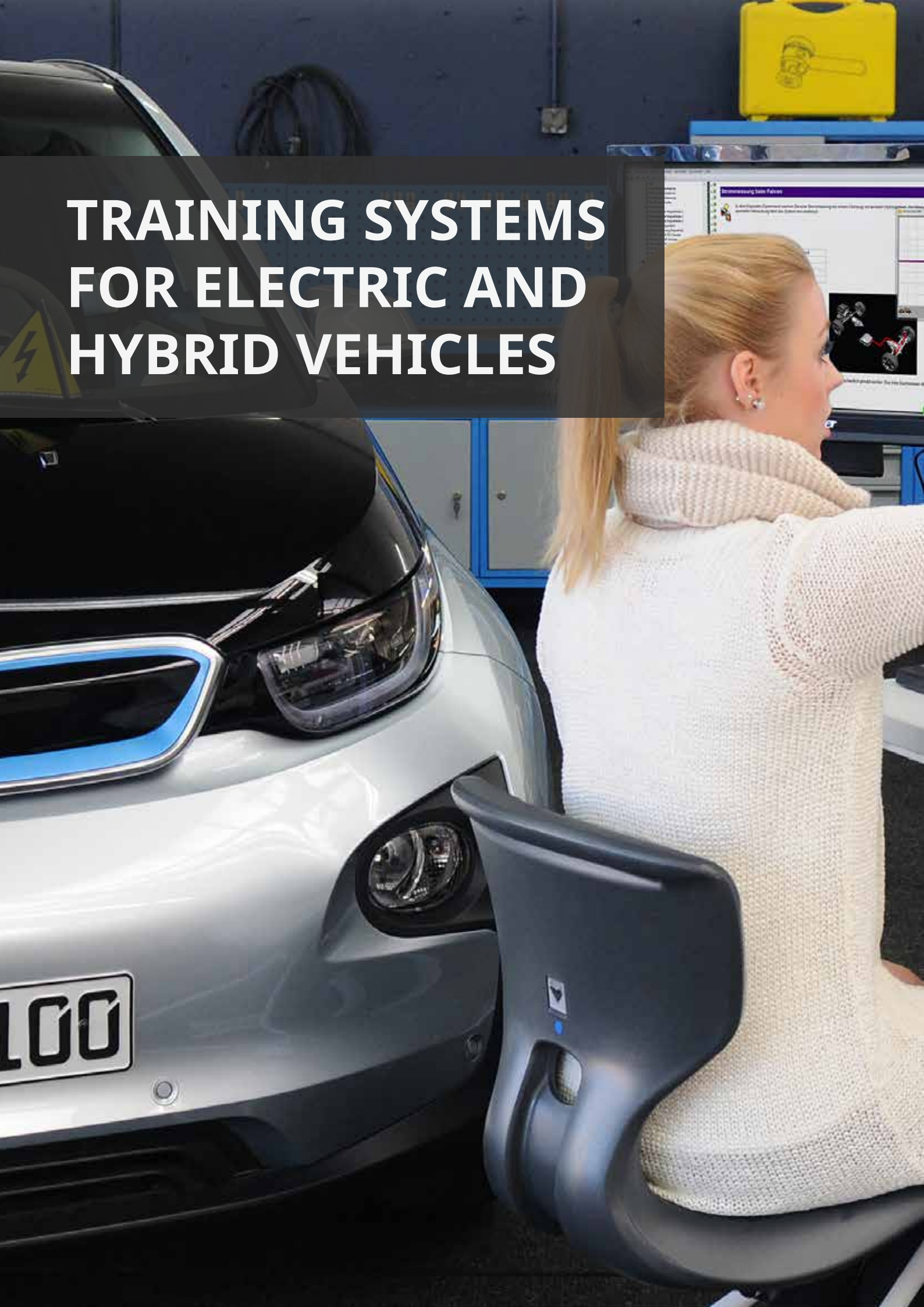


# HYBRID AND ELECTRIC VEHICLES

Automotive Training Systems

# TRAINING SYSTEMS FOR ELECTRIC AND HYBRID VEHICLES



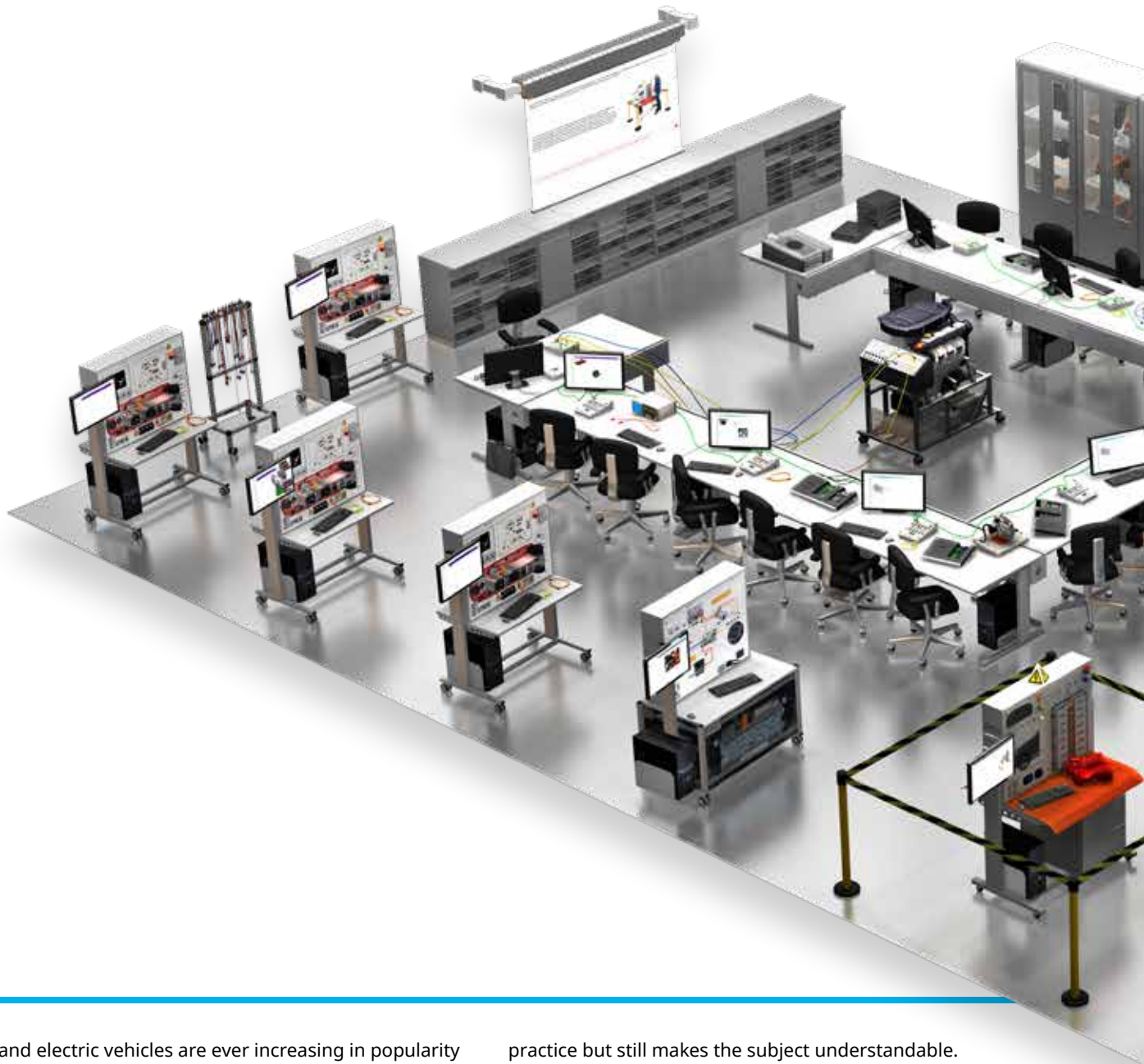




## FACTS AND FIGURES

- Training is based on DGUV 200-005
- Training as high-voltage technicians, levels 2 and 3
- Training systems with real high-voltage battery circuitry
- Training of disconnection procedure similar to actual practice
- Training of disconnection procedure similar to actual practice
- Advanced training for technicians, mechanics and engineers

# HYBRID AND ELECTRICAL VEHICLES – A NEW ERA



Hybrid and electric vehicles are ever increasing in popularity throughout the world and now represent one of the most innovative and trail-blazing areas of automotive technology. Toyota alone has already sold more than 7 million hybrid vehicles across the globe. The next generation of skilled automotive professionals needs the optimum training to be prepared for the demands of this new discipline.

Lucas-Nülle has developed training systems for precisely this kind of teaching. They are setting whole new standards for functionality, educational value and usability. They offer users the opportunity to experience all the facets of working with electric and hybrid vehicles. This starts with how electric drive systems work and how they are controlled in motor vehicles, but then goes deeper into the various drive configurations employed in hybrids and in wholly electric vehicles. All these topics are handled in a way which reflects authentic modern

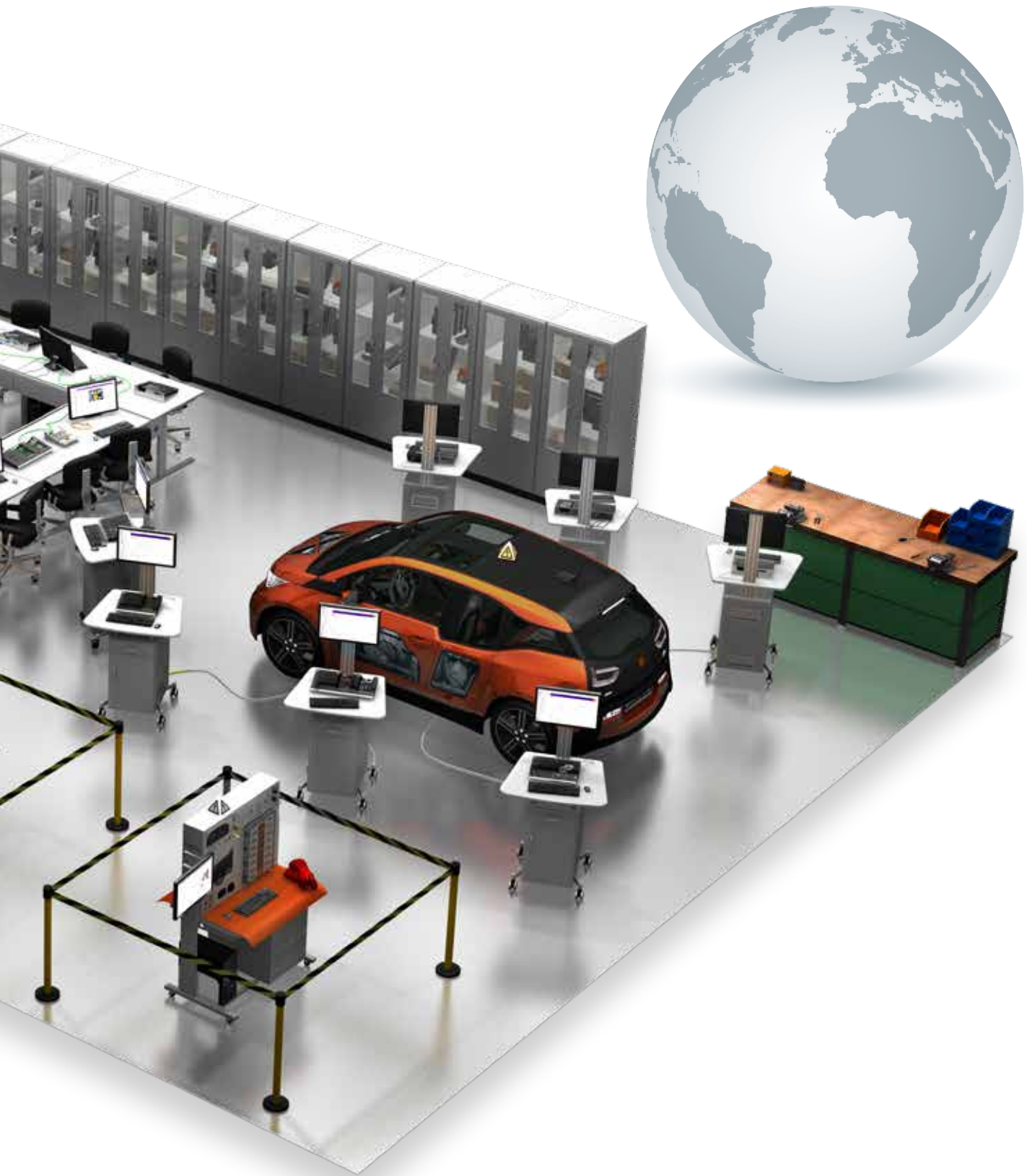
practice but still makes the subject understandable.

Aside from technical content, there is a major focus on safety at work and how to deal safely with high-voltage systems.

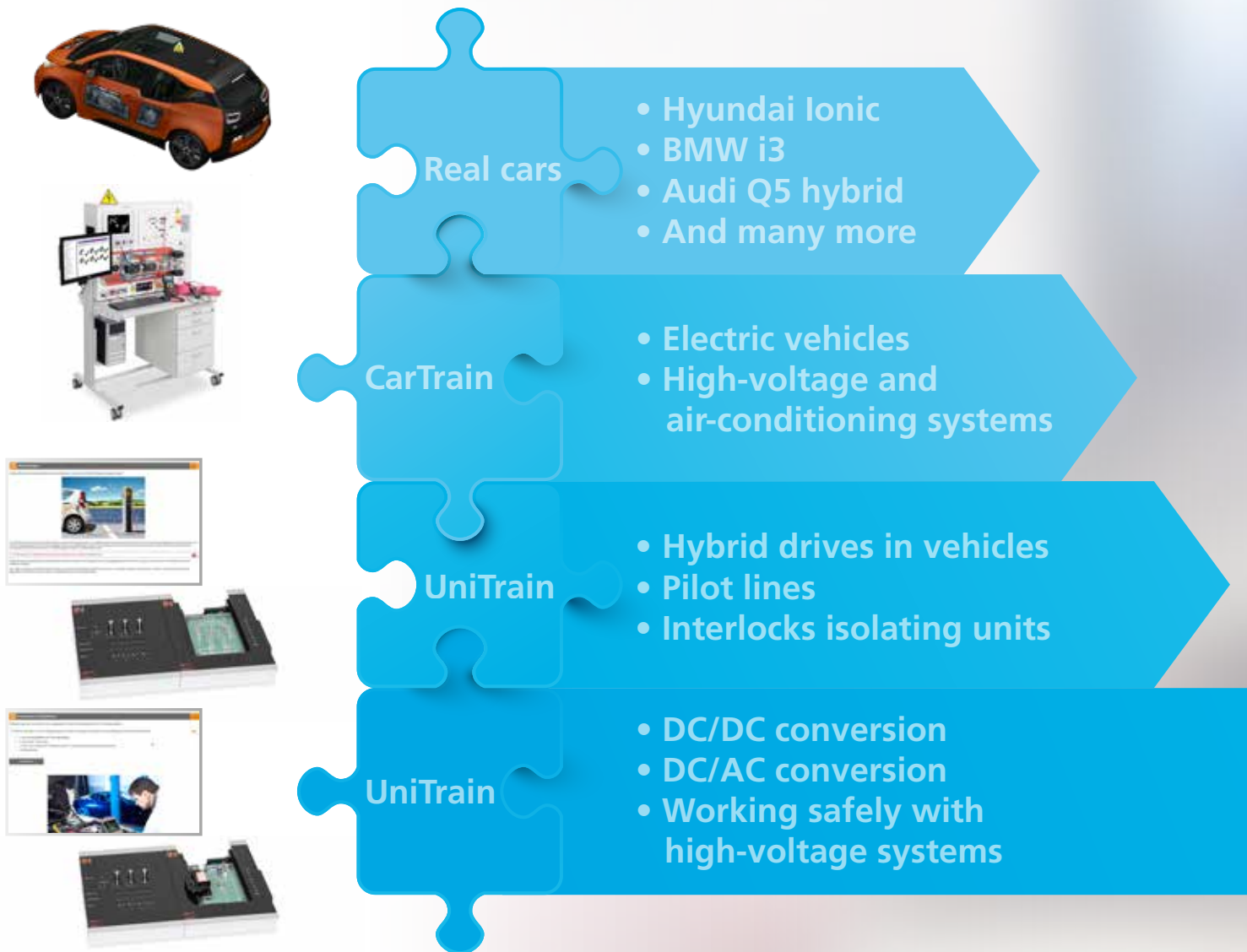
All Lucas-Nülle training systems are developed with the objective of imparting content in a manner carefully tailored to the target audience and which is closely aligned to authentic practice. For those taking the courses, this means that the knowledge they have learned can be applied directly in their professional lives, so that they will already possess all the technical skills they require.

**Training to the very latest state of the art!**





# TRAIL BLAZING: THE LN TRAINING CONCEPT



For 40 years Lucas-Nülle training systems have been assisting education and training, and the company is synonymous with progressive and innovative training. Each training system developed by engineers at Lucas-Nülle GmbH is incorporated into the overall training concept and smoothes the way to a successful career.

Whether you want to purchase an individual training system or a fully equipped lab for studying hybrid and electric vehicles, we are passionate about meeting all your needs.

### **Real cars**

Learning to work on a genuine, digitally networked, training vehicle forms the final stage of the Lucas-Nülle training concept. Trainees are ideally prepared for the challenge

of applying the skills they have learned to use on a real car. This means they can not only enhance their skills, but also develop their own working methods.

### **CarTrain**

The CarTrain systems provide trainees with an effective and efficient learning platform. The hardware is based on the latest technology and is combined with a multimedia LabSoft course on automotive technology. The operation of modern vehicle components is conveyed in a practical, hands-on fashion using authentic original equipment. The

system can be put into use immediately with all the necessary components already installed and configured and thanks to the realistic simulation of faults, trainees can gain elementary diagnostic skills. In order to carry out any measurements, the system comes complete with built-in measurement interface.

### **UniTrain**

The UniTrain system gives an introduction to the world of automotive training and provides trainees with the necessary fundamental knowledge in a way that is simple and motivating. The compact desktop lab is portable and usable

anywhere. The multimedia training platform ensures a high degree of motivation and the best chance of successful learning, guaranteeing effective and efficient learning.

### **UniTrain**

In the multimedia courses, the theoretical background is explained and then experiments are carried out using experiment hardware which is specific to each course. In addition, the intelligent measuring interface includes analog and digital inputs and outputs for measurement and control. In combination with virtual instruments, the whole system represents a high-quality piece of lab equipment. Learning

progress can be monitored in troubleshooting exercises on the course hardware as well as by tests, all of which can be digitally documented. The electrical and electronic circuitry needed for the experiments is connected to the system by means of an "Experimenter" module. Access to the courses themselves and control of the virtual instruments and experiment hardware are provided by the LabSoft browser platform.

# UNITRAIN – BASIC KNOWLEDGE TRAINING



## UniTrain hybrid automotive drives

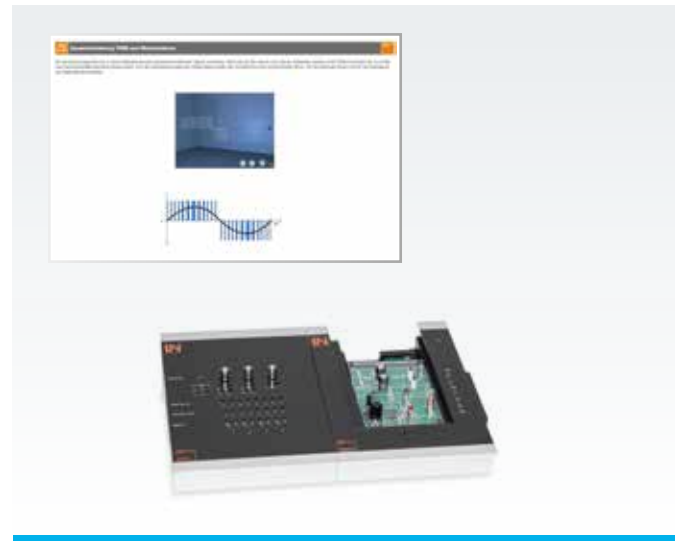
With this system, students can build their own electric motors, as the best way of developing the understanding they will need for such systems.

### Training contents

- Design and operation of synchronous and asynchronous motors
- How inverters work
- Rectification of three-phase electricity
- Regenerative braking
- Energy-efficient drive system
- Generating rotating electric fields
- LabSoft course software

Approx. 60 questions for testing knowledge

Order no. CO4204-6V



## UniTrain DC/AC conversion

Batteries can only store and supply direct current. However, in order to drive an electric traction motor, an alternating current is required. This course provides a host of experiments to demonstrate how conversion from one form to the other can be achieved.

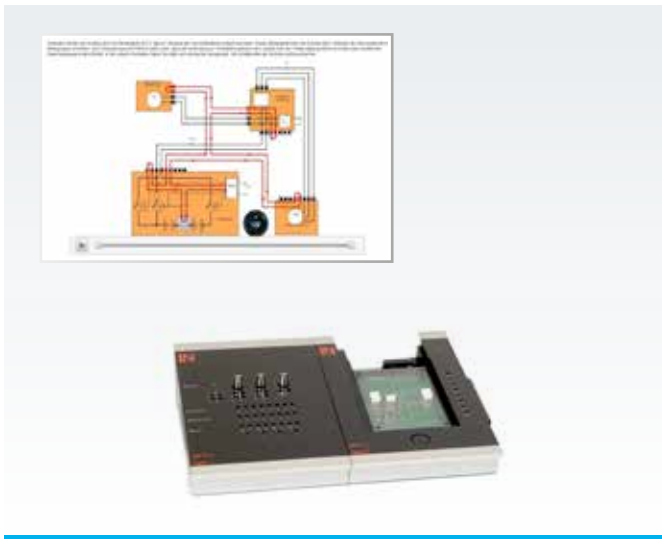
### Training contents

- Electrical induction
- Relationship between voltage and current
- Generation of pulse-width modulated voltage signals
- Conversion of DC voltages to AC
- LabSoft course software

Approx. 30 questions for testing knowledge

Order no. CO4204-6L





### UniTrain electrical interlocks in electric and hybrid vehicles

An interlock is a safety mechanism designed to ensure the safety of drivers and workshop mechanics dealing with electric vehicles. The interlock separates the high-voltage battery from the rest of the vehicle as soon as wires are wrongly disconnected or in the event of malfunctions. Trainees learn all about interlock systems with the help of experiments featuring interactive assistance.

#### Training contents

- Electrical circuitry for interlocks
- Interlock signals
- Investigation of an interlock by measurement
- Simulation of faults commonly encountered in practice
- LabSoft course software

Approx. 40 questions for testing knowledge

Order no. CO4205-1H



### UniTrain HV battery disconnect systems in hybrid vehicles

This training system explains how the contactors for a high-voltage battery disconnection system operate. The system monitors the high-voltage installation and only connects the battery when a self-test confirms that the vehicle is safe.

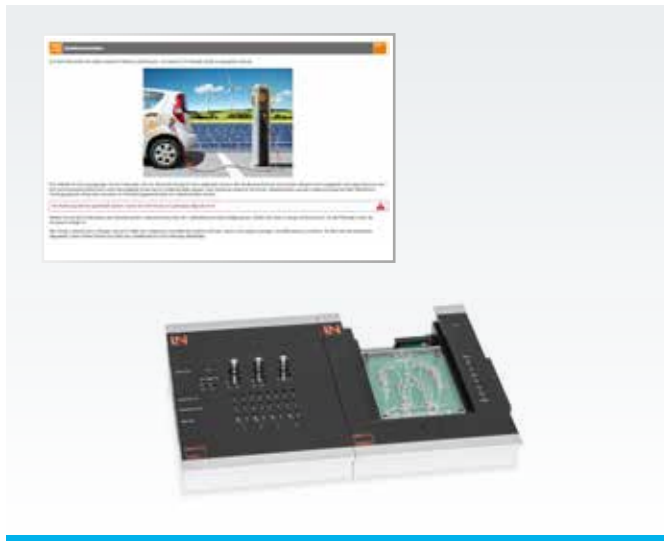
#### Training contents

- Design and function of battery disconnection unit
- How the contactors work
- How the contactors work
- Fault diagnostics – simulated faults can be activated
- Investigation by measurement
- LabSoft course software

Approx. 40 questions for testing knowledge

Order no. CO4205-1J

# UNITRAIN – BASIC KNOWLEDGE TRAINING



## UniTrain Safe handling of HV systems

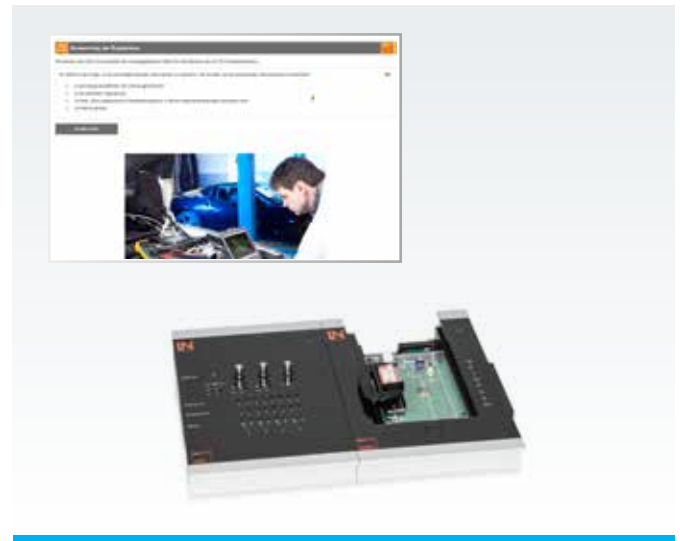
This training system focuses on safety when working on high-voltage systems and the dangers of electricity passing through the human body.

### Training contents

- Fundamentals of safety when working with high-voltage vehicles
- Effects of faults encountered in practice
- Using a model to measure the current passing through a human body
- LabSoft course software

Approx. 40 questions for testing knowledge

Order no. CO4205-1M



## UniTrain Step-up/Step-down converters

The inverters in electric and hybrid vehicles, as well as many other circuit applications, require DC voltages at multiple different levels. Here students can investigate various options for conversion of DC voltages from one level to another.

### Training contents

- 1 course on step-up conversion (from lower voltage to higher)
- 1 course on step-down conversion (from higher voltage to lower)
- Safe handling thanks to safety low voltage
- Practical experience of voltage conversion
- Function and design of DC-DC converters
- Measurement of input and output voltages
- LabSoft course software

Approx. 40 questions for testing knowledge

Order no. CO4205-1K /CO4205-1L



### UniTrain Fuel cells

Internal combustion engines still produce large quantities of CO<sub>2</sub>. That is why it is essential for engineers to seek out alternative drive concepts. One such concept involves the use of electric traction motors in conjunction with a fuel cell. This training system allows trainees to learn about this fascinating technology and gain an understanding of how it works.

#### Training contents

- Fuel cell application in motor vehicles
- Function of a fuel cell
- Design of a fuel cell
- Fundamentals of the chemical process
- Properties of fuel cells
- Recording characteristics
- Efficiency of a fuel cell
- LabSoft course software

Approx. 50 questions for testing knowledge

Order no. CO4204-6M



### UniTrain Photovoltaics

The term photovoltaics means a direct conversion of (sun) light into electrical energy by means of solar cells. The energy obtained in this manner can be supplied to ancillary consumers to enhance driving comfort, e.g. to provide extra cooling for a vehicle's interior in extremely bright sunshine. With our UniTrain photovoltaics system, students very quickly grasp the fundamentals of this technology.

#### Training contents

- Use of photovoltaic system in motor vehicles
- Design of a photovoltaic cell
- Open-circuit voltage
- Short-circuit current
- V-I characteristic
- Power of a photovoltaic cell
- Series-connected photovoltaic cells
- Parallel-connected photovoltaic cells
- Direct operation
- Storage operation
- LabSoft course software

Approx. 50 questions for testing knowledge

Order no. CO4204-6N



# UNITRAIN – 48-VOLT SUB-SYSTEM FOR ON-BOARD NETWORK



Integration of a 48-volt sub-system in an on-board network in conjunction with its own lithium-ion battery requires a consistent rethink of the way mechanics have to work. The focus here is on how to deal with this new technology safely and develop practical, targeted ways of working, as well as learning essential diagnostic skills. We offer all of this to you as part of this package.

## Training contents

- Benefits of a 48-V sub-system in an on-board network
- Design of a 48-V sub-system
- Possible dangers from electricity
- Disconnection / isolation of a 48-V system using a tester
- Manual disconnection of a 48-V system
- Diagnostics in 48-V systems

Approx. 60 questions for testing knowledge

Order no. CO4205-1T

# CARTRAIN – LEARNING DIAGNOSTIC SKILLS



5 different drive configurations



## CarTrain Hybrid and electric vehicles

This is the only electric vehicle training system which combines 5 different drive configurations and includes all the necessary terminals for making measurements on a highvoltage system.

The new CarTrain version offers the following benefits over its predecessor: The high-speed CAN bus is directly integrated into the control system for the high-voltage circuitry and a built-in touchscreen makes it easy for you to understand the various drive modes and how energy flows from place to place.

The system operates using the same high voltage which is present in real vehicles. This means that students can practice how disconnection of real high-voltage systems is accomplished.

### Benefits

- Touchscreen displays the energy flow
- Over 30 measuring points in high-voltage system
- Authentic high voltage
- Disconnection just like in authentic practice
- Fault simulation
- LabSoft course software

Approx. 263 questions for testing knowledge

Order no. CO3221-6X



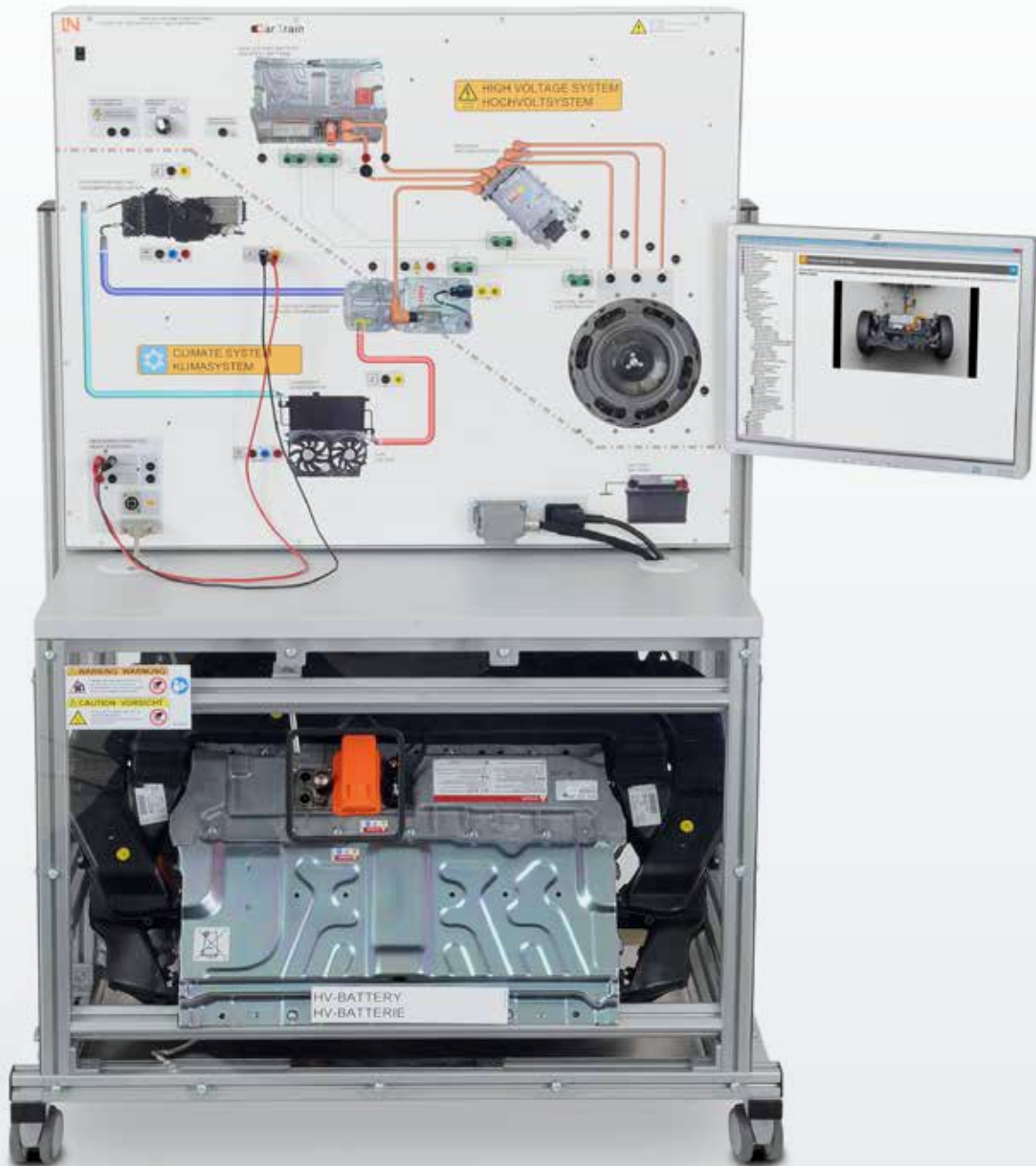
## CarTrain charging station

Use the charging station to investigate a vehicle and the station itself, with all the essential safety precautions.

### Benefits

- Real charging station
- Possible to use on real vehicles
- Monitoring of the charging process
- Safety concepts
- Analysis of the communication protocol between the vehicle and the charging station

Order no. CO3221-6Q



### CarTrain High voltage and air conditioning training system

Combined equipment for the topics of hybrid drive trains and high-voltage air conditioning in vehicles. Trainees can use the set to learn about the aspects of servicing, diagnostics and repair of high-voltage networks and air conditioning.

Approx. 72 questions for testing knowledge

Order no. CO3221-6P

### Benefits

- Authentic high voltage
- Simulation of various operating modes
- High-voltage air conditioning compressor
- Contactless measurement
- Fault simulation
- Fully functioning high-voltage air conditioning system featuring authentic original components from a real vehicle
- High-voltage battery with original servicing and maintenance plug
- Interlock
- Original insulation monitors
- LabSoft course software



# CARTRAIN – DIAGNOSTICS AND MAINTENANCE OF HV BATTERIES



Based on DGUV 200-005 level 3



Working directly on a real high-voltage battery and inside it: The system is set up to be just like a high-voltage battery in a standard production vehicle. With this training system, trainees can make measurements and diagnoses inside the high-voltage battery, working down to the level of individual cells and even replacing them.

Wide-ranging yet easy to use, fault simulation prepares students for numerous things which can go wrong in the real world. While trainees are working out the best way to diagnose problems for themselves, they gain skills which will stand them in good stead for modern-day challenges in a mechanics' repair shop.

## Training contents

- Analysis of an authentic high-voltage battery
  - 16 Lithium-ion cells
  - 8 Temperature sensors
  - Cells and sensors can be dismantled
  - Air cooling
  - Interlock
- Disconnection of high-voltage systems
  - Disconnection via diagnostic tool
  - Disconnection by removal of service and maintenance plug
  - Disconnection for rescue personnel
- Measuring options
  - CAN bus interconnection of BMS 1-3
  - High-voltage battery disconnecting relay
  - High-voltage level and cell voltages
  - Interlock
- Charging infrastructure
  - AC charging types 1 and 2
  - CCS DC charging

Order no. CO3221-6S

# SETTING UP A SAFETY ZONE



Certified components

When it comes to diagnostics on hybrid and electric vehicles, safety is absolutely paramount, especially when diagnostics or repairs need to be made on the battery itself.

In order to learn the necessary safety requirements and implement them accurately, the training system teaches the use of an overall, prescribed safety concept for work on high-voltage batteries.

## Training contents

- Personal protective equipment (PPE)
  - Practical application of protective equipment
  - Checking protective equipment
  - Certified components
  - Suitable for use with vehicles
- Safety zones
  - Setting up a safety zone
  - Certified components
  - Suitable for use in workshops
- Classification of high-voltage batteries
  - Proper status
  - Critical status

# DIAGNOSTICS ON HV BATTERIES

**+** Safe training system



In conjunction with safety clothing and equipment, plus the integrated high-voltage diagnostic tester, the training system provides unique diagnostic range closely aligned to authentic practice.

In addition to the guided diagnostics, trainees can carry out a variety of measurements directly on the training system itself.

Measurements on the interlock system and directly involving the battery management system (BMS) for the high-voltage battery are a very special part of the training content. Focus is placed on the HV system relay and switching the high-voltage system on and off.

## Training contents

- Measurement of voltage in HV system
- Measurements on BMS
  - HV system relay
  - High-voltage capacitors
  - High-speed CAN bus
  - Pre-load phase
  - Active/passive discharge
- Measurements on interlock system
- Measurements on temperature sensors
- Measurements of supply voltage



# SIMULATION OF HV FAULTS COMMON IN WORKSHOPS



Diagnosis of faults which can be specifically activated allows students to gain skills which will be of use to them in a real vehicle workshop.

The training system meets the most severe demands as regards safety. Trainees and the system itself are both protected in the event of any incorrect operation.

As soon as a diagnostic case from the digital course is opened, the fault in question is automatically activated.

Then it is up to the trainees to document their own diagnostic procedures in detail. The work can be evaluated at a later date without further ado.

## Diagnostic contents

- Over 50 different diagnostic cases
- BMS faults
  - Temperature sensors
  - CAN bus
  - HV system relay
  - Battery cooling
- Interlock faults
  - Cover for HV battery
  - Service and maintenance plug
- Disconnection faults
  - Procedure
- HV battery faults
  - Lithium-ion cells
  - Insulation resistance
  - Capacitors

# LABSOFT – THE MULTIMEDIA LEARNING PLATFORM

Further information is available at  
[www.lucas-nuelle.com](http://www.lucas-nuelle.com)



## FACTS AND FIGURES

- HTML-based multimedia courses
- All languages supported by HTML
- Animations and graphics
- Theory and diagnostic exercises in a single training unit
- Documentation of results
- Questions for testing knowledge
- Access to all virtual instruments
- Log-in with user data
- Choice of languages
- Choice of courses
- Saving of individual platform configurations



# DIGITALLY NETWORKED TRAINING VEHICLES



Choose from four different cars. The cars chosen for these training systems are selected according to strict quality guidelines. This is how we guarantee you a high-quality product with excellent cost efficiency.

All the cars are specially modified so that they fit perfectly into the educational concept. Apart from visualisation of the key systems in a vehicle, various break-out boxes are supplied, along with more than 30 fault activation switches. All these vehicles are accompanied by their original circuit diagrams, allowing diagnostics to be carried out under practical conditions.

## Hybrid vehicles

- VW Golf GTE (LM8296)
- Hyundai Ionic (LM8319)

## Electric drive trains

- VW e-Golf (LM8295)
- BMW i3 (LM8298)

Order no. LM8293/94/95/96/98 and LM8319





### The digitalisation package – Digital diagnostics on a real vehicle

In order to exploit the full potential of a training vehicle, we recommend installing our digitalisation package. This package introduces a WiFi-capable measurement and diagnostics interface into the vehicle, allowing activation of simulated faults and transmission of measurement results to the training platform. All the measuring instruments (4-channel oscilloscope, multimeters, current probe, etc.) are already built in and can be run directly from the training platform, thus saving space.

#### Benefits

- Digitally networked training platform
- Interactive diagnostic course
- WiFi-capable measuring interface
- Includes non-contact current measuring probe
- WiFi-capable diagnostic interface
- OBD-II-break-out box

Order no. CO3223-7E



### Measurement expansion package – Simultaneous working for any number of trainees

The measurement expansion package allows multiple trainees to carry out measurements and diagnostics on a single vehicle simultaneously by adding extra student measuring stations. Up to six different signals are fed into the vehicle's signal interface and then made available at the students' workplaces. The number of student measuring stations can be increased as needed. This allows a whole class of trainees to work on the same vehicle at once.

#### Benefits

- Built-in signal interface
- Includes 6 external student measuring stations
- Parallel transmission of signals
- Custom extensibility
- Can be combined with training platform
- Built-in CAN interface

Order no. CO3223-7F



## LABSOFT CLASSROOM MANAGER – ADMINISTRATION, CUSTOMISATION, TESTING AND EVALUATION



### **LabSoft Manager**

Manage your LabSoft courses, students and classes using the LabSoft Manager. This ensures that your students always have the right training content available.



### **LabSoft Questioner**

In order to set up questions, measuring exercises and tests, LabSoft Questioner provides multiple varieties of question. The exercises and questions can then be inserted into courses and tests.



### **LabSoft Editor**

Numerous wizards within the LabSoft Editor help you set up your own new courses and guide users step by step through the necessary procedures.



- Optimal use of resources
- Minimisation of management work
- Maximisation of learning success at all times
- Check on student progress at any time
- Everything always at your fingertips



#### LabSoft TestCreator

LabSoft TestCreator helps you set up tests so that you can check both students' knowledge and their practical skills. Filter functions assist you with manual or automated selection of test questions.



#### LabSoft Reporter

LabSoft Reporter shows you the progress of all your students along with their test results. There are multiple student assessment options for individual or class results in courses and tests, allowing you to monitor them in a quick and targeted fashion.



#### LabSoft ControlCenter

With the ControlCenter you are always up-to-date on everything in your classroom. It shows what your classroom is currently working on, inserts help questions and permits the distribution of individual screen content to the group.





Representative



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