDU-SSCP is required).

32.-Understanding the cavitation phenomenon in a centrifugal pump (MDU-SSCP is required).

33.-Identifying vibrations caused by the movable vanes in the vibration spectrum (MDU-SSCP is required).

34.-Measuring the pitch frequency between movable vanes (MDU-SSCP is required).

35.-Measuring the blower vibrations (MDU-SSCP is required).

36.-Learning about the effect of an asymmetric air gap on the vibration behavior and the electromagnetic and performance losses (MDU-SEV is required).

37.-Learning about the effect of the electrical windings on vibration behavior (MDU-SEV is required).

Other possibilities to be done with this unit:

38.-Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

39.-Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

40.-The Computer Control System with SCADA allows a real industrial simulation.

41.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.

42.-This unit can be used for doing applied research.

43.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

44.-Control of the MDUC unit process through the control interface box without the computer.

45.-Visualization of all the sensors values used in the MDUC unit process.

- By using PLC-PI additional 19 more exercises can be done.
- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Computer.

DIMENSIONS AND WEIGHTS

MDUC:
Unit:
- Dimensions: 1100 x 700 x 400 mm approx. (47.24 x 27.55 x 15.74 inches approx.)
- Weight: 20 Kg approx. (44 pounds approx.)

Control Interface Box:
- Dimensions: 490 x 330 x 310 mm approx. (19.29 x 12.99 x 12.20 inches approx.)
- Weight: 10 Kg approx. (22 pounds approx.)

MDU-MLB:
- Dimensions: 1100 x 770 x 820 mm aprox. (43.30 x 30.31 x 32.28 inches approx.)
- Weight: 35 Kg aprox. (77 pounds approx.)

MDU-SM:
- Dimensions: 1100 x 770 x 260 mm aprox. (43.30 x 27.55 x 15.74 inches approx.)
- Weight: 10 Kg aprox. (22 pounds approx.)

MDU-BLU:
- Dimensions: 600 x 400 x 320 mm approx. (23.62 x 15.74 x 12.59 inches approx.)
- Weight: 30 Kg approx. (66.13 pounds approx.)

MDU-SES:
- Dimensions: 600 x 400 x 120 mm approx. (23.62 x 15.74 x 4.72 inches approx.)
- Weight: 6 Kg approx. (13.22 pounds approx.)

MDU-SRS:
- Dimensions: 400 x 300 x 120 mm approx. (15.74 x 11.81 x 4.72 inches approx.)
- Weight: 3 Kg approx. (6.61 pounds approx.)

MDU-SRBF:
- Dimensions: 400 x 300 x 120 mm approx. (15.74 x 11.81 x 4.72 inches approx.)
- Weight: 4 Kg approx. (8.81 pounds approx.)

MDU-SCO:
- Dimensions: 400 x 300 x 170 mm approx. (15.74 x 11.81 x 6.69 inches approx.)
- Weight: 6 Kg approx. (13.22 pounds approx.)

MDU-SBD:
- Dimensions: 600 x 400 x 170 mm approx. (23.62 x 15.74 x 6.69 inches approx.)
- Weight: 6 Kg approx. (13.22 pounds approx.)

MDU-SSDG:
- Dimensions: 600 x 400 x 320 mm approx. (23.62 x 15.74 x 12.59 inches approx.)
- Weight: 25 Kg approx. (55.11 pounds approx.)

MDU-SCM:
- Dimensions: 600 x 400 x 170 mm approx. (23.62 x 15.74 x 6.69 inches approx.)
- Weight: 8 Kg approx. (17.63 pounds approx.)

MDU-SSCP:
- Dimensions: 600 x 400 x 320 mm approx. (23.62 x 15.74 x 12.59 inches approx.)
- Weight: 16 Kg approx. (35.27 pounds approx.)

MDU-SSVF:
- Dimensions: 400 x 300 x 320 mm approx. (15.74 x 11.81 x 12.59 inches approx.)
- Weight: 6 Kg approx. (13.22 pounds approx.)

MDU-SEV:
- Dimensions: 400 x 300 x 320 mm approx. (15.74 x 11.81 x 12.59 inches approx.)
- Weight: 11 Kg approx. (24.25 pounds approx.)

REQUIRED ELEMENTS (Not included)

Required (only one):

- MDU-MBL. Mobile Structure for MDU.

or

- MDU-SM. Top Table Structure for MDU.

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- MDU-BLU. Break and Load Unit.
- MDU-SES. Set of Elastic Shaft.
- MDU-SRS. Set of Rotating Shaft with Crank.
- MDU-SRBF. Set of Roller Bearings with Faults.
- MDU-SCO. Set of Couplings.
- MDU-SBD. Set of Belt Drive.
- MDU-SSDG. Set to Study Damage in Gears.
- MDU-SCM. Set of Crank Mechanism.
- MDU-SSCP. Set to Study Cavitation in Pumps.
- MDU-SSVF. Set to Study Vibrations in Fans.
- MDU-SEV. Set of Electromechanical Vibrations.

SIMILAR UNITS AVAILABLE

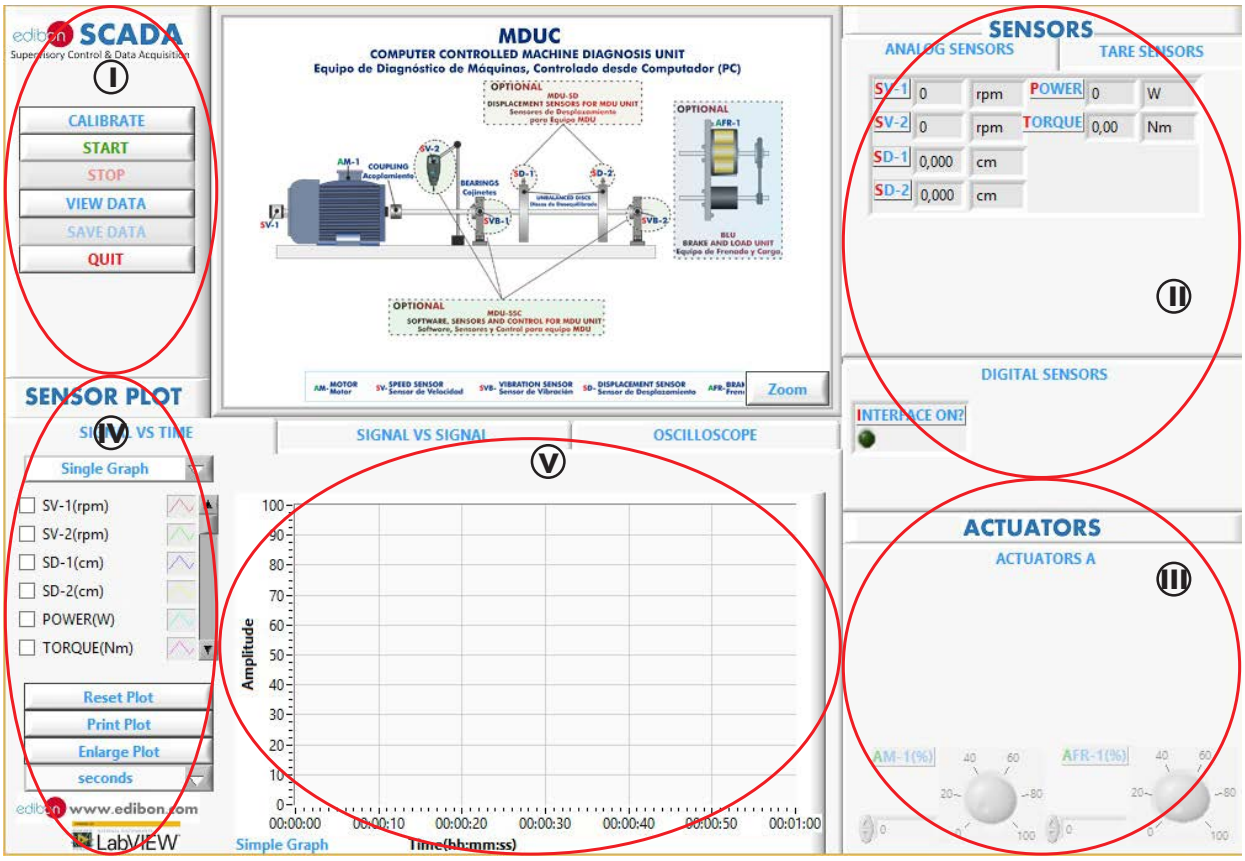
Offered in this catalog:

- MDUC. Computer Controlled Machine Diagnosis Unit.

Offered in others catalogs:

- MDU. Machine Diagnosis.

SCADA
Main screen



Ⓘ Main software operation possibilities.

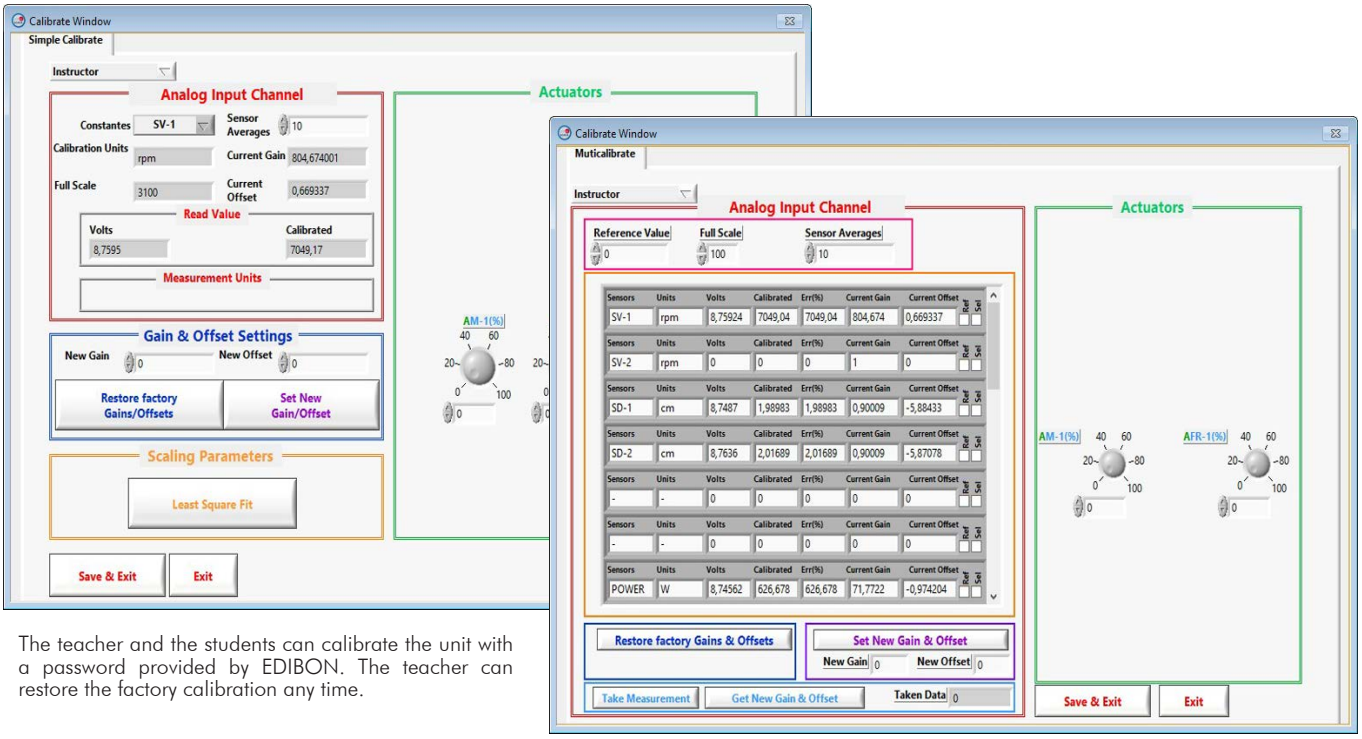
Ⓘ Sensors displays, real time values, and extra output parameters. Sensors: SV=Speed sensor. SD=Displacement sensor. SVB=Vibration sensor.

Ⓘ Actuators controls. Actuators: AM=Motor. AFR=Brake.

Ⓘ Channel selection and other plot parameters.

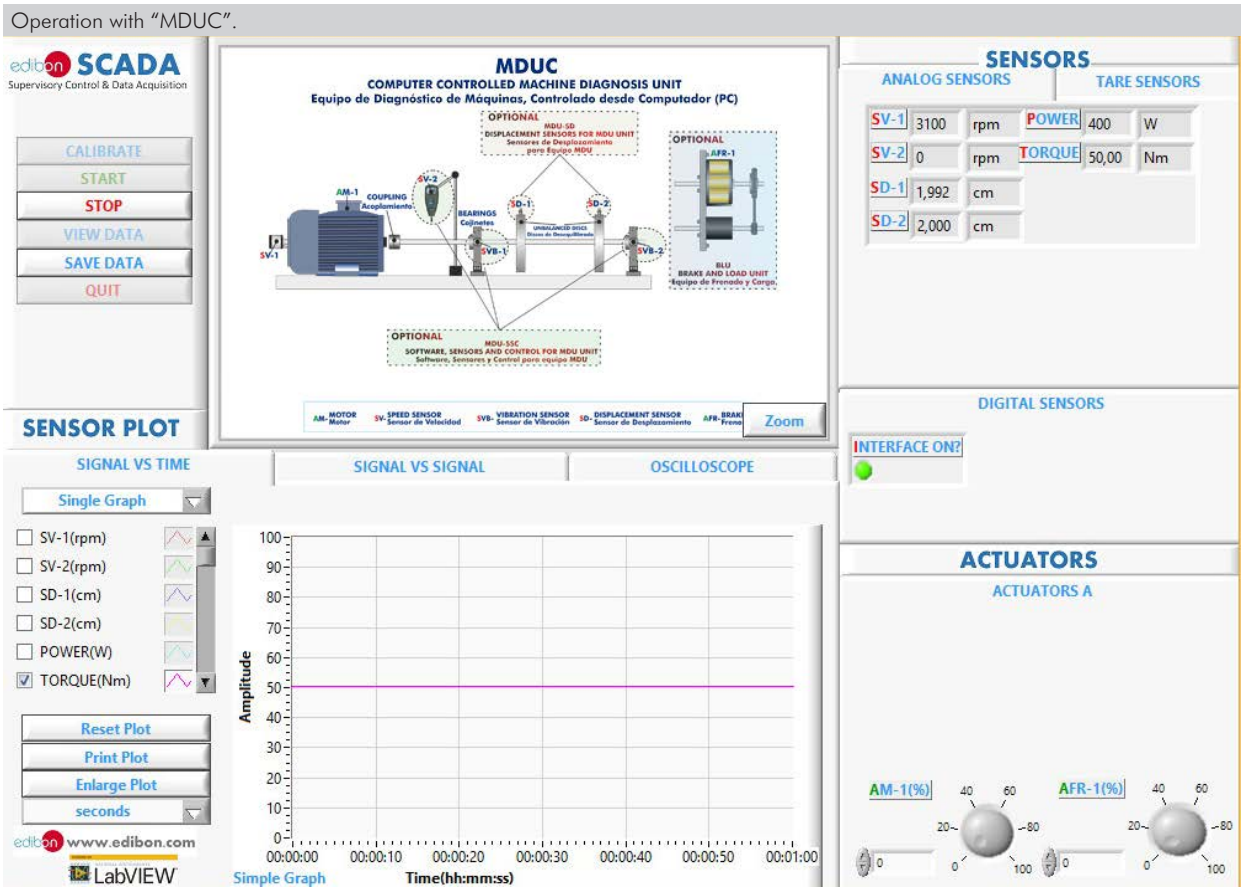
Ⓘ Real time graphics displays.

Software for Sensors Calibration
Example of screen

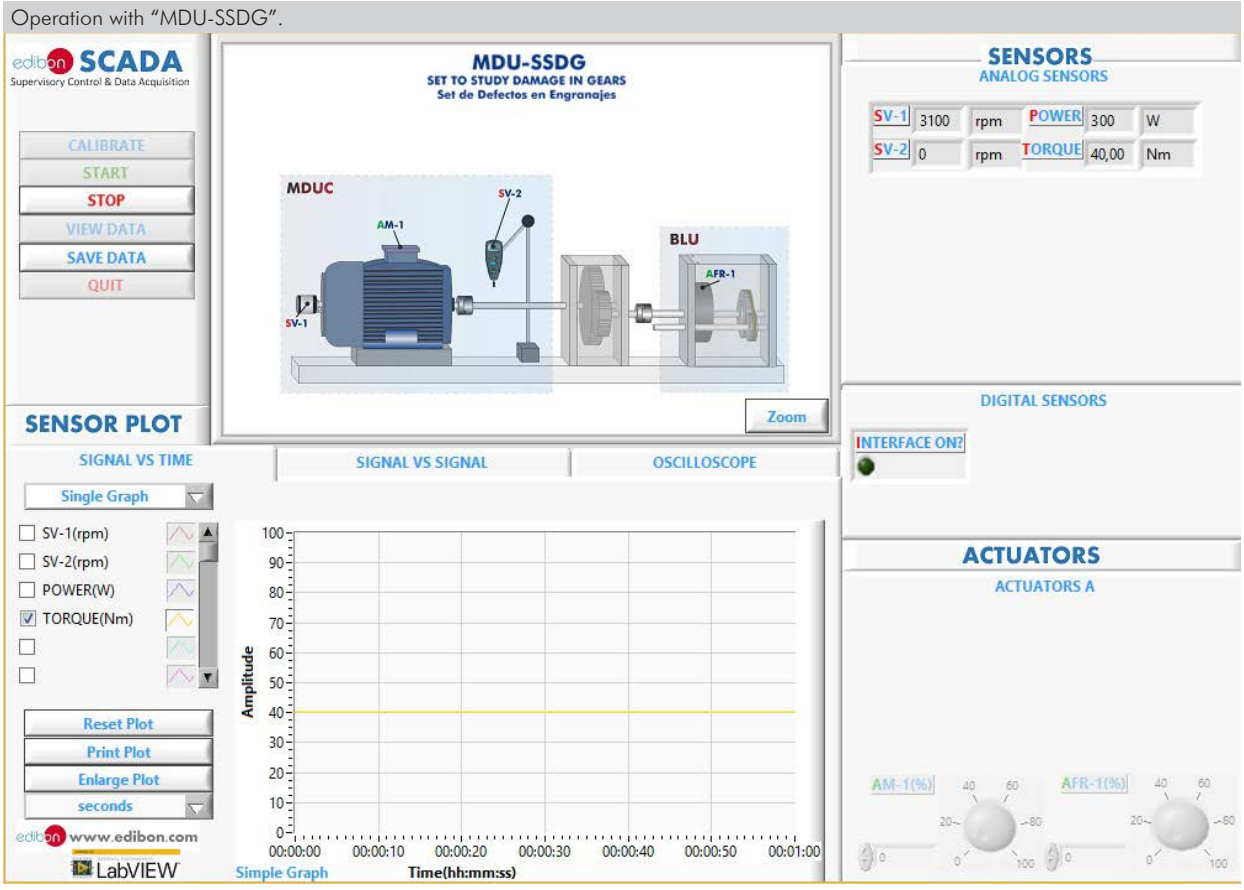


The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

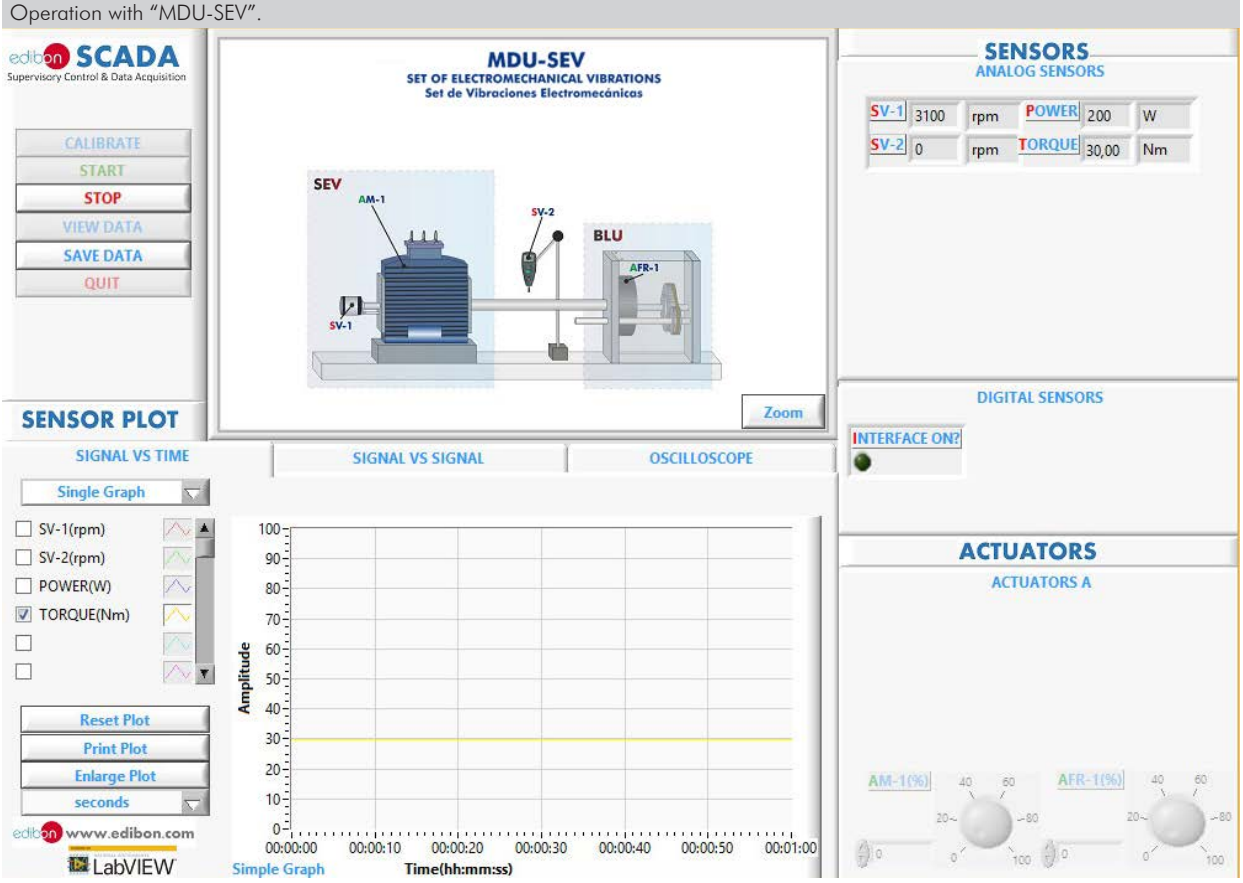
Operation with "MDUC".



Operation with "MDU-SSDG".



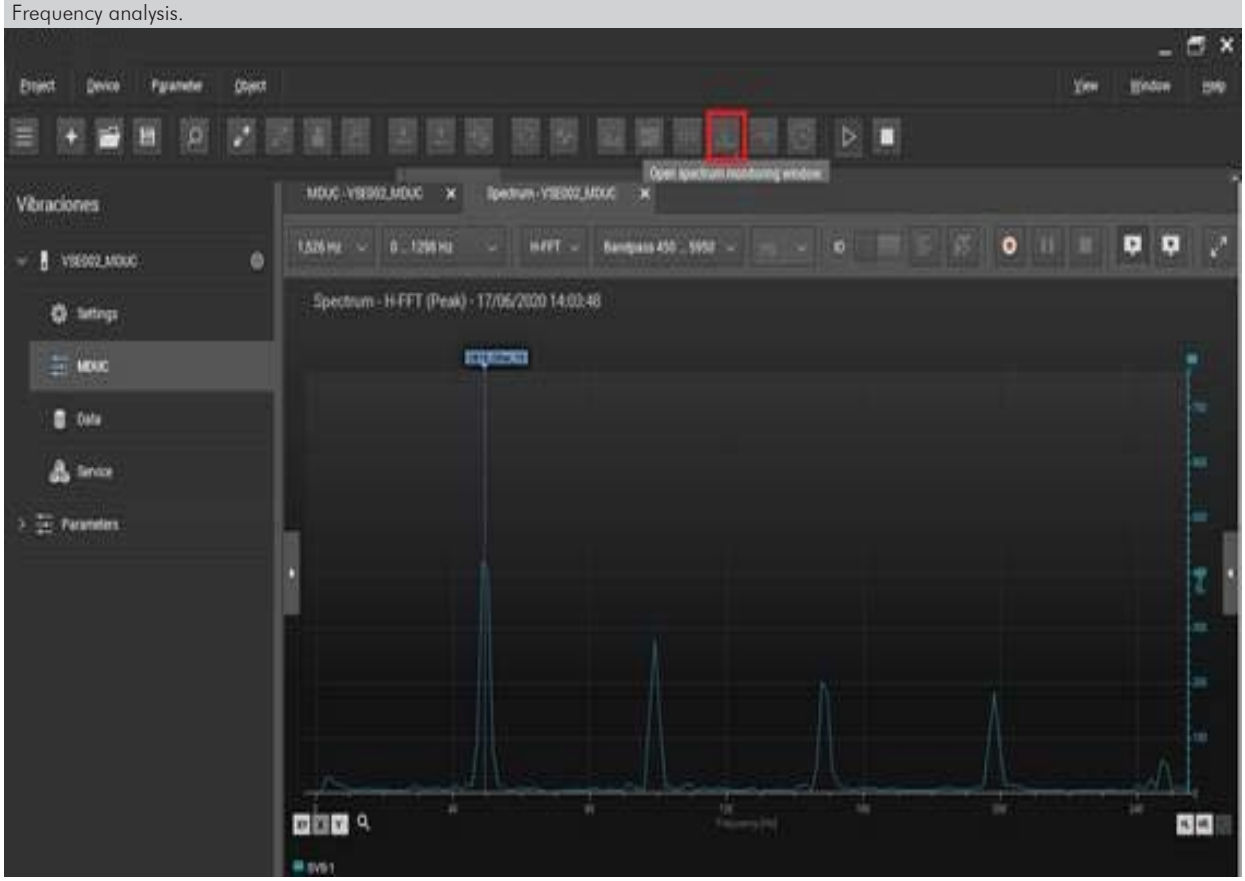
Operation with "MDU-SEV".



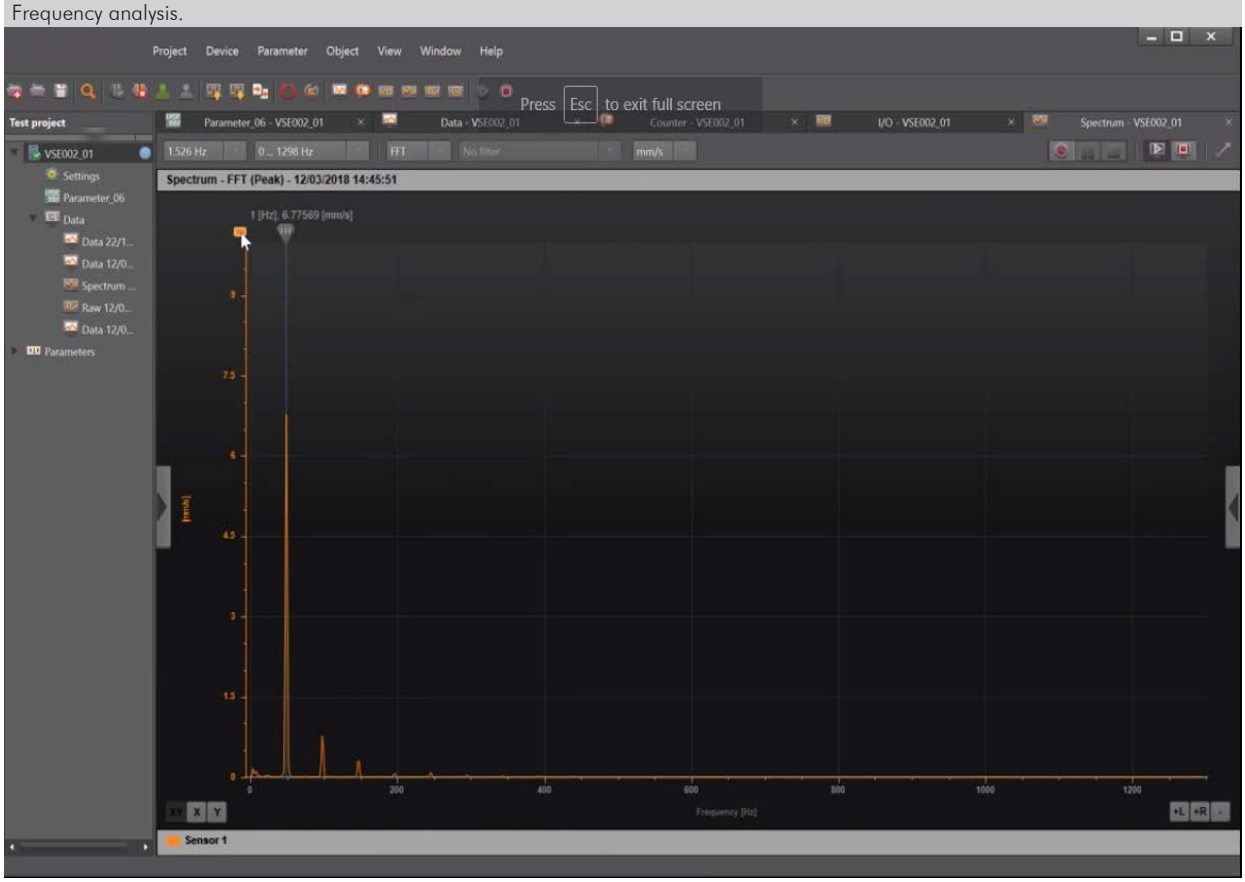
Analysis over time.

Some **real** results obtained from this unit

Frequency analysis.

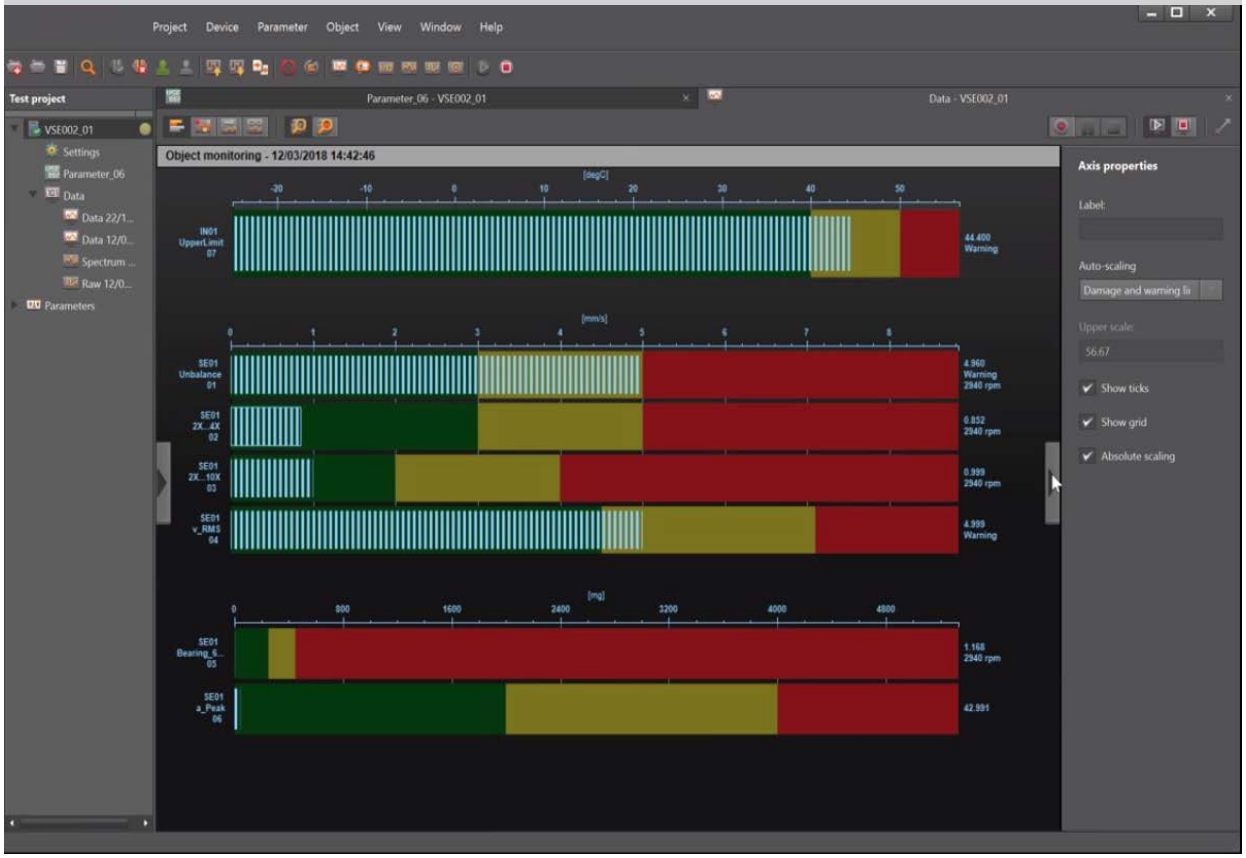


Frequency analysis.

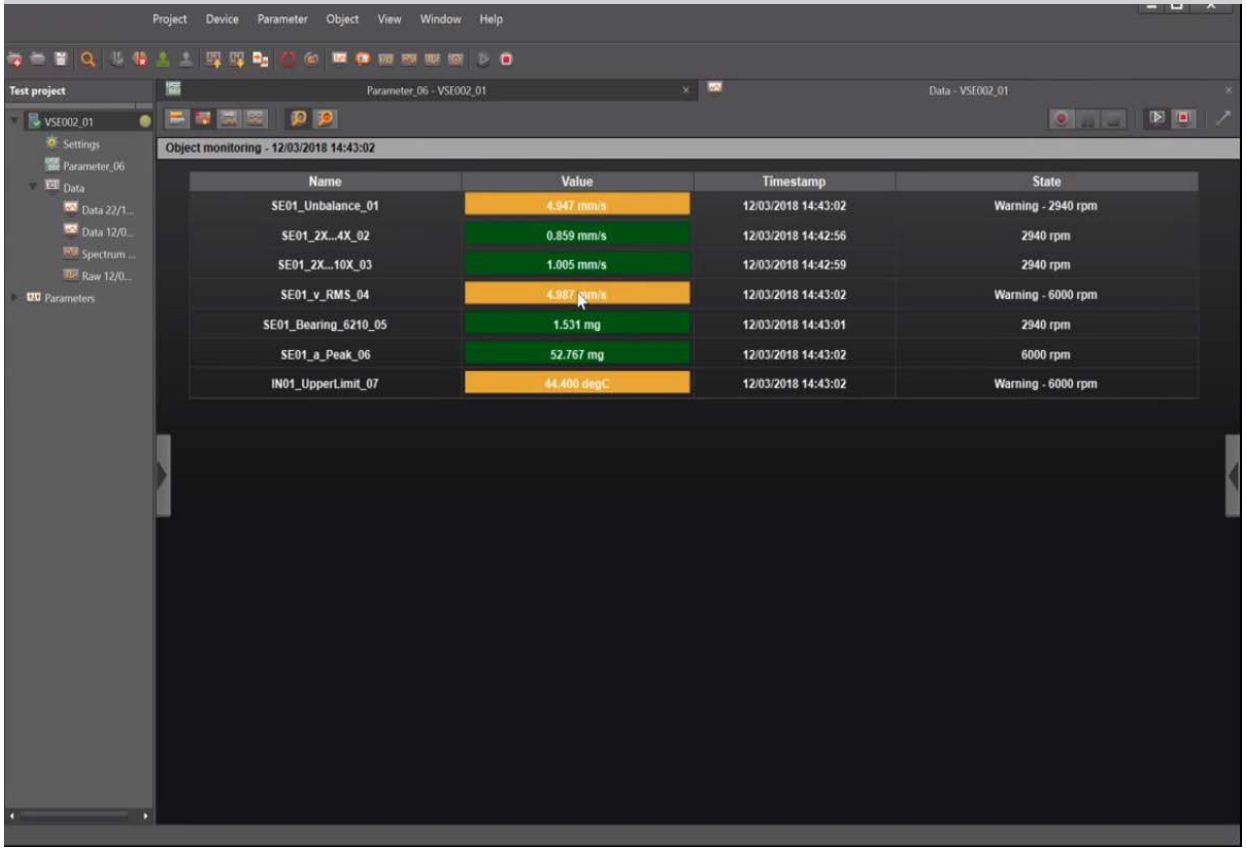


Some **real** results obtained from this unit

Values with alarms.



Instantaneous values.



Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 11.
All these items try to give more possibilities for:

a) Industrial configuration. (PLC)
b) Technical and Vocational Education configuration. (ICAI and FSS)
c) Multipost Expansions options. (MINI ESN and ESN)

a) Industrial configuration

⑦ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.

Circuit diagram in the module front panel.

Front panel:

Digital inputs (X) and Digital outputs (Y) block:

16 Digital inputs, activated by switches and 16 LEDs for confirmation (red).

14 Digital outputs (through SCSI connector) with 14 LEDs for message (green).

Analog inputs block:

16 Analog inputs (-10 V. to + 10 V.) (through SCSI connector).

Analog outputs block:

4 Analog outputs (-10 V. to + 10 V.) (through SCSI connector).

Touch screen:

High visibility and multiple functions. Display of a highly visible status. Recipe function. Bar graph function. Flow display function. Alarm list. Multi language function. True type fonts.

Back panel:

Power supply connector. Fuse 2A. RS-232 connector to PC. USB 2.0 connector to PC.

Inside:

Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.

Panasonic PLC:

High-speed scan of 0.32 μsec. for a basic instruction.

Program capacity of 32 Ksteps, with a sufficient comment area.

Power supply input (100 to 240 V AC).

DC input: 16 (24 V DC).

Relay output: 14.

High-speed counter.

Multi-point PID control.

Digital inputs/outputs and analog inputs/outputs Panasonic modules.

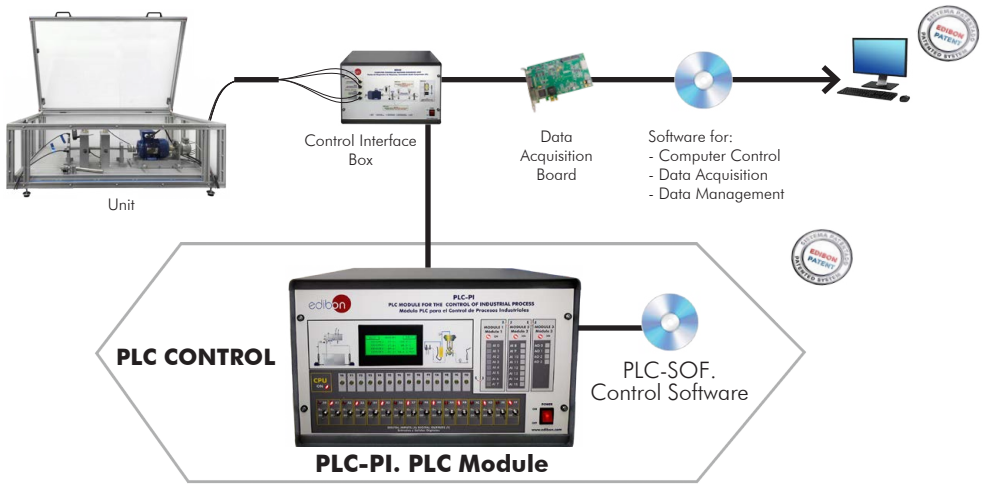
Communication RS232 wire to computer (PC).

Dimensions: 490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.). Weight: 30 Kg. approx. (66 pounds approx.).

-MDUC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

The software has been designed using Labview and it follows the unit operation procedure and linked with the Control Interface Box used in the Computer Controlled Machine Diagnosis Unit (MDUC).



Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.
13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
14.-New configuration and development of new process.
15.-Hand on an established process.
16.-To visualize and see the results and to make comparisons with the particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ MDUC/ICAI. Interactive Computer Aided Instruction Software.

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.

This software is optional and can be used additionally to items (1 to 6).

- 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.**

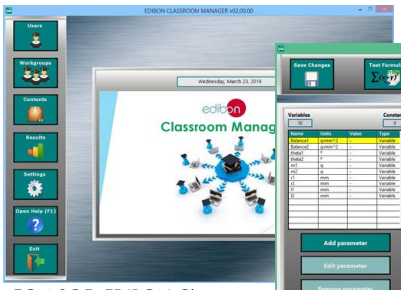
- ESL-SOF. EDIBON Student Labsoft (Student Software).

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.

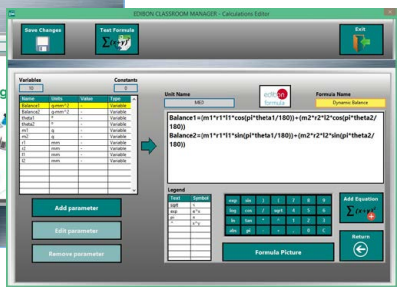
Innovative features:

- **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.**

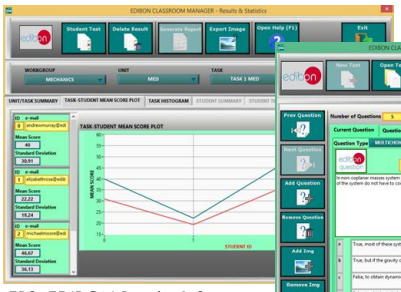
Instructor Software



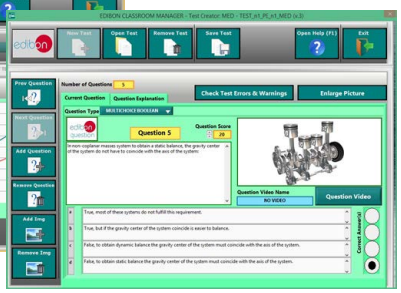
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



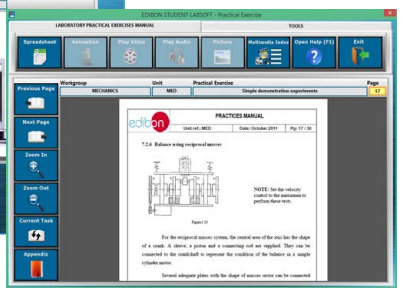
ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram



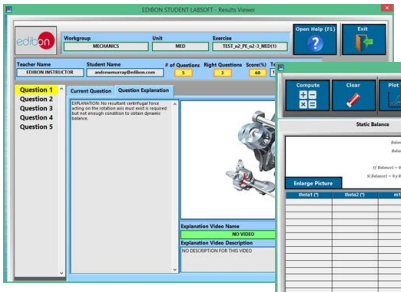
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software

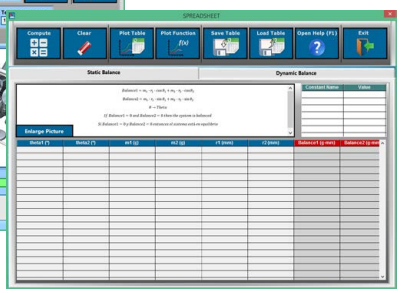
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

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

www.edibon.com/en/interactive-computer-aided-instruction-software

⑨ MDUC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit. It is useful for Technical and Vocational level.

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them. There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- **An incorrect calibration is applied to them.**
- **Non-linearity.**

Faults affecting the actuators:

- **Actuators channels interchange at any time during the program execution.**
- **Response reduction of an actuator.**

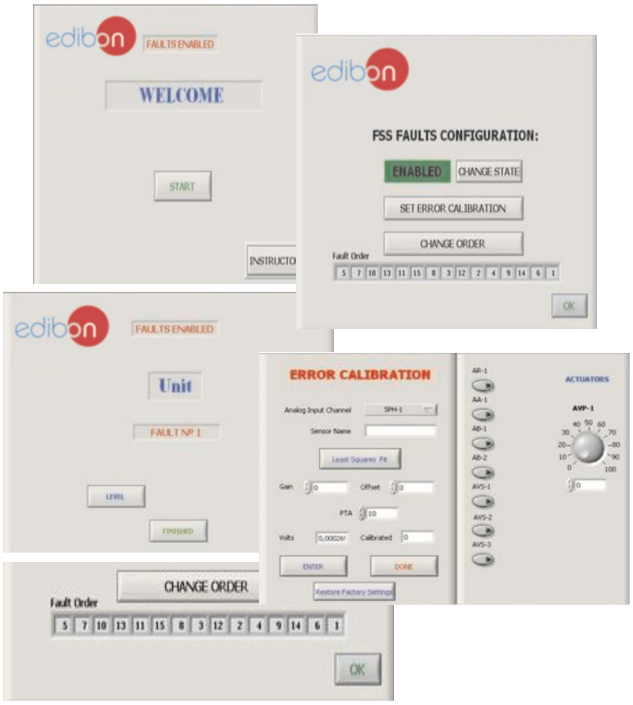
Faults in the controls execution:

- **Inversion of the performance in ON/OFF controls.**
- **Reduction or increase of the calculated total response.**
- **The action of some controls is annulled.**

On/off faults:

- **Several on/off faults can be included.**

Example of some screens



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

www.edibon.com/en/fault-simulation-system

c) Multipost Expansions options

⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

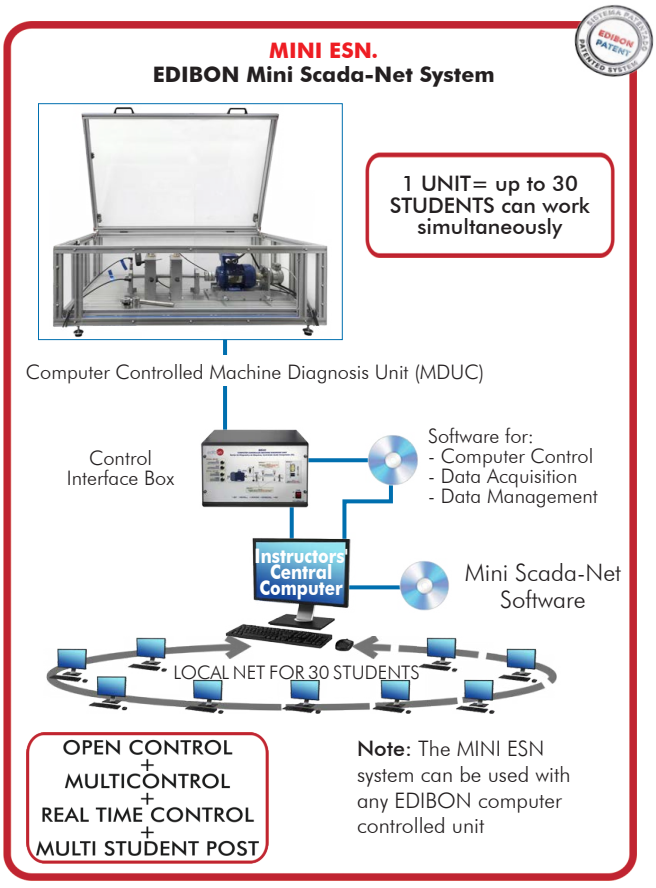
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

- **It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.**
- **Open Control + Multicontrol + Real Time Control + Multi Student Post.**
- **Instructor controls and explains to all students at the same time.**
- **Any user/student can work doing "real time" control/multicontrol and visualisation.**
- **Instructor can see in the computer what any user/student is doing in the unit.**
- **Continuous communication between the instructor and all the users/students connected.**

Main advantages:

- **It allows an easier and quicker understanding.**
- **This system allows you can save time and cost.**
- **Future expansions with more EDIBON Units.**



For more information see **MINI ESN** catalogue. Click on the following link:

www.edibon.com/en/edibon-scada-net

⑪ ESN. EDIBON Scada-Net Systems.

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

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

www.edibon.com/en/edibon-scada-net

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

①**Unit: MDUC. Computer Controlled Machine Diagnosis Unit.**

②**MDUC/CIB. Control Interface Box.**

③**DAB. Data Acquisition Board.**

④**MDUC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**

⑤**Cables and Accessories,** for normal operation.

⑥**Manuals.**

*IMPORTANT: Under MDUC we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.

Optional items (supplied under specific order)

a) Industrial configuration

⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

- PCL-PI. PLC Module.
- MDUC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

⑧ MDUC/ICAI. Interactive Computer Aided Instruction Software.

⑨ MDUC/FSS. Faults Simulation System.

c) Multipost Expansions options

⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑪ ESN. EDIBON Scada-Net Systems.

① MDUC. Unit:

The Computer Controlled Machine Diagnosis Unit, "MDUC", includes the following elements:

- The MDU Base Unit, "MDU-UB".
- The Software, Sensors and Control for MDU Unit, "MDU-SSC".
- Displacement Sensors for MDU Unit, "MDU-SD".

- MDU-UB. MDU Base Unit.

Main metallic elements made of stainless steel.

Asynchronous motor with frequency variator, with sliding support and two micrometres:

Drive power: 0.37 kW.

Nominal speed: 2800 rpm.

Adjustable power and speed.

Two shafts:

Short, diameter: 20 mm, length: 300 mm.

Long, diameter: 20 mm, length: 500 mm.

Three flexible motor-shaft couplings in order to compensate possible misalignments.

Two bearing sawhorses:

Ball bearings 6204-SKF.

Two unbalanced flywheels with removable counterweights (screws), thus allowing the balancing in 1 or 2 planes:

Diameter: 150 mm, 1700 g each.

Tachometer for recording the speed.

Toolkit and screws for assembly of all components.

Storage case.

Electronic console:

Metal box.

Main switch.

Speed sensor connector.

Motor connector.

Motor start switch.

Motor stop switch.

Motor rotation switch.

Motor controller by potentiometer.

Digital display for motor speed.

Digital display for motor power.

- MDU-SSC. Software, Sensors and Control for MDU Unit.

Two acceleration sensors for recording oscillation travel, oscillation speed and acceleration:

Frequency range: 1 – 10 kHz, sensitivity: 100 mV/g.

Resonance frequency of about 32 kHz.

Optical tachometer sensor:

Range: 100 – 60000 rpm.

Optical range: up to 2 m.

Class 2 laser of 675 nm.

USB connection.

- MDU-SD. Displacement Sensors for MDU Unit.

Two inductive displacement sensors:

Range: 1 – 10 mm.

The complete unit includes as well:

Advanced Real-Time SCADA.
Open Control + Multicontrol + Real-Time Control.
Specialized EDIBON Control Software based on LabVIEW.
National Instruments Data Acquisition board (250 KS/s, kilo samples per second).
Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.
Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
Capable of doing applied research, real industrial simulation, training courses, etc.
Remote operation and control by the user and remote control for EDIBON technical support, are always included.
Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
Designed and manufactured under several quality standards.
Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

Required elements (only one) (Not included):

- **MDU-MLB. Mobile Structure for MDU.**

Mobile table for the MDU Base Unit, "MDU-UB" or for the Computer Controlled Machine Diagnosis Unit, "MDUC", with the dimensions of 1100 x 770 x 820 mm.
The Mobile Structure for MDU, "MDU-MLB", includes:
MDU-SM. Top Table Structure for MDU:
Anodized aluminum frames.
Aluminum frame assembly without mechanization.
Transparent protective cover with safety switch.
Diagram in the front panel with distribution of the elements similar to the real one.
TF-WLB. Wheeled Laboratory Bench.
Anodized aluminum frames.
Aluminum frame assembly without mechanization.
Four steering wheels with brakes on two of them.
Two shelves for the accessories.

or

- **MDU-SM. Top Table Structure for MDU.**

Anodized aluminum frames.
Aluminum frame assembly without mechanization.
Transparent protective cover with safety switch.
Diagram in the front panel with distribution of the elements similar to the real one.

Additional recommended elements (Not included):

- **MDU-BLU. Break and Load Unit.**

The set consists mainly of:
Magnetic particle brake (adjustment and measurement of the braking torque):
Speed range: 200 – 2000 rpm.
Braking torque: 10 Nm.
Adjustment and measurement of the braking torque.
Integrated belt drive for the second speed range and the moment range:
Gear ratio between brake shafts: i = 3.
Speed range: 600 – 6000 rpm.
Braking torque: 3.3 Nm.
Axial fan for heat discharge.
Electric protection against superheating
Electronic console:
Main switch.
Brake switch.
Brake controller.
Digital display of brake excitation current.

- **MDU-SES. Set of Elastic Shaft.**

This set consists primarily of:
Two elastics shafts made of high-grade steel:
Diameter: 10 mm.
Length: 550 mm.
Nominal length between bearings: 450 mm.
Three bearings with holes for sensor housing.
Two bearing supports with oscillating ball bearings.
Vibration amplitude limitation bearing, diameter: 20 mm.
Storage case.
Required elements (Not included): MDU-SD. Displacement Sensors for MDU Unit.

- **MDU-SRS. Set of Rotating Shaft with Crank.**

The set consists mainly of:
Taker-in plate.
Flange with short shaft (additional recommended element Set of Belt Drive, "MDU-SBD"):
Diameter: 90 mm.
Flange with long shaft (for flywheel).
Diameter: 90 mm.
Six screws:
Hexagon head screw for flange M8 x 20.
Clamping kit.
Two shafts:
Diameter: 20 mm.
Short shaft for "projecting shaft end" simulation:
Length: 85 mm.
Max. allowable bending moment: 15.9 Nm.
Long shaft for "elastic rotor" simulation:
Length: 200 mm.
Max. allowable bending moment: 3,9 Nm.
Centering mandrel for shaft alignment during the test assembly.
Required elements (Not included):
- MDU-SES. Set of Elastic Shaft.
and
- MDU-SBD. Set of Belt Drive.

- **MDU-SRBF. Set of Roller Bearings with Faults.**
  The set consists mainly of:
    Six oscillating ball bearings:
      Inner diameter: 20 mm.
      Outer diameter: 47 mm.
      Width: 14 mm.
      Number of balls: 12.
      Bearings:
        Bearing with damaged outer ring.
        Bearing with damaged inner ring.
        Bearing with damaged rolling element.
        Bearing with combined damage.
        Widely used bearing.
        New and non-faulty bearing
    Roller bearing bracket.
    Retaining rings.
    Tool for retaining rings.
  Additional recommended elements (Not included): MDU-SBD. Set of Belt Drive.

- **MDU-SCO. Set of Couplings.**
  The set consists mainly of:
    Curved tooth coupling.
    Non-faulty flange coupling.
    Flange coupling with eccentricity fault:
      Eccentricity fault (non-centering): 0.2 mm.
    Flange coupling with oscillation fault:
      Oscillation fault: 0.4 ± 0.1 mm.
    Bolt coupling with variable pitch fault:
      Non-eccentric bolt.
      Eccentric bolt:
        Bolt eccentricity: 1 mm.
      Max. pitch error: 180° ± 1.909°.
    Four stars for claw coupling:
      98 Shore A (red).
      92 Shore A (yellow).
      64 Shore D (green).
      80 Shore A (blue).
    Roller bearing bracket with elastic support.
  Additional recommended elements (Not included): MDU-BLU. Break and Load Unit.

- **MDU-SBD. Set of Belt Drive.**
  The set consists mainly of:
    Rubber V-belt:
      SPX profile, approx. 10 mm wide.
      Belt length: 915 mm.
    Damaged rubber V-belt:
      SPX profile, approx. 10 mm wide.
      Belt length: 915 mm.
    Small drive pulley:
      Diameter: 63 mm.
    Small pulley with eccentricity fault for the V-belt:
      Diameter: 63 mm.
    Large pulley:
      Diameter: 125 mm.
    Distance between shafts: 300 mm.
    Clamping kit.
    Belt pre-tension meter: 0 – 150 N.
    Belt tensioning device.
    Individually adjustable tensor rollers.
    V-belt tension adjustment.
  Required elements (Not included): MDU-BLU. Break and Load Unit.

- **MDU-SSDG. Set to Study Damage in Gears.**
  The set consists mainly of:
    Transparent box cover to observe the gear in operation.
    Holes for vibration sensors.
    Sets of straight-toothed gears, with fault:
      Sprocket wheel: 75 teeth each, m= 2.
      Pinion: 25 teeth each, m= 2.
    Sets of straight-toothed gears, without fault:
      Sprocket wheel: 75 teeth each, m= 2.
      Pinion: 25 teeth each, m= 2.
    Sets of helical-toothed gears, with fault:
      Sprocket wheel: 75 teeth each, m= 2.
      Pinion: 25 teeth each, m= 2.
    Sets of helical-toothed gears, without fault:
      Sprocket wheel: 75 teeth each, m= 2.
      Pinion: 25 teeth each, m= 2.
    Gear fixing shafts.
    Variable wheelbase.
    Motor oil SAE 10 W – 40, 1 l for lubricating the gears.
    Storage case.
  Required elements (Not included): MDU-BLU. Break and Load Unit.

- MDU-SCM. Set of Crank Mechanism.

The set consists mainly of:
- Crank and connecting rod mechanism with adjustable stroke:
  - Stroke: 50 – 75 – 100 mm.
- Two balance weight masses: Total 490 g, designed to operate with a 50 mm stroke.
- Bearing set adjustment:
  - Bearing clearance: 0 – 1 mm.
- Two pressure springs:
  - Length without tension: 170 mm.
  - Spring ratio: R = 0.55 N/mm.

Additional recommended elements (Not included):
- MDU-SBD. Set of Belt Drive.

or
- MDU-SSDG. Set to Study Damage in Gears.

- MDU-SSCP. Set to Study Cavitation in Pumps.

The set consists mainly of:
- Centrifugal pump:
  - Max. flow rate: 17 l/min (3300 min^{-1}).
  - Max. lift height: 12 m (3300 min^{-1}).
  - Three-vane impeller.
  - Minimum speed for cavitation: 2240 min^{-1} approx. (choked suction side).
- Two manometers:
  - Pressure side: 0 – 4 bar.
  - Suction side: -1 – 1.5 bar.
- Casing cap.
- Knurled screw to open the casing cap.
- Suction side tube.
- Two ball valves.
- Set of flexible tubes.
- Tank:
  - Material: HDPE.
  - Capacity: 20 l.

Additional recommended elements (Not included): MDU-SBD. Set of Belt Drive.

- MDU-SSVF. Blower Vibration Set for MDU.

The set consists mainly of:
- Steel plate impeller with three movable vanes:
  - Diameter: 204 mm.
  - Max. speed: 3000 min^{-1}.
- Steel plate impeller with five movable vanes:
  - Diameter: 204 mm.
  - Max. speed: 3000 min-1.
- Steel plate impeller with seven movable vanes:
  - Diameter: 204 mm.
  - Max. speed: 3000 min^{-1}.
- Flywheel plate to simulate axial forces.
- Protective cover.
- Roller bearing bracket.
- Aluminum protective plate, diameter: 220 mm.
- Permanent magnet.

Additional recommended elements (Not included): MDU-SBD. Set of Belt Drive.

- MDU-SEV. Set of Electromechanical Vibrations.

The set consists mainly of:
- Asynchronous motor with variable speed:
- Drive power: 0.37 kW.
- Nominal speed: 2800 rpm.
  - Adjustable power and speed.
  - Variable air gap due to stator displacement.
  - Winding disconnect switch.
- Current clamp. Adjustable magnet-vane distance.

Required elements (Not included): MDU-BLU. Break and Load Unit.

② MDUC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.
Control interface box with process diagram in the front panel.
The unit control elements are permanently computer controlled.
Simultaneous visualization in the computer of all parameters involved in the process.
Calibration of all sensors involved in the process.
Real time curves representation about system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
Shield and filtered signals to avoid external interferences.
Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.
Real time computer control for parameters involved in the process simultaneously.
Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.
PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.
Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).
Analog output: Channels=2. Resolution=16 bits, 1 in 65536.
Digital Input/Output: Channels=24 inputs/outputs.
The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

④ MDUC/CCSOF. Computer Control +Data Acquisition+Data Management Software:

The three softwares are part of the SCADA system.
Compatible with the industry standards.
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
Management, processing, comparison and storage of data.
Sampling velocity up to 250 KS/s (kilo samples per second).
Calibration system for the sensors involved in the process.
It allows the registration of the alarms state and the graphic representation in real time.
Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

This unit is supplied with 8 manuals: Required services, Assembly and Installation, Interface and Control software, Starting-up, Safety, Maintenance, Calibration & Practices manuals.

Exercises and Practical Possibilities to be done with the Main Items

1.- Assessment of the vibration state of a machine.
2.- Measuring the vibrations caused by unbalanced operation of rigid rotors in 1 and 2 planes.
3.- Study of the basic essentials of the vibration measurement in shafts and bearings.
4.- Study of the basic magnitudes and parameters.
5.- Use of measuring sensors and instruments.
6.- Understanding the influence of speed and shaft and recorder arrangements.
7.- Learning to balance rigid shafts in operation and alignment between motor and bearing.
8.- Understanding and interpreting the frequency spectra.
9.- Learning about the different vibration signals.
10.- Applying the FFT analysis correctly.
11.- Measuring the speed, oscillation travel, oscillation speed and acceleration.
12.- Learning about the effects of alignment on different types of couplings.
13.- Learning about the effects of speed on vibration behavior.
14.- Learning about the effects of the balanced and unbalanced elastic rotor (MDU-SES kit is required).
15.- Study of the variation of a typical vibration behavior (vibration velocity, frequency, amplitude, and phase) due to a fissure (MDU-SRS kit is required).
16.- Identifying cracks and fissures in shafts through acceleration curves and order analysis (MDU-SRS is required).
17.- Identifying a fissure through the variation of a vibration spectrum (MDU-SRS is required).
18.- Estimating the life cycle of a roller bearing (MDU-SRBF is required).
19.- Identifying faulty roller bearings (MDU-SRBF required).
20.- Checking the effects of roller bearing faults on outer and inner ring, or the roller bearing body on the vibration spectrum (MDU-SRBF is required).
21.- Understanding the effect of ring gear hardness on claw couplings (MDU-SCO is required).
22.- Comparing the curved tooth, bolt, flange or claw couplings (MDU-SCO is required).
23.- Understanding the importance of belt tension in vibration behavior (MDU-SBD is required).
24.- Checking the effect of the eccentricity in pulleys and the speed in vibration behavior (MDU-SBD is required).
25.- Comparison between defective and non-defective belts (MDU-SBD is required).
26.- Understanding and interpreting the frequency spectra in order to differentiate between defective and non-defective belts (MDU-SBD is required).
27.- Identifying defects in the gears according to their vibration behavior (MDU-SSDG is required).
28.- Learning about the effect of the toothed gear, the lubrication used and the wheelbase and the backlash (MDU-SSDG is required).
29.- Identifying wear on the rod and piston (MDU-SCM is required).
30.- Learning about the effect of bearing clearance and impacts (MDU-SCM is required).
31.- Study of the vibrations of a centrifugal pump in operation (MDU-SSCP is required).
32.- Understanding the cavitation phenomenon in a centrifugal pump (MDU-SSCP is required).
33.- Identifying vibrations caused by the movable vanes in the vibration spectrum (MDU-SSCP is required).
34.- Measuring the pitch frequency between movable vanes (MDU-SSCP is required).
35.- Measuring the blower vibrations (MDU-SSCP is required).
36.- Learning about the effect of an asymmetric air gap on the vibration behavior and the electromagnetic and performance losses (MDU-SEV is required).
37.- Learning about the effect of the electrical windings on vibration behavior (MDU-SEV is required).

Other possibilities to be done with this unit:

38.-Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
39.-Open Control, Multicontrol and Real Time Control.
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
40.-The Computer Control System with SCADA allows a real industrial simulation.
41.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
42.-This unit can be used for doing applied research.
43.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
44.-Control of the MDUC unit process through the control interface box without the computer.
45.-Visualization of all the sensors values used in the MDUC unit process.

- By using PLC-PI additional 19 more exercises can be done.
- Several other exercises can be done and designed by the user.

a) Industrial configuration

⑦ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.
Circuit diagram in the module front panel.
Digital inputs (X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.
Analog inputs block: 16 Analog inputs.
Analog outputs block: 4 Analog outputs.
Touch screen.
Panasonic PLC:
High-speed scan of 0.32 μsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.
Digital inputs/outputs and analog inputs/outputs Panasonic modules.

-MDUC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.
13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
14.-New configuration and development of new process.
15.-Hand on an established process.
16.-To visualize and see the results and to make comparisons with the particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **MDUC/ICAI. Interactive Computer Aided Instruction Software.**

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.

- 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.

- 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.

⑨ MDUC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit.
The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them.
There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:
- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:
- Actuators channels interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:
- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

On/off faults:
- Several on/off faults can be included.

c) Multipost Expansions options

⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.
The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.
Main characteristics:
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:
- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:
This system is used with a Computer Controlled Unit.
- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

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

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REPRESENTATIVE: