LUCAS-NÜLLE

# HEAVY VEHICLE TECHNOLOGY

## Training in the Automotive Diagnostics Workshop Lab

1st Edition

# Training Systems for Heavy Vehicles

**These automotive training systems are for use in training and testing of the following career options:**

- ✓ Vehicle mechatronics technicians – focusing on commercial vehicles
- ✓ Mechatronics technicians for agricultural and construction machinery

**They can also be used for advanced training of the following professionals:**

- ✓ Technicians
- ✓ Mechanics
- ✓ Engineers
- ✓ Service-oriented technicians in after-sales servicing & maintenance

In all **training topics** trainees need to be versed in the key aspects of **working with intrinsically safe high-voltage vehicles**. Even before the first part of their apprenticeship examinations, trainees should learn how isolation of high-voltage systems is carried out and why this is so essential for **safety at work**.

Mastering modern procedures and techniques, as well as complying with required international standards and quality requirements is a challenge to the technical skills of professionals, technicians, engineers and scientists now and in the future. It is also just as important for after-sales service staff and maintenance engineers.

Lucas-Nülle considers meeting such a challenge as its duty, particularly in view of the changes emerging in transport and logistics technologies towards electric vehicles, plus innovations like "smart cities" and digitalisation of commercial vehicles. This is why we are developing and making training equipment and systems in keeping with the background of the traditionally high quality levels of German vocational and engineering training for key technologies.

A high percentage of hands-on, practical training qualifications provide the guarantee to industry that trainees will have the practical skills they need.

These are the prerequisites for mastery of sophisticated technologies. After all, such technologies require theoretical knowledge and practical abilities. Experimentation with our educationally optimised systems combines theoretical information with hands-on know-how, and teases practical expertise out of theoretical knowledge thus guaranteeing bona fide occupational skills.

In addition to our classical experiments and training systems our new generation of PC-based systems provide the answer to increasing global demand for "blended learning" solutions in the area of automotive technology training and instruction.

To spark interest and enthusiasm, to provide insight into complex relationships and permit practical applications, these are the training and educational objectives that are paramount for us in designing and developing Lucas-Nülle training systems.

## Guarantee for successful training

These technical systems are supplemented by high-end literature and experiment manuals, which ensure not only that the necessary technical know-how is understood but that the experiments are also carried out safely and successfully.

Thanks in part to its technical competence and social commitment, a willingness to cooperate and work on a personal level, success is as good as guaranteed for our company. The company fosters a living, breathing team spirit which is anchored in the lean organisational structure of the firm.

# Teaching Skills and Know-how Using LN Training Systems

To enhance the individual learning curves of every trainee, Lucas-Nülle offers a variety of training systems. This is how the individual topics of vocational and advanced training in automotive technology can be optimally and efficiently taught. At the focal point of our system is the link between experiment hardware and training software. This is our way to break down any hurdles which may be perceived to differentiate our training systems from real motor vehicles.

Three separate system groups can be operated as desired, in combination or on their own. For the area of automotive technology the following three system groups are on offer:

- UniTrain
- CarTrain
- Training panel system

The need for three different systems lies in the complexity of the subject material to be mastered along with the level of knowledge of the trainees.

The UniTrain system is suitable in particular for teaching the basics. Single topics in automotive technology are mapped out and taught using numerous experiments.

The CarTrain or the training panel systems are designed for the study of whole system groups, as can be found in the area of engine management, for example. Trainees can investigate the individual sensors and actuators and focus on fault finding and fault elimination. Afterwards they can try out what they have learned on a real vehicle.

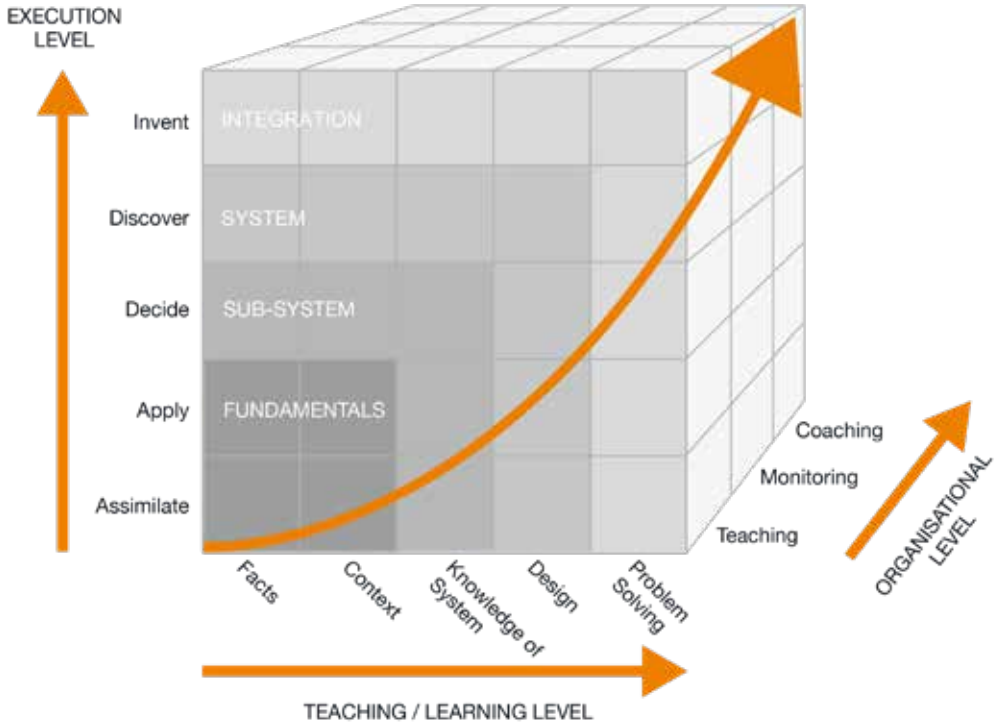
It doesn't even matter what system you choose. Each one is supplied with an expansive multimedia course. The course is conceived in such a way that trainees can work through the material on their own. They learn the theory and what they have learned can be monitored by means of test questions.

Theory is not all that is covered, though. All the experiments have instructions which are illustrated by animations. Each of the experiments also has a set of questions to help evaluate the conclusions.

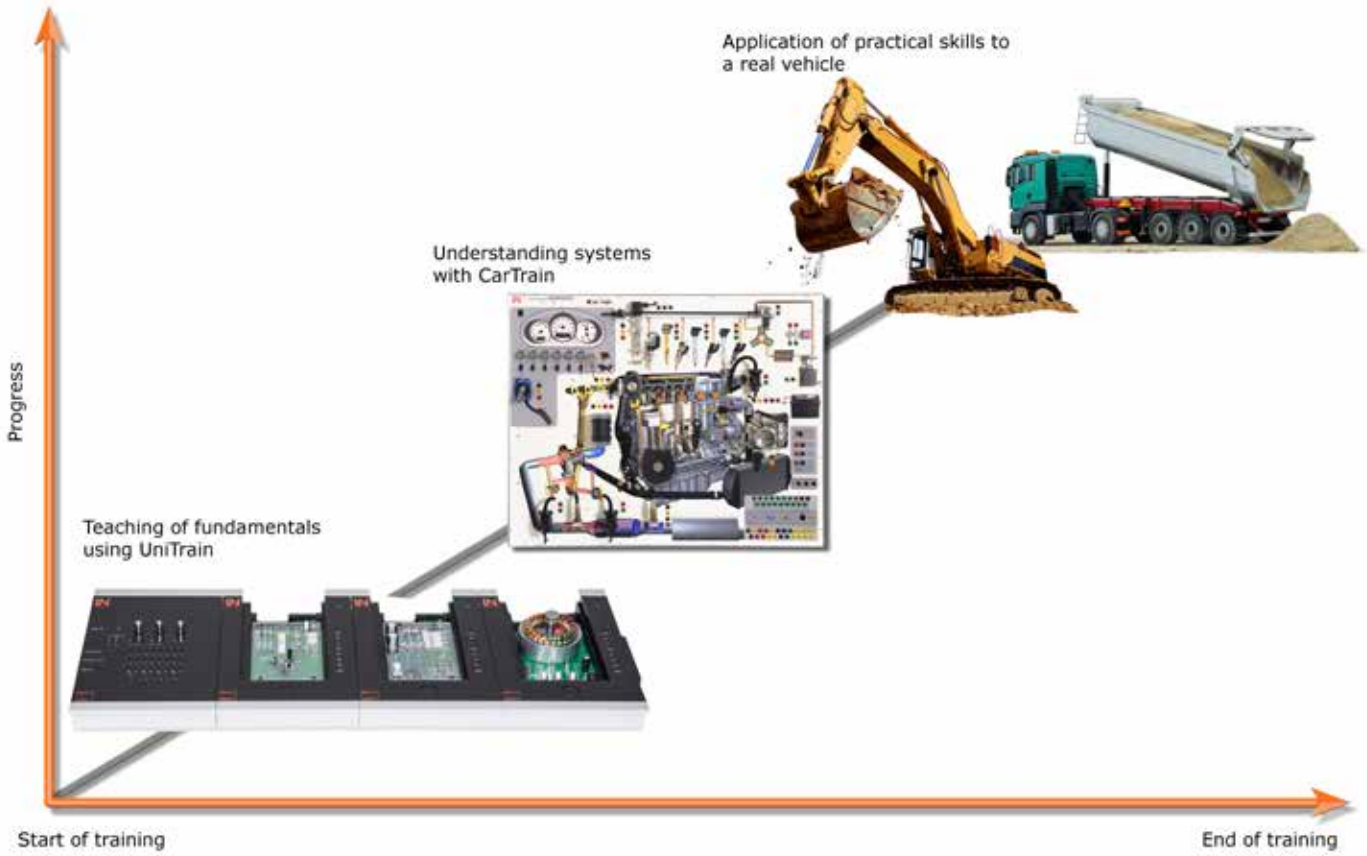
## Teaching skills and expertise

It is no longer possible to use rudimentary materials and methods to explain and demonstrate the complexity of a modern motor vehicle.

Nowadays trainees are confronted with the problem that even though it may be possible to identify the source of the customer complaint, there may not be enough know-how available to solve the problem. With the aid of training systems from Lucas-Nülle, trainees gain a step-by-step understanding of how a motor vehicle works. The UniTrain system covers the beginning of the process, where the basics are learned.




*Dimensions of the learning process*




Measurements can be carried out on the electrical hardware of the experiments, parameters can be modified and functions can be tested. At any time, teachers can check on students' progress with the help of Classroom Manager (see page 98). Each course covers a specific topic and advances trainees to a new level of practical skill. Once the fundamentals are familiar, training can progress to the understanding of systems with the help of CarTrain or the training panel system.

During this phase, trainees work with authentic vehicle components, covered in their own topics, such as CarTrain's direct petrol injection system, which includes a complete engine management system.

All systems are supplied straight from the factory with an extensive educative multimedia course, which includes not only theory, but also tests of knowledge and instructions for practical experiments.

**The irreplaceable focus is always on real vehicles. The training systems are used to convey the fascinating technology used in automotive technology.**

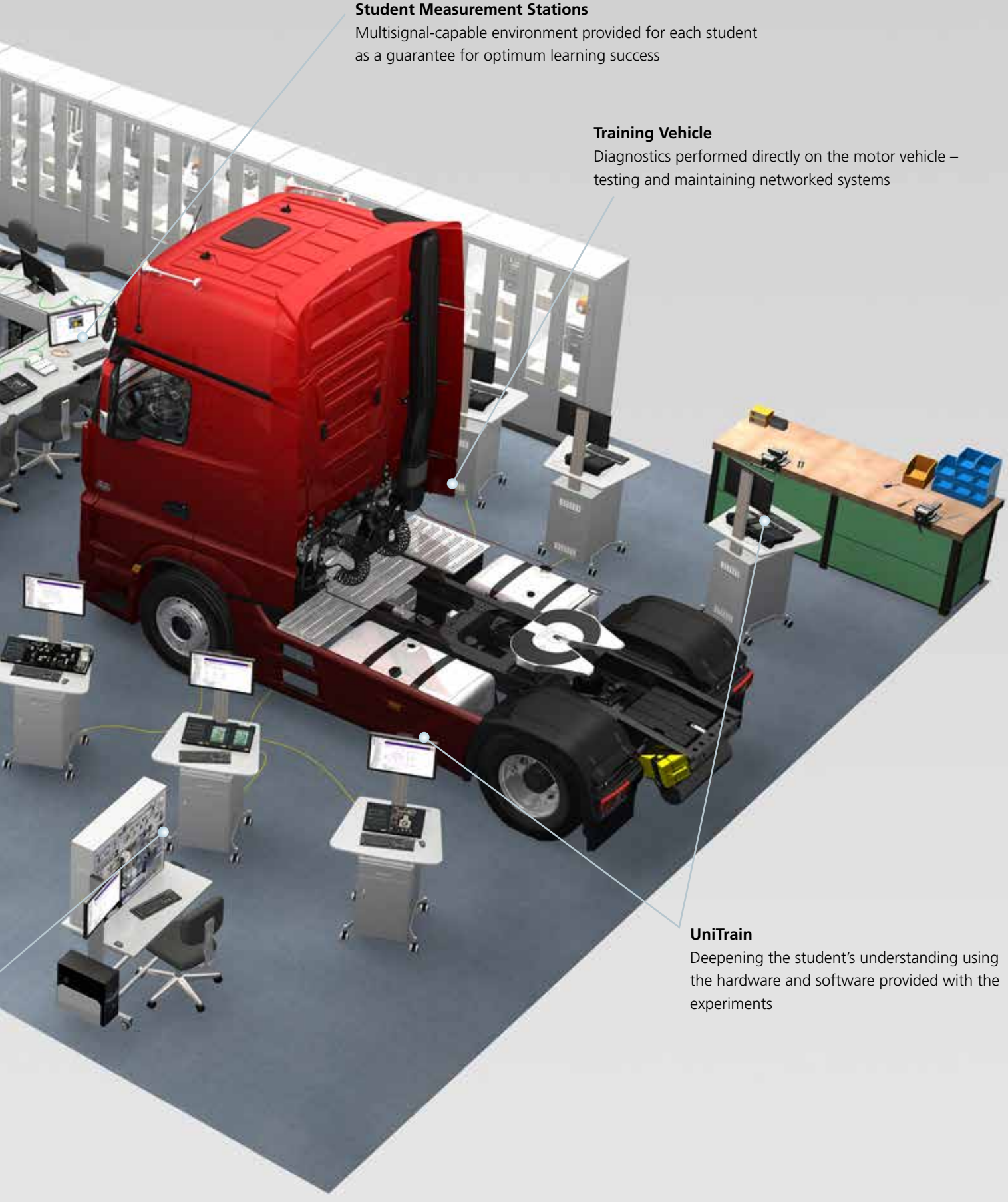
Lucid presentations of complex concepts with modern training and educational media

Complete solutions for modern engine management, brake, climate control and airbag systems

**Training Panel Systems**
Individual experiment set-ups for competent system understanding

**CarTrain**
Training on real components – interactive course software is used to facilitate overall system comprehension

# More than a Laboratory



**Student Measurement Stations**
Multisignal-capable environment provided for each student as a guarantee for optimum learning success

**Training Vehicle**
Diagnostics performed directly on the motor vehicle – testing and maintaining networked systems

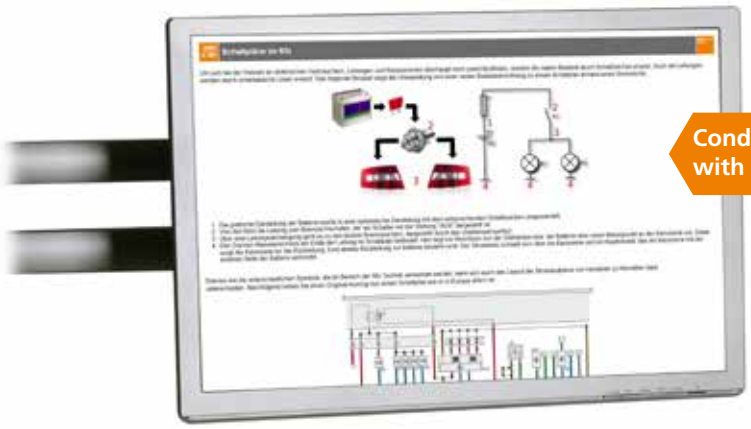
**UniTrain**
Deepening the student's understanding using the hardware and software provided with the experiments

# Practical Training

# Electricity/Electronics

## DC and AC Technology in the Motor Vehicle

The growing importance of electrical and electronic components in the motor vehicle makes the hands-on training approach to basic electronic circuits an absolute necessity. Our UniTrain course on DC and AC technology in the vehicle enable students to acquire this know-how through independent self-learning. They come to grips with such terms as current, voltage and resistance, and train in how to operate measuring instruments and conduct experiments using Ohm's and Kirchhoff's laws. All of the required measuring instruments are already built into the UniTrain's multimedia training environment.



**Conducting Measurements with the Computer**

UNITRAIN SYSTEM

### Training contents

- Basic concepts of current, voltage and resistance
- Handling power sources and measuring instruments
- Usage of circuit diagrams for the analysis of electrical components
- Putting to use accident prevention regulations pertaining to work with electrical current
- Measurements on series and parallel circuits, voltage dividers and mixed circuits
- Evaluation of measurement findings using comparative tables
- Recording characteristics of variable resistors (LDR, NTC, PTC, VDR)
- Troubleshooting

# Electronics and Digital Technology in the Motor Vehicle

Knowledge of the characteristics and functionality of electronic components forms the basis for understanding and analysing such components and their circuits in motor vehicles. Course topics include diode characteristics, basic transistor circuits, determination of valve- and rectifier-action of a diode and circuit design.

UNITRAIN SYSTEM

## Training contents

- Open- and closed-loop control operations in motor vehicle components
- Component classification according to hydraulic, pneumatic or electrical/electronic systems
- Recording diode characteristics
- Setting the operating point on the basic transistor circuit
- Understanding and using gain, emitter and collector circuits
- Design of basic logic circuitry
- Becoming familiar with Boolean functions and laws
- Experimenting with static and dynamic switching response
- Design of counter circuitry

# Electricity/Electronics

## Pulse-Width Modulated Signals (PWM)

Many actuator systems in motor vehicles require variable power levels for the devices being controlled. Actuators which need to assume intermediate values between the ON and OFF limits are controlled by means of pulse-width modulated signals. With our training system trainees document their measurement results, signals and fault protocols and analyse, evaluate and present their findings. This way they are able to isolate faults and propose suitable strategies for fault rectification.

UNITRAIN SYSTEM

### Training contents

- Principle of PWM
- Automotive PWM applications
- Adjusting the power of electrical loads with PWM
- Measuring a PWM signal's characteristics: frequency, amplitude, mark-to-space ratio
- Pulse width, edges and signal shapes
- Control and operating-current circuits
- Diagnosis of PWM-controlled components

# Fundamentals of Automotive Electronics

This training system is your introduction to the fascinating world of electronics in vehicles. All the circuits are pre-fabricated and can be put into action simply by plugging in a few jumpers. Apart from the hardware for the experiments, the system also features an extensive multimedia course. In addition, special attention has been paid to using and handling measuring instruments in conjunction with customers' vehicles.

UNITRAIN SYSTEM

## Training contents

- Introduction to parallel and series circuits
- Using multimeters
- Using oscilloscopes
- How a relay works
- Investigation of transistor circuits
- Experiments on a resistor in series with a ventilation system
- Measuring resistance

# General Electrical Systems in Vehicles

## Battery Diagnostics Training System

Batteries used in vehicles may be subjected to extreme operating conditions. Different vehicles use a wide variety of batteries. The battery diagnostics training system allows you to set up various internal resistances and voltages on an AGM battery and a conventional lead-acid battery for reliable and reproducible diagnostic investigation.

### Training contents

- Safe working with car batteries
- Key characteristics of car batteries
- Types of car battery
- Fundamentals of power generation
- Chemical processes in lead-acid batteries
- Vehicle maintenance/battery testing
- Measurements on a battery
- Use of battery testing equipment
- Troubleshooting batteries

# Three-phase Alternator/Generator

Virtually all modern motor vehicles are equipped with a three-phase generator to produce the required electrical energy. With the UniTrain course the trainees gain insight into the generator's basic functions and learn how to control it. They also plan and carry out diagnostics, maintenance and repair work on the power supply and the starting systems.

UNITRAIN SYSTEM

## Training contents

- Generator principle
- Basics of three-phase current
- Diode and rectifier circuits
- Functionality of an unregulated three-phase alternator/generator
- Discrete and integrated voltage controllers
- Regulated three-phase alternator/generator
- Fault diagnosis
- Compliance with accident prevention regulations

# General Electrical Systems in Vehicles

## Three-phase Generator with Hybrid Controller

Our system enables the trainees to become familiar with the function of the hybrid controller. Experiments are conducted and observations made as to how the hybrid controller maintains the generator voltage at a certain level, regardless of speed and load. The role of the average excitation current is explored as well as how changes are brought about in the magnetic field and stator winding induction. The trainees thereby learn independently and can monitor their knowledge in exercises and tests.

### Training contents

- Workshop orders and descriptions of faults form the basis of students' plans for testing and repairing automotive electrical and electronic systems
- Principle of three-phase generation and voltage regulation
- Understanding how a three-phase alternating voltage arises
- Properties of a hybrid controller
- Understanding the necessity of exciter diodes
- Investigating the exciter current
- Fault diagnosis in the system

# Three-phase Generator with Multifunction Controller

This training system is used to examine how energy is generated in modern motor vehicles. Today's compact generators make use of a monolithic controller. This kind of multifunction controller (MFC) has now largely replaced hybrid controllers. A progressive sequence of experiments gradually introduces students to the subject of power generation in automobiles.

## Training contents

- Workshop orders and descriptions of faults form the basis of students' plans for testing and repairing automotive electrical and electronic systems
- Principle of three-phase generation and voltage regulation
- Understanding how a three-phase alternating voltage arises
- Properties of a multifunction controller
- Understanding rectification and protection using power Z-diodes
- Battery monitoring (sensing)
- Examining pre-excitation (PWM)
- Fault diagnosis in the system

# General Electrical Systems in Vehicles

## Main Lighting

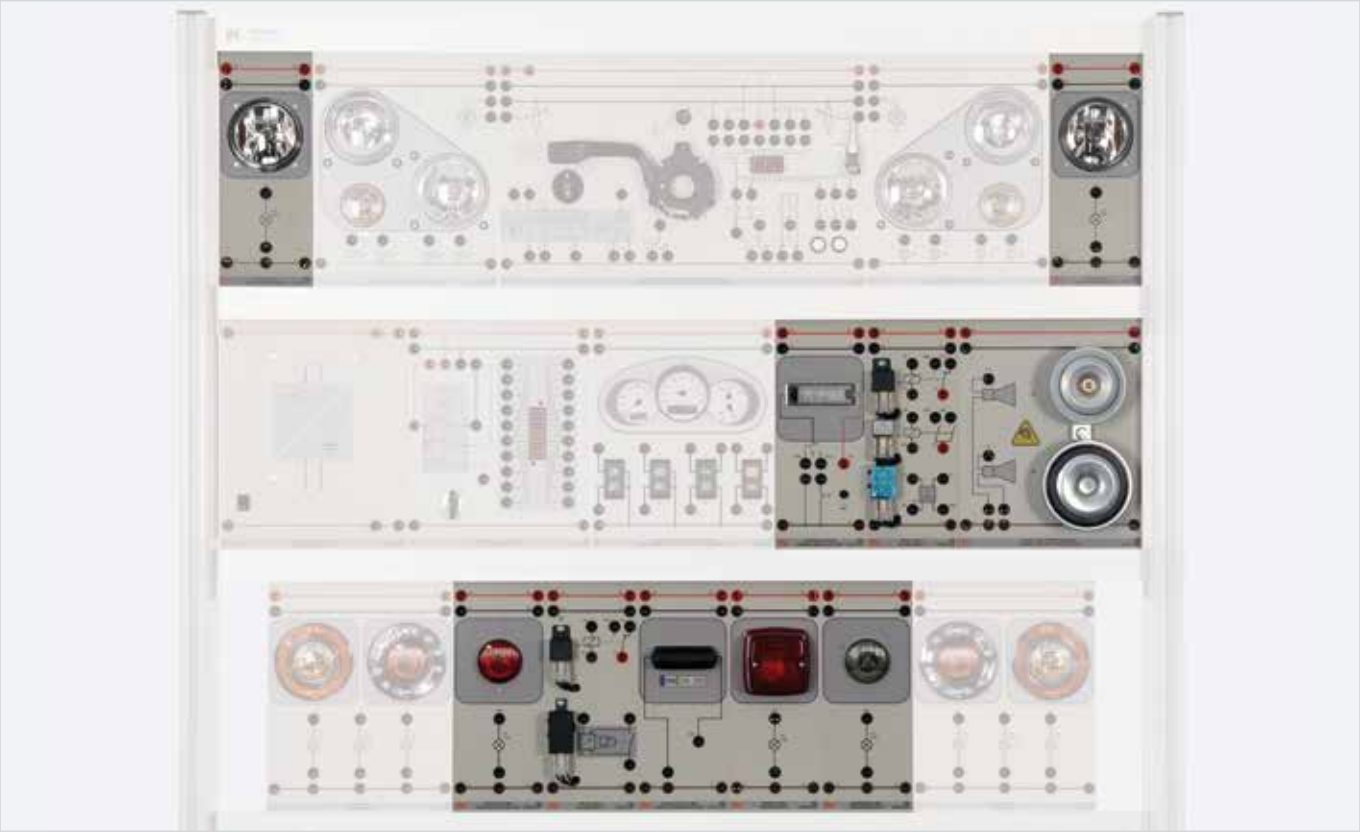
The main lighting system including all supplementary equipment is comprised of original automotive components.
With this system you establish the foundation for an individually expandable lighting panel wall. Combine other modules together to provide clear and easy understanding of a highly complex lighting system.

### Training contents

- Become familiar with local road traffic regulations
- Learn to distinguish between control and load circuit
- Practice protecting circuits with fuses
- Learn to use electronic relays
- Investigate how the manual headlight range adjustment works
- Record measurement values and document faults

# Auxiliary Lighting

This system is used to cover the topics involving auxiliary headlights and signalling systems – the latter is obligatory in every vehicle and thus enjoys special consideration in training programs. What is of interest here is that control of these components can vary depending on the vehicle. For that reason, instructors can only profit from a system that allows them to become familiar with different versions of these right there in the classroom.



## Training contents

- Become familiar with local road traffic regulations
- Learn to distinguish between control and load circuit
- Practice protecting circuits with fuses
- Learn to use electronic relays
- Investigate how the manual headlight range adjustment works
- Record measurement values and document faults

# General Electrical Systems in Vehicles

## Trailer Lighting

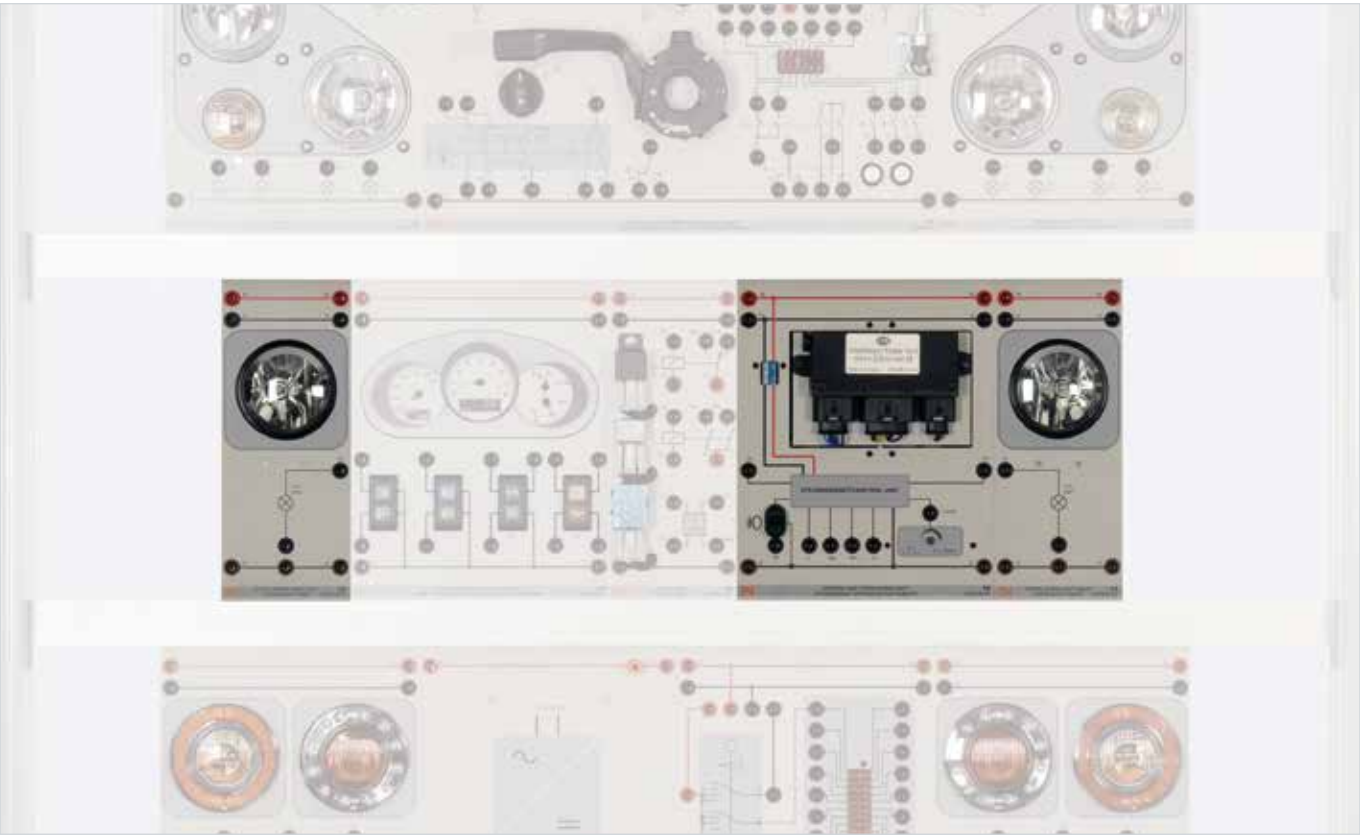
Once upon a time trailer lighting was simple to explain, but those days are over. Now the demands being made on teachers have grown in step with the complexity of the electrical system in question. In today's classroom it is not just how the plug's 7-pin or 13-pin socket assignment works, but also how to protect the towing vehicle from overloading and whether or not the control functions on the trailer comply with legal stipulations.

### Training contents

- Installation and commissioning of auxiliary equipment and systems according to manufacturing specs
- Perform retrofitting of lighting systems on the motor vehicle and become familiar with local road regulations
- Become familiar with local road traffic regulations
- Distinguish between control and load circuits
- Protect circuitry with fuses
- Record measured values and perform troubleshooting
- Trailer socket and plug assignments

# Static Cornering Light

This system helps instructors to impart know-how in all topics involving auxiliary headlights and signalling systems – the latter being obligatory in every vehicle and thus enjoying special consideration in training programs. What is of interest here is that control of these components can differ depending on the vehicle. For that reason instructors can only profit from a system that allows them to become familiar with various versions of these right there in the classroom.



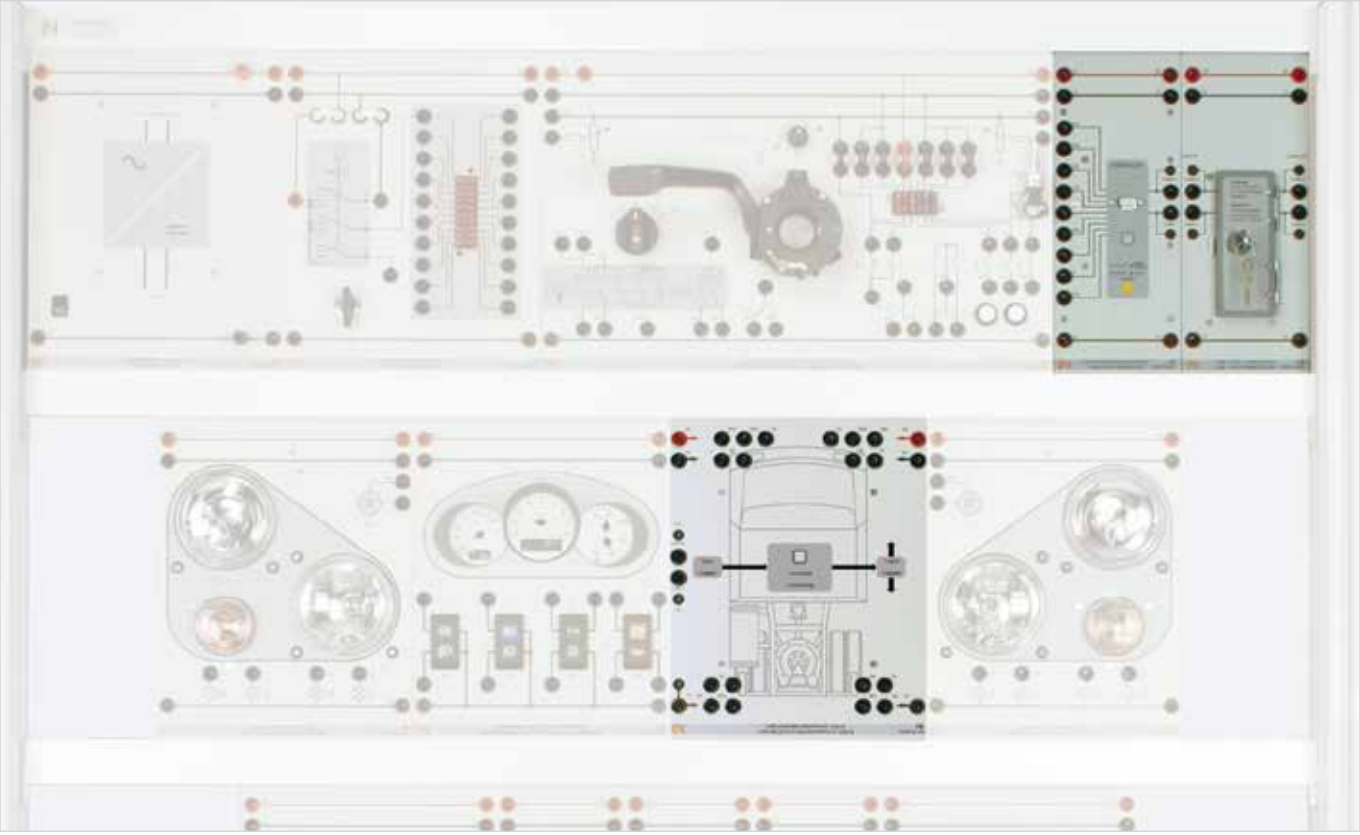
## Training contents

- Use of circuit diagrams
- How the yaw rate sensor works
- Retrofitting auxiliary systems
- Combination of cornering light and low beam headlight
- Calibration of motor vehicle components

# General Electrical Systems in Vehicles

## CAN Bus Extension

Expand any of the existing automotive lighting displays by a CAN bus node that is diagnostics capable. This novel concept permits operation in low-speed mode and, with just the push of a button, in high-speed mode, too. As a result, even without a CAN bus drive you can explore the basics of the different transmission speeds and the voltage levels associated with them. With the fault simulator you only have to activate a switch to feed various ISO standard fault codes onto the CAN bus.

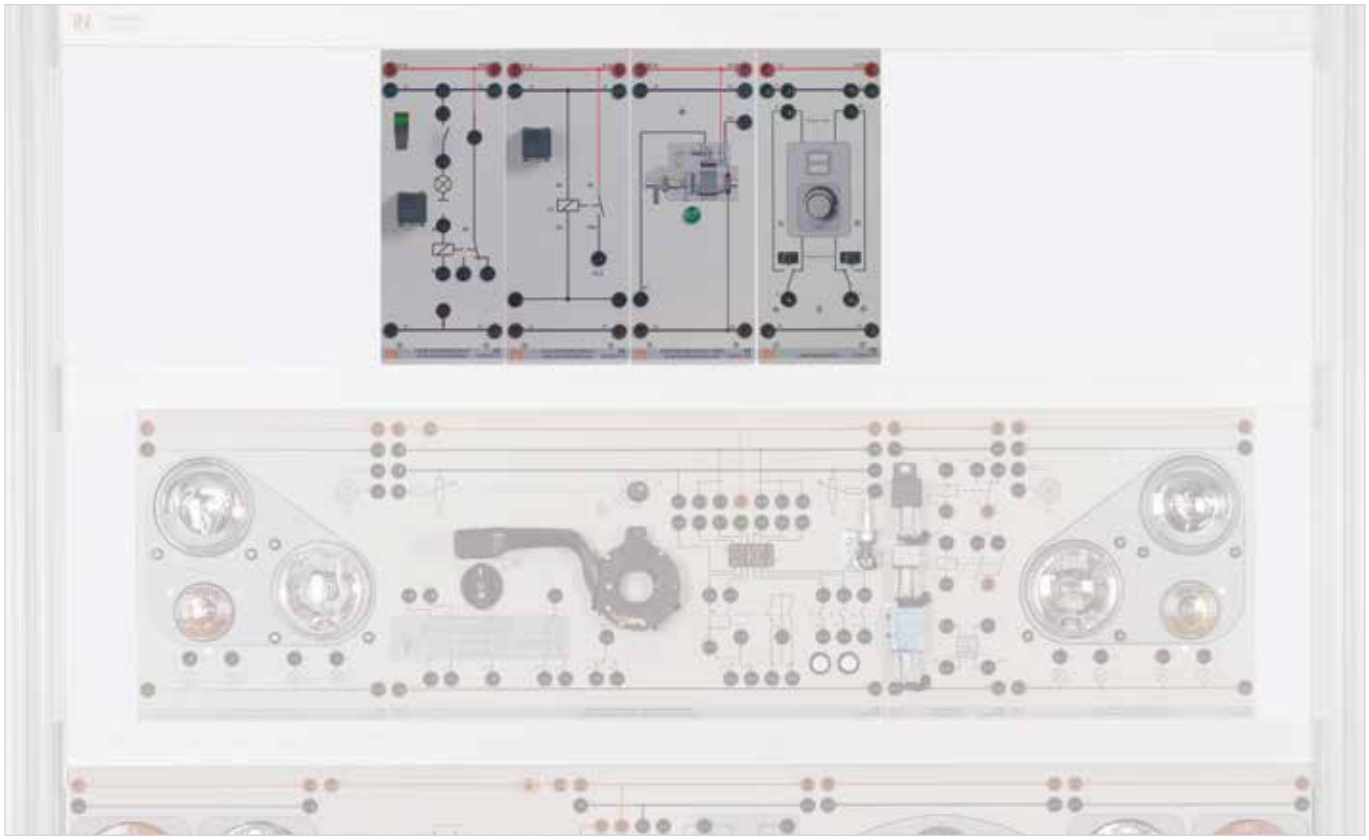


### Training contents

- Design of a steering column control unit
- Data transmission via a CAN bus
- Data protocol for low-speed CAN (class B), data protocol for high-speed CAN (class C)
- Fault patterns on a high-speed CAN bus and on a low-speed CAN bus
- Perform diagnostics on the CAN bus and analyse the baud rate
- Carry out short-circuit test of the power output stage

# Onboard Power Supply Expansion

The motor vehicle's onboard power supply is very complex. The authorities are constantly stipulating new rules and regulations involving this aspect in motor vehicles. This means that expansions and adaptations of the training material should permit the training system to reflect existing legal requirements. Facilitating the adaptation of onboard power supply systems to the latest technologies is one of the hallmarks of a training system designed for practical applications.



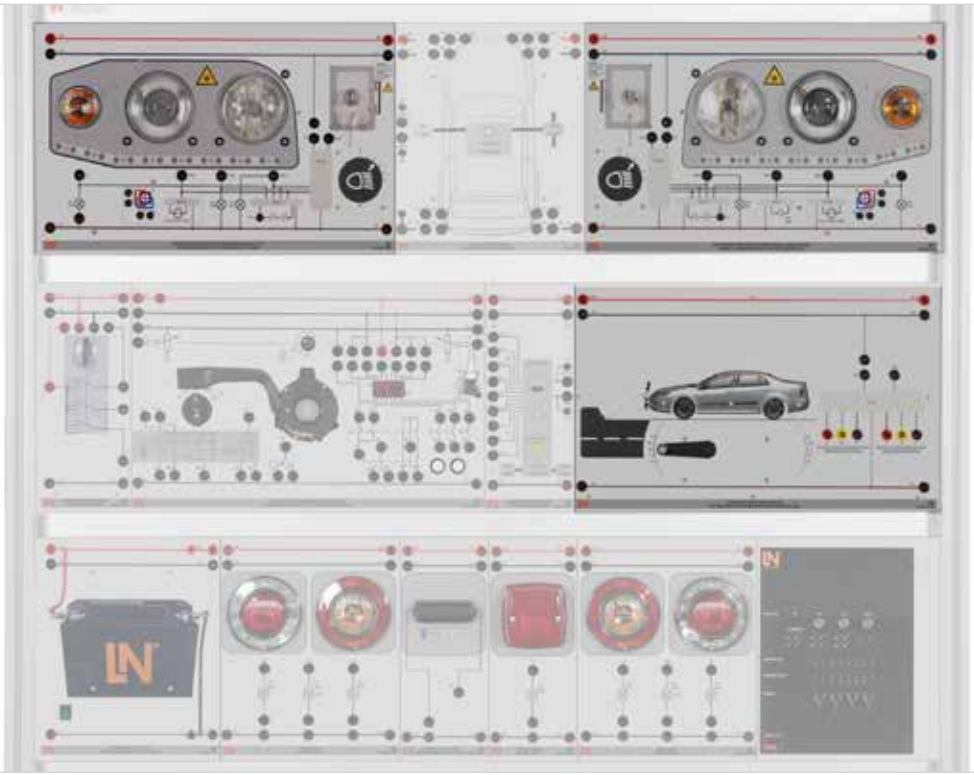
## Training contents

- Design a daytime running light controlled using PWM control
- Use incandescent lamp circuit in practical applications
- Assemble a circuit designed to unload the onboard power supply during start ignition
- Understand the design of relay circuits and be able to use them in practical application
- Comprehend starter connection and how the internal starter circuitry works

# General Electrical Systems in Vehicles

## Xenon, LED and Daylight Driving Lights

Supplement your existing CAN bus lighting panel with a modern lighting concept for front headlights. Thanks to its special educational design, this is now the one and only way to comprehensively and practically explain and explore the topics of xenon and LED headlamps and daylight driving lights by means of a training system. The system allows trainees to investigate the various lighting ideas simultaneously, thus offering a practical way to become familiar with the features of the lights and the differences between them. In addition, an automatic height adjustment system for the xenon lights is also included. By means of the various fault simulation switches, it is possible to activate various faults on the LIN bus which commonly occur in practice. This helps trainees to learn essential diagnostic skills.



### Training contents

- Activation of faults in the lighting system
- Direct comparison of modern lighting concepts
- Automatic height adjustment of headlights
- Communication via CAN bus and LIN bus
- Measurements on stepper motor

# Networked Systems

## Use of CAN Buses in Commercial Vehicles

Modern vehicles have countless electronic controllers, which continuously communicate with each other via digital bus systems. CAN buses are as widespread in cars and commercial vehicles as in construction or agricultural machinery. This training system therefore imparts a vital topic in a realistic way. Trainees carry out diagnostic and maintenance work on networked electronic systems in vehicles.

UNITRAIN SYSTEM

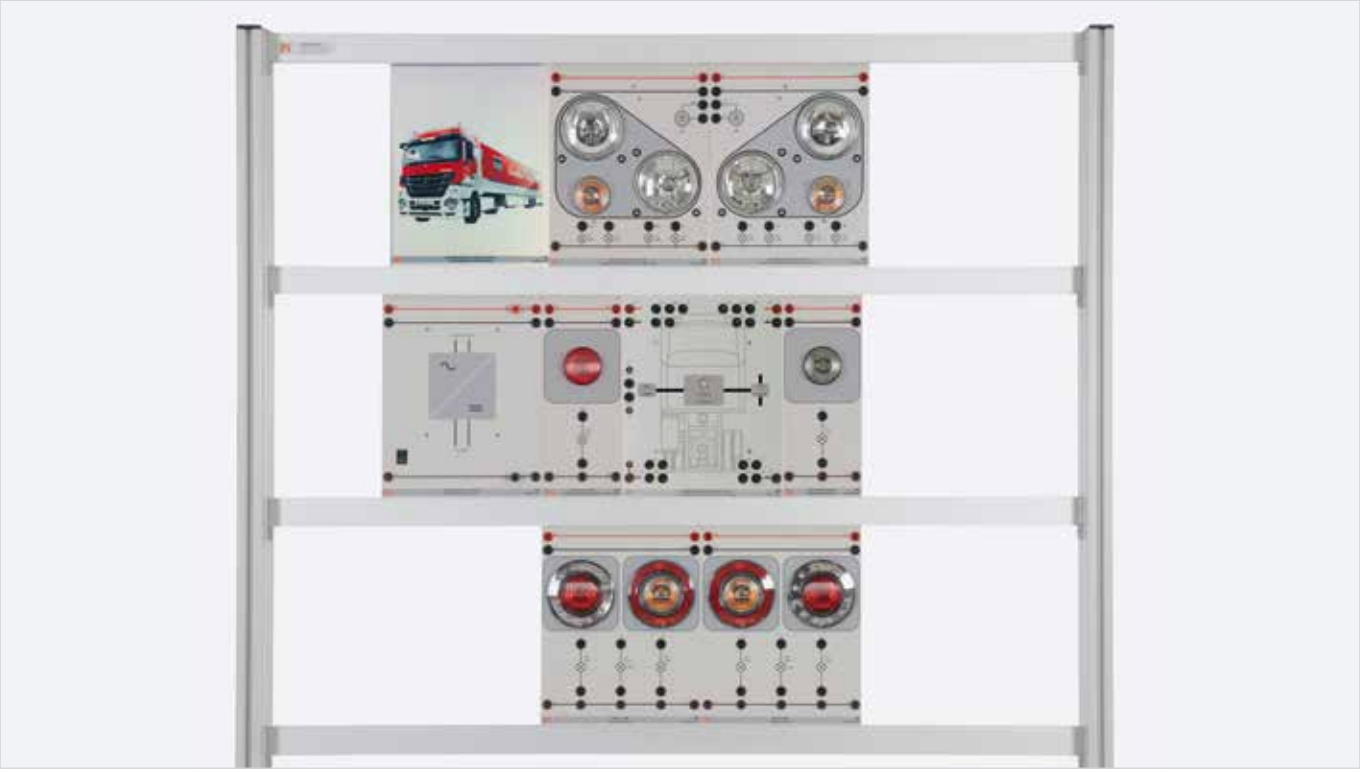
### Training contents

- Reasons for the use of bus systems in vehicles
- Topology and components of a CAN bus system in a vehicle
- Differences between low-speed and high-speed CAN buses
- Electrical properties of a CAN bus
- Data rates, identifiers, addressing and arbitration (low-speed and high-speed CAN bus)
- Structure of a packet frame for a CAN message
- Analysis of CAN packets via CAN monitor and oscilloscope
- Editing and transmission of CAN messages via a PC
- Troubleshooting

# Networked Systems

## CAN Lighting, Programming and Diagnostics

The "Lighting systems" training project adds another control unit to the CAN bus course. The "Lighting systems" interface makes it possible to control any conventional lighting systems. These can be operated by means of the switches and buttons on UniTrain cards from the "CAN bus" course.



### Your benefits

- Universal in application
- All baud rate parameters are configurable
- Troubleshooting with real components
- Data can be programmed as required

# LIN Bus

In addition to the CAN bus, the somewhat simpler LIN bus is also used. This bus is employed mainly for comfort systems which are not crucial to safety. With this training system, students examine the bus protocol and learn to perform systematic troubleshooting.

UNITRAIN SYSTEM

## Training contents

- Development of bus systems in motor vehicles
- Topology and components of a LIN bus system
- Electrical properties of a LIN bus
- Addressing of a LIN bus
- Master/slave principle
- Measurement tests of data fields
- Message frame structure
- Analysis of LIN messages
- Editing and sending LIN messages
- Troubleshooting

# Networked Systems

## Fibre Optic Waveguides

At present, optical bus systems are used mainly to achieve high data transmission rates in luxury automobiles. However, optical buses are likely to find broader use in view of the increase in data volumes that generally require processing in automobiles. For that reason fibre optics is an important topic for today's trainees and will be encountered more and more frequently on the job. Our training system has been designed so that trainees can distinguish between open and closed loops and classify them in accordance with their electronic systems.

UNITRAIN SYSTEM

### Training contents

- Data networks in motor vehicles
- Rationale for using optical waveguides in automotive applications
- Fundamentals of the MOST bus
- MOST protocol and control units
- Ring breakage diagnosis
- Design of optical waveguides in motor vehicles
- Optical bus systems in motor vehicles
- Fundamentals of ray optics (refraction, reflection)
- Attenuation by optical waveguides
- Data transmission and optical measurements on optical waveguides

# Workshop Communications with RFID

Communication with customers and filling out customer job orders form the basis for every single activity that follows. Information on motor vehicle data is obtained not only in talks with the customer but also by technical means involving communication between the motor vehicle and the PC. RFID (radio-frequency identification) technology is used to access the motor vehicle data contained in the motor vehicle's key and to read it out. This course provides insight into this functionality and its applications in the area of automotive engineering. The system comprising reader and transponder is studied both in terms of power as well as data transmission.

UNITRAIN SYSTEM

## Training contents

- Communication with internal and external customers
- Planning and preparation of work processes
- Service job order
- Complete job order
- The driver's key as a communication tool
- Reading data into the motor vehicle key
- Reading data out of the motor vehicle key
- RFID applications generally and specifically in the motor vehicle
- Understanding the components required for data exchange
- RFID transponder and antenna ranges
- Physical context and standards

# Networked Systems

## Comfort Systems and Keyless Entry

Comfort systems in the motor vehicle provide an essential, overall boost to active safety. Drivers are reluctant to do without a certain amount of driving comfort. New innovative operating systems quickly penetrate the market and rapidly become the standard. Training covers all the essentials of testing, diagnosing, repairing and performing adjustments on comfort systems, safety systems and door-locking systems, all in accordance with customer requirements, and includes documenting the results. With an excellent grasp of the system, the applications are easier to implement in practice.

UNITRAIN SYSTEM

### Training contents

- Comfort settings in the motor vehicle
- Active safety
- Door-locking system
- Central locking
- Remote radio control
- Keyless access to vehicle
- Capacitive pushbutton
- Basics of antenna technology
- How central locking works with CAN bus and expansion to keyless system

# Safety and Comfort

## Electromechanical Power Steering

Electromechanical power steering has many advantages over hydraulic steering. It assists the driver not just in purely physical terms, but also intelligently by responding only when the driver explicitly requests it. Steering assistance is provided as a function of vehicle speed as well as steering moment and angle. With this fully functional cutaway model the trainees quickly learn just how electromechanical power steering works. They also have the opportunity to conduct CAN measurements directly on the steering mechanism.

### Training contents

- Design of electromechanical power steering
- Function of the individual assembly groups
- Steering geometry
- Inverter control
- CAN bus control
- Vehicle speed sensor
- Steering angle sensor
- Steering moment sensor

CO3221-9B equipment set
Lucas-Nülle

# Safety and Comfort

## Airbag, Belt Tensioner and Crash Response

Active safety systems like airbags and seat-belt tensioners have been standard features in all vehicle classes for years. Regular inspections of these features are needed to ensure that they operate properly. For that reason this has become a routine part of everyday workshop work. Trainees learn the necessary know-how and troubleshooting strategies using this system as realistically as possible.


*Optional: SO3219-1P*

UNITRAIN SYSTEM

### Training contents

- Active and passive safety in motor vehicles
- Operating principles of airbags and seat-belt tensioners
- Safety switch and ignition cap
- Operating principle of pressure and acceleration sensors
- Measurement of acceleration
- Typical crash situations
- Trigger times and sequences
- Fault management for airbag systems
- Troubleshooting

# ABS/ASR/ESP

Brake systems of modern motor vehicles are becoming increasingly complex. Electronic aids such as ABS, ASR and ESP are now standard features in such systems. They are designed to keep the vehicle stable with physical limits and thus help assist in protecting the driver. Each individual system is mutually dependent and in part uses the same sensor signals. With this training system the trainee becomes familiar with and understands how the various systems function and interact.

UNITRAIN SYSTEM

## Training contents

- Basic physics of driving
- Understeering
- Oversteering
- Function and design of sensors
- ABS function and design
  - What is slip?
  - ABS control loop
- ASR function and design
  - Controlling situations
- ESP function and design
  - Operating principle

# Safety and Comfort

## Wheel Speed Sensor Technology

The means of registering wheel speed signals have undergone drastic changes in recent years. In many motor vehicles, the mechanical pulse generator ring has been replaced by a magnetic encoder. This has also given rise to new ways of diagnosing electrical signals and checking mechanical components. The "wheel speed sensor technology" training system allows proven techniques comprising inductive and Hall sensors to be compared directly with magneto-resistive sensors. Also included in practical training are mechanical checks of the pulse generator ring and magnetic encoder.

### Training contents

- Purposes and applications of wheel speed sensors
- Design and function of an inductive sensor, Hall sensor and magneto-resistive sensor
- Mechanical checks of a pulse generator ring and magnetic encoder
- Measurements and diagnoses of an inductive sensor, Hall sensor and magneto-resistive sensor
- Changing wheel bearings possessing a magnetic encoder
- Reading and understanding circuit diagrams
- Using diagnostic functions
- Repair methods and customer consultations
- Impacts of faults of practical relevance

# Electromechanical Parking Brake with Auto-hold Function

An electromechanical parking brake replaces the conventional handbrake with a simple switch on the dashboard so that there is no need for a handbrake lever. On uphill starts, sensors determine how steep the slope is. If the driver stops the vehicle, the brake engages automatically until the car is started again.

This new auto-hold function is being integrated into more and more vehicles and in the future will gain in significance. In our system we have depicted the modern electromechanical parking brake in such a way that it is easily understood and can be experimentally tested by trainees and students.

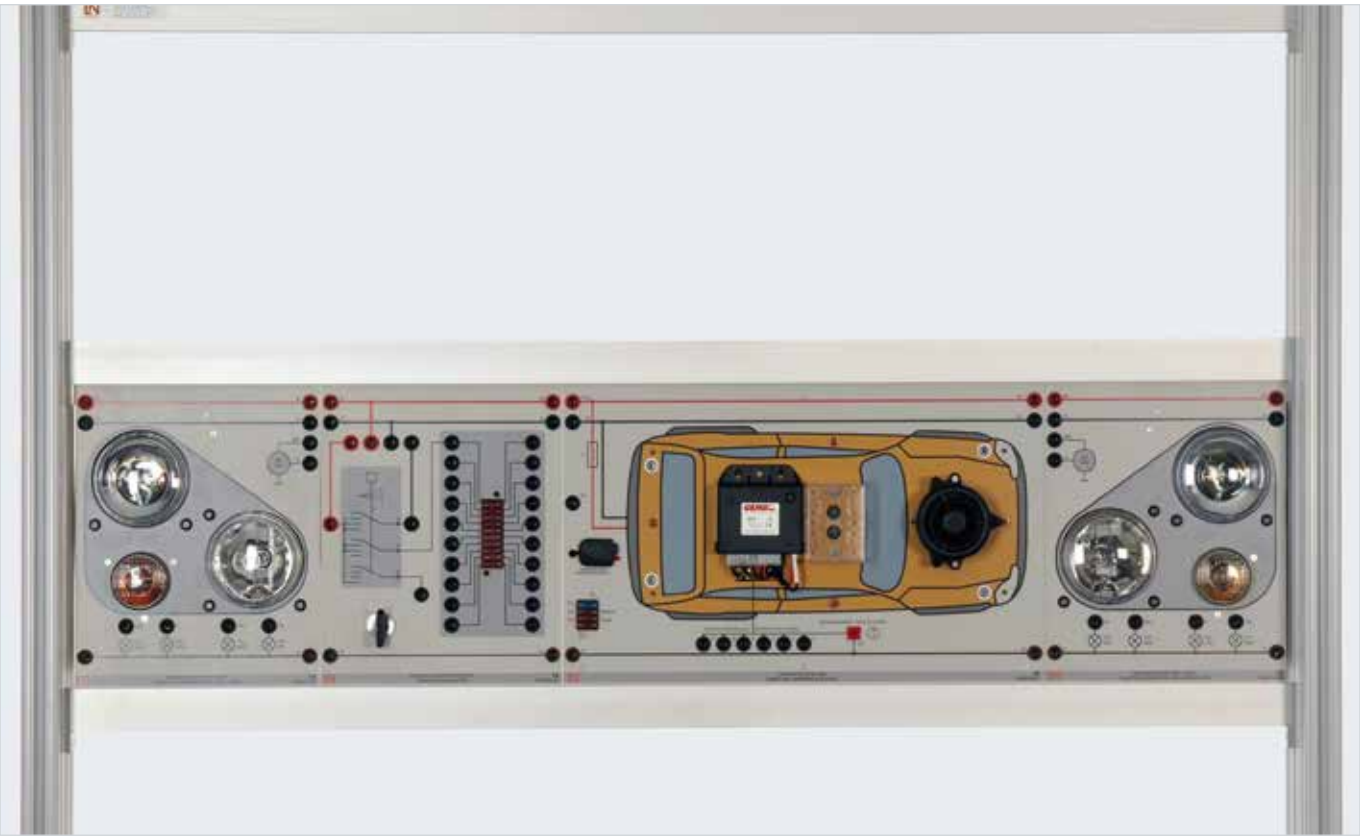
## Training contents

- How rear-wheel brake actuators work
- Sensors and actuators in an electromechanical parking brake
- How an electromechanical parking brake works
- Parking brake function
- Dynamic pull-away assistant
- Dynamic emergency brake function
- Auto-hold function
- Gauging of brake discs
- Understanding how brake boosters and hydraulic brakes work
- Interpretation and use of technical documentation
- Experimental investigation of the various functions for improved understanding
- Assembly, configuration and testing of mechanical components
- Design and function of disc brakes

# Safety and Comfort

## Alarm Systems and Immobilisers

The alarm system issues optical and acoustic signals in the event of attempted intrusion. Arranged compactly on a panel for training purposes, this fully functional alarm system permits clear demonstrations of functionality. In this course students can activate and deactivate the alarm system. The system can easily and optimally be integrated into the existing lighting systems and it is extremely well suited to accommodate the retrofitting of auxiliary systems for instruction purposes.



*CO3216-3C Alarm System and Immobiliser*

### Training contents

- Design type and operation of an alarm system with immobiliser
- Testing and adjusting alarm system function and immobiliser
- Programme the country-specific modifications of the alarm system and test how the alarm system works with other motor vehicle components
- Fault simulation

# Engine Management System

## High-Speed Glow Heating Systems

A wide variety of glow plugs are used in diesel engines. One very important distinguishing feature is the operating voltage of the plugs. Glow plug systems are conventionally powered using 12 V. Modern systems, though, are controlled using pulse-width modulation, which results in a voltage of close to 12 V during starting but 5 V during normal operation. Glow plugs controlled in this way are known as low-voltage plugs.

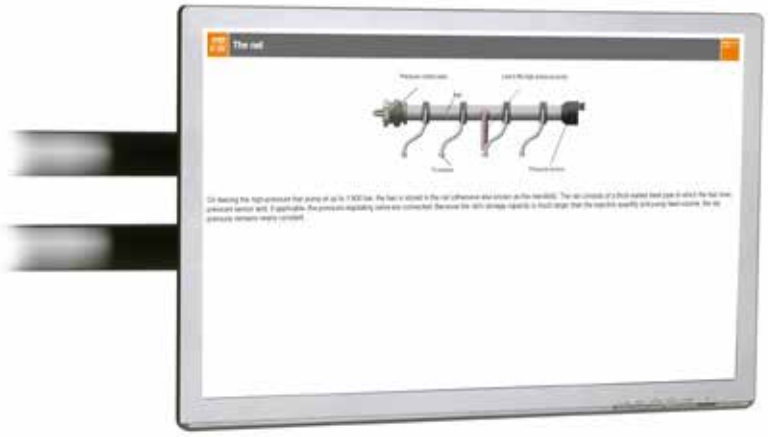
### Training contents

- Necessity for starting aids
- System components in a heater (glow) plug system
- Heater (glow) plugs
- Heater (glow) plug controller
- Pre-heating, pre-start heating, start heating
- Afterheating, intermediate heating
- Measuring voltage with an oscilloscope

# Engine Management System

## Common Rail Diesel Injection System

What goes into making a diesel engine run "smoothly"? How can engines be designed to lower exhaust gas emissions? The fact that everything is just a question of the injection system makes this field all the more exciting. This topic is made easier to comprehend using our training system, which empowers the trainee to learn about injection pressures, processes and air-fuel quantities in a self-controlled learning process. In order to cover the entire spectrum of systems available on the market, the trainees are able to switch between the various injector types and thus gain an overview of the entire topic.



**Piezo technology with up to seven injection cycles**

UNITRAIN SYSTEM

### Training contents

- Requirements to be met by diesel injection systems
- Introduction to various designs
- Design and functionality of a common rail system
- Fault localisation on a common rail system
- Injection characteristics of common rail systems and piezo injectors (with up to seven injection cycles)
- Investigation of the fuel system and differentiation between low- and high-pressure circuits
- Understand the process of electrical tests of injectors
- Examination of a common rail system's hydraulics

# CarTrain Common Rail

The common rail engine management system combines the entire engine control electronics into a single control unit. The training system is designed to perform actuator control as a function of the corresponding sensor signals. This makes it possible to reproduce and understand different driving conditions. The sensors and actuators used in the engine management system are genuine, fully-operational components.

## Training contents

- Understand how the engine management system works
- Grasp how the control loops in the system operate
- Learn about the design and function of sensors and actuators
- Learn how to interpret and use circuit diagrams
- Conduct practical, hands-on measurements on the engine management components
- Read out fault memory
- Measure and test electrical, electronic, mechanical, hydraulic and pneumatic variables
- Adjust engine management system parameters
- Learn to use expert systems and remote diagnostics

# Engine Management System

## CarTrain Common Rail with Variable Geometry Turbocharger

This combination of a common rail engine management system with a variable geometry turbocharger illustrates the fascinating topic of charge optimisation in a modern fuel injection system.

All the sensors and actuators can be investigated and assessed by means of a wide range of measurements. The built-in fault simulation feature facilitates training focussed on hands-on skills.

### Training contents

- How engine management systems work
- How the control loops making up the system function
- Design and operating principles for sensors and actuators
- Interpretation and use of circuit diagrams
- Authentic practical measurements on engine management components
- Reading out fault memory
- Measuring and testing electrical, electronic, hydraulic, mechanical and pneumatic variables
- Adjustment of management systems
- Expert systems and remote diagnostics

# Ignition Systems

To ignite the air-fuel mixture, combustion engines have always needed an ignition system. Nowadays such ignition systems have become extremely complex and precise in order to comply with emission standards while at the same time enabling modern combustion engines to unleash their tremendous power. With our training system the trainees come to grips with these topics early on and can use the UniTrain system to learn on their own and at their own speed how the ignition system is designed, what can go wrong and how this can be identified. Trainees also learn to carry out diagnostics and maintenance in the area of engine management.

UNITRAIN SYSTEM

## Training contents

- Observe how the ignition spark is generated
- Learn about ignition timing (mechanical and map-based)
- Conventional ignition system and dual-spark ignition systems are introduced
- Transistorised ignition systems with Hall and inductive sensors
- Become acquainted with the electronic ignition system
- Learn how to record and evaluate ignition oscillographs
- Find out the basics of static and rotary high-voltage distribution

# Engine Management System

## CarTrain Motronic 2.8

The motronic system unites in one control unit the engine management's entire electronics (air-fuel mixture and ignition). Motronic 2.8 is a multi-point injection system in which each cylinder has its own injection valve. The actuators contained in this training system are controlled as a function of corresponding sensor signals. Different driving conditions can be reproduced and analysed. All sensors and actuators of the engine management system are original, fully functional components.

### Training contents

- Understand how the engine management system works
- Function and operation of the relevant control loops
- Design and operating principles of the sensors and actuators
- Interpretation and application of circuit diagrams
- Conducting hands-on measurements on engine management components
- Fault memory read-out
- Measuring and testing electrical, electronic, hydraulic, mechanical and pneumatic variables
- Engine management system settings
- Expert systems and remote diagnostics

# Changing Timing Belts in Overhead Camshaft Engines

Changing timing belts is one of the key jobs to be carried out when servicing vehicles with overhead camshafts. It is especially vital to maintain valve timing accurately and not to alter the positions of the cams with respect to the crankshaft. This training system teaches you the best and safest way to change a timing belt.

## Training contents

- Changing timing belts
- Information for servicing systems subject to wear and tear
- Engine management
- Purpose of the pulleys
- Setting the correct tension in the belt
- Interaction between crankshaft and the valves
- Correct tightening torque for bolts

# Engine Management System

## Working Engines and Cut-Away Models for Diesels

Decide for yourself whether you just need a fully functioning engine or even a fully set-up vehicle. All systems are manufactured to the highest safety standards, in such a way that there is no immediate access to any rotating parts. Any components which may get hot are also covered. All systems can be equipped with fault simulation capabilities and signals can be measured with the help of break-out boxes. Original workshop documentation is supplied with all systems.

Contact us for more information.

*Example of a fully functional engine. Your dealer can supply you with additional models or information.*

### Your benefits

- Practical training using original vehicles/components
- All components are fully functional
- Self-diagnosis and acquisition of operational data
- Simulation of malfunctions
- Direct measurements on vehicle/engine without the need for disassembly
- Measurements on all systems can be made while the engine is running
- Investigation of electrical and mechanical components

# Hydraulics and Electro-Hydraulics

## Fundamentals of Hydraulics and Electro-Hydraulics in Commercial Vehicles

Due to the increasing complexity of modern commercial vehicles, the demands on the hydraulic systems used in such vehicles are continuously becoming higher. The growing requirements for safety and comfort systems, as well as the need for improvements in energy efficiency have led to major developments of hydraulic applications. Such modern systems, which continue to be developed, are nowadays heavily linked to open- and closed-loop control technology. The multiplicity of functions demands from servicing mechanics a deep and extensive knowledge of fundamental hydraulics and the various associated applications. This is why Lucas-Nülle has developed a training system which allows for learning in ways closely based on authentic practice and which imparts the necessary fundamentals to trainees simply and comprehensibly. The course teaches basic knowledge of hydraulics. The functioning principles and design of hydraulic control systems are conveyed with clarity by means of numerous well tested experiments.

UNITRAIN SYSTEM

### Your benefits

- Hydraulics and electro-hydraulics in a single training system
- Leak-proof connectors
- PC-based recording of displacement-time diagrams
- Built-in circuit diagram editor
- Combination of theory and practice by means of blended learning
- Exercises based on authentic practice

# Hybrid and All-Electric Vehicles

## DC/AC Conversion

Electric energy is tapped at the car battery in the form of DC voltage and is then applied as a DC current. However, in modern electrical drives an AC voltage is needed with an approximate sinusoidal alternating current. In this course the generation of AC voltage and currents is described and demonstrated in a simple and graphic fashion. The knowledge acquired in the theoretical section is then verified empirically by means of experiment. All of the components need-ed for the experiment are arranged on a single printed circuit board. In knowledge tests the student's progress is checked and thus the most important aspects of DC/AC conversion are effectively learned in the fastest possible time.

UNITRAIN SYSTEM

### Training contents

- Ohm's law
- PWM modulation
- Generation of half-wave sinusoidal current
- Generation of a negative voltage
- Alternating voltage and alternating current
- Magnetic fields permeating a coil
- The rotating electrical field

# DC-DC Step-Up and Step-Down Converters

For inverters in electric and hybrid vehicles, as well as in many other circuitry applications, DC voltages of differing levels are required. This training system allows investigation of various possibilities for DC to DC conversion.

UNITRAIN SYSTEM

## Training contents

- One course for step-up conversion (converting low DC voltages to higher ones)
- One course for step-up conversion (converting high DC voltages to lower ones)
- Safe handling thanks to safety low voltage
- Practical understanding of voltage conversion
- Function and design of DC-DC converters
- Measurement of input and output voltages

# Electromobility

## Hybrid Drive in Motor Vehicles

Hybrid drives are essentially meant to meet three objectives: save fuel, reduce emissions, and increase torque/power. Different hybrid concepts can be employed depending on the required application. With our system trainees can learn on their own the most important technical fundamentals, of hybrid drives. Based on job orders and fault descriptions students plan diagnostics of individual components, carry out testing on systems and do repair work on original motor vehicle parts. In the course of measurements and experiments, the students acquire practical know-how for every day on the job and for vocational training.

UNITRAIN SYSTEM

### Training contents

- Benefits of hybrid systems
- Serial hybrid system
- Parallel hybrid system
- Power-split hybrids
- Design of electrical machines
  - Asynchronous machines
  - Synchronous machines
- Fundamentals of inverters
  - Converters
- Fundamentals of frequency converters
- Three-phase voltage supply
- Measuring
  - DC voltage
  - AC voltage
  - Three-phase AC voltage
- Investigation of energy and power flows
- Onboard power supply of hybrid vehicles

# Pilot Line

A pilot line is a system designed solely for safety purposes which ensures the safety of drivers and of mechanics working on and around a vehicle at a workshop. Its purpose is to disconnect the high-voltage battery in the event that cables have been incorrectly disconnected or if faults have occurred. Trainees become familiar with the pilot line by means of interactively based experiments.


UNITRAIN SYSTEM

## Training contents

- Electric circuitry of pilot line
- Signals on a pilot line
- Investigation of pilot line by measurement
- Simulation of faults commonly encountered in practice

# Hybrid and All-Electric Vehicles

## High-Voltage Battery Disconnection Unit

This training system explains how the contactors of a high-voltage battery disconnection unit work. The system monitors the high-voltage network and only connects the battery when a self-test has successfully proven that the system is safe.


UNITRAIN SYSTEM

### Training contents

- Design and function of battery disconnection unit
- How the contactors work
- Sequence of contactors in circuit
- Fault diagnostics – simulated faults can be activated
- Investigation by measurement

# Safe Handling of High-Voltage Systems

This training system concentrates on safety when working with high-voltage vehicles and the dangers of high current passing through the body.

UNITRAIN SYSTEM

## Training contents

- Fundamentals of safety when working with high-voltage vehicles
- Effect of faults encountered in practice
- Measurement of current passing through a human body by means of a model

# Hybrid and All-Electric Vehicles

## Training System for High-Voltage and Air-Conditioning Systems

The training system for high-voltage and air-conditioning systems from the well established CarTrain range leads trainees further into the specific features of high-voltage electrical systems in vehicles. The system teaches specific diagnostic skills along with theoretical and practical know-how needed for appropriate diagnosis and customer-oriented service in and around electric vehicles. In order to achieve this objective, the training system focuses on the subject of high-voltage drives, systems for intrinsic safety and high-voltage air-conditioning systems. Trainees get the chance to make measurements directly on the traction motor without any contact, which is a huge benefit to safety. It is also possible to acquire an understanding of the pilot line or insulation monitor by carrying out measurements on them.

Where the system really adds value is based on the fact that it includes an authentic, operational high-voltage air-conditioning system. This makes it possible to see the individual components of the system and to carry out the kind of servicing on them commonly done in modern repair shops. Trainees can record communication between system components on both the CAN bus and the LIN bus. Moreover, the training system is designed in such a way that the risk of hazards can be eliminated at all times.

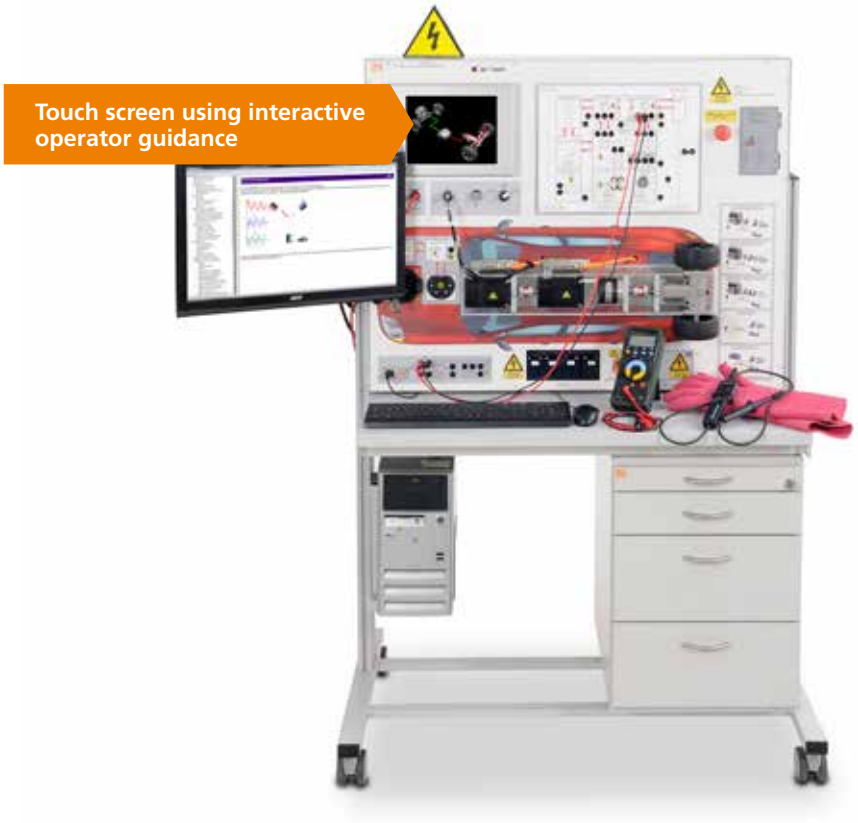
### Training contents

- Genuine high-voltage
- Various operating modes can be simulated
- Optimisation of control for high-voltage drive system
- Non-contact measurement of high-voltage drive system
- Interactive fault simulation
- Fully functional high-voltage air-conditioning system including HV compressor (original vehicle components)
- Original casing for a high-voltage battery including servicing plug
- Measurements on pilot line
- Measurements on insulation monitor
- Diagnostic procedures based on authentic practice with workshop job orders

# CarTrain Hybrid and All-Electric Vehicle Technology Trainer

When we think about the future of our planet, the development and production of vehicles equipped with hybrid drives is a logical and necessary step. Lower emissions and less fuel consumption are benchmarks for future generations of modern automobiles. Such measures ensure that the fundamentals necessary for life are sustained while quality of life improves.

Hybrid motor vehicles and electric cars are not just a future consideration, but in fact the auto industry has already made them available on the market. The only rational diagnostic strategy available for these vehicles presupposes the necessary system understanding.




## Training contents

- Use of HV systems in motor vehicles
- Smart grid
- Vehicle to grid
- Drive concepts in HV vehicles
- Energy flows in HV systems
- Onboard power supply of HV vehicles
- Practical, hands-on procedures in the repair shop
- How electrical machines function
  - Inverters
  - Switching possibilities of three-phase motors
- Work safety
- Design of electrical machines
- Asynchronous machines
- Synchronous machines
- Electromagnetic compatibility

# Diagnostics and Instrumentation

## Student/Teacher Measuring Stations

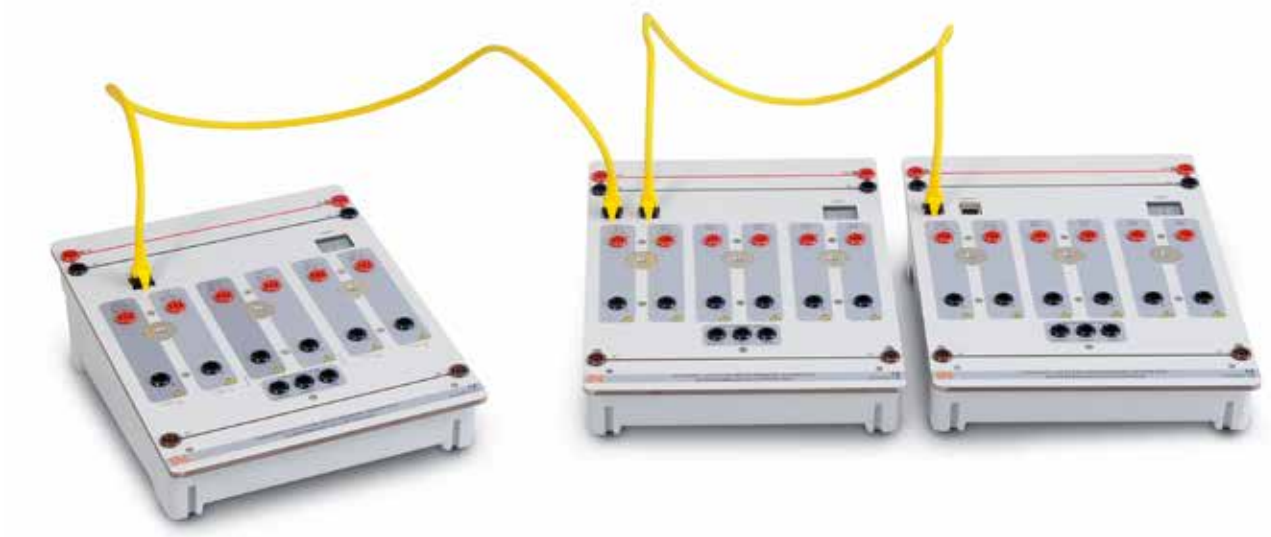
Many a teacher would wish for highly flexible, safe student/teacher measuring stations which can be networked together. Lucas-Nülle have therefore developed a system which allows for students to receive identical signals to those being read by their teacher. The signals can be transmitted from a system such as CarTrain or from an actual vehicle. This is because the new system can be connected to any electronic system, including other Lucas-Nülle training systems from topic areas other than automotive technology.

The new Lucas-Nülle student/teacher measuring stations allow teachers to transmit high-voltage signals from their own stations at any time. Signals are automatically converted for each student and output at lower voltage to the students' measuring stations. Curves of the signals, however, are displayed exactly as if there were indeed a high voltage present. This allows students to understand the typical features of high-voltage signals without being subjected to any safety hazards.


1. Training system with signal generation → 2. Teacher station interface → 3. Student stations

# Student/Teacher Measuring Stations

The teacher measuring station includes a gateway which allows a variety of CAN bus signals to be fed in. This topic, which is crucial to diagnostics and testing, can therefore be taught highly efficiently with the help of the student/teacher measuring stations. The last interface in a system has a terminating resistor switched in so that automatic bus determination is possible. One other, quite essential benefit for teachers is that faults or breaks at individual student stations are displayed along with the number of the station in question. This allows teachers or training personnel to immediately identify the break and respond to it. This cuts down on lost lesson time and also encourages successful learning.



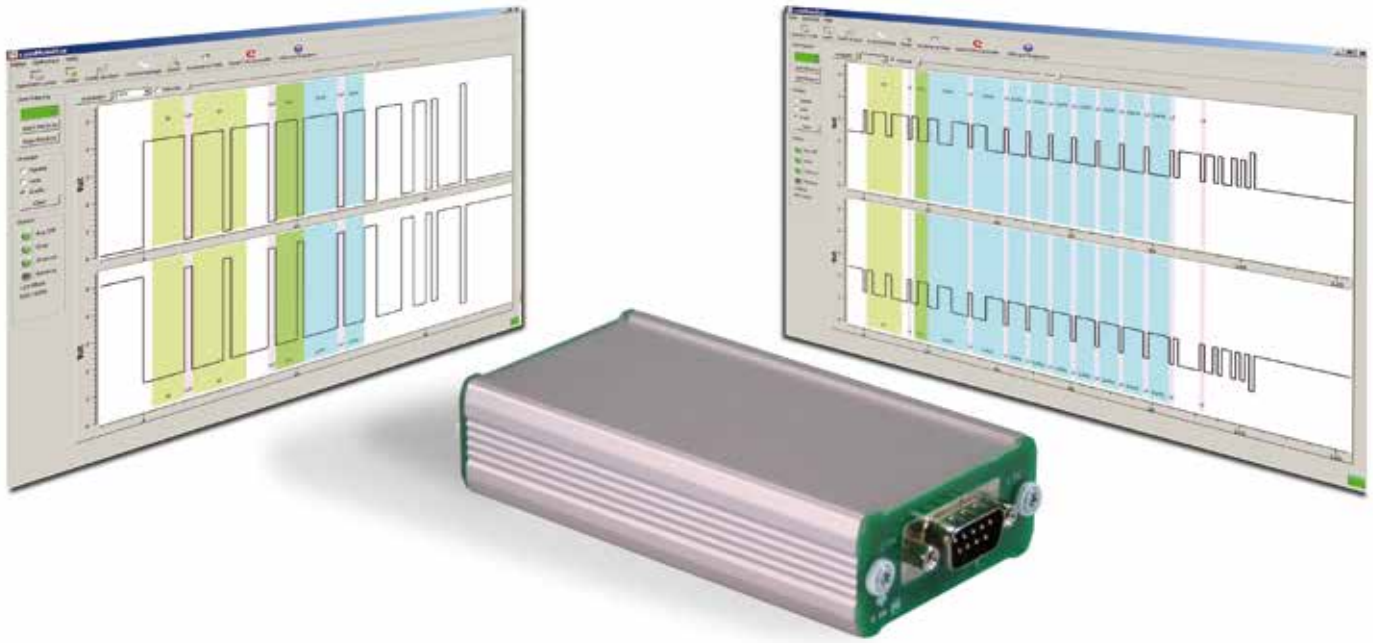
## Your benefits

- For universal use in all training classes
- Transmission of both analog and digital signals
- Signal inputs up to +/-500 V / signal outputs up to +/-15 V
- Accurate transmission of signals
- Ease of assembly and disassembly
- Digital display for diagnosing circuit breaks
- Faults do not affect the rest of the system
- Ease of networking in the lab by means of Ethernet cables

# Diagnostics and Instrumentation

## CAN/LIN Monitor

The CAN/LIN monitor allows bus protocols on a CAN bus, LIN bus or any serial bus to be recorded and investigated.



### Your benefits

- Visual display of bus protocol structure
- Option for displaying in binary or hexadecimal code format
- Recording of bus packets
- Transmission of bus packets
- Suitable for student experiments and demonstrations
- Simple to put into operation
- Displays
  - identifier
  - data length
  - period
- User-configurable graphic interface

# Mega Macs 66

Well thought-out design, innovative technology and a unique repair concept – that is the Mega Macs 66. Using the touch screen interface is child's play and the menu design is intuitive, allowing you to carry out all the necessary diagnostics, working procedures, measurements and data assessments in real time, without lengthy searches, without any need for guesswork and without unnecessary wasting of time.
The Mega Macs 66 lets you read out and delete fault memory for 40 different makes of vehicle and 38,000 models. Moreover, the diagnostic skills of your trainees can be enhanced by means of actuator tests, read-out of parameters and coding for controllers. Should diagnoses turn out to be complicated, it is even possible to call up repair advice in real time, based on the fault codes and specific to the vehicle. The "Repair-Plus" licence also gives you full-colour, interactive circuit diagrams with current readings and a display of parameters in real time too. All the necessary measurements can be carried out using the built-in dual-channel oscilloscope or multimeter. The signals measured can then be evaluated automatically.

## Your benefits

- Car History for saving full history of vehicle
- WiFi capability
- Inserts for additional functions
- Compatible with CSC tool
- Compatible with BPC tool
- 12.1" touch screen
- USB, WiFi and Bluetooth

# Diagnostics and Instrumentation

## Mega Macs PC

Mega Macs PC is the first software solution from Hella Gutmann Solutions, which transforms your workshop PC into a fully fledged diagnostic station. Ideal for anyone who prefers to carry out professional diagnostics and advised repairs solely from the workshop's PC, laptop or tablet computer. You can also save on investment in additional hardware with Mega Macs PC. If you are familiar with all the diagnostic solutions already available from Hella Gutmann, you will also find Mega Macs PC easy to install and its user interface simple and self-explanatory. Querying of all controllers via wireless communication can also be handled without difficulty by Mega Macs PC, as can reading out or deleting fault codes, carrying out service resets, detecting sensors, resetting values or switching systems on and off. All these things will in future be possible to do simply from a computer. What is more, it can be done for more than 35,000 models of vehicle.
Whether you use a local network or WiFi, with Mega Macs PC you get a fully fledged and powerful software-based diagnostic solution for your workshop, providing for more comfort, quicker repairs and increased earnings.


### Your benefits

- Documentation and printing of Car History
- Bluetooth technology for communication between PC and device
- Regular updates

## Multiscan

VAG-COM is a Windows-based program for complete professional diagnosis of vehicles made by the VAG group. It provides a graphic user interface with access to all controls at the click of a mouse. The system consists of the AI Multiscan USB diagnostic adapter with CAN capability and the VCDS/VAG-COM diagnostic program in German and English.

### Your benefits

- Full support for complete VAG diagnostic functionality via VAG-COM
- Access to all diagnostic interfaces and protocols for VAG proprietary and OBD2 diagnostics (ISO9141, VPW, PWM, KWP1281, KWP2000, CAN)
- With USB port and support for CAN
- Built-in dongle function for VAG-COM
- Built-in self-activation function
- Automatic baud rate detection

Equipment LM8250

## Common Rail Diagnostics Set: High-Pressure and Low-Pressure Circuits

The portable diagnostics set allows common rail high-pressure injectors to be tested while the engine is running.
All common rail systems in widespread use can be connected to the diagnostics set by means of original connectors. Fuel return (leakage), fuel pressure and temperature of the fuel return can all be constantly measured during the diagnostic testing.

### Training contents

- Understanding how common rail technology works
- Testing high-pressure injectors using feed and return (leakage testing) methods
- Diagnosis and maintenance of engine management systems
- Enhancement of diagnostic skills
- Measurements on common rail systems
- How rail pressure control works

High-pressure equipment set LM8232, low-pressure equipment set LM8233
Lucas-Nülle

# Diagnostics and Instrumentation

## High-Voltage Instrumentation
## AVL DiTEST HV SAFETY 2000

This flexible measurement system permits rapid, safe and simple diagnosis of high-voltage motor vehicles. Here emphasis is on maximum protection for personal safety and the motor vehicle.

### Your benefits

- Flexible system for simple integration into the testing and diagnostics platform
- Adaptable interface to log test procedure and record results
- Multimeter up to 1000 V
- HV insulation resistance measurement
  - Test voltage up to 1000 V
  - Voltage according to SAE J1766
- Simple operation
  - Even includes HV protective clothing
- Calibration certificate in accordance with DIN EN ISO 9002
- Self-testing
- Test current max. 1 mA
- Automatic disabling of test voltage in the event of a fault or physical contact

LM8258 equipment set

## AVL DiTEST MDS 105

The AVL DiTEST MDS 105 supports 12-V and 24-V systems, all standard and manufacturer-specific diagnostic protocols and can be used for most commercial vehicles, cars and trailers. Connection to the diagnostic software is via Bluetooth or USB.


### Your benefits

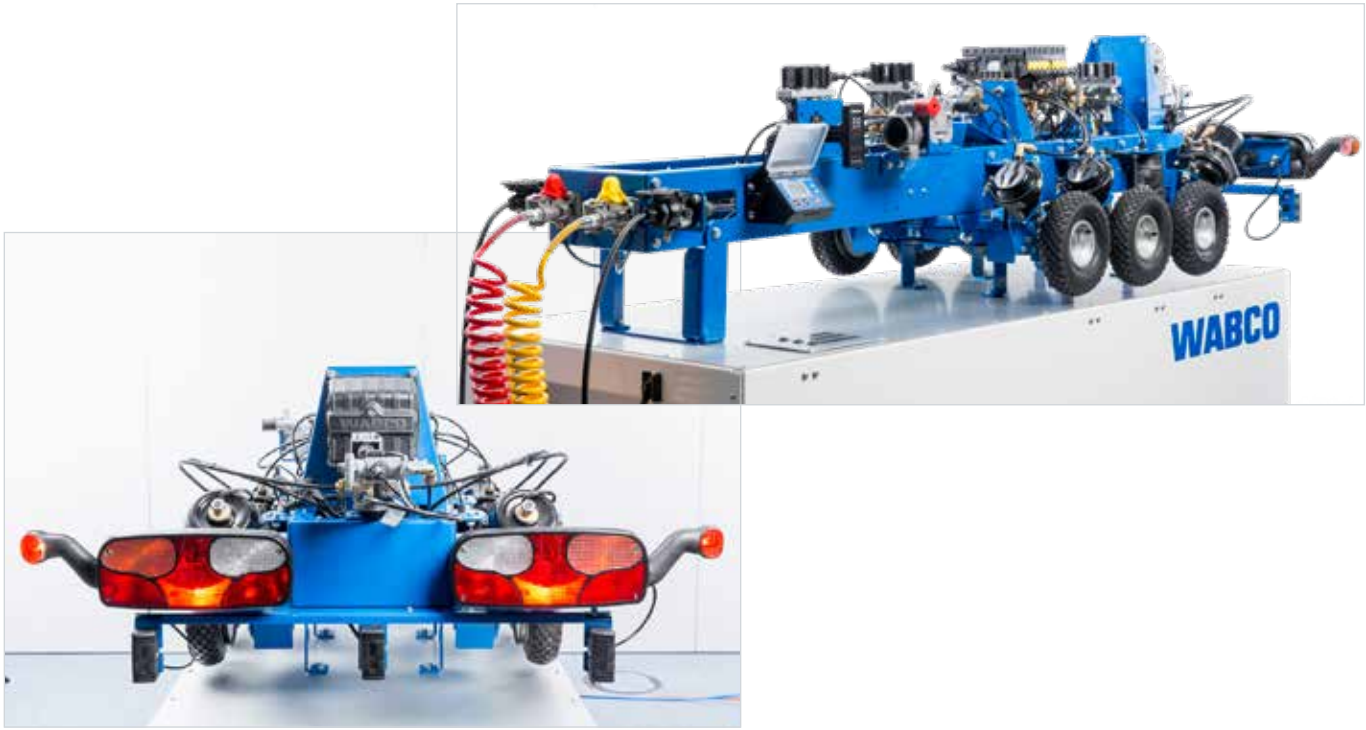
- Usable for 12-V and 24-V on-board networks
- USB/Bluetooth interface
- Diagnosis of multiple marques
- Comprehensive diagnostic function
- Simple operation
- Usable for cars, trucks, trailers and buses
- Includes 16-pol diagnostic cable and transport case
- OBD and EOBD compatible
- Extensible with type-specific cable sets

LM8275 equipment set
Lucas-Nülle

# Compressed-Air Brakes

## Compressed-Air Brake Systems

Professional engineers know that there is more to modern compressed-air brakes than control of an air cylinder by a four-circuit protection valve. Compressed-air brake systems nowadays are fully electronic and highly complex. This is true not only for the tractor units but also for trailers. This trailer training model is equipped with an electronic braking system (EBS E) made by WABCO. Standard components of brake and suspensions systems as found on a wide variety of vehicles make training using this system so essential. Working, measuring, diagnosing and programming using this training system contribute greatly to up-to-date training. Apart from the electronic compressed-air braking system, the electronically controlled air suspension (ECAS), TailGUARD™ (rear blind-spot monitoring), lift axle and a park-release emergency valve are fully wired into the training system and are fully operable.




### Your benefits

- Fully diagnostic-capable training system with built-in SmartBoard, trailer remote control
- Practical training using original vehicle components
- Used for training of safety inspection professionals (vehicles)
- Transportable on mobile trolley
- Investigation of electric and mechanical components including:
  - Electronic brake system (EBS E)
  - Electronically controlled air suspension (ECAS)
  - TailGUARD™ (rear blind-spot monitoring)
  - Lift axle
  - Park-release emergency valve (PREV)

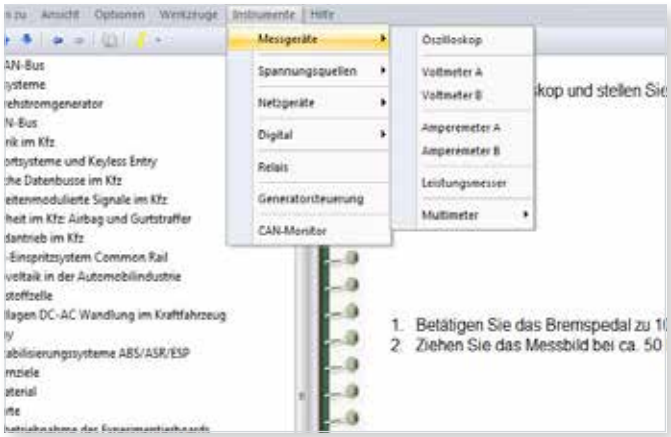
# LabSoft – The Multimedia Training Platform

## Benefits of LabSoft

LabSoft forms the link between the experiment hardware and an educational multimedia course. Users are guided step by step through the program and learn the various skills on their own initiative

- **Graphics and animation**
  Every one of the multimedia courses has been developed with a host of graphics and animations. This means that even complex and intricate system functionality can be explained in a simple and easily understood way.
- **Navigation**
  The built-in navigation window on the left provides direct access to all LabSoft courses installed on the computer. The open tree structure allows you to open the course at any location.
- **Simulation or real mode**
  In order to prepare students for practical lessons even better, it is possible to operate LabSoft in simulation mode without the hardware connected. This means that the theoretical basics can be learned earlier, leaving more time for experiments in the laboratory.
- **Freedom of language**
  LabSoft provides for all the languages implemented in HTML. You can even switch from one language to another, in order to learn the basis for foreign terminology, for instance.

### Virtual Instruments




**The "Instruments" menu** gives you full access to all virtual instruments and power supplies.

### Saving

**Measurement results can be saved** by dragging and dropping them into the placeholders provided in the courses themselves.

**Network LabSoft**
You can install LabSoft locally on your own computer or in a network. In order to facilitate incorporating courses into modern learning management systems (LMS), LabSoft courses are developed in accordance with international standards (SCORM).

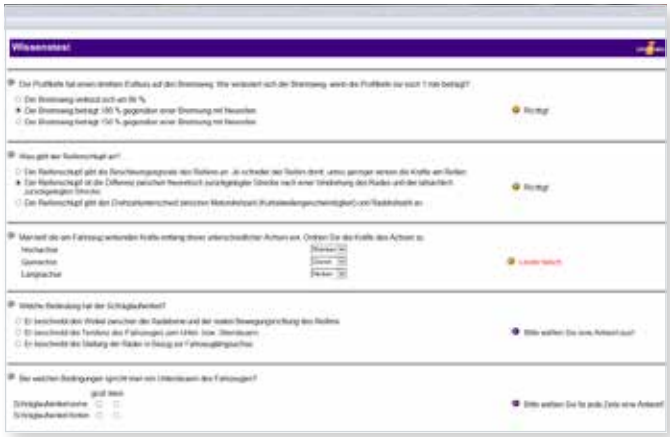
**Software-based learning platform**
Continuous communication between the experiment hardware and the multimedia course ensures that the learning proceeds in optimum fashion.

**LabSoft functions**
- HTML-based multimedia courses
- All languages supported in HTML
- Animations and graphics
- Theory and laboratory experiments as part of a single training module
- Documentation of results
- Questions for testing knowledge
- Access to all virtual instruments
- Logging in with user data
- Choice of language
- Selection of courses
- Individual learning progress can be saved

## Set-up animations


**Set-up animations** explain how experiments are carried out step by step.

## Knowledge Test




**Built-in tests of knowledge** keep a constant check on the knowledge gained by users. Both users themselves and their teachers can monitor how much has been learned.

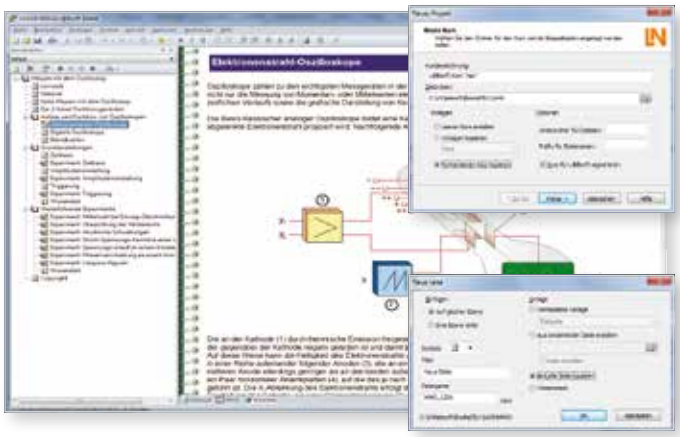
# LabSoft Classroom Manager 4.0

## Administration, Customisation, Monitoring, Evaluation

## Benefits of LabSoft Classroom Managers 4.0

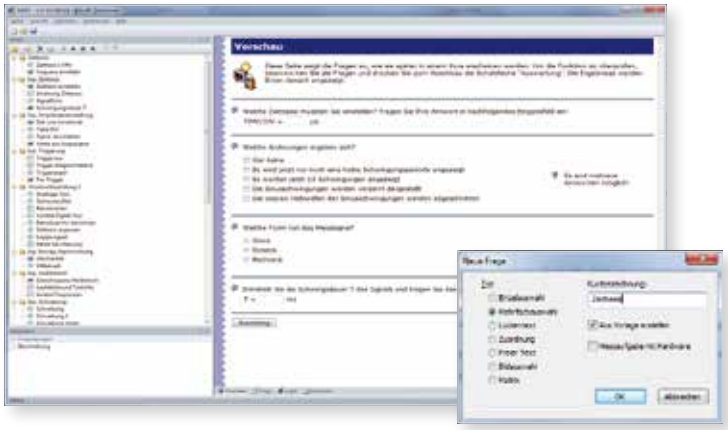
- **Optimum use of resources**
  Use Classroom Manager to get the best out of the educational concept behind Lucas-Nülle training systems.
- **Minimisation of administration work**
  Save time and paper by electronically administering all LabSoft courses and all trainees in LabSoft Manager. Organise contents, users and groups of users.
- **Continually maximise successful learning**
  Use LabSoft Editor to personally customise LabSoft courses to the individual needs of students. Devise your own questions, experiments, measuring exercises and even your own courses, which are then instantly available to trainees.
- **Monitoring learning progress at all times**
  You can use TestCreator to set up your own tests with just a few clicks of the mouse. Utilise pre-prepared questions and measuring exercises to test your students' knowledge and skills.
- **Keep everything in view at all times**
  Access learning progress and test reports with the help of LabSoft Reporter. Easily understood selection functionality quickly leads you to the information you want.

### LabSoft Editor

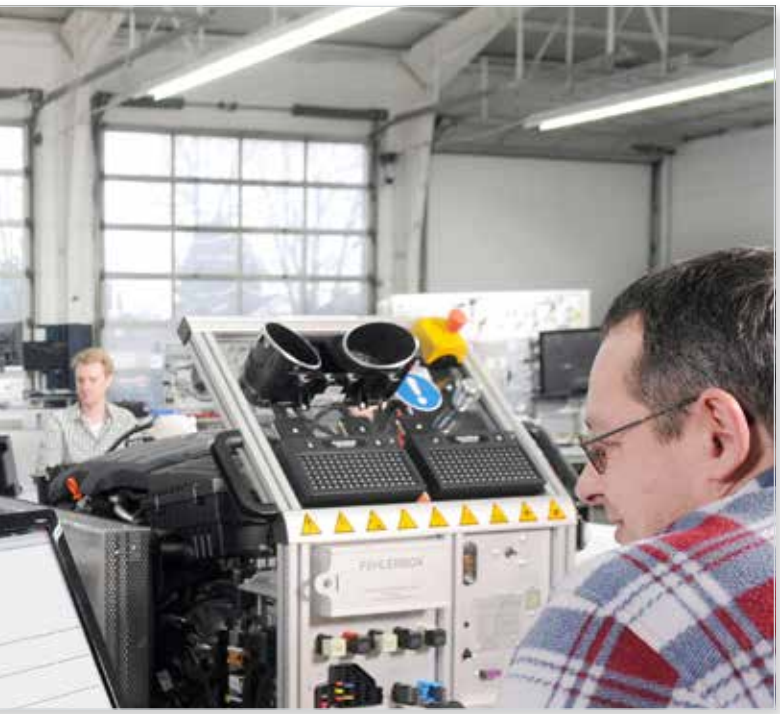


**LabSoft Editor features several wizards** to help you devise your own new courses and guide trainees step by step through the necessary tests.

### LabSoft Questioner



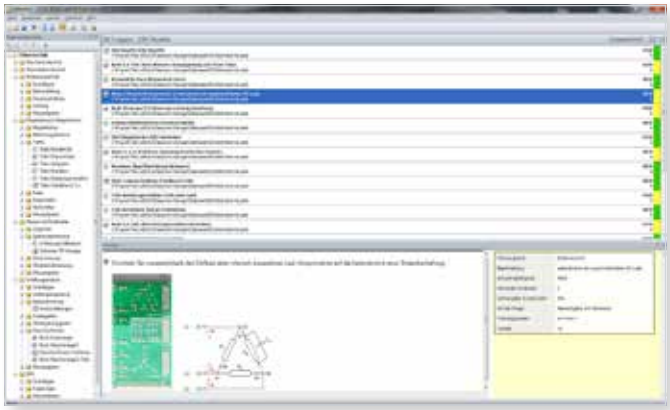
In order to create the **questions, measuring exercises and tests, LabSoft Questioner** has various types of question available. Exercises and questions can then be inserted into courses and tests.



### LabSoft TestCreator

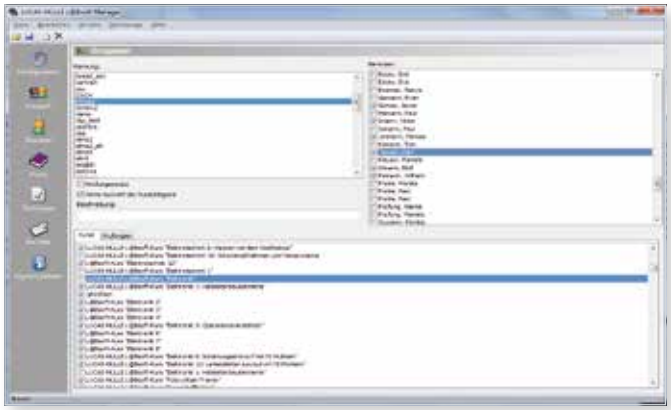
LabSoft TestCreator is used to put together tests, which can be used to check knowledge and practical skills at the same time. Filter functions help to select the questions either manually or automatically.

## LabSoft TestCreator



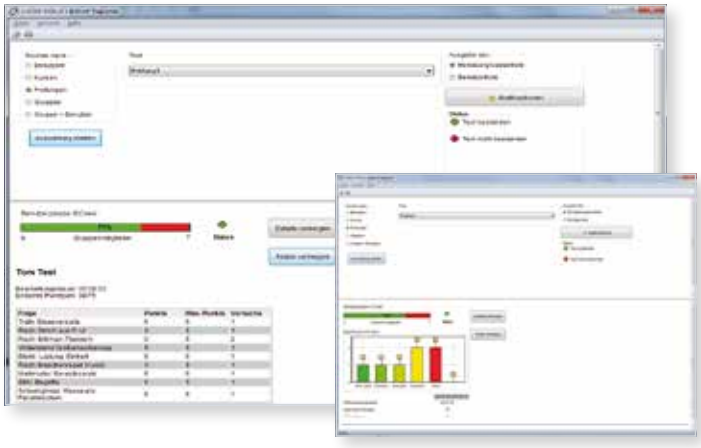
Use **TestCreator** to put together tests suitable for your own purposes in a matter of seconds.

## LabSoft Manager



Administer your LabSoft courses, students and student groups with **LabSoft Manager**. Then you can provide students with the right exercises for their needs at all times.

## LabSoft Reporter



**Progress and test results** can be displayed using **LabSoft Reporter**. This provides multiple ways of assessing results of courses and tests for individuals or groups allowing you to quickly and specifically monitor progress.

# Academy

YOUR PARTNER FOR TECHNICAL EDUCATION:
**PRACTICAL SEMINARS FOR TEACHERS.**

*“Learning is experience.*
*Everything else is just information.”*
Albert Einstein

# The Whole is Greater than the Sum of its Parts

## Individual Consultation with Lucas-Nülle

**Do you require comprehensive advice or a firm offer?**

**Then you can contact us using any of the following means:**

Tel.: +49 2273 567-0

Fax: +49 2273 567-39

E-Mail: export@lucas-nuelle.com

**Lucas-Nülle is a byword for custom occupational training courses in all of the following areas:**


Building management systems


Fundamentals of electrical engineering & electronics


Machinery and systems engineering


Electrical power engineering


Telecommunications


Refrigeration and air-conditioning technology



Renewable energies


Process engineering


Microcontrollers


Power electronics, electrical machines, drive technology

Process control


Automation technology

UniTrain


Electropneumatics, hydraulics


Automotive


Instrumentation


Lab systems

**Ask us for detailed information using any of the given methods of contact.**

**Our employees will be happy to advise you.**

**Further information on our products can be found at the following web address:**

**www.lucas-nuelle.com**

Lucas-Nülle

LUCAS-NÜLLE


**LUCAS-NÜLLE GMBH**

Siemensstraße 2
50170 Kerpen, Germany

Tel.: +49 2273 567-0
Fax: +49 2273 567-39

www.lucas-nuelle.com
export@lucas-nuelle.com



Ref. No.: K-A0-1164-GB
Heavy Vehicle Technology

03/18-GB (Printed in Germany)
Subject to technical alterations.