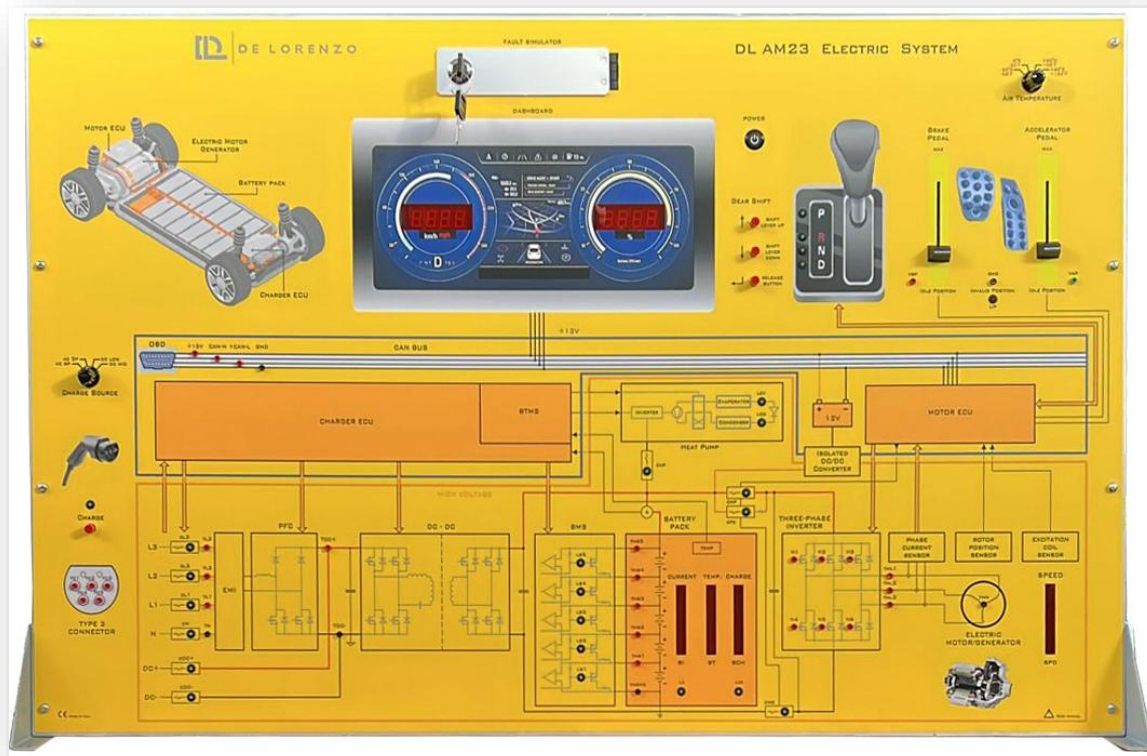




ELECTRIC VEHICLE SYSTEM



DL AM23

The **DL AM23** Simulator allows the theoretical and practical study of the main systems and components found in **Electric Vehicles (EV)**.

It consists of a panel that shows the complete diagram of all the components, with switches, buttons, commutators and potentiometers to reproduce the different operating situations that can be set by the students according to the courseware. There are also displays, LED bars, LEDs, measurement terminals to show the operating status of the system and detect the available electrical quantities.

The various sections of the diagram are represented with different colours to highlight both the different components of the electric vehicle and the high and low voltage areas that concern the specific safety issues of this type of vehicle.

There is an **OBD-II** socket to which a **Scantool** can be connected to perform testing operations in the same way as in real vehicles.

The system is completed by a Fault Insertion Unit with switch, with protection key for access by the Teacher only.



The connection of the Simulator to the PC for supervision, graphic display of the parameters of interest such as speed, temperatures, etc., is obtained via a special USB interface.

The Simulator is accompanied by the Windows application **DLworkspace** which provides an integrated teaching environment for using the Simulator itself.

This previous application brings together, in a single graphical user interface, all the tools required to use the Simulator:

- the Training Software (i.e. the teaching material) with the theoretical guide to the study topics, the guide to the exercises, the questionnaires and the guide to troubleshooting;
- the tools for the display of the quantities acquired by the Simulator with high graphic performance;
- some service tools such as Dashboard and Scantool.

It has the following technical characteristics:

- 7-segment display to show the vehicle's forward speed and battery charge level,
- Pushbutton ignition key,
- Potentiometers and buttons to select the operational conditions,
- LED bars for:
 - ◆ battery temperature,
 - ◆ charging and delivered currents,
 - ◆ motor rotation speed.
- LED displaying the status of the devices,
- Test jacks/Terminals for measuring and testing,
- Battery voltage test points (*),
- Battery charge test points Vac/Vdc (*),
- Motor control test points – PMSM (**P**ermanent **M**agnet **S**ynchronous **M**otor) (*),
- Fault entry system with switches and key cover,
- OBD-II Connector,
- USB interface with dynamic display of the parameters on the PC screen,
- Power supply: 220 Vac \pm 10%, 50 Hz.

(*): All test points report 'real' DC or AC voltage signals, appropriately scaled in value.

The educational program includes the following topics:

- Architecture of an electric vehicle.
- Technical issues and solutions.
- The battery:
 - ◆ Battery types,
 - ◆ Charging batteries,
 - ◆ **B**attery **M**anagement **S**ystem - BMS,
 - ◆ **B**attery **T**hermal **M**anagement **S**ystem - BTMS.
- The electric motor:
 - ◆ **P**ermanent **M**agnet **S**ynchronous **M**otor – PMSM or SMPM,
 - ◆ Driving with Inverter,



- ◆ Data network,
- ◆ The motor control unit - ECU.
- Vehicle Operation:
 - ◆ Motor starting,
 - ◆ Low and high speed operation,
 - ◆ Acceleration, deceleration, braking and reverse,
 - ◆ Regenerative braking,
 - ◆ CAN Network and OBD Diagnosis,
 - ◆ Electrical safety.

The system is provided with technical manuals for theory and exercises.

The following sections provide more information about the Simulator structure, **DLworkspace**, Faults insertion, **OBD** connector and **Scantool**.



Electric Vehicles and the DL AM23 Simulator

The Simulator was born from an accurate analysis of the electric vehicles on the market. From this **DE LORENZO** has developed the: **tEV** (training Electrical Vehicle).

This is a training-oriented vehicle that implements all the technologies that have now become standard for manufacturers: lithium battery, three-phase PMSM synchronous motor, etc.

The typical parameters of the **tEV**, in terms of autonomy, maximum speed, power, etc., were chosen from the average parameters of currently available vehicles.

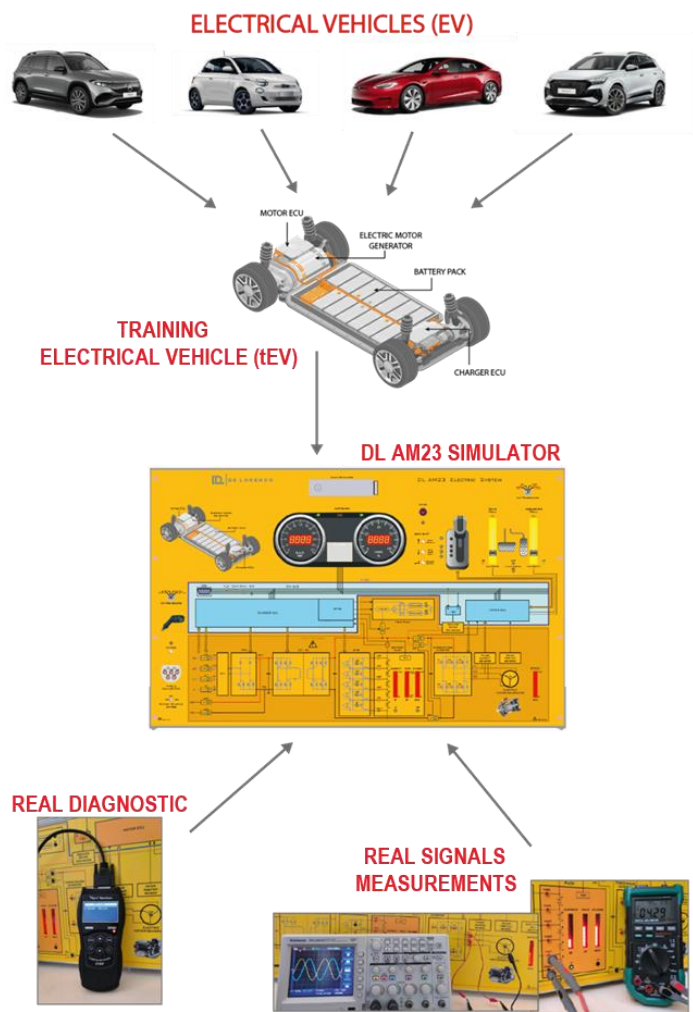
The **DL AM23** Simulator refers to the characteristics of the **tEV** for its parameters and operation.

The simulator features numerous test points that report the voltage signals, both direct and alternating, that characterise the battery charging systems and the **PMSM** engine control system.

The **EV's** high voltage signals are obviously reduced in amplitude for safety reasons.

With simple tools such as Multimeter and Oscilloscope it is possible to measure these signals in order to better understand how the devices work.

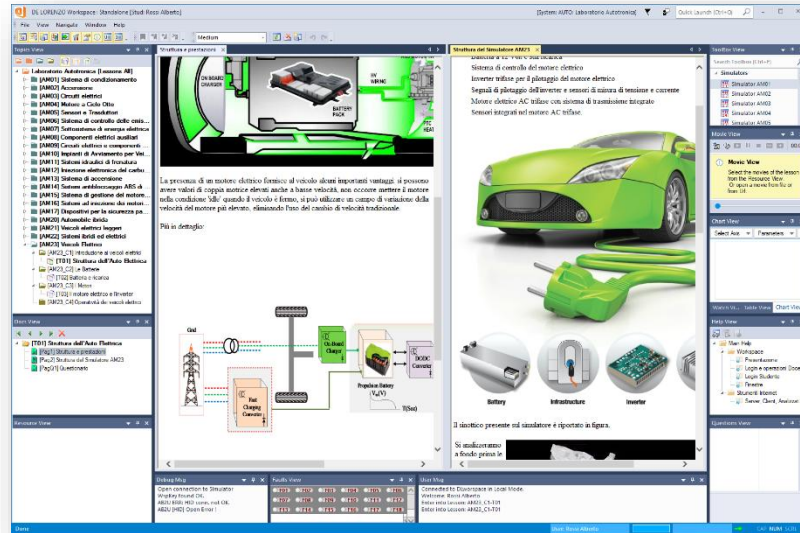
The presence of an **OBD** connector then allows you to use a **Scantool** for diagnostic operations as on a real vehicle.





DLworkspace

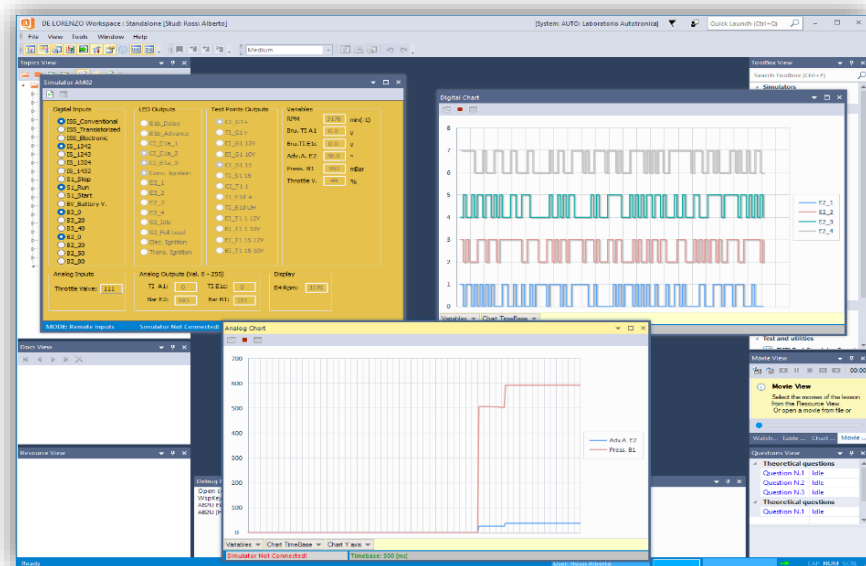
The Windows application **DLworkspace** provides an integrated environment where all the tools for using the Simulator are located and it looks like the figure below:



You may notice:

- the list of topics and lessons on the left,
- the lesson pages in the centre,
- the supervision tools, videos, and management of answers to questions on the right.

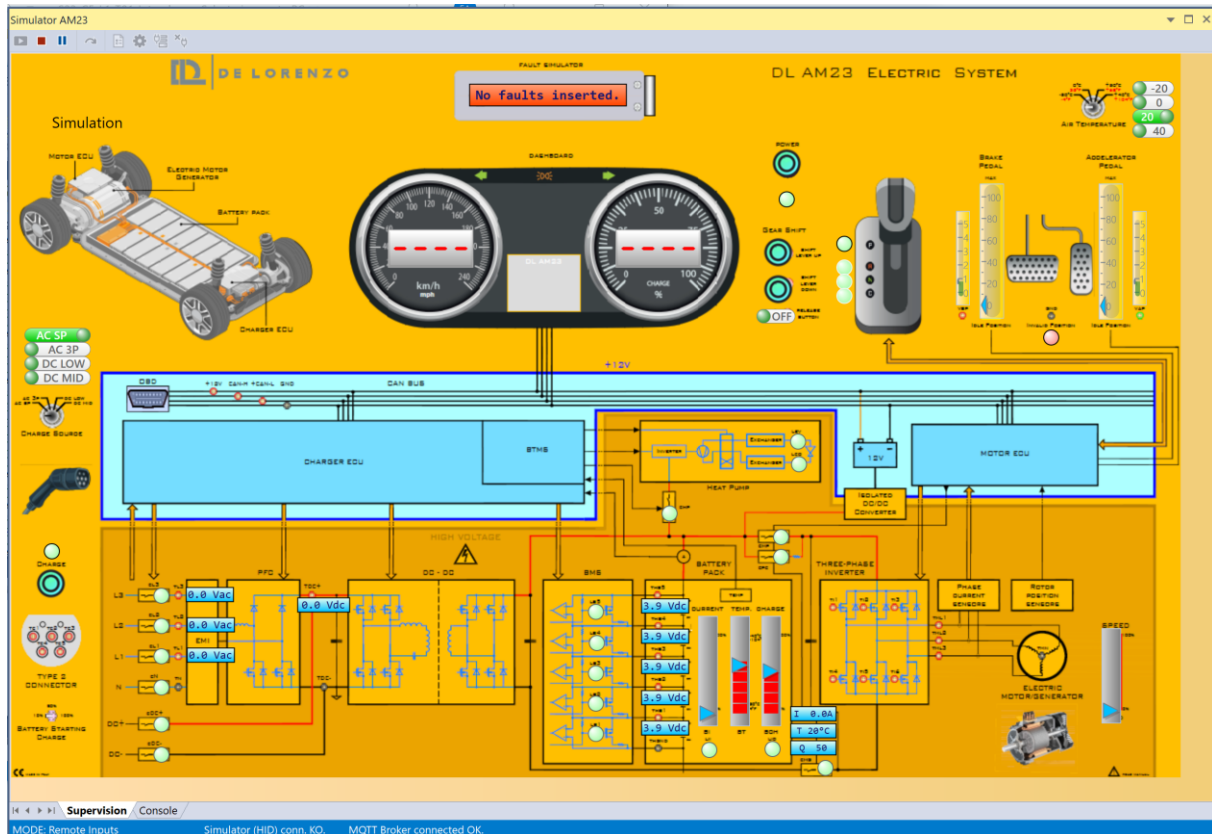
The same environment also houses the Simulator's tools for supervision and graphic processing:





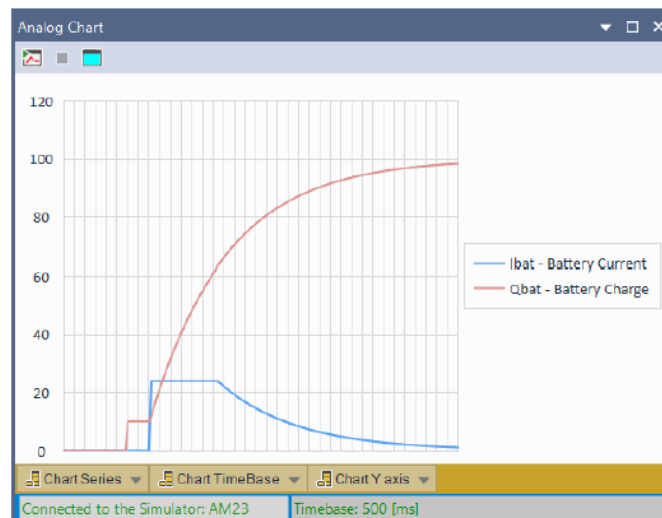
The status of all mechanical and electrical devices, available on the synoptic panel (Display, LED, bars, etc.), are acquired by **DLworkspace** via the USB connection.

The **Simulation Window** allows real-time control providing additional information useful during the simulation to monitor additional variables not displayed on the synoptic.



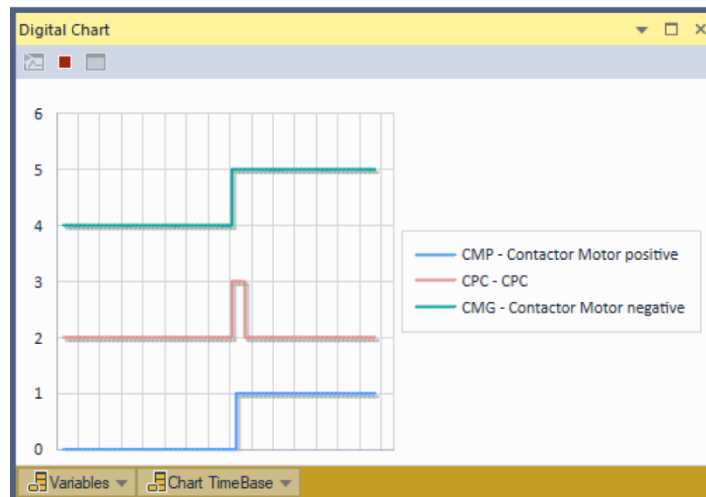
All simulation variables can be graphically processed, in real time, using appropriate analog and digital tools.

The **Analog Chart** allows you to view the real-time trend of analog parameters during the simulation. It is possible to select multiple parameters at the same time.

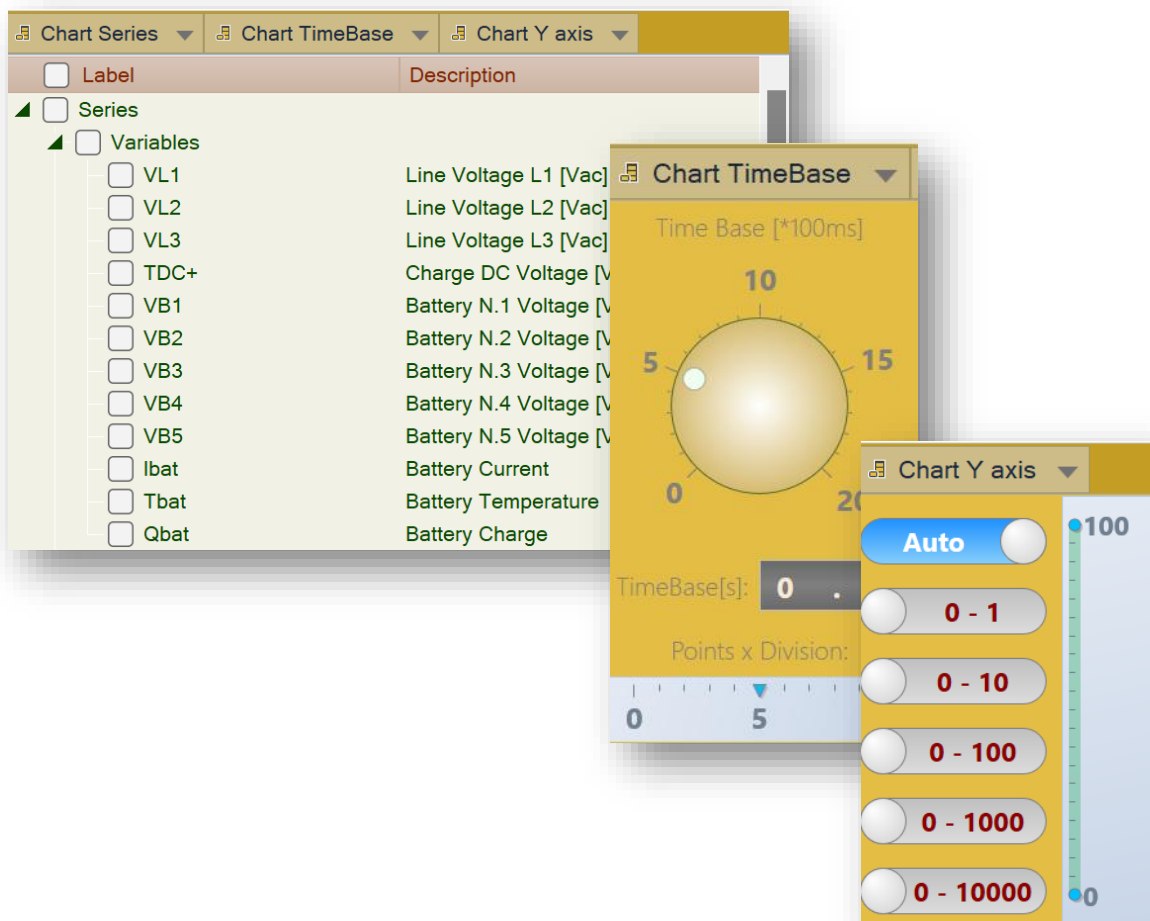




The **Digital Chart** allows you to view the real-time trend of ON-OFF quantities during the simulation.



All parameters relating to the graphs, i.e. variables, time base, vertical scale, etc., can be selected at will via the '**setting boxes**' of the tools:





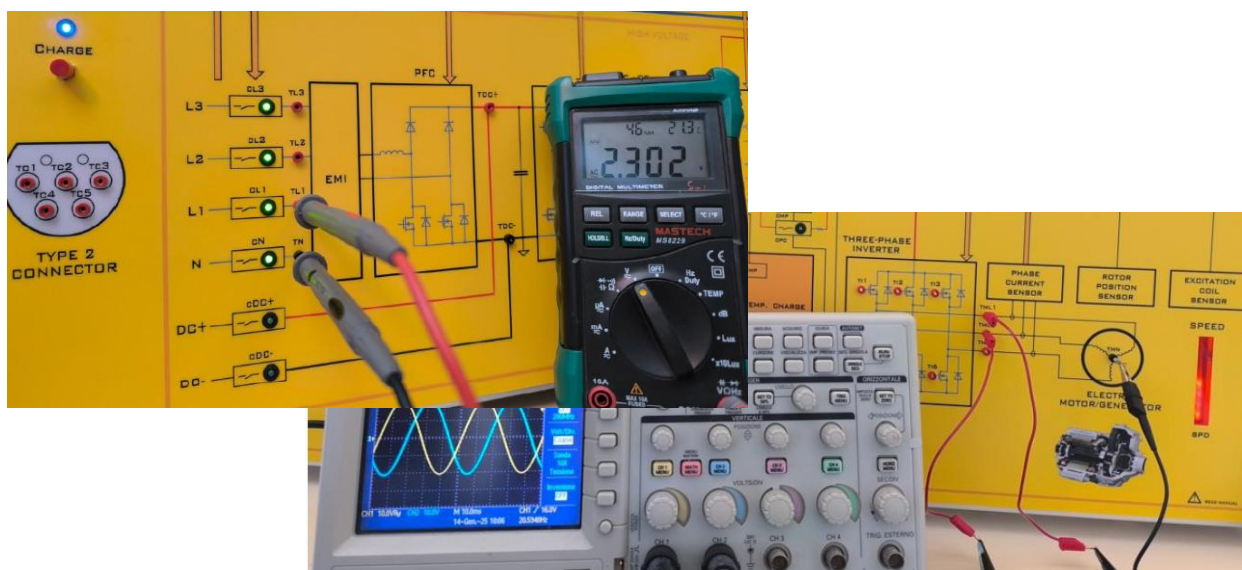
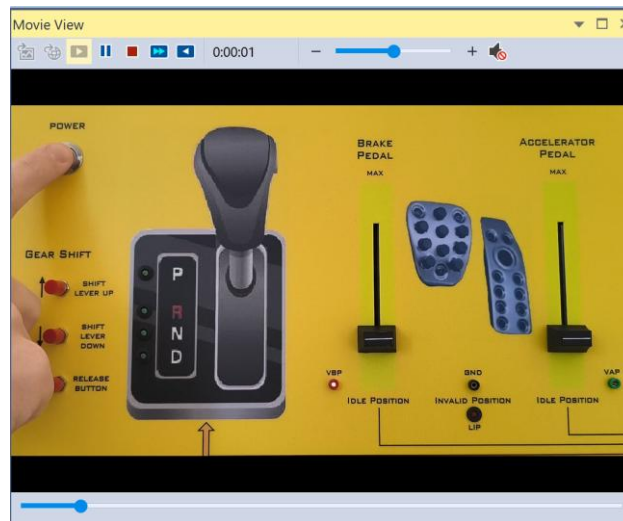
Images and Videos

Video clips are an increasingly important resource in today's multimedia teaching. The **DL AM23** Simulator Training Software uses the **DLworkspace** video clip support.

This importance derives above all from the fact that at the moment the main channels of communication among young people are represented by social media, where videos are widely used, and their production is very simple.

Videos are therefore, without a doubt, an important tool to use as they also allow you to express messages characterized by a more effective and immediate communicative value.

Some examples of videos and images are shown below.





Faults Insertion

The Simulator supports the insertion of faults, during operation, to allow troubleshooting operations.

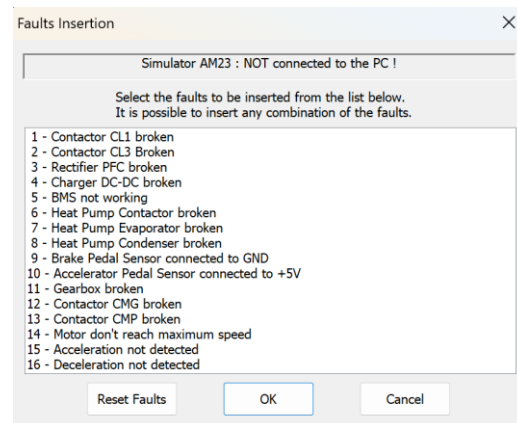
Faults can be entered by the Teacher, or by the Students, in different ways.

Faults Entry by the Teacher

Via the 16 switches of the Fault Insertion Unit, with access key.

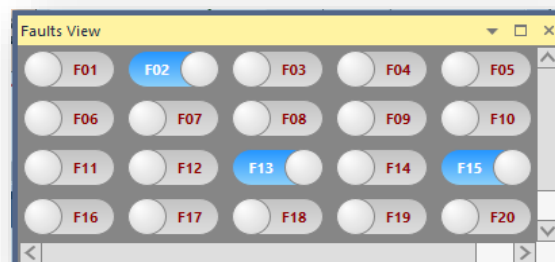


Via the **DLworkspace** Fault Entry window, protected by a password.



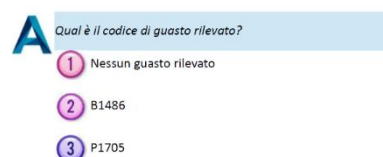
Faults Entry by the Student

The Student inserts faults, guided by the Training Software lessons, via the **Faults View** window of the **DLworkspace**.



Collegare lo Scantool in dotazione e rilevare se l'autodiagnosi (OBD) interna ha riconosciuto qualche malfunzionamento.

For each fault, there are questions related to it to verify the correctness of the search.





OBD connector and Scantool

The **DL AM23** Simulator is equipped with an **OBD** connector on the left side that allows connection to a **Scantool** for diagnostic operations on the vehicle. The control units inside the Simulator are equipped with a **CAN-BUS** interface and **OBD-II** protocol.



They provide the same diagnostic information as real control units to an external **Scantool**.

A **real Scantool** is supplied which can be used for diagnosis on any car, compliant with standards **ISO 15031** e **SAE J1979**.

In case of USB connection to the computer, **DLworkspace** provides an additional **Scantool software** and the **car Dashboard**.

