Technical Specifications

AUTOMOTIVE EQUIPMENT
ADA Series

AlecopGroup
Knowledge & Technology

ADA-300 Automotive Electricity.

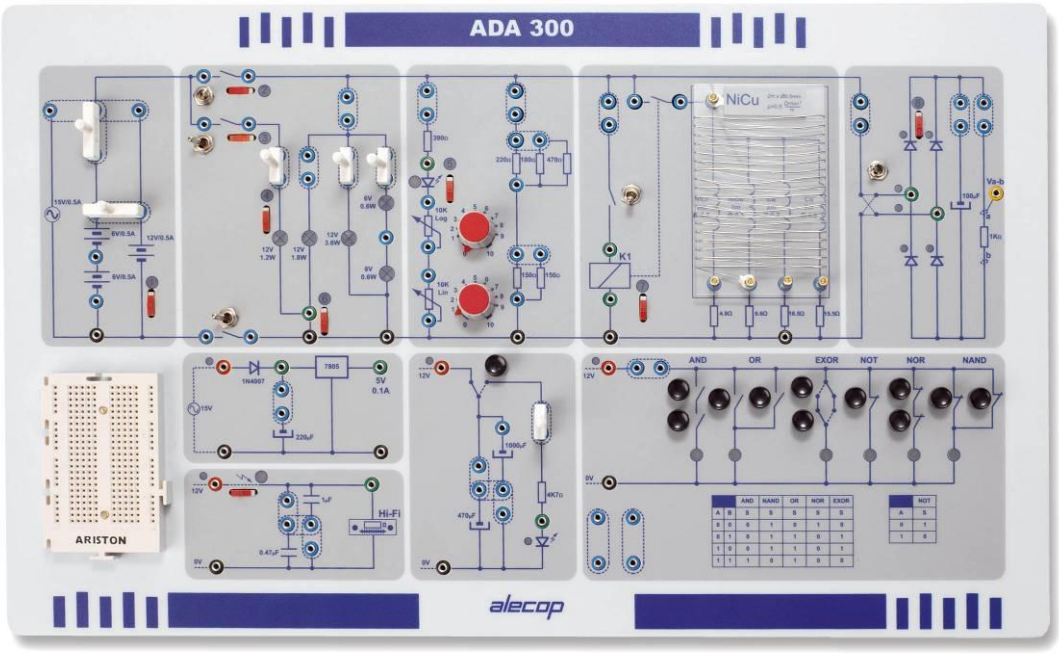
Manufacturer: Alecop **Ref.: 9EQ300AA6C**

Equipment to study basic automotive electricity. The unit contains several basic electrical circuits, mounted and functioning, to enable the study of the basic concepts of electricity required in the automotive field.

The configuration of the circuit to be analysed is carried out quickly by means of connection bridges. The equipment enables also the generation of faults in several of the circuit's components.

The blocks of components/circuits implemented in the application are as follows:

- Power circuit: Alternating and direct current.
- Lamp circuits: Parallel, series, mixed, different-powered lamps.
- Circuits with resistances: Parallel, series, mixed, linear potentiometer and logarithmic potentiometer.
- Circuit with relay.
- Circuit with different conducting materials: copper, nichrome and constantan.
- Full wave rectifier circuit.
- Half wave rectifier circuit.
- Circuit using the capacitor as a filter.
- Circuit using the capacitor as a power "store".
- Circuits with logic gates.



The purpose of this equipment ADA300 is to familiarise students, in a flexible way, with basic electricity in general and more specifically its application in cars. The application can be used to analyse and check different basic electric circuits as well as their components without wasting any time on assembly and dismantling.

However, if you want to extend some activities, the application has a complementary circuit assembly board. This board enables electric/electronic elements to be interconnected (resistances, capacitors, diodes, etc.) in a quick and easy way without the need to solder the components, making it possible to reuse the components for several different assemblies. The unit is complemented with a set of electrical/electronic components for carrying out all the complementary activities described in the practicals manual.

Technical specifications.

- Incorporates the following components/circuits:
  - Power circuit: Alternating current (AC) and direct current (DC).
  - Circuit with lamps: Parallel, series, mixed, lamps with different powers.
  - Circuit with resistances: Parallel, series, mixed, linear and logarithmic potentiometer.
  - Circuit with relay.
  - Circuit with different conductor materials: Copper, nichrome and constantan.
  - Full wave/half wave rectifier circuit.
  - Circuits with capacitors: filter, power store.
  - Circuit with logic gates.
- Test points to take measurements on the different circuits.
- Accessibility to all components for analysis under voltage or without voltage.
- Possibility of generating disfunctions in components of the equipment.
- Possibility of doing different electric/electronic assemblies on a proto-board.
- **Supply:** 230V/50Hz .
- Consumption: 25W.
- **Measurements:** 446x270x100 mm.

Contents to be studied:

- AC power supply.
- DC power supply.
- Batteries: Characteristic. Association of batteries in series and in parallel.
- Lamps. Identification. Association of lamps.
- Ohm's law: voltage, current, resistance.
- Association of resistances in series and in parallel.
- Characteristics of linear and logarithmic potentiometers.
- Electric power.
- Conductor materials: Copper, nichrome and constantan.
- Study of capacitors in DC: Filter, power store.
- Binary logic: AND, OR, EXOR, NOT, NOR and NAND.
- Full wave/Half wave rectification, filtering with capacitor.
- Components: Resistances, capacitors, diodes, leds, potentiometers, lamps, relays.

Skills to be developed:

- Skills to be developed
- Using equipment to measure electric/electronic components and circuits and interpret the data obtained with the multimeter and the oscilloscope.
- Checking electric/electronic components not under voltage and under voltage.
- Analysing basic electric/electronic circuits and linking them to car components.
- Assembling basic electric/electronic circuits.
- Running diagnostics and repairing simple faults in car electric/electronic systems:

Earth fault, faulty switch, flat battery, open-circuit potentiometer, faulty diode, etc.

Practical activities to be carried out:

Lesson 1: Operational and functional study of the application.
- Installation, recognition of blocks, components and connectors.
- Application functioning.

Lesson 2: Batteries and power source.
- Battery recognition, characteristics and maintenance.
- Battery charging. Power source.

Lesson 3: Electrical circuits with lamps.
- Simple electrical circuit on positive line.
- Simple electrical circuit on negative line.
- Alternating current circuit.
- Connection of lamps in parallel, in series and mixed circuit (series/parallel).

Lesson 4: Electrical circuits with resistances.
- Connection of fixed resistances in parallel and in series.
- Linear and logarithmic variable resistance.

Lesson 5: Conducting and insulating materials. Resistivity.
- Concepts of conducting material and insulating material.
- Conductor resistivity.

Lesson 6: Semi-conductor materials. Diodes.
- Concept and characteristics of semi-conductor material.
- Semi-conductor diodes. Bridge rectifiers.

Lesson 7: Capacitors and applications.
- Concept and electrical characteristics of the capacitor. Capacitor association.
- Applications of capacitors.

Lesson 7: Logic gates.
- Concept and application of logic gates. AND, OR, EXOR logic gates (open circuit). NOT, NOR, NAND logic gates (closed circuit).

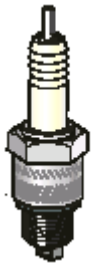
Equipment composition:

- ADA300 panel.
- CD with Users' manual and Manual of practical activities.
- Wires with different conductor materials.
- Electric/electronic components to assemble complementary circuits.
- Accessories store.

ADA-301 Automotive electronics

Manufacturer: Alecop **Ref.: 9EQ301AA6C**

Device for studying part of the electronics applied to vehicles. The training process for this application is based around a typical vehicle circuit: the ignition circuit.



The purpose of this circuit is to produce a high voltage spark between the sparkplug electrodes, to ignite the explosion of the mixture inside the explosion chamber. This is powered by the 12V battery voltage. Additionally, the system must also be synchronised with the crankshaft and camshaft and therefore with the position of the pistons in each of the cylinders.

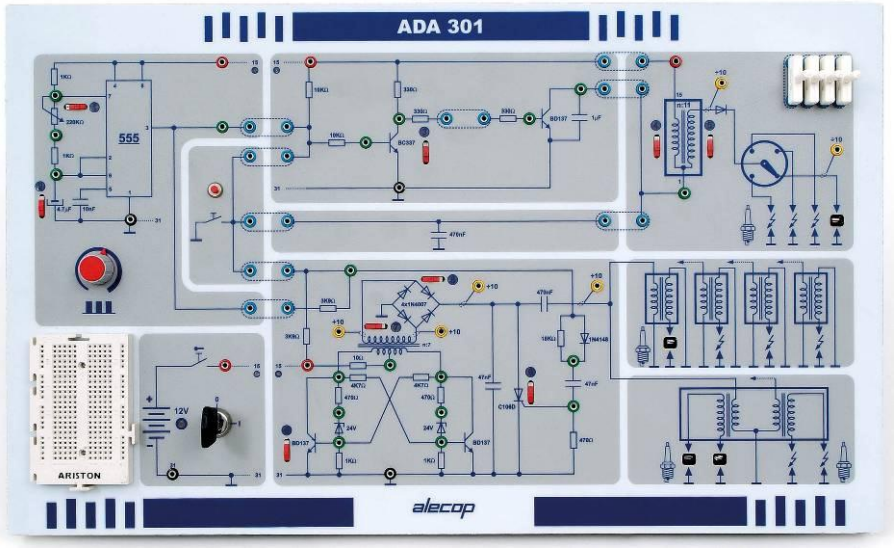
The ignition circuit is a vital system for correct engine functioning, and it has undergone major improvements throughout its history until reaching the solutions available today, all of them electronics-based. This is one of the reasons why we have decided to base part of the study of electronics for automotive use on this real vehicle application. Other ADA applications will complement the study of electricity/electronics for automotive use.

The ADA301 application has different electronic circuits that can be combined to make the assembly of the different systems used in the design of ignition circuits:

- Spark generation by contact breaker.
- Spark generation by transistorized circuit.
- Spark generation by capacitor discharge.

The electronic circuits installed in the application are as follows:

1. Power supply unit: Consists of the battery and a key-type switch enabling the battery to be connected and disconnected from the circuit.
2. Contact breaker unit: Consists of a button that simulates activation of the contact breaker when it is pressed.
3. Multivibrator unit, generating a variable square wave: Consists of a 555 integrated circuit generating a frequency-variable square wave by means of a potentiometer.
4. Transistorized amplifier unit: Transistor-based current amplifier circuit.
5. High voltage coil unit: Consists of a transformer. It generates the high ignition voltage for the sparkplug.
6. Distributor unit: A distributor is printed on this unit, in a fixed position connected to one of the sparkplugs.
7. Capacitor unit: Consists of a 0.47μF capacitor, for use together with the contact breaker unit for mounting a conventional ignition circuit.
8. High voltage impulse generator unit: This unit generates high voltage impulses by means of a capacitor discharge.
9. Ignition coil unit with one coil per cylinder. This unit represents an ignition system whereby each sparkplug has its own high voltage coil.
10. Ignition coil unit with "lost spark" system. This unit represents an ignition system whereby each coil supplies two sparkplugs.
11. Other complementary circuits to be mounted on the protoboard.



The ultimate objective of the ADA301 application is for the student to become quickly and easily familiarised with electronics in general and, more specifically, with its application in vehicles. Different circuits and components can be analysed and tested using this application, with no need to waste time assembling and removing them.

However, if you should wish to extend any of the activities, the application has a mounting plate for complementary circuits enabling quick and easy interconnection of electronic elements (resistors, transistors, integrated circuits, etc.) without the components needing to be soldered, so that the components can be re-used for several assemblies. The device is complemented with a set of electrical/electronic components for carrying out all the complementary activities included in the practical activity manual.

Apart from the different ignition-related circuits on the panel, the device is also supplied with two additional accessories:

- 12V direct current (DC) motor.
- 12V/6W lamp.

These are supplied with the device with the purpose of studying other standard current amplifier unit applications such as DC motor supply or lamp supply.

Technical characteristics of the device

- It includes the electronic units required for studying the following circuits:
  - Supply circuit
  - Spark generation by contact breaker circuit
  - Multivibrator or square signal generator circuit
  - Transistorized spark generation circuit
  - Spark generation by capacitator discharge circuit
  - DC motor supply circuit
  - DC motor speed variation circuit
  - Lamp brightness variation circuit analysis
- Test points for taking measurements on the different circuits.
- Accessibility to all the electronic components for analysing them, with or without voltage.
- Possibility of generating malfunctions in different components of the device, enabling analysis of circuit functioning with failures.
- Possibility of making electronic assemblies on a protoboard complementing the device.
- **Supply:** 230V/50Hz .
- **Consumption:** 25W.
- **DIMENSIONS:** 446x270x100 (mm)

Study content:

- Study and control of the functioning of different electronic components: Diode, transistor, zener diode, thyristor.
- Basic study of the different ignition systems used in vehicles.
- Current polarity reversal circuit in the transistorized ignition circuit.
- Current amplifier circuit.
- Integrated circuit: NE555 multivibrator.
- Rectifier circuit.
- Time-varying signal generation.
- High voltage generation from low voltage.
- Capacitor discharge circuit on coil primary.
- Voltage variation applied to a device (motor, valve lamp).

Skills development:

- Using component and electronic circuit measuring devices and interpreting the data obtained with the voltammeter and the oscilloscope.
- Testing electronic components with and without voltage.
- Analysing general electronic circuits and linking these with automotive components.
- Mounting basic electronic circuits.
- Diagnosing and repairing simple failures in automotive electronics systems.

Practical activities:

Lesson 1: Operative and functional study of the application
- Installation, recognition of units, components and connectors
- Application functioning
- Analysis of components and basic electronic circuits (diodes, LEDs and zener diodes)
- Analysis of components and basic electronic circuits (transistors and thyristors)

Lesson 2: Electronic application of transistorized ignition
- General concepts of contact breaker ignition
- Transistorized electronic ignition

Lesson 3: Electronic application of ignition by capacitor discharge
- Electronic ignition by capacitive discharge

Lesson 4: Other electronic applications
- NE555 oscillator timer
- Indicators
- Speed control for direct current (DC) motors

Device elements

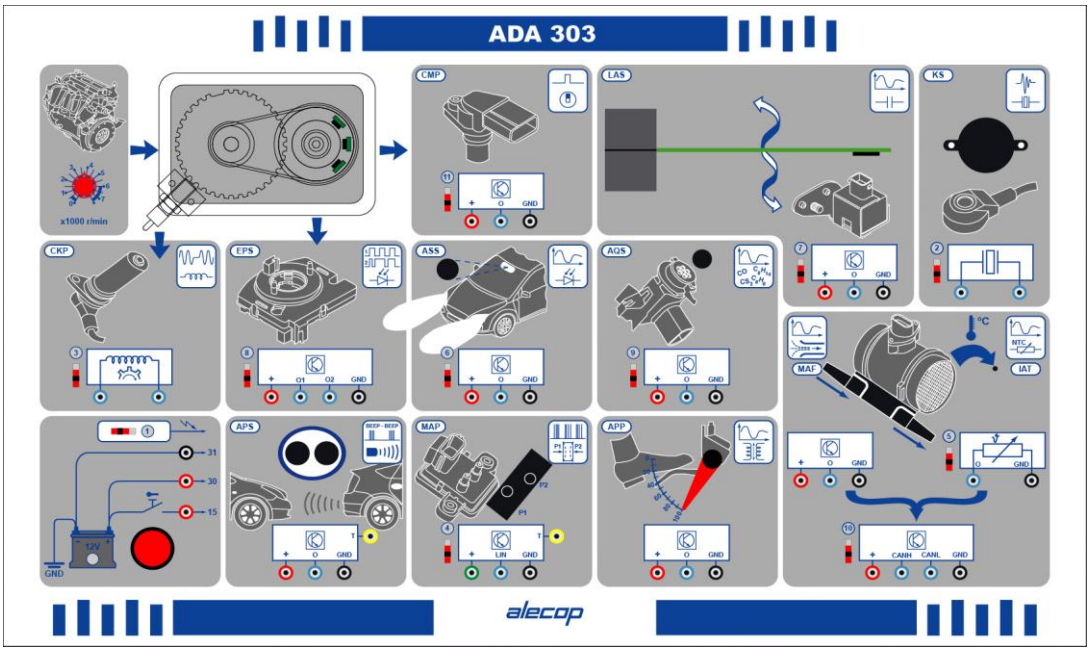
- ADA301 panel
- CD with Users' manual and Manual of practical activities.
- Accessory store
- 12V direct current (DC) motor
- 12V/6W lamp
- Electronic components for mounting complementary circuits

ADA-303 Automotive sensors.

Manufacturer: Alecop **Ref.: 9EQ303AA6C**

Equipment for the study of sensors in a car.

Equipment conceived to study different sensors, depending on technologies, types of regulation, capturing parameters and means of transmission of information used in the different electrical electronic systems which can be found at present in a vehicle. Thanks to these sensors the electronic systems receive information of the physical and or chemical magnitudes necessary through the ECU in order to make the calculations required to start the different actuators working. The actuators will be in charge of producing the physical variations which make the different electromechanical components of the vehicle work. The equipment has 12 sensors, similar to those actually used in the car (CKP-CMP-MAF-MAP etc.) through which and thanks to the combination of different technologies used in their construction a high number of vehicle sensors can be studied. Some of the signal reception elements can be connected to the UCE ADA304 application, and along with the ADA305 actuator they make the equipment form a complete electronic control system.



Technical characteristics:

- Autonomous equipment for the study of sensors in a car.
- The equipment includes sensors using different types of technology:
- Crankshaft position sensor: inductive.
- Camshaft sensor: Hall.
- Steering column sensor (position, speed): Optical.
- Light sensor: Optical.
- Parking distance sensor: Ultrasound.
- MAP collector absolute pressure system: Piezoresistive.
- Lateral acceleration sensor for electronic stability control: Capacitive.
- Air quality sensor: MOS (Metal Oxide Semiconductor).
- Accelerator pedal position sensor APP: inductive.
- KS Knock sensors: Piezoelectric.
- Air mass sensor MAF: Hot wire.
- IAT air temperature admission sensor: NTC Resistive.
- The communication of the sensors with the outside is carried out by different means:
- Digital output.

- Analogue Output.
- Communication by CAN bus.
- Communication by LIN bus
- Each sensor has information printed on it about:
- The technology used.
- Type of output generated.
- Physical shape of the sensor in the vehicle.
- Testing points protected against possible incorrect manipulations, for carrying out measurements at the different points of the circuit.
- Possibility of generating faulty situations in the signal sent by the sensors to the ECU, enabling the analysis of malfunction in the system.
- Possibility of connecting various sensors to the ECU control unit panel ADA304.

Contents to study:

- Technologies used in sensor design.
- Types and characteristics of sensors.
- Types outputs (analogue, digital, CAN bus, LIN bus).

Training to be carried out:

- Analysis of the working of the different sensors and their association in the different automobile systems.
- Testing electrical/electronic signals without voltage and under voltage.
- Diagnosis of faults in the sensors: Lack of supply, broken sensor, short circuit to mass or to positive of the sensor, failure in the bus of communication of the sensor (CAN-LIN) etc.
- Instrumentation handling: Oscilloscope, Multimeter

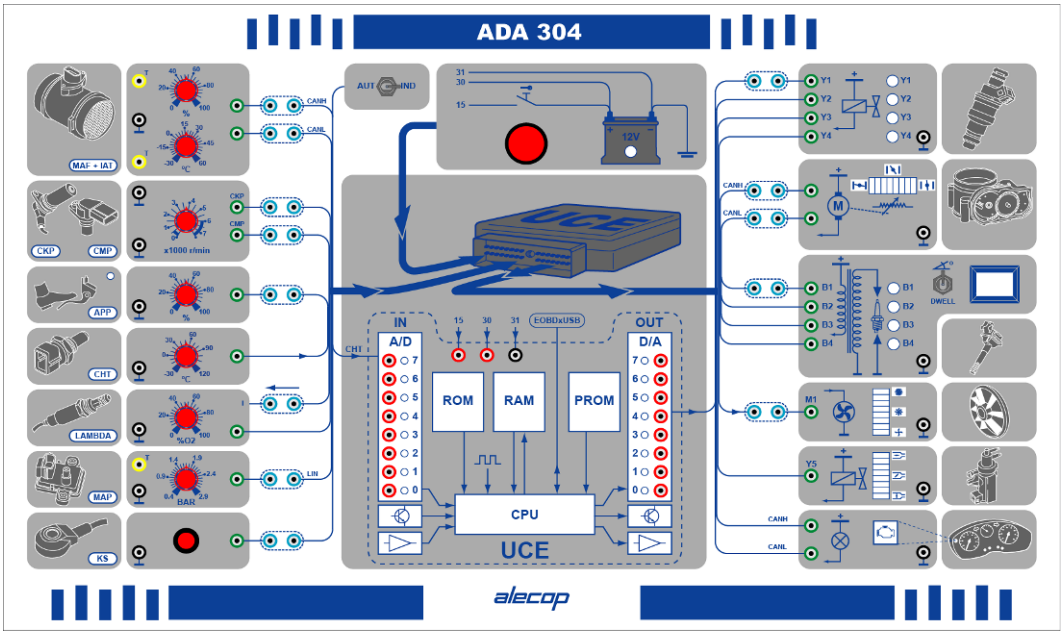
Equipment composition:

- ADA303 Panel.
- CD with Users' manual and Manual of practical activities.
- Accessories: Syringe and plastic tubes.
- Accessory store.

ADA-304 ECU Electronic control unit.

Manufacturer: Alecop **Ref.: 9EQ304AA6C**

Equipment for the study of electronic control systems in a car. Equipment to study how the electronic control unit (ECU) of a petrol engine works with a multipoint sequential injection system and static ignition. The equipment enables, by means of a series of potentiometers, different operation conditions to be simulated (amount and air mass, temperature, rpm, cooling temperature etc.) which the ECU, depending on the programming, uses to carry out the necessary calculations and make the different system actuators work (injectors, coils, air flow valve, electro fan , etc).
Input and output signals can be adjusted independently. Nevertheless, to avoid malfunctions (unlikely) on the injected system, an AUT mode has been implemented where the sensor signals evolves depending on the programmed algorithm thus allowing the student to quickly begin to understand how the injection system works.
Similarly, it incorporates the auto-diagnosis system which alongside the DD-Car software allows the student to become familiar with auto-diagnosis techniques.



Technical characteristics

- Stand-alone equipment that incorporates the simulation of the following sensors and actuators:
- SENSORS: Air mass senor, air admission temperature, crankshaft position, camshaft position, accelerator pedal position, coolant temperature , wide band Lambda sensor, absolute pressure sensor and vibration sensor.
- ACTUATORS: Gas injectors, gas valves, spark plugs, Turbo electrovalve and MAL (Malfunction Indicator Lamp).
- Sensor and actuator communication with the ECU by different types of signal; analogue, digital, multiplexing buses CAN and LIN.
- Testing points protected against possible incorrect manipulations, for carrying out measurements at the different points of the circuit.
- Possibility of generating malfunctions in the signal sent by the sensors to the ECU.
- Automatic or individual operation of the sensors (AUT/IND)
- Reprogramming function (Flash) of the ECU as a Turbo motor or Atmospheric.
- Auto-diagnosis function implemented in the ECU.
- Possibility of disconnecting the sensors/actuators simulated in the panel and of connecting the real sensors/ actuators of the ADA303 and ADA305 applications.

AUTO-DIAGNOSIS Software DD-Car

DD-Car is a Diagnosis Teaching Tool prepared to work with the ADA304. Working with DD-Car will allow the student to become familiar with the operation of auto-diagnosis consoles on the market allowing their adaptation to any of them to be quicker and easier, in addition testing can be carried out without the risk entailed on working directly on the systems of the vehicles.

The following functions can be made:

- Reading and deleting the breakdown code.
- Reading of values and analysis in real time of the operation of the system.
- Activation of the actuators.
- ECU Programming (flash)
- Carrying out basic adjustments in the system.

Contents to study

- ECU Sensor inputs: types, characteristics etc.
- Actuator outputs from the ECU: types, characteristics etc.
- Internal architecture of an electronic control unit
- Working of an electronic injection control unit, injection control algorithms
- Injection time and ignition time (ignition angle and DWELL angle)
- Types and characteristics of sensor/actuator signals: Analogue, digital, multiplexing buses (CAN and LIN).
- Auto-diagnosis in electronic injection systems, failure EOBD codes.
- Reprogramming (Flash) of the electronic control unit.
- Digital /Analogue and Analogue/ Digital conversion.

Training to be carried out

- Analysis of how the electronic injection control unit works on an ECU- Motor.
- Analysis of the ECU input signals.
- Analysis of the ECU output signals.
- Testing electrical/electronic signals with without voltage and under voltage.
- Handling of auto-diagnosis tools: DD-Car.
- Fault Diagnosis: Broken sensor, failure in the communication bus (CAN-LIN), etc.
- Testing of sensors and actuators using an auto-diagnosis tool.
- Instrumentation handling: Oscilloscope, Polymeter

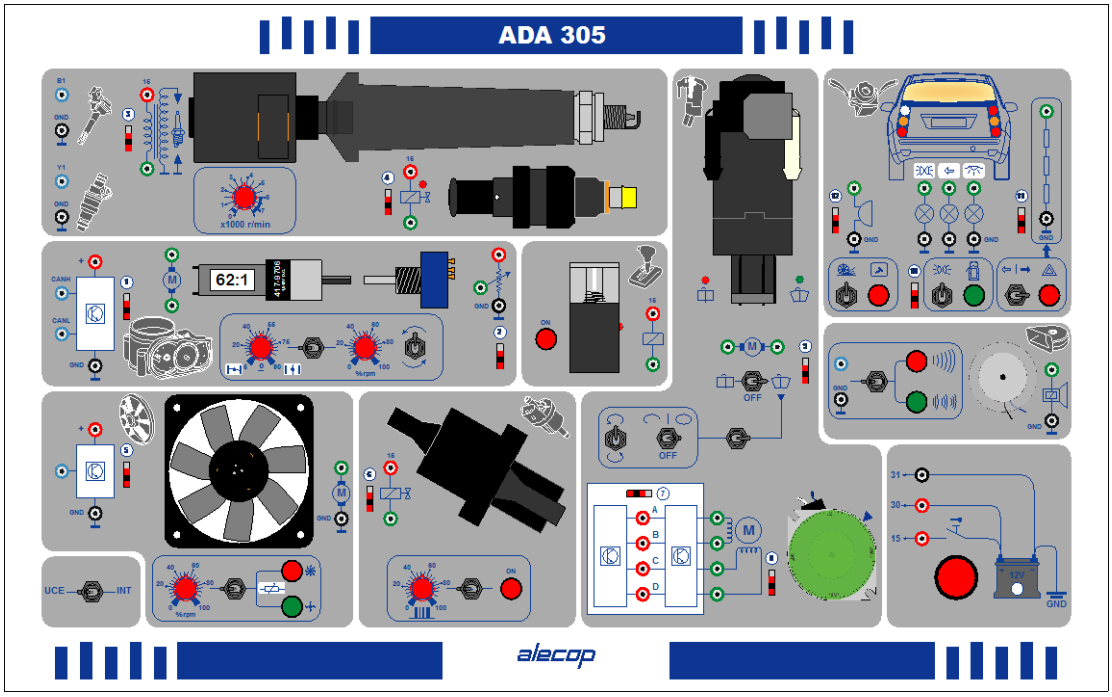
Equipment composition

- ADA304 Panel
- CD with Users' manual and Manual of practical activities.
- DD-Car auto-diagnosis software
- Accessory store

ADA-305 Automotive actuators.

Manufacturer: Alecop **Ref.: 9EQ305AA6C**

Equipment for the study of actuators in a car. Equipment conceived to study different actuators, depending on technologies, types of regulation and means of control used in the different systems which can be found at present in a vehicle.
These actuators are controlled from the electronic control unit ECU based on control algorithms programmed on the unit, which are responsible for making the system respond to the variation required for the behaviour of the vehicle.
The equipment has 10 actuators, similar to the ones in use at present in a car (spark plug, injector, step motor, canister valve, etc.), through which, and thanks to the combination of different technologies they use and of the different means of control, they allow a high number of vehicle actuators to be studied.
Some of the equipment actuators can be controlled from application UCE ADA304, and can together with the ADA303 sensor equipment form a complete control system.



Technical characteristics

- Autonomous equipment for the study of actuators in a car.
- The actuators included in the equipment are:
- Ignition coil with incorporated spark
- Electromagnetic injector
- DC Motor: Open loop speed control and closed loop control position potenciometre on the shaft.
- Cooling fan: Analogue or series resistance speed control
- Electrovalve: All/Nothing Control (ON/OFF) and linear control by means of Pulse Width Modulation (PWM).
- Electromagnet: ON/OFF Control
- Windscreen washer motor pump: Motor pump control in both directions.
- Step Motor: Two working speeds.
- Actuators related with lighting: Position-brake light, emergency warning lights, lights on warning
- Acoustic actuator, piezoelectric buzzer: Actuation of the same with two different tones.

- The control technologies implemented are:
- Digital control
- Analogue Control
- Control by CAN bus
- Control by pulse width modulation PWM
- Testing points protected against possible incorrect manipulations, for carrying out measurements at the different points of the circuit.
- Possibility of controlling various actuators from the control unit ECU-ADA304.

Contents to study

- Technologies used in the actuator design
- Types and characteristics of actuators
- Types actuator control systems (analogue, digital, CAN bus , LIN bus)

Training to be carried out

- Analysis of how the different actuators work.
- Testing electrical/electronic signals with without voltage and under voltage.
- Diagnosis of faults in the actuators: Lack of supply, actuator broken, short circuit to mass or to actuation positive, failure in the communication bus of the actuator (CAN-LIN).
- Instrumentation handling: Oscilloscope, Polymeter

Equipment composition

- ADA305 Panel
- CD with Users' manual and Manual of practical activities.
- Accessory store

ADA-306 CAN/LIN multiplexed bus application

Manufacturer: Alecop **Ref.: 9EQ306AA6C**

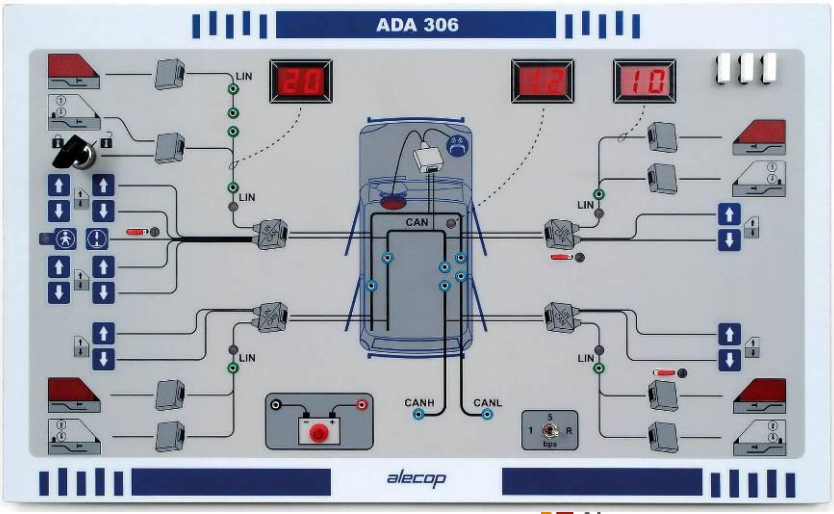
Device designed for the conceptual study of data networks and multiplexing in vehicles. The device simulates part of the comfort and safety devices used in today's vehicles. The simulated devices are:

- Central locking system
- Electric windows
- Airbag

Two buses used in vehicles will be used for transmitting the information between the different nodes: CAN (Controller Area Network, ISO 11898-3 or ISO 11519-2 specification) and LIN (Local Interconnect Network). The former is already used in vehicles at present, and the latter is a **new** bus that is beginning to be implemented in vehicles. The special feature of the LIN bus making its rapid implementation likely is its low cost compared to other solutions such as CAN, and its standardisation, in which several vehicle manufacturers have been involved.

CHARACTERISTIC	CAN	lin
Interface	Specified by the CAN standard	Based on the serial communication used in PC's (RS232C).
Speed (Kbits/sec)	10 - 1000	1 - 20
Relative cost per node	Approximately 2	Approximately 1
Wiring	2 wires, differential mode based on a 5V supply	1 wire, 12V based on battery supply
Physical level	Specified by the ISO11898 standard.	Complies with the ISO9141 standard specification.
Safety	High, two wires, failure-tolerant.	Moderate

The device enables analysis of the functioning of the two buses implemented in **real** mode and in **slow** mode. This latter mode enables quick, didactic analysis of the functioning of the serial data transmission used in all the multiplexed buses. In real mode, the two buses function at real speed (125 Kbits/sec for CAN and 19200 bits/sec for LIN), while in slow mode it can function at 1 bit/sec or 5 bits/sec, for very easy analysis of the data transmitted.



Technical characteristics of the device

- Implementation of multiplexed bus for comfort with an ISO 11898-3 CAN line, failure-tolerant at 125K bps.
- Implementation of control of buttons and electric windows on vehicle doors with LIN bus at 19200 bps.
- Test points on the different bus lines.
- Malfunctions can be generated on the different buses, enabling analysis of the system's performance in different failure situations:
    1. Short circuits to Vbat and earth
    2. Short circuits between the lines
    3. Line cut-off
    4. Control unit failure simulation.
- Real or slow functioning selection switch. Enables functioning analysis with an oscilloscope (real functioning) or a voltammeter (slow functioning).
- Slow mode viewing of the different frameworks circulating through the buses on alphanumerical displays in hexadecimal notation.
- Possibility of CAN communication via optical fibre. The conventional wiring is substituted by an optical fibre cable on the CANH or CANL lines **(ACCFI306ZX optional)**.
- **Supply:** 230V/50Hz.
- **Consumption:** 25W.
- **DIMENSIONS:** 446x270x100 mm.

Study content:

- Binary logic.
- Numbering systems (Binary, hexadecimal)
- Serial data transmission.
- Data network architectures (Multi-master, Master-Slave)
- CAN bus (Differential data transmission, voltage levels, frameworks, failure tolerance, etc)
- LIN bus (Data transmission, voltage levels, LIN frameworks, etc)
- Data transmission via optical fibre **(ACCFI306ZX optional)**.

Skills development:

- Analysis of multiplexed systems.
- Failure diagnosis and repair in multiplexed systems.

Practical activities:

Lesson 1: Operative and functional study of the application
- Installation, recognition of controls.
- General system functioning.

Lesson 2: Introduction to multiplexed buses
- General concepts of point-to-point systems/multiplexed systems.
- Differences between buses and classification.
- Communication by multiplexed buses.

Lesson 3: CAN data buses
- CAN bus characteristics
- Physical level of the CAN bus
- CAN bus communication protocol
- CAN bus access priority control
- Safety level and error correction
- Viewing and reading the complete CAN framework

Lesson 4: LIN data buses
- LIN bus characteristics
- Physical level of the LIN bus
- LIN bus communication protocol
- Safety level and error correction for the LIN bus
- Viewing and reading the complete LIN framework

Lesson 5: Failure diagnosis.
- Complete multiplexed order transmission process
- Failure pinpointing and diagnosis

Lesson 6: Other buses and their applications.
- Knowledge of other buses used in vehicles

Lesson 7: Optical fibre transmission
- Communication by optical fibre

Device elements

- ADA306 panel
- CD with Users' manual and Manual of practical activities.
- Accessory store
- Optical fibre transmitter/receiver **(ACCFI306ZX optional)**

ADA-307 Hybrid vehicle application

Manufacturer: Alecop **Ref.: 9EQ307AAZC**

Tool used in conceptual studies of combined cycle hybrid vehicles.
The goal of this equipment is to get students to know hybrid vehicle technology. The application uses the most efficient system on the market: the plug-in hybrid electric vehicle (PHEV).
The application consists of a panel showing all the parts of a hybrid vehicle and a virtual instrument panel with advanced functions for data generation, acquisition, and analysis.
This system is used to:

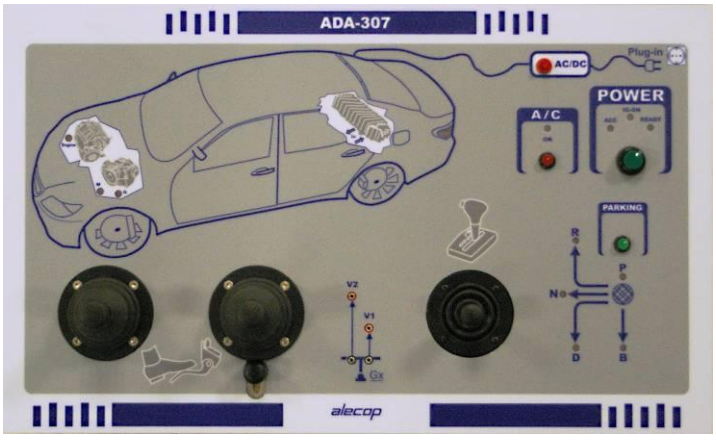
- Make conceptual studies in combined cycle PHEVs simulating the operation of a real vehicle on different journeys and contexts.
- Assess high-voltage electricity flows.
- Analyse the power combination of an internal combustion engine and an electric motor/generator.

It includes an application developed with MATLAB/Simulink, the user manual, and practical exercises.

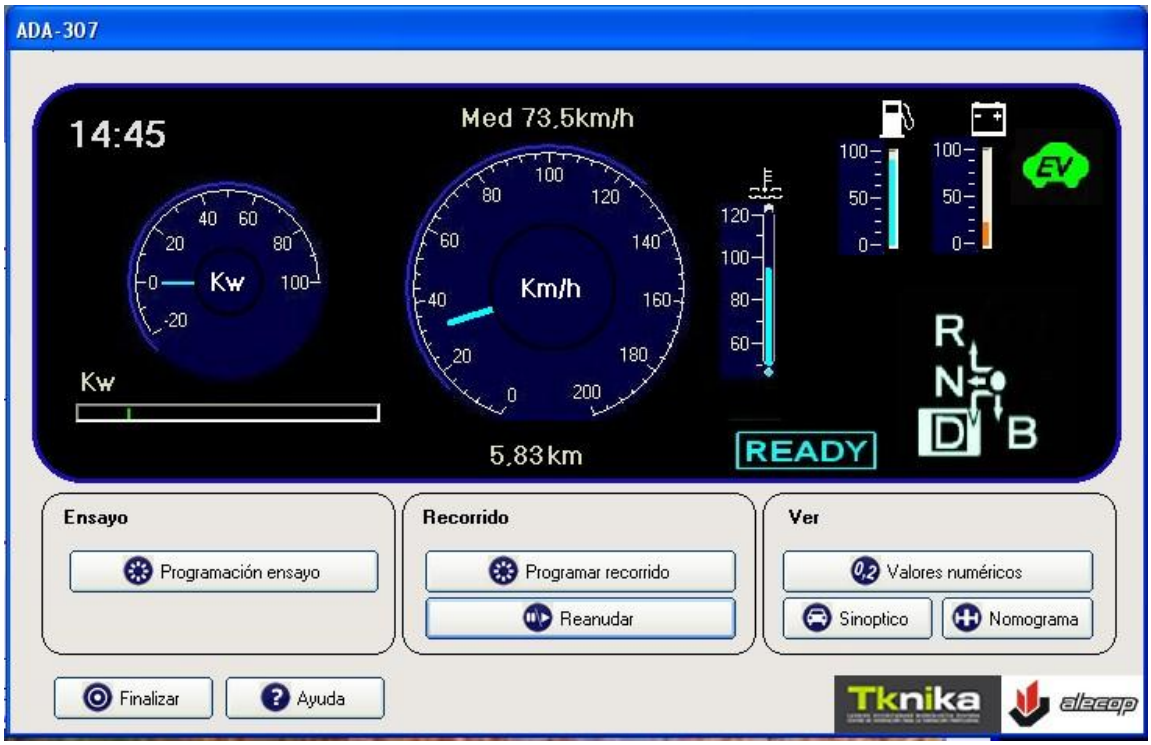
Interactive panel

The interactive panel has the same devices as a vehicle: start switch, accelerator, brakes, speed selector, A/C switch, and off-board battery charge button (plug-in).
It reproduces the different stages in an engine operation cycle (electric motor, internal combustion engine) as well as the battery pack status (charged, depleted, generator).
Two measuring positions, V1/V2, to check the parameters selected with the software:

- Battery pack charge level.
- Battery voltage.
- Battery charging current.
- Electric motor work voltage.
- Vehicle speed.

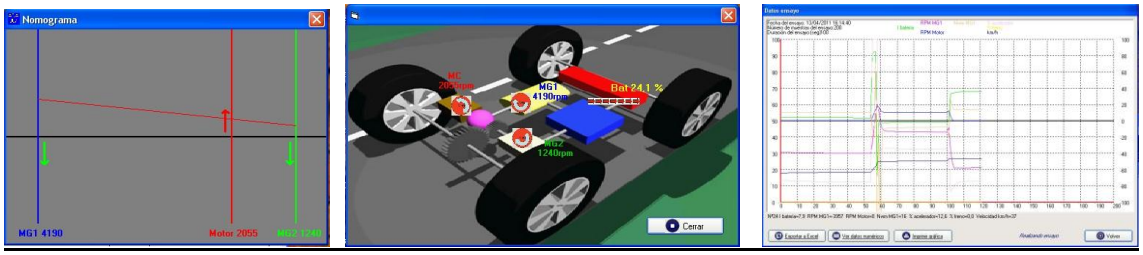


Virtual model



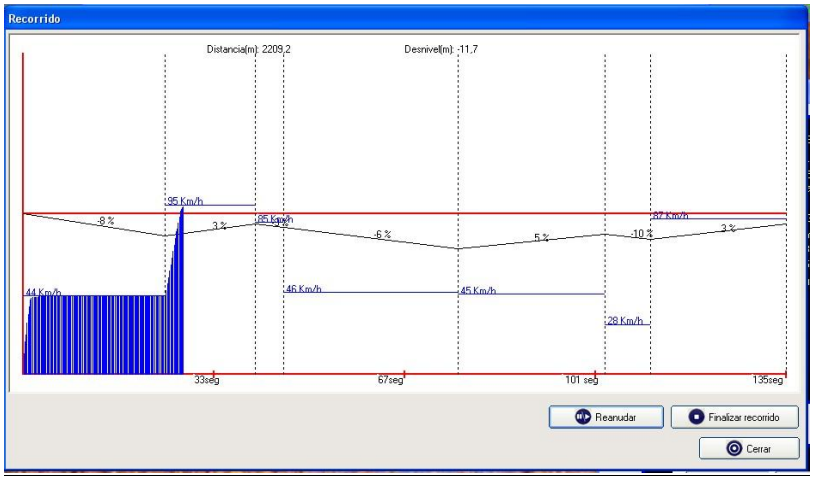
The hardware trainer is a driving simulator (gear, speed, battery charge, fuel gauge).
All the actions performed on the panel are represented in the software instrument panel.
The ADA307 software provides information on vehicle performance in figures, graphics, and gauges.
The user can choose to view the numerical data screen, the nomogram screen, or the synoptic chart screen.

Nomogram **Synoptic graphic** **Data acquisition**



The effect of various situations on hybrid vehicle performance can be assessed by programming journeys and carrying out tests. The data can be exported to Excel.

Programming journeys



The virtual model shows all operating stages:
- Electric motor.
- Internal combustion engine.
- Electric motor + internal combustion engine and overlapping mode.
- Energy restoration and battery charging.

Modelling with MATLAB Simulink®
It is delivered as executable software to be used with no need of a MATLAB licence, including sources.
SimulHyb offers:

- Vehicle operating simulation (considering weight, fuel level, vehicle power, etc.)
- Energy distribution simulation:
  - in acceleration mode (consumption).
  - in braking mode (recharge).

DIMENSIONS: 446x270x100 mm.

Study content:

- HYBRIDIZATION
- ELECTRIC MOTORS
  - Electric rotary machines
  - Operating principle
  - Advantages of electric motors
  - Classification of electric motors.
  - Synchronous motors.
  - Asynchronous or induction motors.
  - Permanent magnet synchronous motors.
  - Basic functioning.
  - Three-phase asynchronous motors.
  - Short-circuited asynchronous rotor motors.
  - Wound rotor asynchronous motors.
- CONVERTER/INVERTER:
  - High and low voltage supply system
  - Hybrid-electric system control unit
  - Inverter unit.
  - Functioning as a motor.
  - Functioning as a generator

- Two-way booster.
- DC/DC converter.
- Cooling systems.
- Diagram of real converter/inverter components (example: toyota).

- BATTERY TYPES:
  - Introduction.
  - Battery characterisation terminology.
  - Terminology used to describe a battery's construction characteristics.
  - Electrodes.
  - Electrolyte.
  - Separator.
  - Container.
  - Terminology used to describe a battery's functional characteristics 80
  - Voltage.
  - Capacity.
  - Battery types.
  - Classification.
  - Lead-acid batteries.
  - Valve-regulated lead-acid (vrla) batteries.
  - Alkaline batteries.
  - Nickel-cadmium batteries.
  - Nickel-metal hydride batteries.
  - Lithium-ion batteries.
  - Advanced batteries.
  - Molten salt batteries.
  - Metal-air batteries.
  - Flow batteries.
  - Battery management systems.
  - Hazards connected with high voltage and with the use and handling of vehicle batteries.
  - High voltage safety measures for hybrid vehicles.
  - Precautions for handling the hv battery.
  - Charge types and connectors.
  - Charge types.
  - Connector types.
  - Possible european connector standards.

- COMBINED CYCLE:
  - Combined cycle system functioning.
  - Main components.
  - Synergy drive hybrid driving phases.
  - Combined cycle system operating strategy.
  - Hybrid transaxle.
  - Operating principle of the power distribution device.
  - Nomograms.
  - Ready status on (vehicle stationary).
  - The vehicle begins to run.
  - Driving on a flat road with a light load.
  - On full acceleration.
  - During deceleration.
  - On reversing.
- EFFICIENT DRIVING:
  - Introduction.
  - Main advantages of efficient driving.
  - Increased safety.
  - Lower consumption.
  - Lower cost.
  - Lower emissions.
  - The engine: relevant variables for consumption.
  - Transmission.
  - Vehicle travel resistances.
  - Rules for efficient driving.
- BIBLIOGRAPHY.

Skills development:

- Analysis of HYBRID VEHICLES systems.

Practical activities:

Lesson 1: Operative and functional study of the application

- Installation and recognition of the different controls and components.
- Application functioning.
- Becoming familiarised with vehicle runs and functioning.

Lesson 2: Vehicle hybridization

- Identifying the different types of hybrid electric systems.

Lesson 3: High voltage batteries

- Operating characteristics of high voltage batteries.
- Study of the high voltage battery management system.
- Circuit disconnection and procedure for handling NiMH batteries.
- Study of the types of charging connesctors existing today and in the near future.

Lesson 4: Electric motors

- Electric machines.
- Synchronous and asynchronous electric motors.
- Torque in hybrid vehicles

Lesson 5: Power electronics (converter-inverter).

- High voltage current conversion and inversion.

Lesson 6: Combined cycle hybrid system.

- Identification of the system's components and operating principle.
- Power distribution device and nomogram representation.
- READY Status on / Vehicle stationary.
- Ignition / Start-up.
- Travelling on a flat road / Light acceleration.
- Full acceleration.
- Deceleration.
- Reversing.

Lesson 7: Efficient driving.

- General rules for efficient driving.
- Simulated driving using the training device.

Device elements

- ADA307 panel.
- CD with Users' manual and Manual of practical activities.