

## DESCRIPTION

The EMDA is a complete digital and analogue communications trainer designed to explain the basic concepts of modulation.

It covers the principles of many of the modulation and demodulation techniques used in modern analogue and digital communication systems.

The trainer provides a basic understanding of the concepts behind analogue and digital communications techniques: Amplitude Modulation (AM), Frequency Modulation (FM), Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Pulse Code Modulation (PCM), Differential Pulse Code Modulation (DPCM), Delta and Continuously Variable Slope Delta (CVSD) Modulation, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK/BPSK), etc.

It allows students to study some of the line coding techniques like NRZ(L), NRZ(M), RZ, RB, AMI, etc.

Finally, the basic principles of Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM) are introduced.



**Metallic box.**

**Power Supply.**

**Block diagram.**

**Carrier signal Generators Circuits.**

**Audio signal Generator Circuit.**

**Digital Generator and Line Coding Circuits:**

- Non Return to Zero Level line coding circuit (NRZL).
- Non Return to Zero Mark line coding circuit (NRZM).
- Biphase Manchester line coding circuit.
- Biphase Mark circuit line coding circuit.
- Return to Zero line coding circuit (RZ).
- Return to Bias line coding circuit (RB).
- Alternate Mark Inversion line coding circuit (AMI).

**Pulse Amplitude Modem (PAM):**

- Sample & Hold circuit.
- Filter and Amplifier circuits.

**Pulse Width Modem (PWM):**

- Sawtooth Generator circuit.
- Mixer circuit.
- Filter and Amplifier circuits.

**Pulse-Position Modulation Modem ( PPM):**

- Mixer circuit.
- Filter and Amplifier circuits.

**Amplitude-Shift Keying (M-ASK):**

- Mixer circuit.
- Zero-Crossing circuit.
- Filter and Amplifier circuits.

**Frequency-Shift Keying (FSK):**

- Mixer circuits.
- Phase-Lock Loop circuit.
- Voltage Controlled Oscillator circuit.
- Phase Comparator circuit.

**Phase-Shift Keying (PSK):**

- Binary Phase Shift Keying modulator circuit (BPSK).
- Quadrature Phase Shift Keying modulator circuit (QPSK).
- Differential Phase Shift Keying modulator circuit (DPSK).
- Mixer circuits.
- Phase-Lock Loop circuit.
- Voltage Controlled Oscillator circuit.
- Phase Comparator circuit.
- Filter and Amplifier circuits.

**Amplitude Modulation (AM):**

- AM modulator circuit (AM).
- Single Side Band Suppressed Carrier AM modulator circuit (SSBSC).
- Double Side Band Suppressed Carrier modulator circuit (DSBSC).
- Quadrature Amplitude modulator circuit (QAM).
- Radio- Frequency Tuning circuit.
- Intermediate-Frequency Mixer circuit.
- Intermediate-Frequency Amplifier circuit.
- Envelope detector circuit.
- Product Detector circuit.
- Filter and Amplifier circuits.

**Frequency Modulation (FM):**

- Mixer circuits.
- Phase-Lock Loop circuit.
- Voltage Controlled Oscillator circuit.
- Phase Comparator circuit.
- Filter and Amplifier circuits.

**Time Division Multiplexing (TDM):**

- Sample and Hold circuits.
- Synchronization circuits.
- Multiplexing circuits.
- Filter and Amplifier circuits.

**Frequency Division Multiplexing (FDM):**

- Mixer circuits.
- Band-Pass Filters.
- Filters and Amplifier circuits.

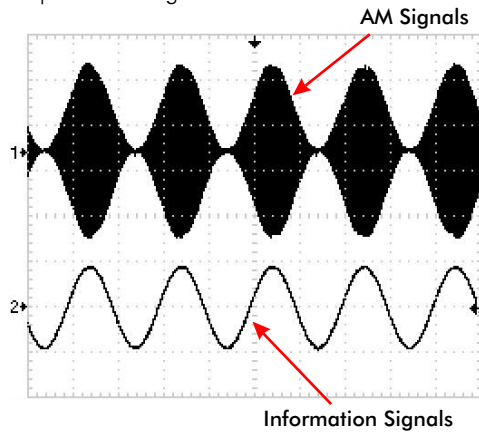
**Cables and Accessories,** for normal operation.

**Manuals:**

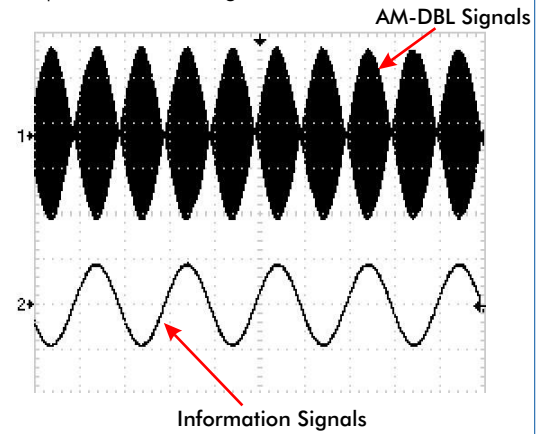
This unit is **supplied with the following manuals:** Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

## Some Typical Signals

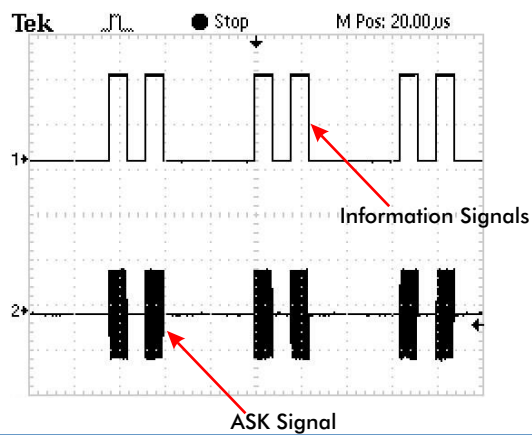
Example of **AM** Signals



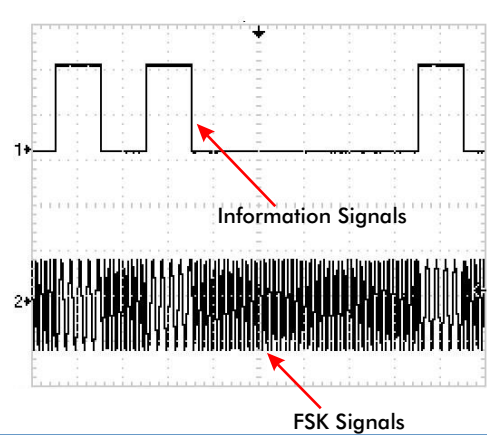
Example of **AM-DBL** Signals



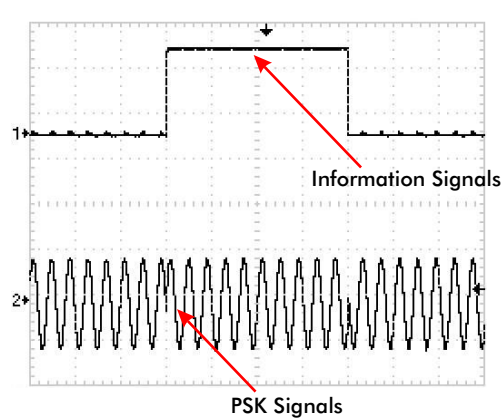
Example of **ASK** Signals



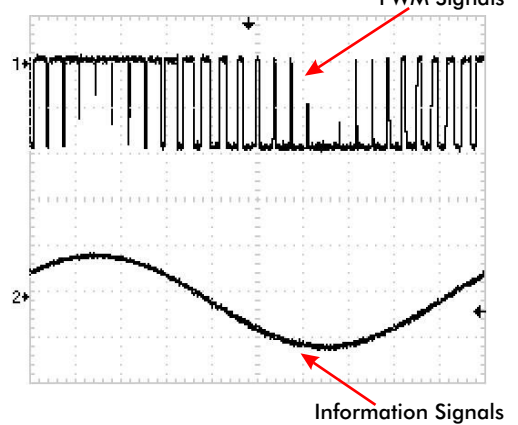
Example of **FSK** Signals



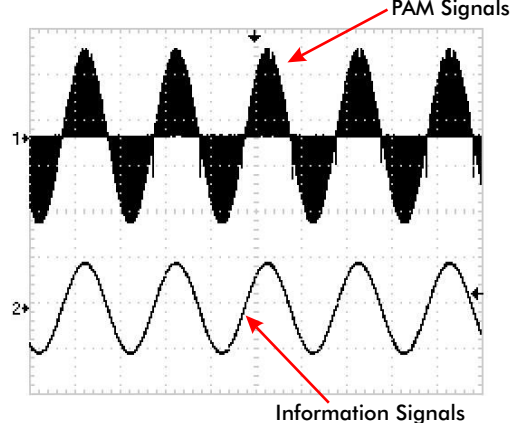
Example of **PSK** Signals



Example of **PWM** Signals



Example of **PAM** Signals



## EXERCISES AND PRACTICAL POSSIBILITIES

### Some Practical Possibilities of the Unit:

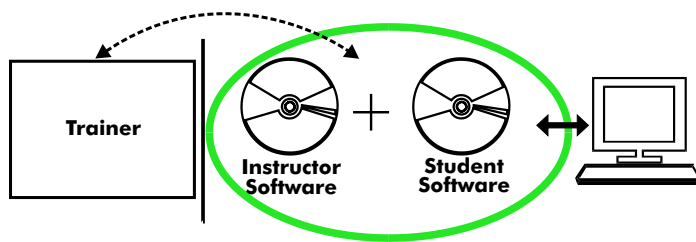
- |  |   |
|--|---|
| <ul style="list-style-type: none"><li>1.- Study of the data coding techniques : NRZ(L), NRZ(M) RZ, RB, Biphase Mark, AMI.</li><li>2.- Study of basic principles of ASK modulation and demodulation technique.</li><li>3.- Study of the spectrum of an ASK signal.</li><li>4.- Study of a 4-ASK signal.</li><li>5.- Study of basic principles of FSK modulation and demodulation technique.</li><li>6.- Study of the spectrum of an FSK signal.</li><li>7.- Advantages and disadvantages of ASK and FSK signals.</li><li>8.- Basic principles of PWM and PPM modulation and demodulation.</li><li>9.- Study of basic principles of PSK modulation and demodulation technique.</li><li>10.- Study of PSK and QPSK variants of PSK modulation.</li><li>11.- Study of basic principles of AM modulation and demodulation technique.</li><li>12.- Comparison of the spectrum of AM, SSBSC, DSBSC signals.</li></ul> | <ul style="list-style-type: none"><li>13.- Introduction to the basic concept of the superheterodyne receiver.</li><li>14.- Introduction to the QAM modulation.</li><li>15.- Study of basic principles of FM modulation and demodulation technique.</li><li>16.- Introduction to the PLL operation.</li><li>17.- Introduction to the principle of TDM.</li><li>18.- Introduction to the principle of FDM.</li><li>19.- Study of Modems.</li><li>20.- Bit error measurements.</li><li>21.- Evaluation of the effects of noise on the transmission of digital signals.</li></ul> |
|--|---|

## DIMENSIONS & WEIGHTS

- Dimensions: 490 x 450 x 470 mm. approx.
- Weight: 40 Kg. approx.

## REQUIRED SERVICES

- Electrical supply: single-phase, 220V./50Hz or 110V./60Hz.



With no physical connection between trainer and computer, this complete package consists on an Instructor Software (INS/SOF) totally integrated with the Student Software (EMDA/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students. These, on the other hand, get a virtual instructor who helps them to deal with all the information on the subject of study.

Examples of the Software screens

With the **INS/SOF. Classroom Management Software Package (Instructor Software)**, the Instructor has a whole range of options, among them:

- Organize Students by Classes and Groups.
  - Create easily new entries or delete them.
  - Create data bases with student information.
  - Analyze results and make statistical comparisons.
  - Print reports.
  - Develop own examinations.
  - Detect student's progress and difficulties.
- ...and many other facilities.



This Instructor Software, working in network configuration, allows controlling all the students in the classroom.

## EMDA/SOF. Computer Aided Instruction Software Package (Student Software).

It explains how to use the trainer, run the experiments and what to do at any moment.

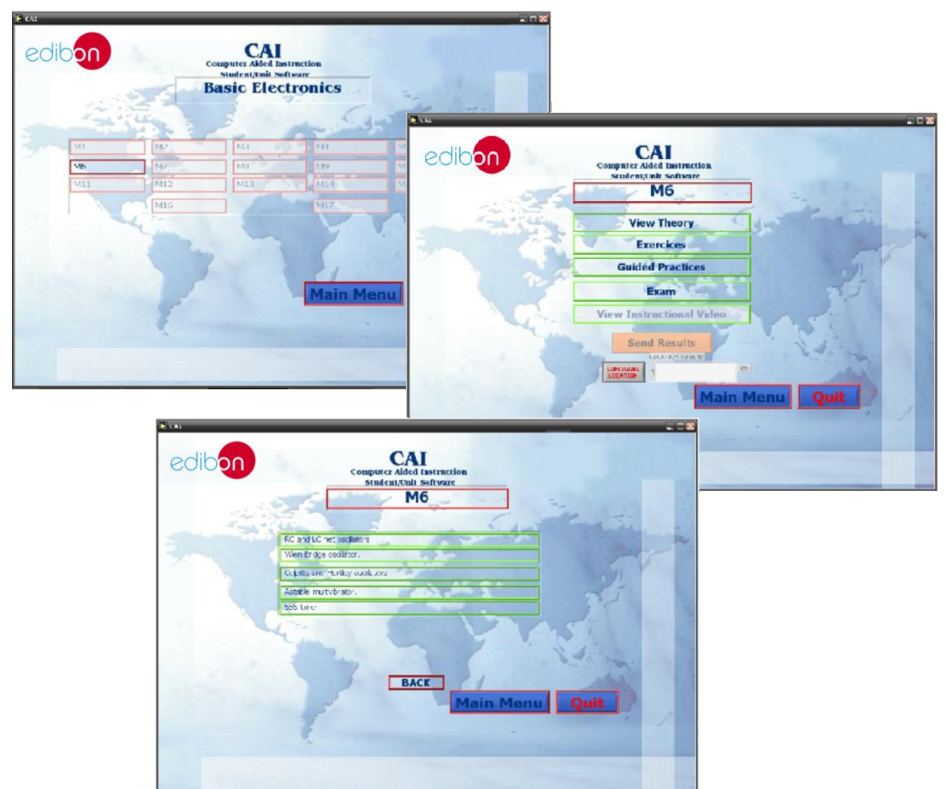
- The options are presented by pull-down menus and pop-up windows.
- Each Software Package contains:

**Theory:** that gives the student the theoretical background for a total understanding of the studied subject.

**Exercises:** divided by thematic areas and chapters to check out that the theory has been understood.

**Guided Practices:** presents several practices to be done, alongside the trainer, showing how to complete exercises and practices.

**Exams:** set of questions presented to test the obtained knowledge.



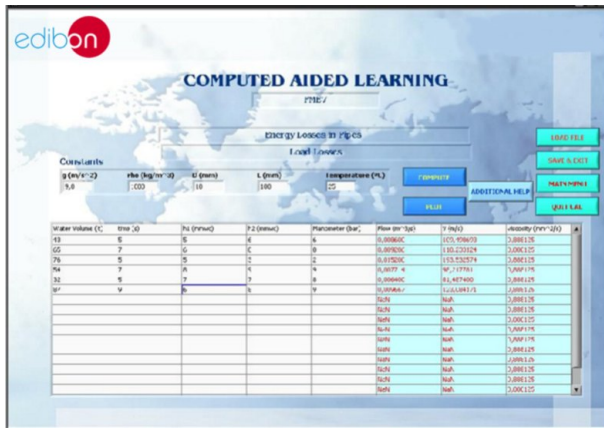


## EMDA/CAL. Computer Aided Learning Software (Results Calculation and Analysis)

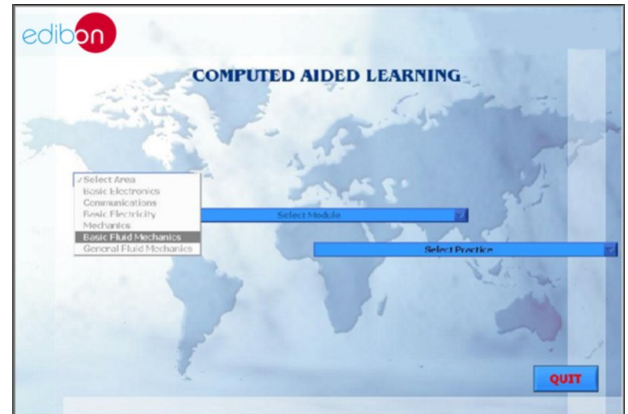
This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use specifically developed by EDIBON. It has been designed to cover different areas of science: Basic Electronics, Communications, Basic Electricity, Energy, Mechanics, Basic Fluid Mechanics and General Fluid Mechanics\*.

\*Although only the purchased areas will be activated and ready to use.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices. With a single click, CAL computes the value of all the variables involved. Also, CAL gives the option of plotting and printing the results.



Simply insert the experimental data, with a single click CAL will perform the calculations.



Once the Area of study is selected, the right module can be chosen among a wide range, each one with its own set of lab exercises.



Between the plotting options, any variable can be represented against any other. And there exist a great range of different plotting displays.



Among the given choices, an additional help button can be found, which offers a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

The screenshot shows the 'COMPUTED AIDED LEARNING' window with a table of 'MAIN CONSTANT VALUES'. The table lists various physical constants, their symbols, and their values.

Quantity	Symbol	Value
characteristic impedance of vacuum	$Z_0 = \mu_0 c$	376.730 313 461 ... $\Omega$
electric constant (permittivity of free space)	$\epsilon_0 = 1/(\mu_0 c^2)$	$8.854 187 817 \times 10^{-12} \text{ F m}^{-1}$
magnetic constant (permeability of free space)	$\mu_0$	$4\pi \times 10^{-7} \text{ N A}^{-2} = 1.2566 370 614 \times 10^{-6} \text{ N A}^{-2}$
Newtonian constant of gravitation	$G$	$6.6742(10) \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
Planck's constant	$h$	$6.626 0693(11) \times 10^{-34} \text{ J s}$
Dirac's constant	$\hbar = h/(2\pi)$	$1.054 571 68(18) \times 10^{-34} \text{ J s}$

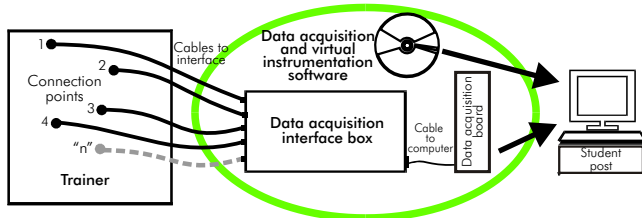
It provides a handy option to avoid using different reference sources while in progress. For example: the values of Physical constants, their symbols and right names, conversion factors...

The screenshot shows the 'COMPUTED AIDED LEARNING' window with a table of 'DIRECT INTEGRALS'. The table lists various mathematical integrals and their results.

Integral	Result
$\int \cos \omega t \, dt$	$\frac{1}{\omega} \sin \omega t$
$\int t^n \, dt$	$\frac{t^{n+1}}{n+1}, n \neq -1$
$\int \frac{dt}{t}$	$\ln  t $
$\int e^t \, dt$	$e^t$
$\int e^{at} \, dt$	$\frac{e^{at}}{a}$

...and the very useful Integral and Derivative tables.

\* Software is available in English and Spanish. Any other language available on request.



EDAS/VIS is the perfect link between the trainer and the PC. With the EDAS/VIS system, information from the trainer is sent to the computer. There, it can be analyzed and represented.

We easily connect the Data Acquisition Interface Box (DAIB) to trainer with the supplied cables (connection points are placed in the trainer). Like any other hardware, the DAIB is connected to the PC through the Data Acquisition Board (DAB), and by using the Data acquisition and Virtual Instrumentation Software, the student can get the results from the undertaken experiment/practice, see them on the screen and work with them.

This EDAS/VIS System includes DAIB + DAB + EDAS/VIS-SOF:

## 5.1) Hardware:

### 5.1.1) DAIB. Data Acquisition Interface Box:

Metallic box. Dimensions: 310 x 220 x 145 mm. approx.

Front panel:

**16 Analog inputs** (1 block with 12 voltage channels and 1 block with 2 current channels (4 connections)).

Sampling velocity **1,250,000 samples per second** for EDAS/VIS 1.25 Version.

Sampling velocity **250,000 samples per second** for EDAS/VIS 0.25 Version.

**2 Analog outputs.**

**24 Digital inputs/outputs**, configurable as inputs or outputs, with 24 state led indicators.

These digital inputs/outputs are grouped in three ports of eight channels (P0, P1 and P3).

**4 Digital signal switches 0-5V. 2 Analog signal potentiometers  $\pm 12V$ .**

Main ON/OFF switch.

Inside: Internal power supply of 12 and 5 V. Potentiometer.

Back panel: Power supply connector. SCSI connector (for data acquisition board).

Connecting cables.



DAIB



### 5.1.2) DAB. Data Acquisition Board:

**For EDAS/VIS 1.25 Version:**

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

**Analog input:** Number of channels= 16 single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536. **Sampling rate up to: 1,250,000 S/s (samples per second)**. Input range (V)= $\pm 10V$ . Data transfers=DMA, interrupts, programmed I/O. DMA channels=6.

**Analog output:** Number channels=2. **Resolution=16 bits**, 1 in 65536. **Max. output rate up to: 833KS/s**. Output range(V)= $\pm 10V$ . Data transfers=DMA, interrupts, programmed I/O.

**Digital Input/Output:** Numbers of channels=24 inputs/outputs. Port 0 up to 8 Mhz.

Timing: Counter/timers=2. Resolution: Counter/timers: 32 bits.

**For EDAS/VIS 0.25 Version:**

Sampling rate up to: **250,000 S/s** (samples per second).

Analog output: **Max. output rate up to: 10 KS/s**.

Digital Input/Output: Number of channels=24 inputs/outputs. Port 0 up to 1 Mhz.

Rest of characteristics are the same than EDAS/VIS 1.25 Version.



DAB



## 5.2) EDAS/VIS-SOF. Data Acquisition and Virtual Instrumentation Software:

Compatible with actual Windows operating systems. Amicable graphical frame.

Configurable software allowing the temporal/frequency representation of the different inputs and outputs. Visualization of a voltage of the circuits on the computer screen.

It allows data store in a file, print screens and reports of the signals at any time.

Measurement, analysis, visualization, representation and report of results.

Set of Virtual Instruments:

### - Oscilloscope:

Channels: 12 simultaneous. Maximum input voltage:  $\pm 10V$ .

All 12 input channels could be scaled to compare signal with different voltage levels.

"Math Menu" with operations as Addition, Subtraction, Multiplication and Division, between any of the 12 oscilloscope channels.

### - Function Generator:

Two independent signal generators, for sinusoidal, triangular, saw tooth and square.

Channels: 2 (allowing working simultaneously). Maximum output voltage:  $\pm 10V$ .

It includes a graph where an output signal for each channel is shown.

### - Spectrum Analyzer:

Channels: 12 (simultaneous). Max. voltage:  $\pm 10V$ . Spectrum analyzer: based on the FFT.

### - Multimeter:

Voltmeter (Channels: 12 (simultaneous). Max. voltage:  $\pm 10V$  RMS).

Ammeter (Channels: 2 (simultaneous). Max. Ampere: 500 mA rms per channel).

### - Transient Analyzer.

### - Logic Analyzer:

Number of Input channels: 8. TTL Voltage Level. Clock Source: 3 different sources.

This instrument allows receiving as far as 8 digital signal simultaneously at 1 or 8 Mbps (depending the version).

### - Logic Generator:

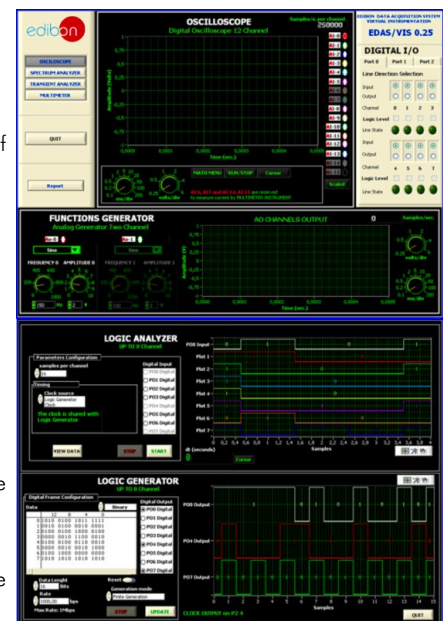
Number of transmission channels: 8. TTL voltage level.

This instrument allows generating up to 8 digital simultaneous signals of 1 or 8 Mbps (depending of the version).

Sampling velocity **1,250,000 samples per second** for EDAS/VIS 1.25 Version.

Sampling velocity **250,000 samples per second** for EDAS/VIS 0.25 Version.

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



EDAS/VIS-SOF

**Important!** Only one EDAS/VIS is needed for all basic electronic boards. One EDAS/VIS is needed for each student work post. The EDAS/VIS allows to work with several basic electronic boards simultaneously.

\* Software available in English and Spanish. Any other language available on request.

Note: for more information see EDAS/VIS specific Catalogue: [www.edibon.com/products/catalogues/en/units/communications/digital/EDAS-VIS.pdf](http://www.edibon.com/products/catalogues/en/units/communications/digital/EDAS-VIS.pdf)

CAI. **Computer Aided Instruction Software System.**

EMDA/CAL. **Computer Aided Learning Software (Results Calculation and Analysis).**

EDAS/VIS. **EDIBON Data Acquisition System/Virtual Instrumentation System.**

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



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REPRESENTATIVE:

