PHYSICS

CHEMISTRY
BIOLOGY

ENGINEERING

LD DIDACTIC

AUTOMOTIVE TECHNOLOGY

TEACHING SOLUTIONS

LEYBOLD®

AUTOMOTIVE TECHNOLOGY

EASILY CONVEY CHALLENGING TOPICS WITH LEYBOLD'S SOLUTIONS

With LEYBOLD's solutions, your trainees and students can effectively learn the complex class subjects in the areas of motor vehicle technology and electrical engineering as well as renewable energy technology. Our didactic equipment and educational systems for technical vocational training ideally combine theory and practice and can be seamlessly integrated into the project work.

This catalog presents our educational systems in the area of motor vehicle technology. With us, you will receive customized solutions for your technology and workshop lab that are adapted to the individual fields of instruction.

LD DIDACTIC GmbH is a world leader in the production of high-grade scientific and technical educational systems for schools, universities and vocational training. LD DIDACTIC distributes its products and complete solutions under the brand name LEYBOLD.

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EQUIPMENT BY TOPIC

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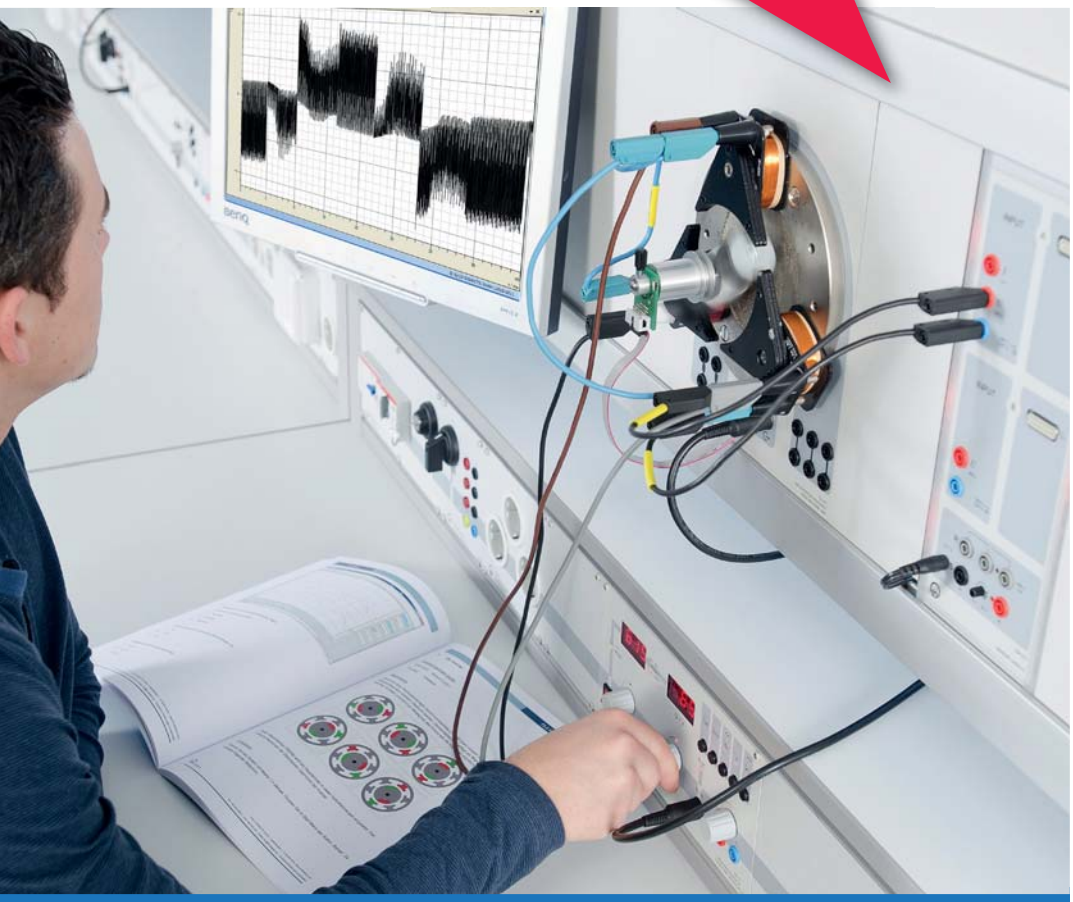
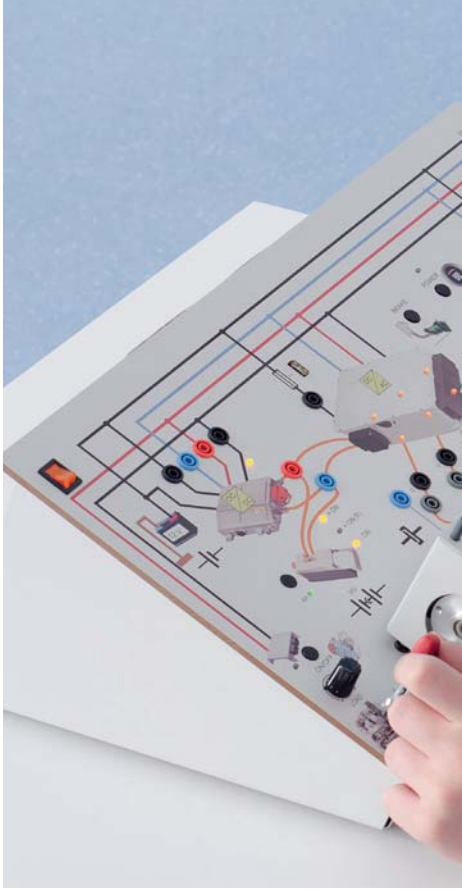
LEYBOLD®

NEW PRODUCTS

ELECTROMOBILITY





HYBRID DRIVES ELECTRICAL MACHINE

SETUP OF A HYBRID ELECTRICAL DRIVE IN MODULAR DESIGN

The new experimental equipment includes machine components for investigation of the operating mode and construction of electrical machines in hybrid vehicle drives.

Currently, it is the only known electrical teaching machine with rotor position encoder for operating the system as a servo drive. This means that precise simulation of an electrical drive in a hybrid vehicle is possible.

STUDENT WORKSTATION HYBRID DRIVES

INNOVATIVE SELF-LEARNING STATION

The hybrid drive student workstation consists of all the major components in a hybrid vehicle at a small scale. This enables students to gain the elementary technical knowledge necessary for a vehicle mechatronics engineer in the hybrid technology sector. The student workstation has been designed so that students are guided through the individual experiments using the integrated touch display.
The program navigates through the experiments and demands solutions for intermediate tasks using the logic of a computer-based training system (CBT system).

EXPERIMENT STAND HYBRID DRIVES

MODULAR 300 WATT HYBRID SETUP

The experiment stand is a system which allows investigations into the torque distribution between the internal combustion engine (ICE), electric drive and load.
The students can investigate e.g. the following operating modes:

- „driving electrically"
- „acceleration"
- „charging battery"

LEYBOLD®

TECHNICAL SERVICE AND CONSULTING

LEYBOLD DOES NOT ONLY PROVIDE THE HIGHEST POSSIBLE PRODUCT QUALITY, BUT ALSO INDIVIDUAL ADVICE AND TECHNICAL AFTER-SALES SERVICE.

INDIVIDUAL ADVICE AND STOCK-TAKING

Are you planning to re-equip your laboratory or simply to add to its equipment? Our specialised advisor will be happy to give you support by suggesting a tailor-made combination suitable to your type of school.

GOODS SERVICE, INSTALLATION, COMMISSIONING AND ON-SITE BRIEFING

We would be delighted to check your new equipment on site for completeness and functionality. We can either take on the whole task of installation for you or our specialists can commission the devices and systems that you have already installed on site yourselves. We would, of course, be delighted to conduct one or more tests together with you and to explain in detail the functions of each individual device.

LEYBOLD®

TECHNICAL AFTER-SALES SERVICE

You may have a technical question on one of our devices or pieces of equipment. Our service team is available by telephone at +49 2233 604-430 and by e-mail at service@ld-didactic.de

SPARE PARTS SERVICE

You can naturally order replacement parts for your equipment.

REPAIR SERVICE

If, despite our demanding quality standards, you should find a fault in your LEYBOLD product, we will naturally repair it as soon as possible. If you still cannot make the equipment work as intended after calling our technical service, you can find help quickly and easily through our "on-site service". Our service technicians come to you, to find the appropriate technical solution on site. Alternatively, you can of course also send your device for repair by post.

REPAIR GUARANTEE FOR A MINIMUM OF 10 YEARS

Our products stand for high quality and durability. If your device should become faulty even many years after purchase, generally we will still be able to repair it. We guarantee the repair of all our devices for 10 years from the date of purchase – and for much of our products, for much longer.

PRACTICAL DEVELOPMENT

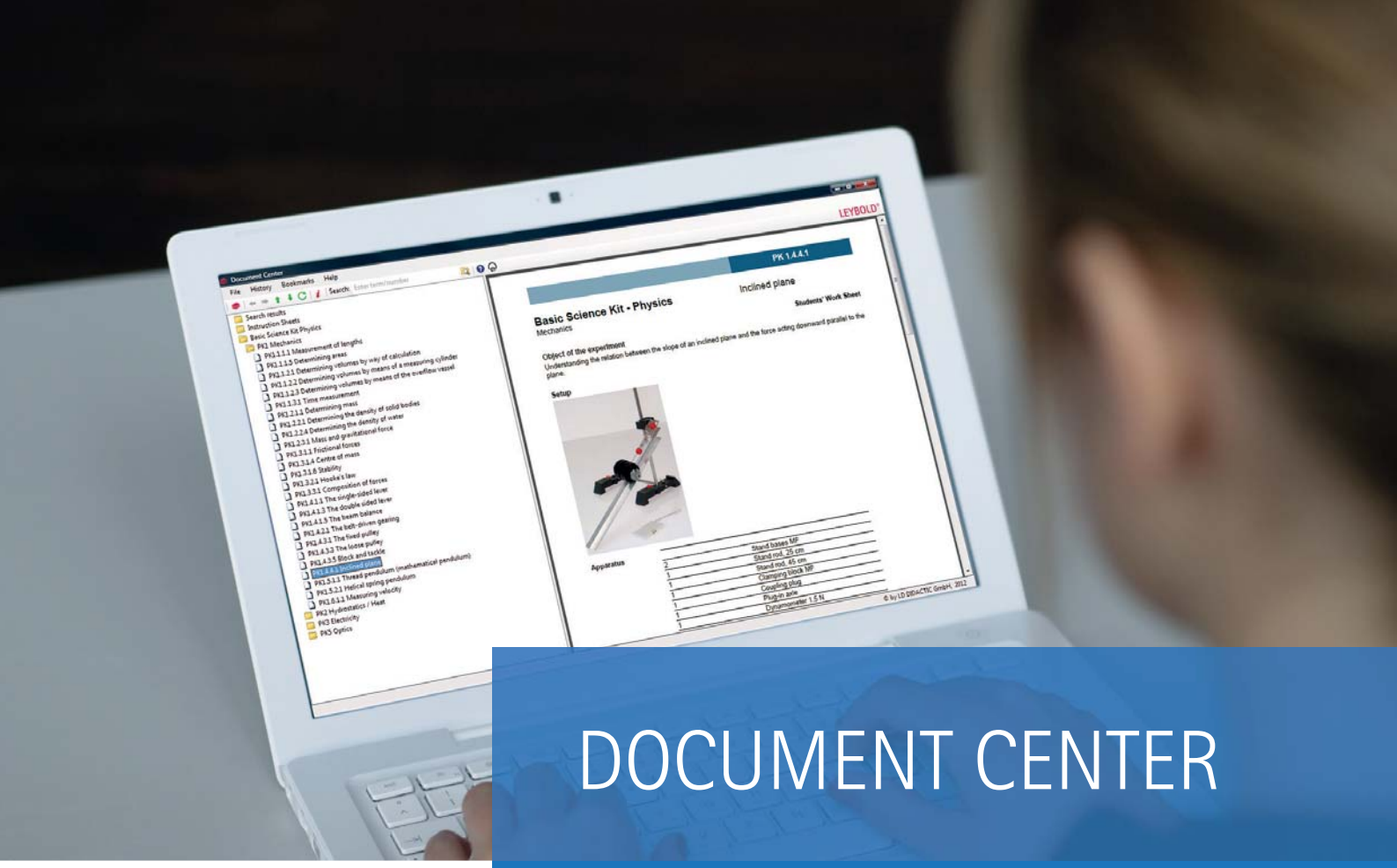
COOPERATION WITH AUDI

TRAINING PANEL LIGHTING

The training panel consists of a modern instrument panel insert with electronic immobilizer, the full steering wheel electronics, the central control module for comfort system and the electronic and electric system.
The lighting system and a windshield wiper motor complete the system.
The basic vehicle electronics and modern data bus systems are clearly and simply represented. This approach places great value on the use of original vehicle parts. The focus is on error detection, analysis and correction.

We develop and produce our educational systems in tight cooperation with the automotive industry, so we can ensure our systems are very realistic and their technology constantly refined.

Since 2003, we have been developing educational systems, such as the training panel lighting, together with AUDI AG's training center. The trainees can learn the fundamentals of vehicle electronics and modern data bus systems with original parts of an AUDI A4.



DOCUMENT CENTER

NEW

THE NEW ELECTRONIC LEYBOLD LIBRARY

- Display and management of students' experiment literature, instructions for demonstration experiments or instruction manuals in one program
- Automatic updating of all documents using free online updates
- Convenient fault-tolerant catchword and catalogue number search

MORE TIME FOR THE IMPORTANT THINGS

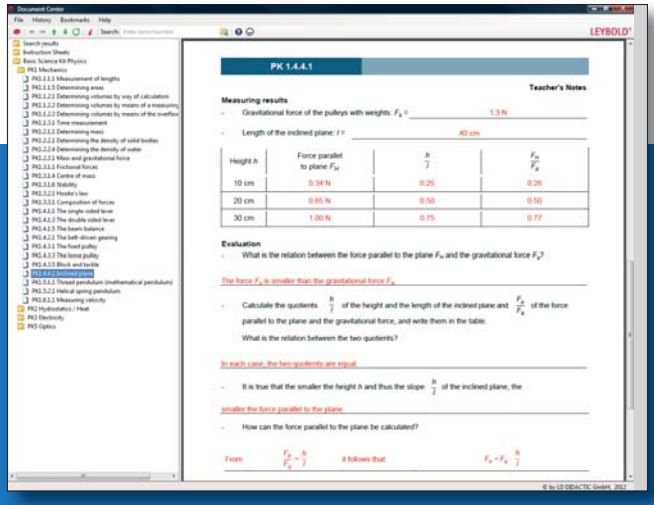
The time-consuming search for experiment instructions in files is a thing of the past! You can save valuable time when preparing your lessons using the new, free Document Center. The Document Center allows for digital access to all technical documents which we provide in the form of extensive literature packages (sometimes subject to charge). Once you have installed it for the first time, the documents automatically update themselves if selected. The literature packages are depicted clearly in a contents list which leads you straight to the target document. The more literature packages you have installed, the more entries are contained in the contents.

You can find the right document very quickly using the convenient error-tolerant search function. The more literature packages you have installed, the more efficient the search function will become.

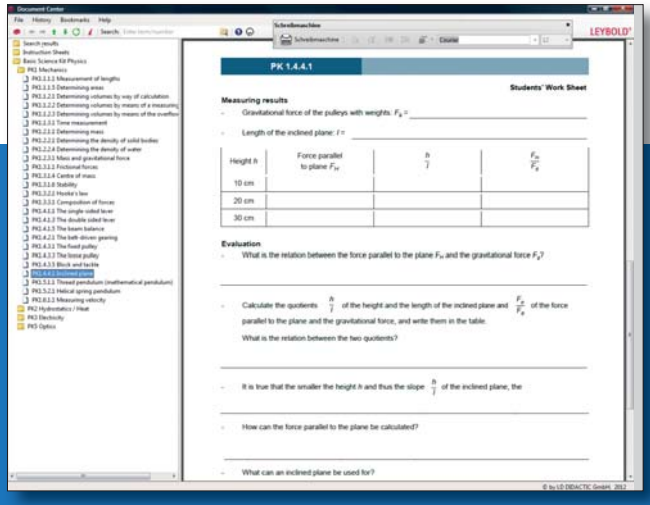
CARRY OUT EXPERIMENTS INTERACTIVELY AND LOG THEM DIGITALLY

Literature packages can also contain application data as well as documents. For example, loading settings and examples from the experiment descriptions contained in a literature package into CASSY Lab is possible with just one click.

If teacher and student versions of a particular literature package have been installed, you can change between both versions with just one click. Student documents can be filled out in the Document Center and saved or printed out as a log.



Teacher version



Student version

COM3LAB MULTIMEDIA

The master unit is compatible with all courses and comprises two digital multimeters, a function generator, a digital storage oscilloscope and a digital analyzer. Simply changing the course board in the master unit unlocks an entirely new subject.

THEORY AND PRACTICE IN PERFECT COMBINATION

COM3LAB multimedia combines educational software with actual hardware and is used for training in schools, universities or industrial plants.

COM3LAB courses are just as useful in presentations, in self-study or in special projects. They consist of an electronic and interactive text-book and the associated hardware.

BENEFITS AT A GLANCE

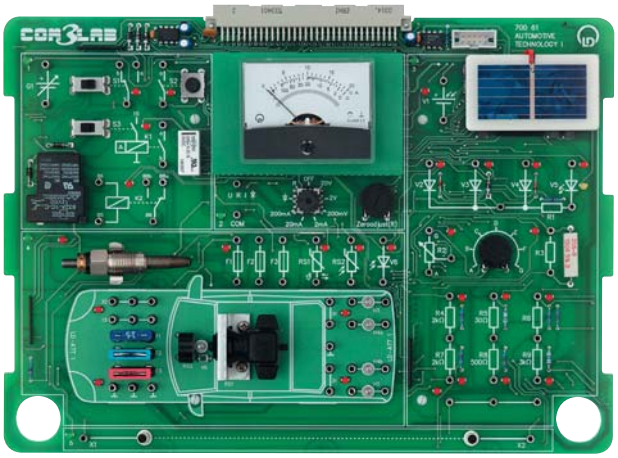
FOR THE TEACHER

- well-grounded content
- experiments relevant to current practices
- descriptive teaching material for presentations
- documents with solutions
- flexible use in the lesson
- time savings due to complete assembly

FOR THE STUDENT

- hands-on learning
- verification of results
- documentation of results
- teamwork or self-study
- choice of languages

EXEMPLARY COURSE FOR MOTOR VEHICLE TECHNOLOGY

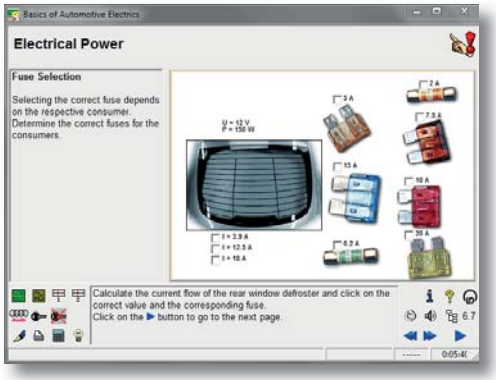


COM3LAB COURSE: AUTOMOTIVE TECHNOLOGY I

70061

This COM3LAB course prepares and conveys the fundamentals of vehicle electrics/electronics in an understandable way. Physical, chemical and mathematical properties of "electricity" thereby lead to extensive understanding of electrical operating sequences and processes in motor vehicles..

Every COM3LAB course has an electronic, interactive textbook with detailed experimental instructions. Subject-specific descriptions, images, videos and animations illustrate both theory and practice. Besides this content, the textbook includes a virtual lab and a multitude of tools, e.g. to compile distinctive documentation.

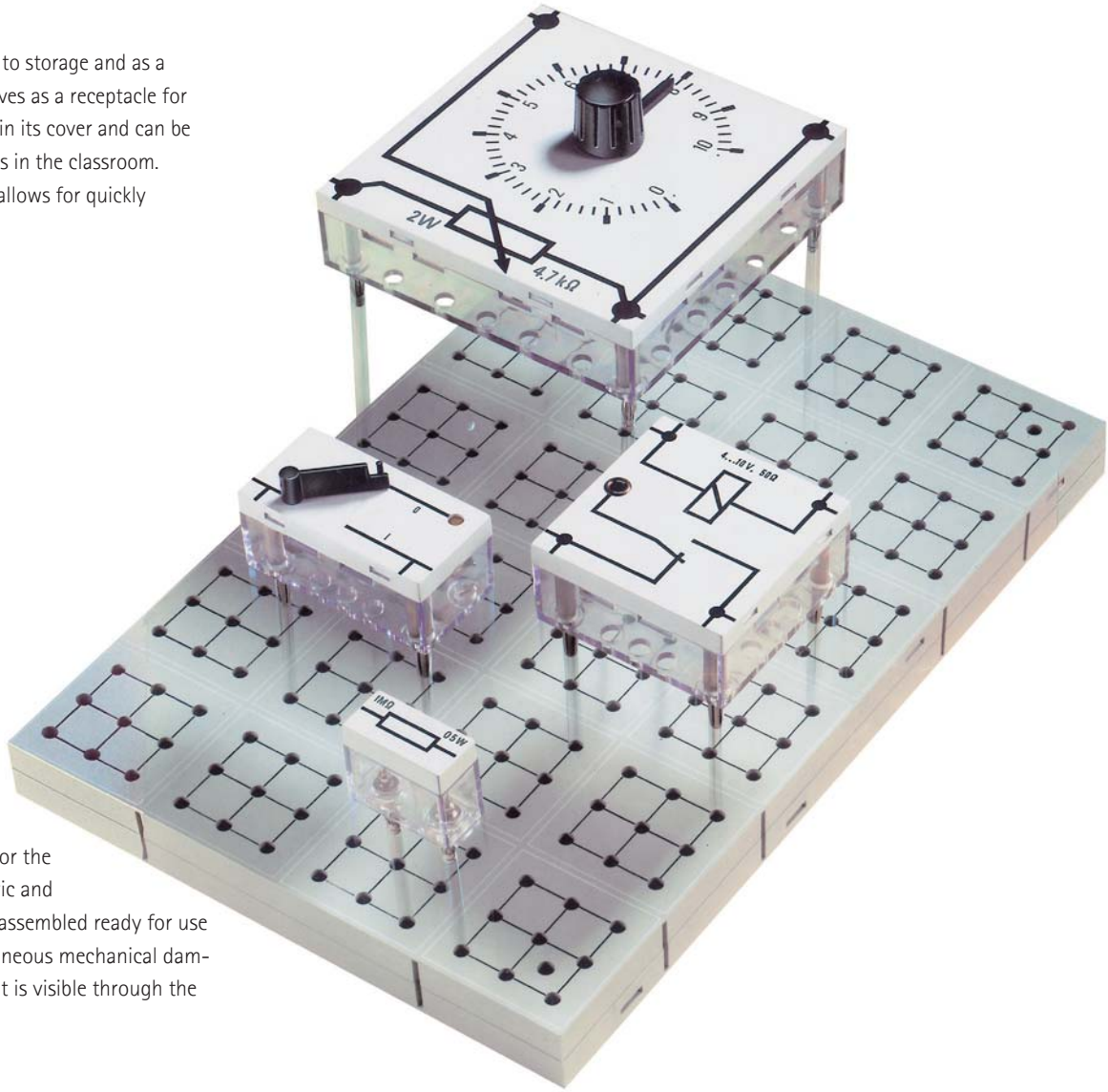


PLUG IN SYSTEM STE

The LEYBOLD plug in system is a proven experimental program for electrics and electronics. Besides the fundamentals, the extensive test program also includes advanced topics, e.g. in telecommunication, information, and control technologies as well as in vehicle electronics.

Experiment descriptions for students and accompanying information for teachers are available to conduct the experiments. The symbols printed on the plug-in elements, connectors and boards result in layouts similar to circuit diagrams for the experiment setup. This facilitates the transfer between circuit diagrams in the textbooks and your own circuit as well as logging the experiment setup, and it also promotes thinking, learning and experimenting with circuit diagrams.

The STE suitcase lends itself to storage and as a student's workstation. It serves as a receptacle for various STE equipment sets in its cover and can be used to conduct experiments in the classroom. The clearly laid out storage allows for quickly launching the experiment.



In the see-through casing for the plug-in elements, the electric and electronic components are assembled ready for use and protected against extraneous mechanical damage. The original component is visible through the transparent base.

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Stackable plastic trays alternatively offer a space-saving and clearly laid out storage of STE elements, components and accessories in cabinets or drawers..

PRACTICAL DIDACTIC SOLUTIONS

INCREASING DEMANDS IN TRAINING ON VEHICLES

The demands that automotive mechatronics engineers and diagnostic technicians face in their trade and in the industry are always growing in complexity: besides mastering conventional technology, they must also gain skills in the area of electronics, microprocessing and databus technology.

Only those who understand operating principles in detail and the functional relationships of electronic components like ABS, map-controlled ignition, motronics, common rail, electrical system management, etc. and the tradition mechanical, hydraulic and pneumatic components are prepared for the daily demands of the work routine. This of course includes the safe manipulation of modern diagnostic systems.

PRACTICAL DIDACTIC SOLUTIONS

LD DIDACTIC offers technical equipment and systems, with which trainees can effectively learn these complex subjects. These are developed in cooperation with the automotive industry and continually adjusted for technical advancements.

LOW TIME REQUIREMENT FOR LESSON PLANNING AND TEACHING

LEYBOLD solutions are not only adapted to the complex class subjects but also to the constantly increasing demands facing instructors. Lesson planning and the experimental teaching structure only require very little of their time, because the comprehensive literature accompanying the experiments provides you with a guide for demonstration experiments, which you can simultaneously hand out to your students as experimental instructions.

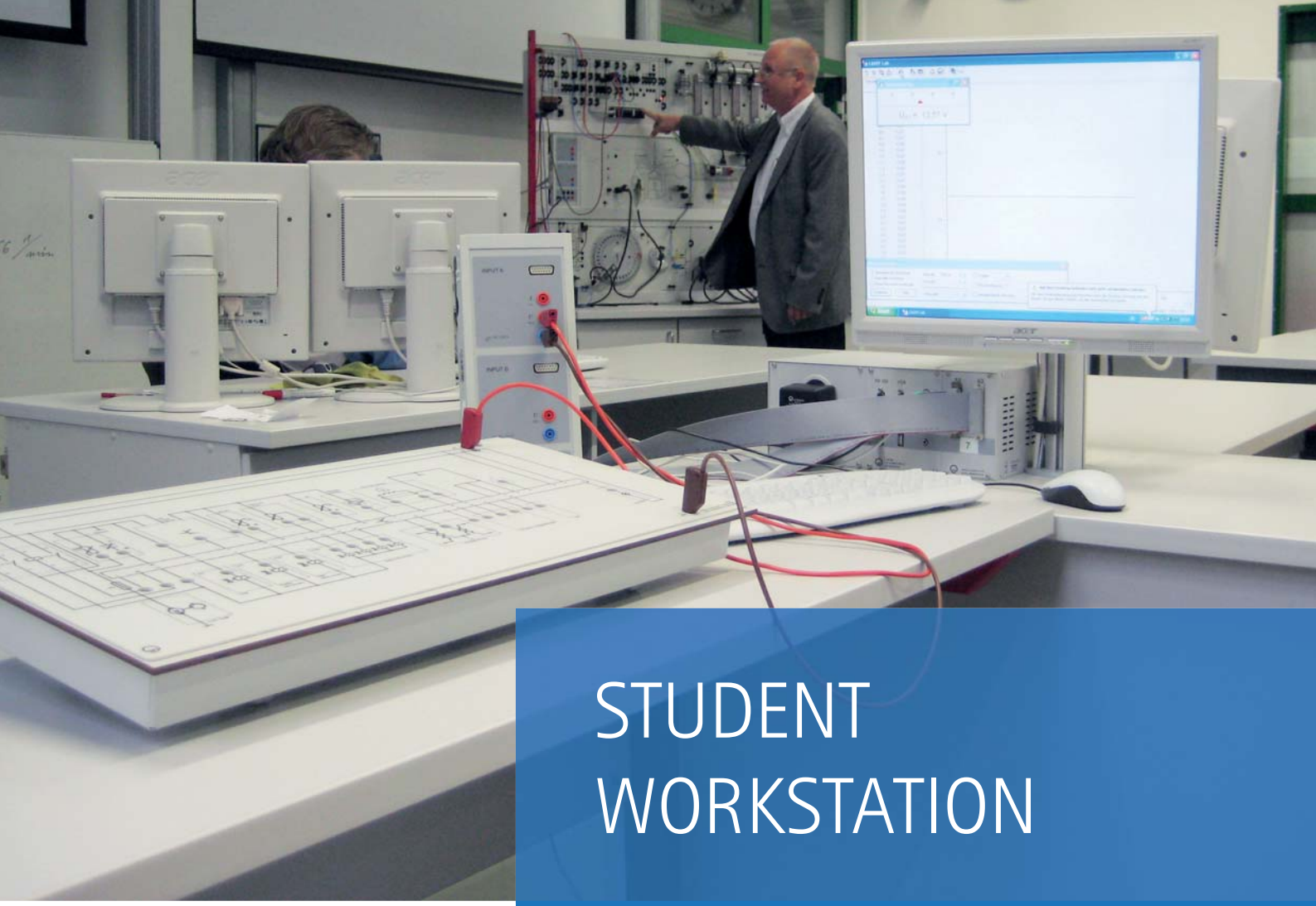
The experiments' literature prepared didactically facilitates lesson planning and teaching for instructors.

TRAINING PANEL SYSTEM – TPS

THE MODULAR EDUCATIONAL PANEL SYSTEM FOR STUDENT AND DEMONSTRATION EXPERIMENTS

- Construction and design similar to the original vehicle
- Self-diagnostic capability
- Use of original components
- Experiment literature for lesson planning and experimentation
- Clear front views

The modular concept allows for the quick and easy conversion and extension of technical laboratories with the TPS system.



STUDENT WORKSTATION

Background:
Demo system for fuel injection A2.3.2.1

Foreground:
Student Adaptor (740050) with overlay mask LH Motronic (740052) and Sensor-CASSY

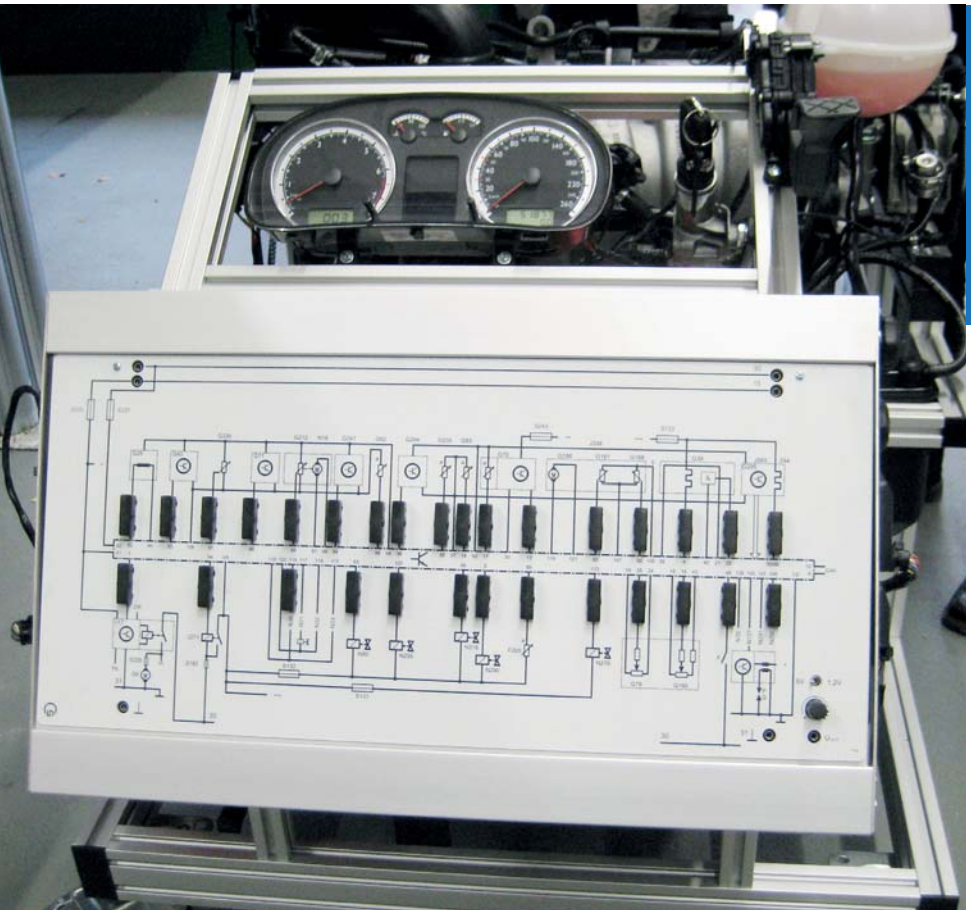
PRACTICAL, FLEXIBLE AND MODULAR

Student measuring stations consist of a student workstation with a measuring adapter and an overlay mask suitable for the experiment setup. These measuring stations are connected by two 38-pole cables and with the teacher's training system – either in star or in series structures.

The students can record and analyze all measurements from the installation online at their workstations. Furthermore, the teacher can simulate system-specific errors to be studied metrologically at the students' workstations. The student measuring stations are decoupled in reverse so that the students cannot cause any error in the teacher's demo system.

Space-saving storage:
Example of a storage solution for
student workstations and
overlay masks

- Quick setup due to simple wiring
- Compact size
- Up to 70 PINs available for use
- Original values from the vehicle or model at the student's workstation
- Short-circuit proof at the control unit
- Overlay masks with circuit diagrams for all available models and vehicles
- Measurements with original meters possible



The modular concept
allows the connection of
function engines.

LEYLAB

EDUCATIONAL LAB MONITORING AND CONTROL

YOUR TECHNICAL LABORATORY FOR THE FUTURE

IP REGISTRATION

MULTIFUNCTIONAL LAB FURNISHINGS AND DEVICES

Our LeyLab program offers you a wide selection of student, laboratory and computer desks. These are flexible, to be customized to your individual equipment and space requirements. Our power supply and experimental equipment is ideally adjusted to them. They can be connected to the available Ethernet and form the "networked learning environment" with the linked computer.

PARALLEL CONTROL OF THE EXPERIMENT SETUPS AND THE LABORATORY'S POWER SUPPLY

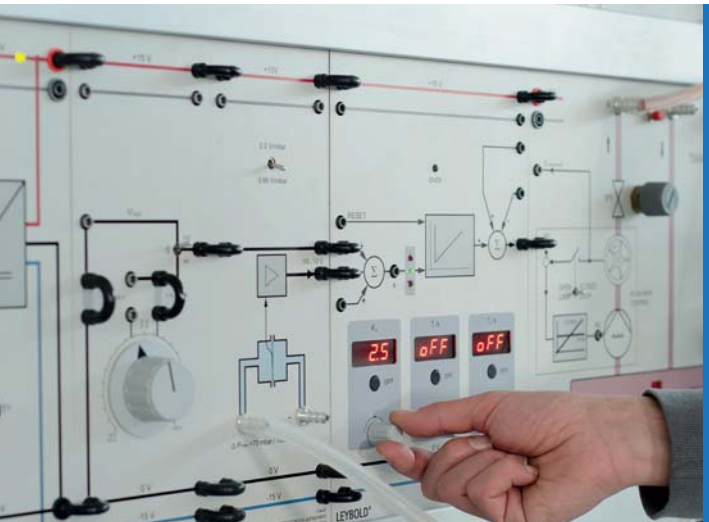
With LeyLab, besides the laboratory's power supply, you can also control key devices in the complete experiment setups with the teacher's PC. The new LeyLab.control software thereby has significant advantages over comparable products. For example, the instructor can protect experiment setups from incorrect voltages or activate and operate individual devices in the experimental setup as well as trigger faults.

LEYLAB.POWER

The LEYLAB.control concept can integrate the laboratory's power supply with the corresponding Ethernet interface. From the teacher's PC, the instructor thus has access at any moment to the devices and can read or change settings. To protect the connected experimental environment, parameters can additionally be limited so that the students cannot manipulate them.

LEYLAB.CONTROL

The LEYLAB.control software is the software for the central control station in the networked laboratory, and it allows actuating the linkable power supply units in the LEYLAB.power series as well as the linkable experiment boards in the TPS series. The instructor can map the laboratory in the program interface and has a graphical overview of all devices connected by Ethernet. The student PCs can have access to the individual devices and can communicate directly.



TPS.NET

Network-compatible TPS modules have an Ethernet interface, with which they can be integrated into the LEYLAB.control concept. The teacher can then access the equipment from his computer either as an observer only or actively, while the students conduct the corresponding experiments. Data acquisition, parameter and limit specifications, and (safe) intrusion of errors are thus easily possible.

SPECIALIZED ROOM PLANNING AND FURNISHING

YOUR NEW LEYBOLD SPECIALIZED ROOM

Based on your ideas, we will plan your specialized room together to suit the curriculum. Our planners design your personal laboratory, in which you can tailor the desired experimental equipment, furniture and storage solutions to your available space.

Because of our long-standing experience, we are your reliable partner in all aspects from project planning until implementation.

ALL FROM THE SAME SOURCE

SPECIALIZED ROOM PLANNING

- Furnishing related to practice
- Observance of safety standards
- Creation of planning documents
- Formulation of output texts

FURNISHINGS

- Customized solutions
- Networking of the educational systems
- Storage solutions appropriate for the devices and fixtures
- Long future-purchase and supplement guarantees

FINANCING

Leasing packages for specialized room furnishings and equipment

LEYBOLD®

COMPUTER-ASSISTED MEASUREMENT AND ANALYSIS IN VEHICLES

The modular CASSY system enables computer-assisted measurement and analysis for all levels of education up to the university.

THE CASSY SYSTEM CONSISTS OF:

1. Interface device for recording measurement data
2. Extensive choice of sensors to calculate electric and nonelectric values within motor vehicle technology
3. CASSY Lab 2: The intuitive measuring and analyzing software supports all CASSY devices and sensors

SENSORS

Catalogue No.	Designation
524 078	CAN bus box
524 081	LIN bus box
524 076	Auto box i
524 077	Auto box Z
738 989	Standard workshop TDC pick-up
738 987	Capacitive-type pick-up
738 986	Inductive-type pulse pick-up
524 064	Pressure sensor S
524 044	Temperature sensor S
524 0511	Lux adapter S
666 243	Lux sensor
524 031	Current supply box
524 043	30 A box
524 0512	Optical power sensor

You will find information on possible applications and technical data in the back of the catalogue under the respective catalogue number.

SENSOR-CASSY 2

worlddidac
15th AWARD 2012

INTERFACE FOR RECORDING MEASUREMENT DATA

- for connection to a computer's USB port, to another CASSY module or to the CASSY-Display
- simultaneous measurement of voltage, amperage and up to two other variables
- automatic detection of sensor boxes
- can be set up as a desktop, console or demonstration unit (also suitable for CPS/TPS panel frames)

Sensor-Cassy 2 (524 013) has two electrically isolated voltage inputs, an alternative current input and two sensor box inputs in parallel.

All inputs have reversible measurement ranges. You will find technical data in the back of the catalogue.

PLUG & PLAY

automatic detection and setting of Sensor- CASSY and sensor boxes

COMPATIBLE

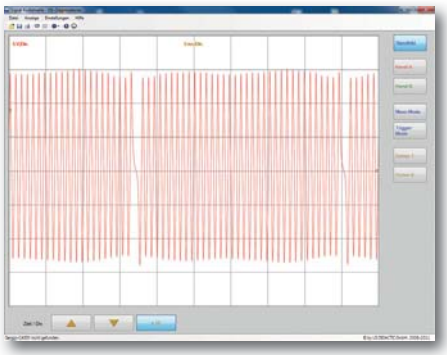
with all CASSY sensor boxes and sensors

CASSY LAB 2 AND VEHICLE DIAGNOSIS

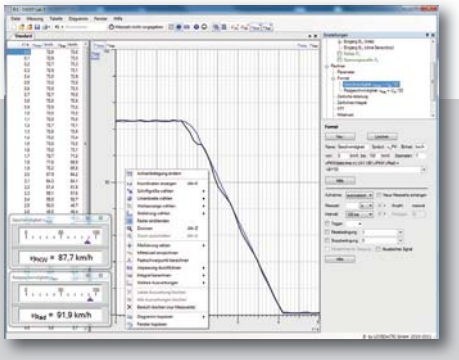
VEHICLE DIAGNOSIS

CASSY diagnosis software for the automotive field. This software provides a user interface for Sensor-CASSY, which is based on original diagnosis software.

- for Sensor-CASSY 1+2
- for selected sensors
- for all of your school's workstations (single license = school license)



SOFTWARE TO RECORD AND ANALYZE MEASURED DATA



Graphical representation of ABS speed signals with CASSY Lab 2

CASSY LAB 2 THE ALL-PURPOSE SOFTWARE

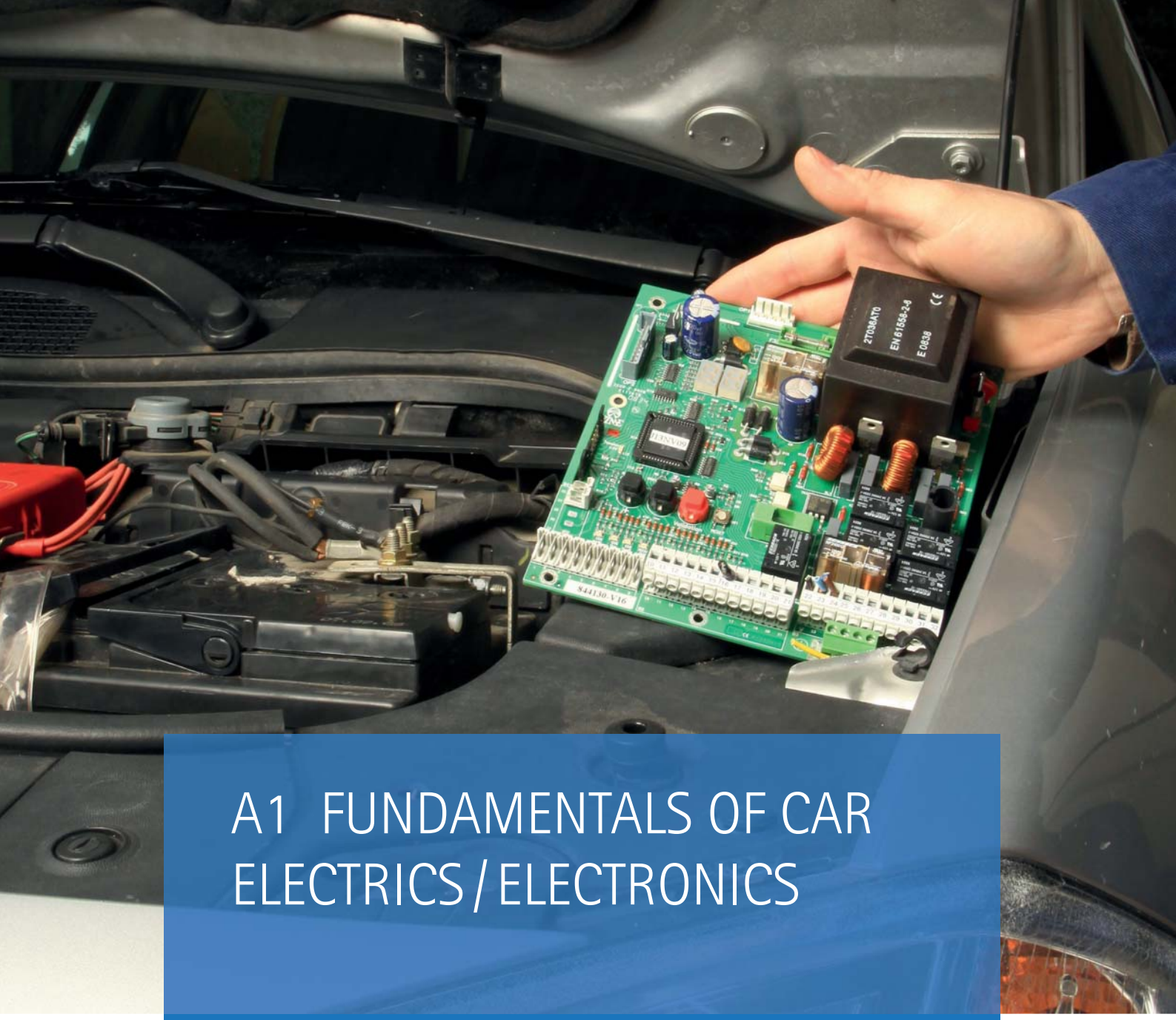
- for all basic equipment
- for all sensors
- for all of your school's workstations (single license = school license)

EQUIPMENT
AT A GLANCE

We have compiled complete, self-contained and operational experiment setups for you on the following pages. These include individual devices, measuring technology, software and teachware. All equipment is designed to cover topics in all fields of instruction within motor vehicle technology. The modular equipment solutions can of course be adapted to your needs. Contact us, and we will gladly help you!

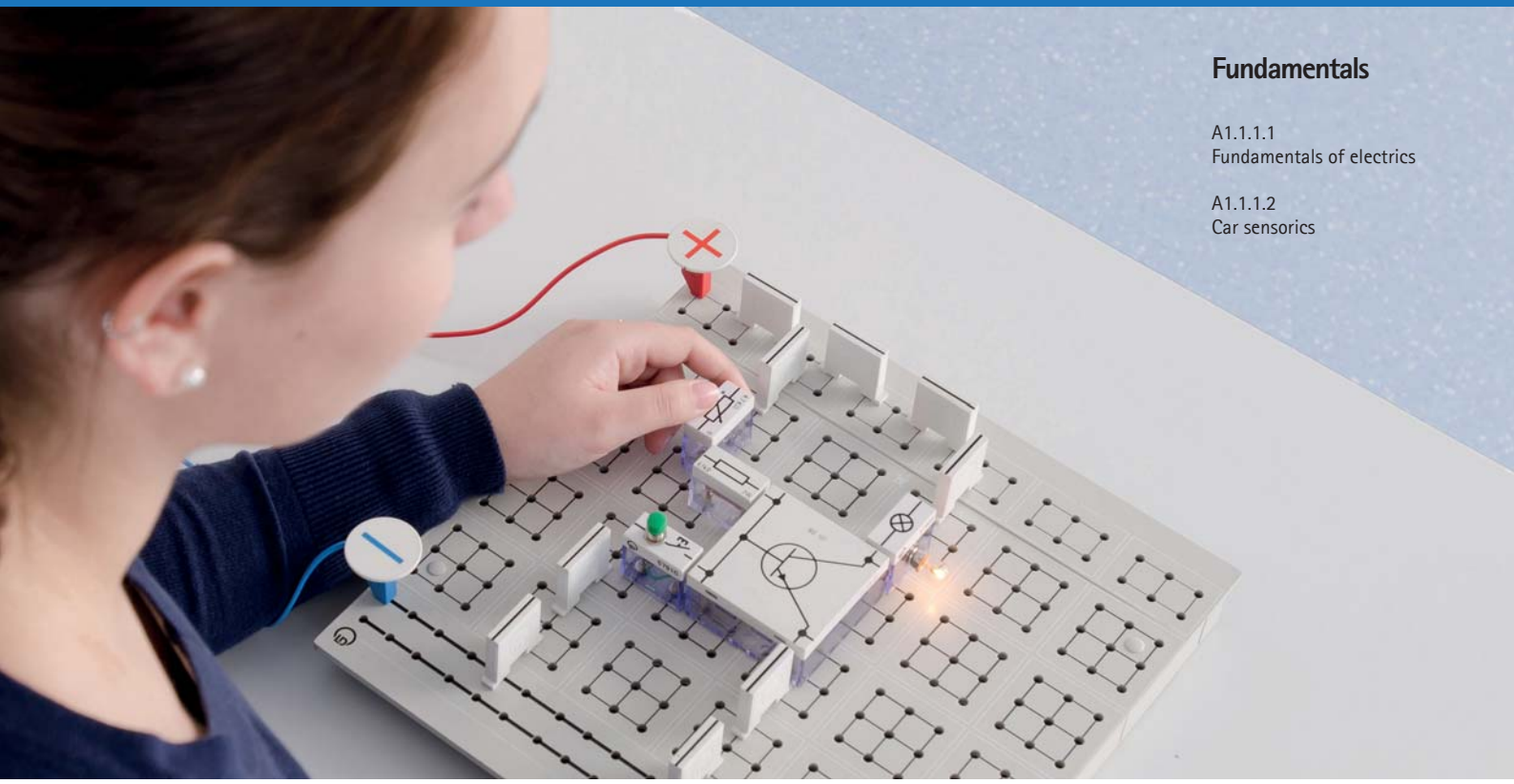
A1 FUNDAMENTALS OF CAR ELECTRICS/ELECTRONICS

A2 VEHICLE TECHNOLOGY



A1 FUNDAMENTALS OF CAR ELECTRICS / ELECTRONICS

A1.1 ELECTRONICS



Fundamentals

A1.1.1.1
Fundamentals of electrics

A1.1.1.2
Car sensorics

Fundamentals of electrics (A1.1.1.1)

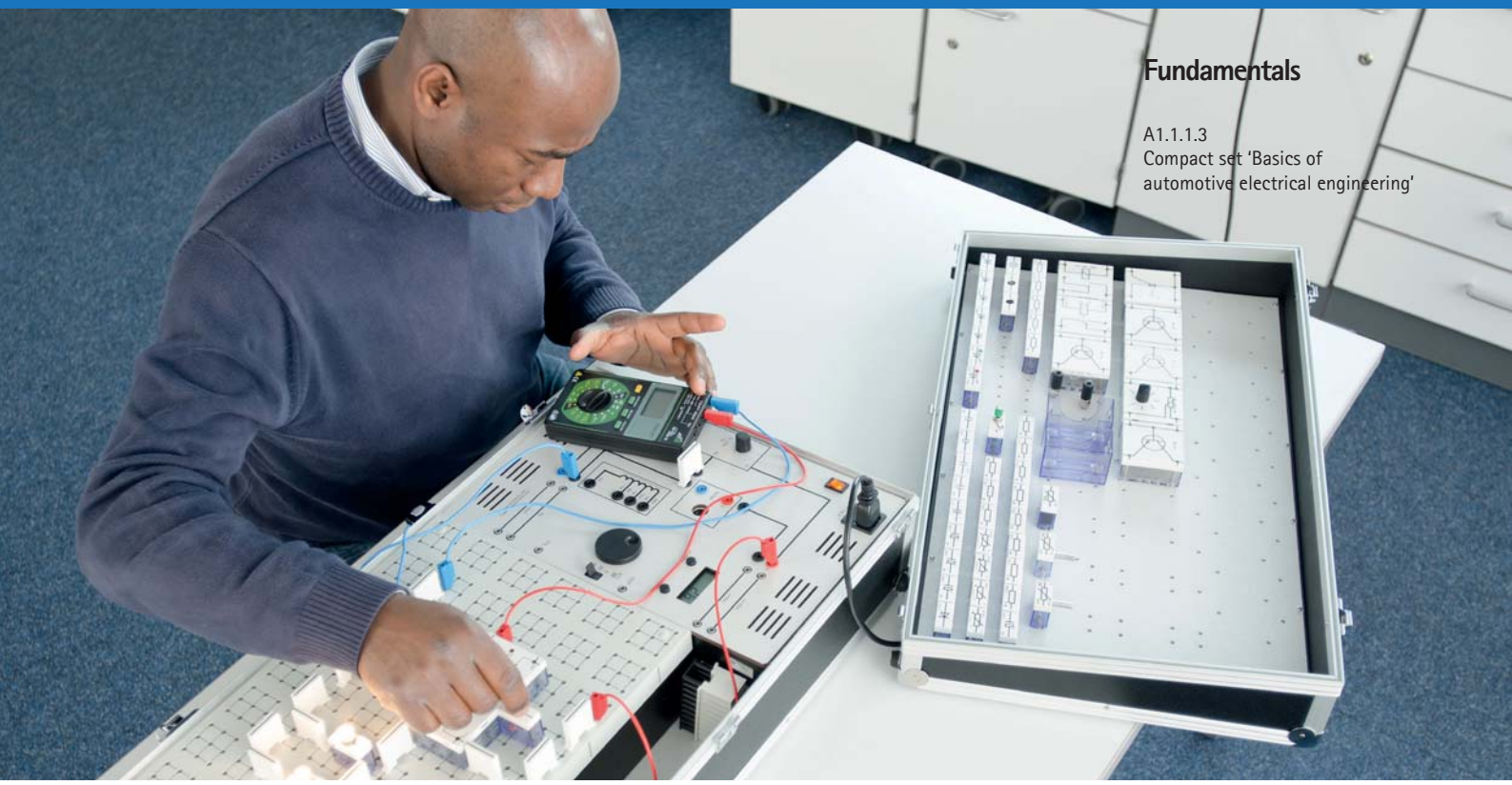
Cat. No.	Description	A1.1.1.1	A1.1.1.2
727 520N	Equipment Set A1.1.1.1, STE	1	
726 50	Plug-in board 297 mm x 300 mm, STE	2	1
726 88	AC/DC Stabilizer	1	1
726 961	Function Generator 200 kHz, 230 V	1	
578 774	Power Switch BTS640 12 A/12	1	
579 162	Simulation ABS/Ti, STE 2/50	1	
726 19	Panel frame SL85, One Level	1	
531 090	Multimeter METRAmax 12	1	
531 120	Multimeter LDanalog 20	1	
575 212	Two-channel oscilloscope 400	1	
575 24	Screened cable BNC/4 mm plug	2	
LDS 00001	Digital Stopwatch	1	
501 46	Connecting lead 19 A, 100 cm, red/blue, pair	3	
501 48	Bridging plugs STE 2/19, set of 10	3	
500 401	Connecting lead 19 A, 10 cm, red	1	
500 402	Connecting lead 19A, 10 cm, blue	1	
500 411	Connecting lead 19 A, 25 cm, red	1	
727 5185	Basic set automotive sensorics, STE		1
531 183	Digital Multimeter 3340		1
727 5182	Vehicle sensors 1, STE, set		1
727 5183	Vehicle sensors 2, STE, set		1
524 013S	Sensor-CASSY 2 Starter		1
739 589	Software: Vehicle diagnosis, german and english		1
524 064	Pressure sensor S, ± 2000 hPa		1
524 031	Current Source Box		1
375 58	Manual vacuum pump		1
577 42	Resistor 680 Ohm, STE 2/19		1
582 629	Air mass flowmeter STE 4/100/200		1

Cat. No.	Description	A1.1.1.1	A1.1.1.2
739 271	Lambda Sensor, heated		1
666 711	Butane gas burner		1
666 712ET3	Butane cartridge, 190 g, set of 3		1
300 02	Stand base V-shape, small		1
300 41	Stand rod 25 cm, 12 mm Ø		1
301 01	Leybold multiclamp		1
666 555	Universal clamp 0...80 mm		1
501 45	Connecting lead 19 A, 50 cm, red/blue, pair		2
775 001EN	LIT: A1.4 Electrical/Electronic in Case	1	1

Our plug-in equipment teaches basic knowledge of electricity, electronics and digital technology specifically in view of typical applications in vehicles.
The plug-in system represents an ideal introduction to these subjects. It also distinguishes itself by:

- conventional electronic components in see-through casing,
- typical vehicle components in see-through casing,
- a particularly robust design, and
- a layout identical to circuit diagrams on the plug-in board with
- ISO-compliant symbolic representation of the components.

Electronic components, vehicle sensors and transmitters, and their applications in a complete circuit are studied.



Fundamentals

A1.1.1.3
Compact set 'Basics of automotive electrical engineering'

Compact set 'Basics of automotive electrical engineering' (A1.1.1.3)

Cat. No.	Description	A1.1.1.3
727 520KOF	Compact set 'Basics of automobile electrical engineering' in the case	1
531 090	Multimeter METRAmax 12	1
531 120	Multimeter LDanalog 20	1
575 212	Two-channel oscilloscope 400	1
575 24	Screened cable BNC/4 mm plug	2
LDS 00001	Digital Stopwatch	1
501 46	Connecting lead 19 A, 100 cm, red/blue, pair	2
775 001EN	LIT: A1.4 Electrical/Electronic in Case	1

The following topics are covered with the equipment set A1.1.1.1:
- The electric circuit
- The ohmic resistance
- Current and voltage sources
- The capacitor
- The coil
- The transformer
- The relay
- Special resistors like NTC, PTC or LDR
- The diode
- The Z-diode
- LEDs
- The transistor, and
- The thyristor.

Finally, with this set applied circuits in vehicle electronics can be assembled, such as:
- The electronic tachometer
- The electronic voltage regulator for three-phase generators, or
- The transistor control unit for breaker-triggered ignition systems.

The equipment in the STE suitcase lends itself for storage and as a student's workstation. It serves as a receptacle for various STE equipment sets in its cover and can be used to conduct experiments in the classroom. The cover can be separated from the base.

Fundamentals with COM3LAB

A1.1.2.1
Automotive electrics

A1.1.2.2
Automotive sensorics

A1.1.2.3
Fundamentals of digital and data bus technology

A1.1.2.4
Digital memory circuits

COM3LAB

Cat. No.	Description	A1.1.2.1	A1.1.2.2	A1.1.2.3	A1.1.2.4
700 00USB	COM3LAB Master Unit (USB)	1	1	1	1
700 00CBTEN	COM3LAB software English	1	1	1	1
700 00CBTFR	COM3LAB software french	1*	1*	1*	1*
700 00CBTSP	COM3LAB software Spanish	1*		1*	1*
700 00CBTPT	COM3LAB software Portuguese			1*	
700 00CBTRU	COM3LAB software russian	1*	1*		
700 61	COM3LAB Course: Automotive Technology I	1			
700 62	COM3LAB Course: Vehicle Sensors		1		
700 64	COM3LAB Course: Automotive Digital Technology I			1	
700 65	COM3LAB Course: Automotive Digital Technology II				1

*additionally recommended

COM3LAB is used for schooling and continuing education in electrical engineering and electronics. Electrical engineering can be taught and learned both theoretically and practically with COM3LAB. COM3LAB is the interface between theory and practice. Subject matters are not only presented theoretically but also simultaneously deepened with practical experiments.
COM3LAB consists of a master unit and several courses (experimental board + CD-ROM). The master unit is the basic device through which the software and experimental board communicate with each other.
The courses provide descriptive theory and many experiments in the widest range of subjects within electrical engineering and electronics. All experiments must be conducted personally. The measurements provide real values.
Ideal for direct transformation from theory into practice.

The COM3LAB courses Electricity and Sensors for Automotive Training formed in cooperation with the automotive industry strategically introduce the fundamentals of electricity. The COM3LAB course „Automotive Technology I" clarifies in a comprehensible way the variables voltage, current and resistance using graphic animations and videos, and the chapter „Counting with Variables" also examines these values. Measurements on real automotive components with analog and digital meters help understand simple electrical circuits. The course „Vehicle Sensors" gives a detailed explanation of the operating principle of electric components and sensors in a motor vehicle.
The course contents are rounded off with extensive instructions for practical troubleshooting. Comprehension questions and parallel audio responses guarantee the most efficient training possible compared to traditional training methods.

In particular, the COM3LAB course „Vehicle Sensors" deals with the following content:
- Wires
- Sensors
- Circuit diagrams and symbolism
- Batteries and accumulators
- Electrical field
- Capacity
- Generator
- Electric motor
- Transistor

The COM3LAB course „Automotive Digital Technology I" deals with the fundamentals of Boolean algebra using logic operations. Animations and interactions illustrate the basics of modern bus systems. The subjects are adjusted to the practice and applications in motor vehicle technology.

A 2.1 ELECTRICS

Power supply

A2.1.1.1
Energy monitoring

Energy monitoring (A2.1.1.1)

Cat. No.	Description	A2.1.1.1
738 031	Battery monitoring	1
739 588	LIN BUS PC interface USB	1
737 9803	OBD Adaptor CAN+USB	1
738 04	Car Battery 12V	1
738 05	Set of Connection Leads I	1
738 90	Parallel Glow System	1
738 963	TDI Control Relay for Preheating System	1
738 10	Ignition Switch	1
726 09	Panel frame T130, Two Level	1
738 042	Battery pole-clamp set	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
738 9991	DC/AC Clamp on current probe	1
500 59	Set of 10 safety bridging plugs, black	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
500 644	Safety connection lead 100 cm, black	5
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
738 021	Battery Charger, Automatic	1*
775 010EN	LIT: A2.1.1.1 Energy Monitoring	1

*additionally recommended

The electrical system describes the energy and data management's setup and function in modern vehicles. It fuses together the power's supply and distribution, including its control and regulation.
The **car battery** is an essential component of the electrical system. The 738031 "Battery monitoring" educational panel contains the "diagnostic interface for data bus" with the battery's energy management functionality. This consists of software and the battery data module (BDM), directly on the vehicle battery's negative pole and connected to the diagnostic interface over a LIN bus line.
The BDM determines the battery's state with sensors recording the battery's current, voltage and temperature. This continually calculates the battery's state of charge and state of wear using, among others, battery characteristics stored in the control unit.
The **standby current** keeps the battery voltage from declining below a minimum value needed to start the vehicle. For example, operation of the auxiliary heating is disabled, and a display on the instrument cluster informs the driver.
The **dynamic management** distributes the energy generated while driving to the individual loads. This is especially important if the energy does is not sufficient for the demand because of the number of loads (seat heater, lights, rear window).

Power supply

A2.1.1.2
Threephase alternator

Threephase alternator (A2.1.1.2)

Cat. No.	Description	A2.1.1.2
738 711	Compact alternator	1
738 631	Motor f. Generator Experiments, 1.0 kW	1
738 632	Belt drive for vehicle 1:3	1
726 10	Panel frame T150, Two Level	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
732 56	Coupling 1.0	2
732 58	Coupling Guard 1.0	2
738 963	TDI Control Relay for Preheating System	1
738 90	Parallel Glow System	1
738 03	Battery Connection Unit	1
738 04	Car Battery 12V	1
738 042	Battery pole-clamp set	1
738 05	Set of Connection Leads I	2
738 10	Ignition Switch	1
738 18	Auxiliary Headlamp	1
500 59	Set of 10 safety bridging plugs, black	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 9821	Safety experiment cables, set of 51	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
738 021	Battery Charger, Automatic	1*
775 011EN	LIT: A2.1.1.12 Three-phase Alternator	1

*additionally recommended

The electrical system describes the energy and data management's setup and function in modern vehicles. It fuses together the power's supply and distribution, including its control and regulation.
The **three-phase generator** - also known as „alternator" - is an induction machine operated as a generator that produces a speed-dependent three-phase alternating current using an electrical field. Since the electrical system is designed as a DC power system, this three-phase voltage must still be rectified. The control technology also comes into play: the voltage level should remain constant independently of the engine speed – the hybrid multifunction controller handles this. In this educational system, a three-phase electric motor drives the compact alternator. The generator itself has power diodes on 4 mm safety sockets for measurement and interruption that are just as accessible as the three-phase winding.

The excitation current and the voltage can be captured on the connection plate, and connections are available

- to the battery monitoring (sensing)
- to the load and error detection, and
- to the rotation speed detection.

The generator's output voltage can be led as a function of temperature or by the engine control unit.
In connection with lighting components, special high-current loads and a vehicle battery, the complete electrical system can be assembled!

Lighting systems

A2.1.2.1
Automotive lighting

A2.1.2.2
Supplementary set 'Trailer'

Automotive lighting (A2.1.2.1)

Cat. No.	Description	A2.1.2.1	A2.1.2.2
738 07	Interior Lamp	1	
738 08	Door Contact Switch	1	
738 09	Fuse Holder	1	
738 10	Ignition Switch	1	
738 11	Head Lamp Switch	1	
738 13	Steering Column Switch	1	
738 14	Fog Lamp Switch	1	
738 15	Indicator Lamps	1	
738 17	Parking Lamp Switch	1	
738 18	Auxiliary Headlamp	2	
738 28	Relieving Relay	1	
738 31	Time Delay Relay	1	
738 35	Normal and High Volume Horn	1	
738 37	Turn Signal Relay	1	
738 38	Warning Lamp Switch	1	
738 87	Starter Substitute	1	
738 166	Headlights right	1	
738 167	Headlights left	1	
738 190	Rear lights	1	
738 291	Relay 1NO	2	
739 573	Automotive Set Point Potentiometer	1	
726 26	Panel frame VT180, Three Level	1	
738 027	Dig. Power supply 1 - 16 V/40 A	1*	
738 03	Battery Connection Unit	1	
738 04	Car Battery 12V	1	
738 05	Set of Connection Leads I	1	
500 990	Adapter sockets, set of 2	1	
738 042	Battery pole-clamp set	1	

Cat. No.	Description	A2.1.2.1	A2.1.2.2
LDS 00001	Digital Stopwatch	1	
537 32	Rheostat 10 Ohm	1	
727 20	Automobile Meter Zero-Left	2	
727 21	Automobile Meter Zero-Center	1	
738 12	Multi-Purpose Switch	1	
738 30	Relay 1 CO	1	
738 361	Side turn signal light LED	2	
500 59	Set of 10 safety bridging plugs, black	7	1
500 592	Safety Bridging Plugs with Tap, black, set of 10	1	
738 9831	Set 102 safety experiment cables	1	
738 01	Cable and plug box	1*	
500 593	Fault simulation plugs, black, set of 10	1*	
738 021	Battery Charger, Automatic	1*	
738 16	Main Headlamp with Side Lamp	2*	
738 27	Trailer lights		1
738 251	Trailer Socket 13 pole		1
775 012EN	LIT: A2.1.2.1 Vehicle Lighting systems	1	

*additionally recommended

Defined functions of the lights at the front of the vehicle, at the rear and inside are part of the vehicle's lighting technology. Even if control units activate modern lighting systems, knowing conventional circuits is indispensable. Certain physical principles, like those of polyellipsoid headlamps, xenon lamps or LED lights must also be mastered. Vehicle lighting systems require knowledge of the stipulations in the Road Traffic Type Approval Law and their requirements with regard to mechanical layout and electrical connection of lighting components.

Automotive lighting with CAN data bus (A2.1.3.1)

Networking lighting systems

A2.1.3.1
Automotive lighting with CAN data bus

A2.1.3.2
Supplementary set 'Trailer control'

Cat. No.	Description	A2.1.3.1	A2.1.3.2
738 111	Intelligent automotive lighting management system	1	
738 1121	OBD Adaptor	1	
726 256	Panel frame VT160, Three Level	1	
738 291	Relay 1NO	1	
579 13	Toggle switch STE 2/19	1	
738 10	Ignition Switch	1	
738 166	Headlights right	1	
738 167	Headlights left	1	
738 361	Side turn signal light LED	2	
739 587	Software: CAN bus visualisation	1	
738 027	Dig. Power supply 1 - 16 V/40 A	1	
500 990	Adapter sockets, set of 2	1	
578 611	Phototransistor STE 2/19	1	
738 190	Rear lights	1	
738 975	Diagnostic Plug 16 Pin	1	
737 9803	OBD Adaptor CAN+USB	1	
524 078	CAN bus box	1	
738 18	Auxiliary Headlamp	2	
524 013S	Sensor-CASSY 2 Starter	1	
739 581USB	CAN bus software USB	1	
524 043	30 A box	1	
577 79	Variable resistor 1 kOhm, STE 2/19	1	
739 589	Software: Vehicle diagnosis, german and english	1	
577 321	Resistor 120 Ohm, STE 2/19	2	
578 02	Photoresistor LDR 05, STE 2/19	1	
739 654	Steering angle sensor	1	
739 585	Fault simulator CAN Bus	1	
738 491S	Automotive fault simulator, starter	1*	

Cat. No.	Description	A2.1.3.1	A2.1.3.2
739 6021	Instrument cluster unit	1	
738 03	Battery Connection Unit	1	
579 162	Simulation ABS/Ti, STE 2/50	1	
500 59	Set of 10 safety bridging plugs, black	14	3
500 592	Safety Bridging Plugs with Tap, black, set of 10	2	1
738 9831	Set 102 safety experiment cables	1	
501 45	Connecting lead 19 A, 50 cm, red/blue, pair	1	
738 01	Cable and plug box	1*	
739 5835	FS vehicle door	1*	
739 5836	Vehicle door PS	1*	
500 593	Fault simulation plugs, black, set of 10	1*	
738 251	Trailer Socket 13 pole		1
738 263	CAN Trailer ECU		1
738 27	Trailer lights		1
726 09	Panel frame T130, Two Level		1
775 013EN	LIT: A2.2.6 CAN-Bus Lighting Control	1	

*additionally recommended

With more data transmission and networking in the motor vehicle, networked control units also take over the management of the lighting and electrical system in modern passenger cars. The educational system consists of a steering column switch with control unit and the electrical system control unit to activate the front and rear lights. It can be expanded with a comfort control unit, an instrument cluster with integrated gateway and a control unit for automatic trailer detection.

Backfitting electrical systems

A2.1.4.1
Electrical systems 230 VAC

Electrical systems 230 VAC (A2.1.4.1)

Cat. No.	Description	A2.1.4.1
738 061	Inverter 12/230 V	1
502 05	Measuring junction box	1
505 27	Bulb 230 V/40 W, E14	1
729 13	Lamp Socket E27	1
726 19	Panel frame SL85, One Level	1
738 06	12 V on-board socket	1
738 10	Ignition Switch	1
738 02	Automotive power supply 13.8 V/36 A	1
500 597	Automobile protection measuring adaptor	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
500 59	Set of 10 safety bridging plugs, black	1
738 9821	Safety experiment cables, set of 51	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
775 014EN	LIT: A2.1.4 Backfitting Electrical syst.	1

*additionally recommended

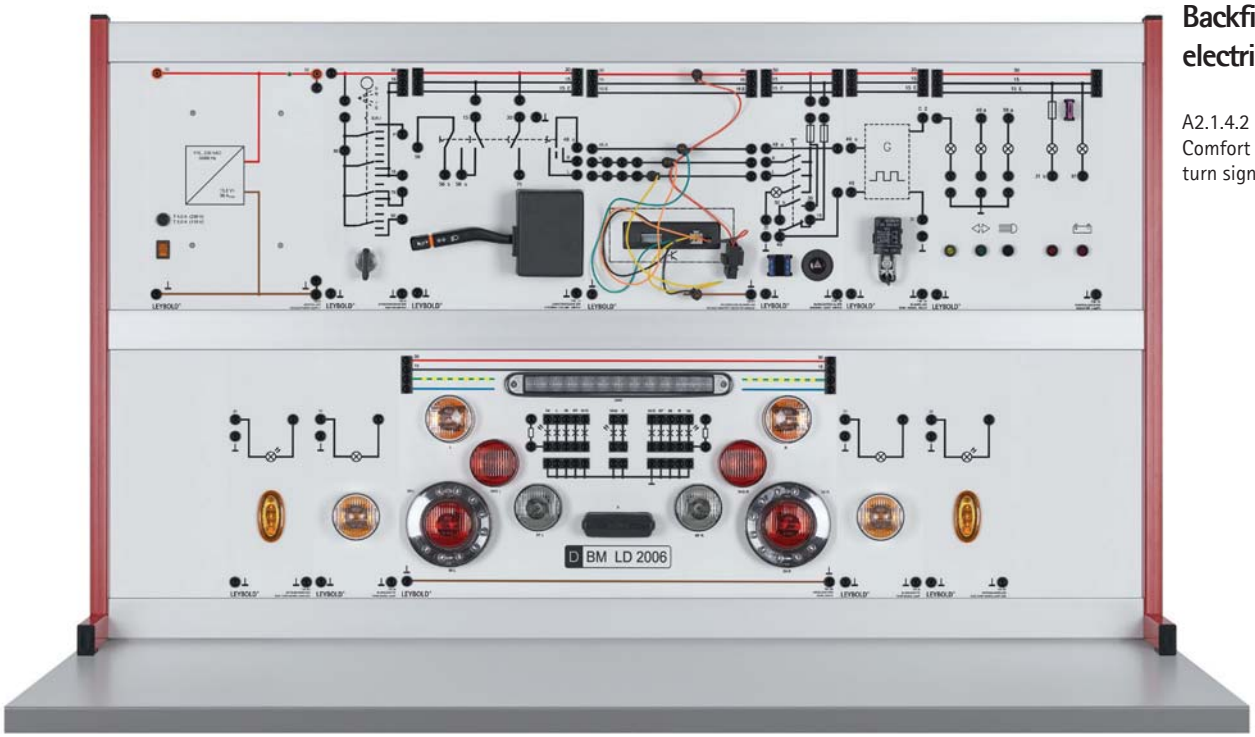
Retrofitting electric systems is now an essential part of the automotive mechatronics engineer's training.

The motor vehicle has become part of everyday life for today's motorists. This includes numerous vehicle owners who would like to use the common, portable devices and consumer appliances even in their car. So automakers optionally deliver their models with 230 V outlets already installed. Alternatively, there are various retrofitting solutions that supply 230 V - by tapping into the 12 V on-board outlet. This situation generates brand new tasks and problems for automotive mechatronics engineers:

- May an automotive mechatronics engineer retrofit such an installation?
- May he make repairs to it?
- Are there any regulations to pay attention to?

This field of instruction exhaustively studies these questions on the one hand and of course the technology on the other hand.

- What is an inverter?
- and how does it work?
- How does it relate to personal safety?
- Which faults may arise and how can they be diagnosed and corrected?



Backfitting electrical systems

A2.1.4.2
Comfort system
turn signal flashing

Comfort system turn signal flashing (A2.1.4.2)

Cat. No.	Description	A2.1.4.2
738 371	Automotive 1 tip/3 flash relay	1
726 10	Panel frame T150, Two Level	1
738 02	Automotive power supply 13.8 V/36 A	1
738 10	Ignition Switch	1
738 13	Steering Column Switch	1
738 38	Warning Lamp Switch	1
738 37	Turn Signal Relay	1
738 15	Indicator Lamps	1
738 36	Turn Signal Lamp	2
738 361	Side turn signal light LED	2
738 190	Rear lights	1
500 59	Set of 10 safety bridging plugs, black	4
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 9821	Safety experiment cables, set of 51	1
500 593	Fault simulation plugs, black, set of 10	1*
738 01	Cable and plug box	1*
775 014EN	LIT: A2.1.4 Backfitting Electrical syst.	1

*additionally recommended

Retrofitting electric systems is now an essential part of the automotive mechatronics engineer's training.

That is especially convenient when passing: Lane changes as well as the return into the line of cars is clearly announced by the repeated use of turn signals, as the German Highway Code (STVO) calls for in §5. The vehicles behind receive sufficient warning, and the passing driver can fully concentrate on the flow of traffic. This „blinking sequence" is a comfort feature that is absent from many production vehicles, especially older ones, and can only be retrofitted.
This subject exhaustively and practically studies such retrofitting.

- How are the existing turn signals connected?
- How should the operating instructions' wiring diagram be read?
- And how should it be copied in the vehicle?
- Where does the aftermarket device connect?
- The module does not work – why?

To establish practical relevance, work is done with the original operating manual and the original set of cables.

A 2.2 ELECTRICAL MACHINE

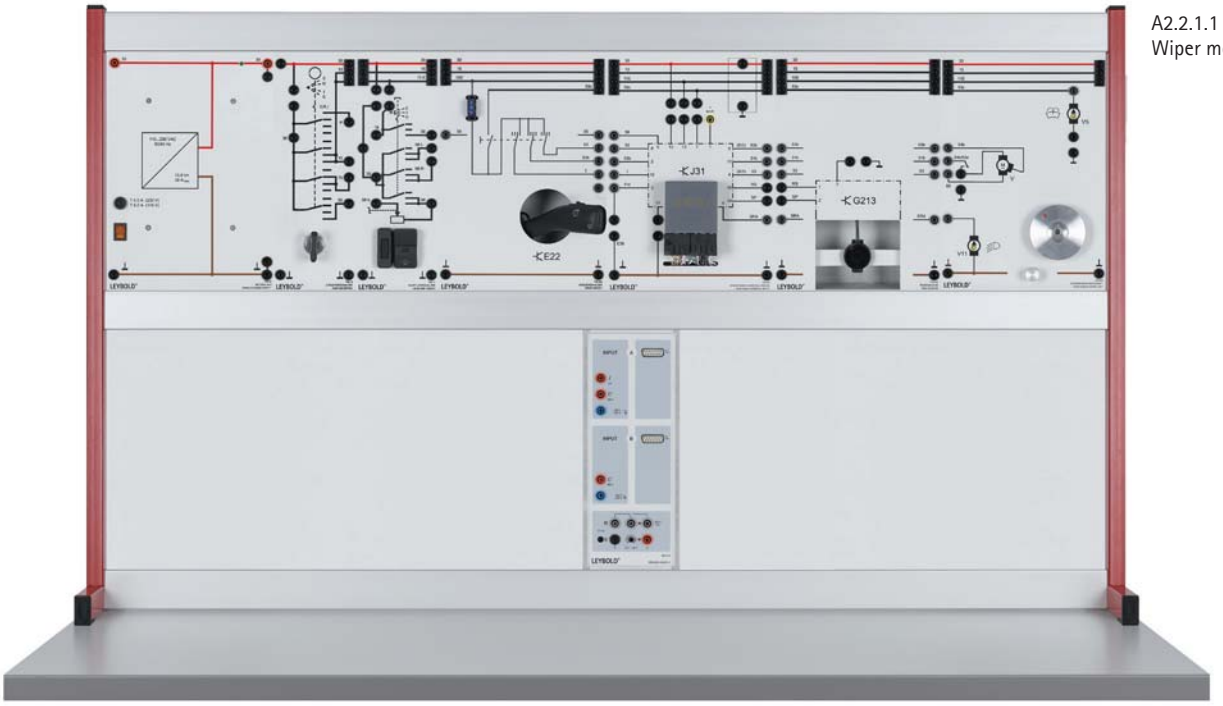
A2.2.1 ELECTRICAL MOTOR

A2.2.1.1 Wiper motor

A2.2.1.2 Electrical starter

Electrical motor

A2.2.1.1
Wiper motor



Wiper motor (A2.2.1.1)

Cat. No.	Description	A2.2.1.1
738 830	Wiper Switch	1
738 831	Wipe-Wash Interval Relay	1
738 832	Rain sensor	1
738 833	Windshield Wiper Unit	1
726 09	Panel frame T130, Two Level	1
738 10	Ignition Switch	1
738 02	Automotive power supply 13.8 V/36 A	1
309 48ET2	Fishing line, 10 m, set of 2	1
315 38	Weight with hook 0.5 kg	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
738 11	Head Lamp Switch	1
500 59	Set of 10 safety bridging plugs, black	3
500 641	Safety connection lead 100 cm, red	2
500 647	Safety Connection Lead 100 cm brown	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
738 491S	Automotive fault simulator, starter	1*
775 020EN	LIT: A2.3 Electrical Motors	1

*additionally recommended

The **electric motor** - the vehicle's second torque! The principle is sound: a current flow generates a magnetic field that, together with a second magnetic field, forms energy. This process can be used to generate linear movements (e.g. valves, injectors, relays) but also rotating movements.

The **windshield wiper** - clear sight, without which nothing goes in the rain! The classic windshield wiper application uses grinding machines for the front wipers. By contrast, the rear window wipers have a pole-changeable operation, since they work predominantly intermittently.
An automatic windshield wiper with rain sensor distinctly increases comfort and contributes to safety when driving.
The complete system consists of:

- a rotating windshield wiper motor
- a wipe-wash interval relay
- a washing pump simulation for the front glass
- a washing pump simulation for the headlights
- the steering column switch, and
- the rain sensor.

The generic term „automotive physics" refers to the system's mechanical side: the motor can be loaded precisely with a weight to determine the motor's efficiency and torque.
The rain sensor is studied in its capacity as an optical sensor and as part of the controlled system. It is assembled behind plexiglass to be activated upon sprinkling with water.

Electrical motor

A2.2.1.2
Pre-engaged-drive starters

Pre-engaged-drive starters (A2.2.1.2)

Cat. No.	Description	A2.2.1.2
738 851	Pre-Engaged Drive Starter, Perman.-Excited	1
732 54	Magnetic Powder Brake 1.0	1
732 55	Control Unit 1.0	1
732 59	Tacho Generator 1.0	1
500 597	Automobile protection measuring adaptor	1
726 09	Panel frame T130, Two Level	1
732 56	Coupling 1.0	2
732 58	Coupling Guard 1.0	2
500 59	Set of 10 safety bridging plugs, black	1
738 9821	Safety experiment cables, set of 51	1
524 013S	Sensor-CASSY 2 Starter	1
738 9991	DC/AC Clamp on current probe	1
738 03	Battery Connection Unit	1
738 04	Car Battery 12V	1
738 05	Set of Connection Leads I	1
738 10	Ignition Switch	1
738 88	Set of Connecting Leads II	1
738 042	Battery pole-clamp set	1
775 020EN	LIT: A2.3 Electrical Motors	1

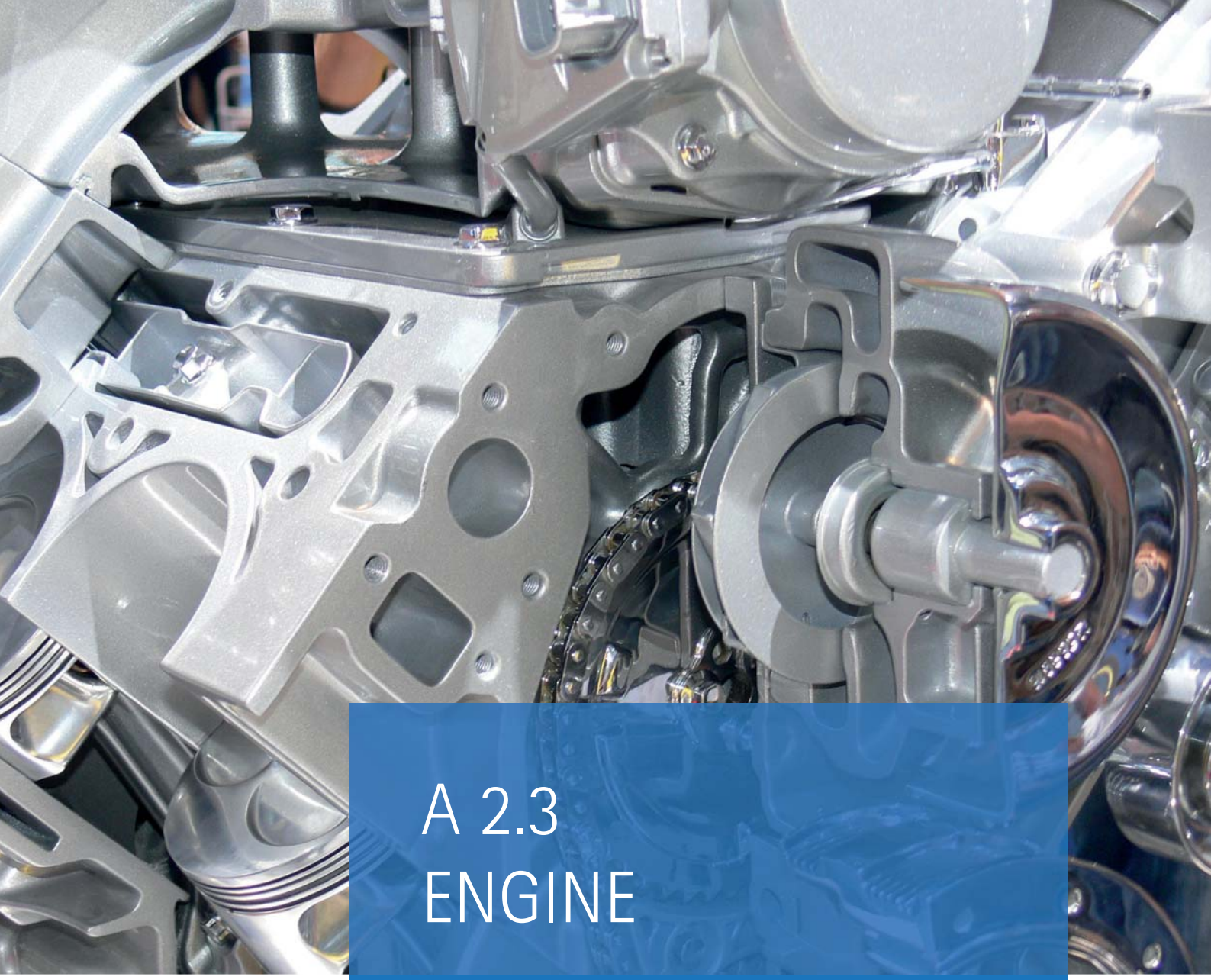
The **electric motor** - the vehicle's second torque! The principle is sound: a current flow generates a magnetic field that, together with a second magnetic field, forms energy. This process can be used to generate linear movements (e.g. valves, injectors, relays) but also rotating movements.

The **starter** is a DC series wound machine that can raise a sufficient torque at relatively low speeds to start the combustion engine. Maintaining the resulting power from the electric system requires correspondingly high current and conductor cross sections.
The educational system is aimed at recording the speed-torque curve. The starter is thus loaded by a magnetic powder brake.

The variables

- brake torque
- voltage
- speed, and
- current through a current probe

can be recorded with CASSY and correspondingly represented and analyzed.

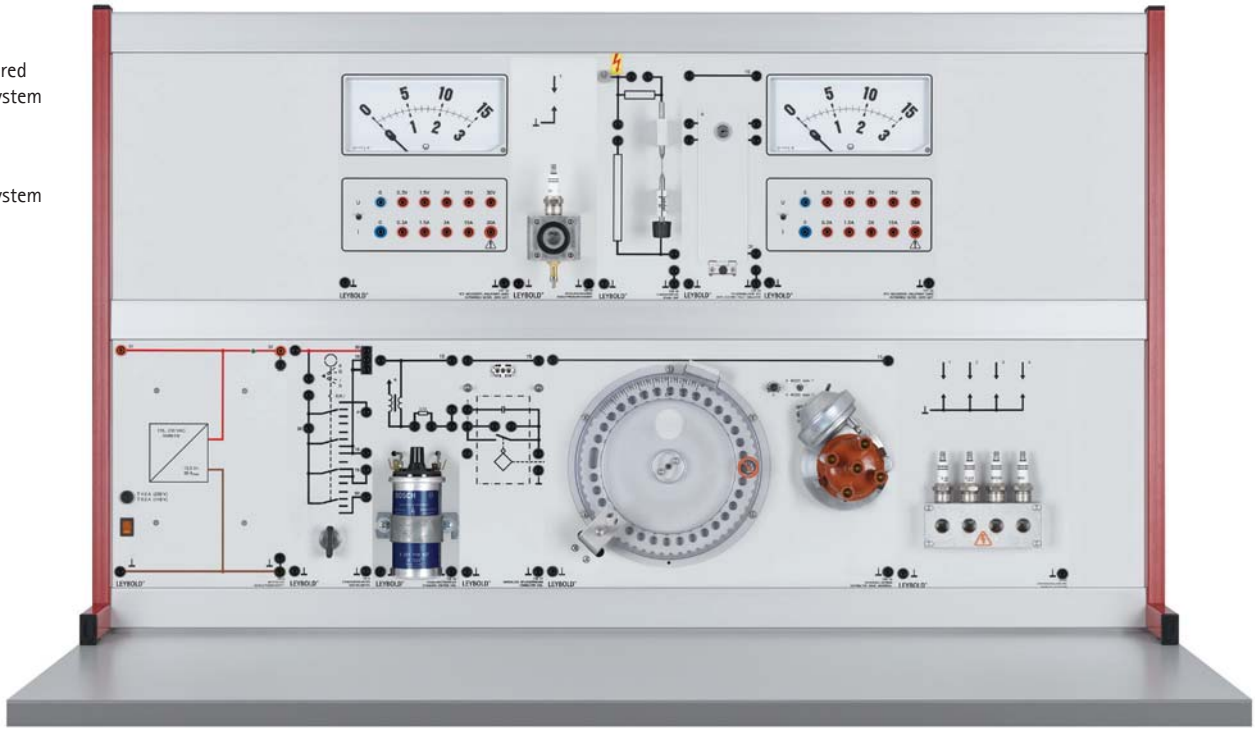


A 2.3
ENGINE

Ignition systems

A2.3.1.1
Breaker-triggered
coil ignition system

A2.3.1.2
Transistorized
coil ignition system



Breaker-triggered coil ignition system (A2.3.1.1)

Cat. No.	Description	A2.3.1.1	A2.3.1.2
738 40	Standard Ignition Coil	1	
738 42	Distributor Breaker-Triggered	1	
738 461	Distributor Cap, Transparent	1	
738 02	Automotive power supply 13.8 V/36 A	1	1
738 441	Spark plug holder	1	1
738 47	Coil Connector Unit	1	1
738 46	Accessory Set Ignition System	1	1
738 997	CASSY automotive measuring set	1	1
375 58	Manual vacuum pump	1	1
738 992	Ignition Timing Light	1	1
739 43	Distributor Drive Universal	1	1
726 09	Panel frame T130, Two Level	1	1
738 10	Ignition Switch	1	1
738 985	Automotive meter	1	1
524 064	Pressure sensor S, ± 2000 hPa	1	2
727 20	Automobile Meter Zero-Left	2	2
738 45	Spark Gap	1	1
738 49	Fault Simulator Automotive	1	1
738 442	Single pressure chamber	1	1
738 998	Pressure pump, foot-operated	1	1
738 991	Automotive Voltage Tester	1	1
562 901	Model ignition system	1	
604 541	Adapter T form PP Ø 6-7mm	1	1
604 520	Connector with nipple	1	1
604 481	Rubber Tubing 4 mm Ø	1	1
500 59	Set of 10 safety bridging plugs, black	2	1
500 592	Safety Bridging Plugs with Tap, black, set of 10	1	1
738 9821	Safety experiment cables, set of 51	1	1

Cat. No.	Description	A2.3.1.1	A2.3.1.2
738 01	Cable and plug box	1*	1*
500 593	Fault simulation plugs, black, set of 10	1*	1*
738 50	Control Unit TI-H		1
738 51	Ignition Coil TI-H/I		1
738 54	Overlay TI-H		1
738 55	Ignition Distributor TI-I		1
738 56	Overlay TI-I		1
738 58	Control Unit TI-I, TD		1
738 531	Distributor TI-H		1
775 030EN	LIT: A2.3.1 Coil Ignition System	1	1

*additionally recommended

Fuel-air mixing and ignition are the essential characteristics of a gasoline engine. After the fuel-air mixture is formed, it must be ignited safely and at the right time. The ignition is responsible for this.
Ignition systems with rotating distribution – already quite rare today, but indispensable for the basic understanding of ignition! Assembled in the classic educational panel style, ignition tests can be run without any danger. They consider the influence of, for example, the contact gap, the electrode gap, the compression pressure or the interference compression components.

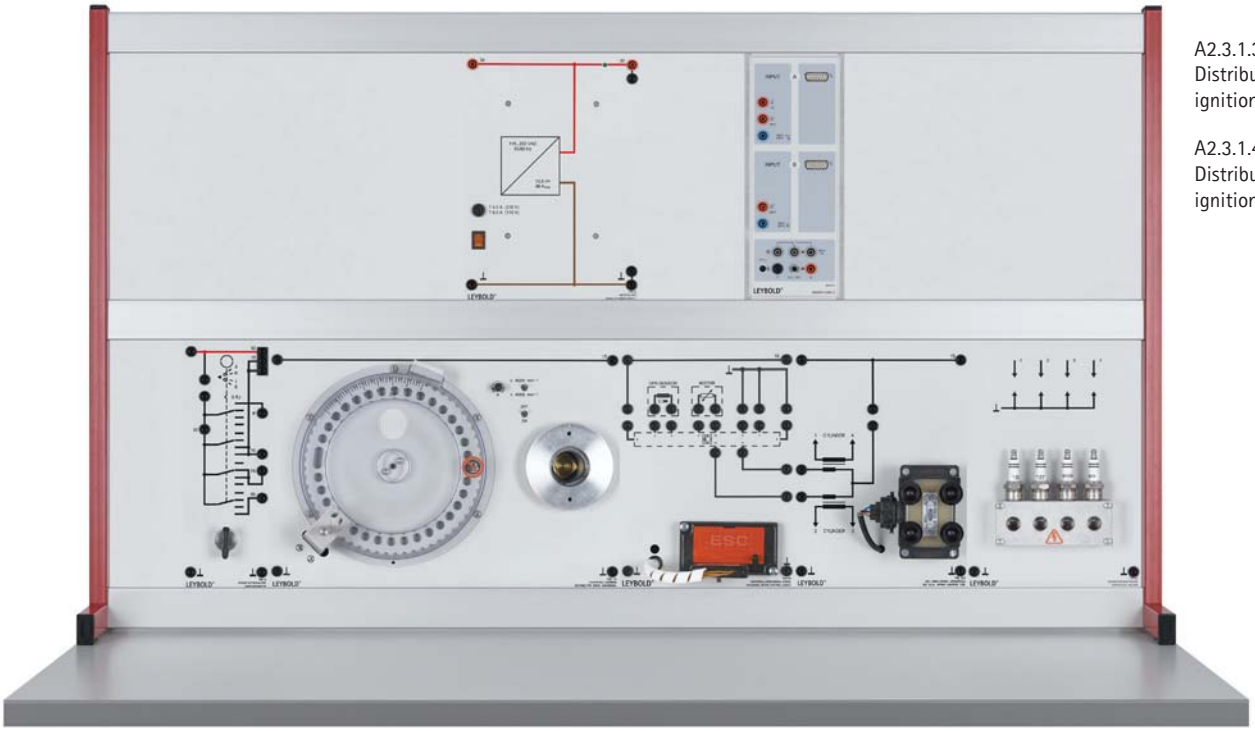
The **transistor ignition** was developed as a result of the contact breaker's limited switching power. This uses electronic high-powered switches and the corresponding control units. The contactless transistor ignition occurs with pulse pick-ups according to the

- induction principle (TI-I) and the
- Hall principle (TI-H).

Ignition systems

A2.3.1.3
Distributorless coil ignition system (DIS)

A2.3.1.4
Distributorless coil ignition system (SSI)



Distributorless coil ignition system (DIS) (A2.3.1.3)

Cat. No.	Description	A2.3.1.3	A2.3.1.4
738 516	Universal Ignition Module (UESC)	1	1
738 02	Automotive power supply 13.8 V/36 A	1	1
738 10	Ignition Switch	1	1
739 43	Distributor Drive Universal	1	1
738 517	DIS-Two Spark Ignition Coil	1	
738 518	DIS-Ignition Cable Set	1	
738 515	Crankshaft Position Sensor (CPS)	1	1
577 82	Variable resistor 47 kOhm, STE 2/19	1	1
738 441	Spark plug holder	1	
726 09	Panel frame T130, Two Level	1	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1	1
524 076	AUTO-BOX i	1	
738 989	Standard Workshop TDC Pick-Up	1	
738 986	Inductive-Type Pulse Pick-Up	1	
579 06	Lamp holder E10, top, STE 2/19	4	
590 83	Coil 500 turns, STE 2/50	2	
590 84	Coil 1000 turns, STE 2/50	2	
593 21	Transformer core, demountable	2	
505 36ET10	Glow lamp 115 V, E10, set of 10	1	
576 74	Plug-in board DIN A4, STE	1	
375 58	Manual vacuum pump	1	
500 59	Set of 10 safety bridging plugs, black	2	2
738 9821	Safety experiment cables, set of 51	1	1
500 596	Safety bridging plug STE 2/19, set of 10	1	
738 01	Cable and plug box	1*	1*
500 593	Fault simulation plugs, black, set of 10	1*	1*
738 481	Single Spark Ignition System (SSI)		1
524 077	AUTO-BOX Z		1

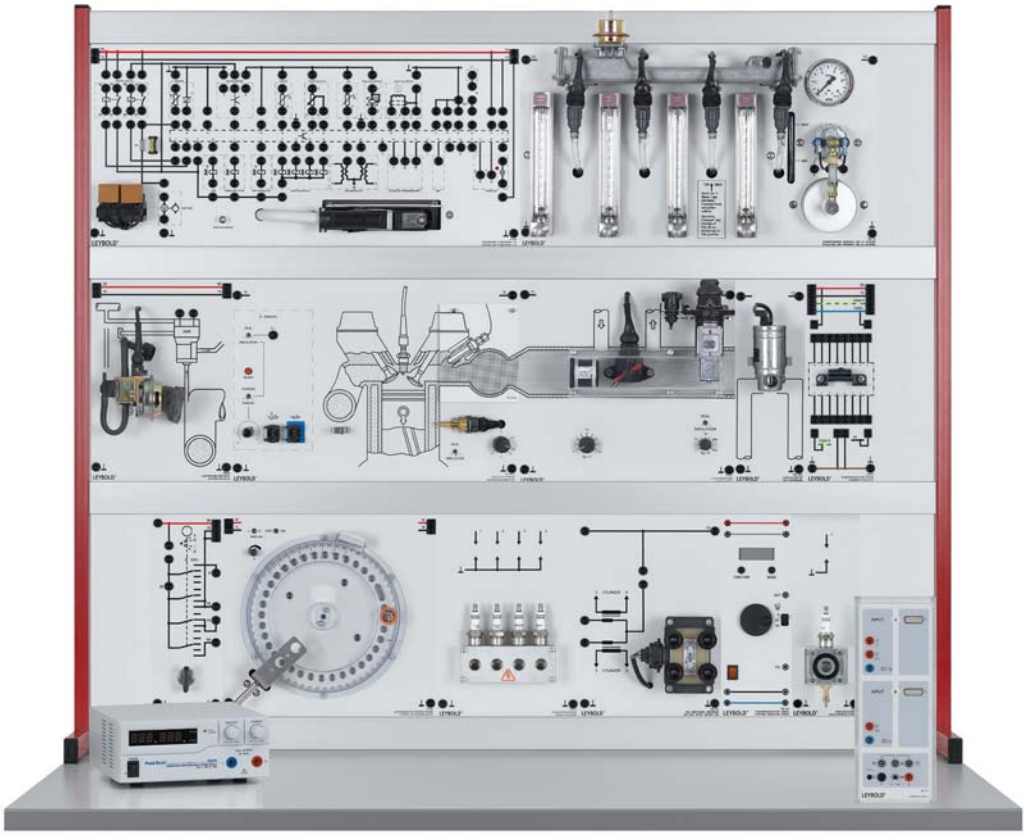
Cat. No.	Description	A2.3.1.3	A2.3.1.4
524 031	Current Source Box		1
738 9991	DC/AC Clamp on current probe		1
738 443	Pencil coil system		2
500 592	Safety Bridging Plugs with Tap, black, set of 10		1
467 251	Compact spectrometer USB, physics		1*
775 030EN	LIT: A2.3.1 Coil Ignition System	1	1

*additionally recommended

Fuel-air mixing and ignition are the essential characteristics of a gasoline engine. After the fuel-air mixture is formed, it must be ignited safely and at the right time. The ignition is responsible for this.
Advancements in the area of ignition from conventional coil ignition (CI) and transistor ignition (TI) to **electronic ignition** (EI) and to **fully electronic ignition** (FI) have happened since 1982. While the high-voltage distribution is still mechanical for EI, it is purely electronic in FI. The latter thus contains no parts susceptible to wear. The spark advance happens electronically, taking into account different variables such as the engine speed.
With the **single spark ignition coil** an ignition coil and a spark plug each form a compact unit. One side of the secondary winding goes to the ground, and the other side connects directly to the spark plug. Thus no capacitive voltage sensor can be connected to the spark plug's lead. The system panel "single spark ignition system" is therefore equipped with two test ports to record the secondary oscillogram.

Motor management fuel system

A2.3.2.1
Fuel injection



Fuel injection (A2.3.2.1)

Cat. No.	Description	A2.3.2.1
739 402	Control Unit, LH Motronic (M 1.5.4)	1
739 37	Evaluation Unit Motronic and LU-Jetronic	1
738 517	DIS-Two Spark Ignition Coil	1
739 255	Electric EGR valve	1
739 191	Substitute Engine Panel	1
739 03	Knocking Sensor	1
739 42	Crank Angle Sensor	1
739 271	Lambda Sensor, heated	1
739 253	Rotary Idle Actuator	1
739 411	Air Mass Meter, LH Motronic	1
738 981	Silicone Oil M3, 1 Liter	2
738 431	Flywheel with Sensor Holder	1
738 441	Spark plug holder	1
726 18	Panel frame T130, Three Level	1
738 027	Dig. Power supply 1 - 16 V/40 A	1
500 990	Adapter sockets, set of 2	1
577 80	Variable resistor 10 kOhm, STE 2/19	2
577 38	Resistor 330 Ohm, STE 2/19	1
577 97	Resistance decade 10 Ohm...11.1 kOhm, STE 4/50/100	1
738 518	DIS-Ignition Cable Set	1
739 421	Cable for Crank Angle Sensor	1
738 10	Ignition Switch	1
524 013S	Sensor-CASSY 2 Starter	1
524 076	AUTO-BOX i	1
738 989	Standard Workshop TDC Pick-Up	1
738 986	Inductive-Type Pulse Pick-Up	1
375 58	Manual vacuum pump	1
726 961	Function Generator 200 kHz, 230 V	1

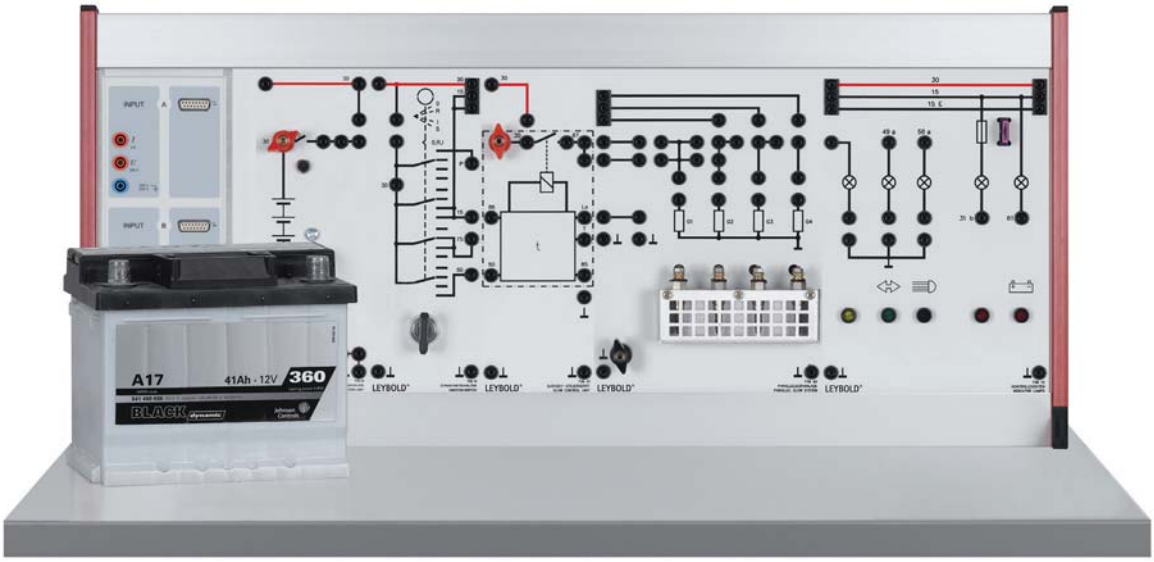
Cat. No.	Description	A2.3.2.1
738 442	Single pressure chamber	1
738 998	Pressure pump, foot-operated	1
666 712ET3	Butane cartridge, 190 g, set of 3	1
666 711	Butane gas burner	1
300 02	Stand base V-shape, small	1
301 01	Leybold multiclamp	1
300 41	Stand rod 25 cm, 12 mm Ø	1
666 555	Universal clamp 0...80 mm	1
666 733	PIEZOELECTRIC GAS IGNITER	1
739 589	Software: Vehicle diagnosis, german and english	1
500 59	Set of 10 safety bridging plugs, black	6
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
739 192	Set 7 Connecting Leads	1
738 9821	Safety experiment cables, set of 51	1
665 010	Funnel, plastic, 100 mm Ø	1
738 01	Cable and plug box	1*
738 975	Diagnostic Plug 16 Pin	1*
738 491S	Automotive fault simulator, starter	1*
737 9805	Workshop diagnosis unit (GER)	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 032EN	LIT: A3.2.1 Air/Fuel Benzine	1

*additionally recommended

Electronically controlled injection systems intermittently inject the fuel with electro-magnetically operating fuel injection valves. In addition the motor management system takes over the control of the ignition. The LH-Motronic 1.5.4. used in the teaching system has an airflow sensor, lambda control, an exhaust-gas recirculation and a static ignition system. To conduct the experiments realistically various sensor signals such as temperature or lambda values can be stimulated.

Motor management diesel system

A2.3.3.1
Pre-heating system



Pre-heating system (A2.3.3.1)

Cat. No.	Description	A2.3.3.1
738 90	Parallel Glow System	1
738 91	Glow Time Control Unit Temperature	1
500 597	Automobile protection measuring adaptor	1
726 19	Panel frame SL85, One Level	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
738 9991	DC/AC Clamp on current probe	1
738 03	Battery Connection Unit	1
738 04	Car Battery 12V	1
738 05	Set of Connection Leads I	1
738 042	Battery pole-clamp set	1
738 10	Ignition Switch	1
738 15	Indicator Lamps	1
576 74	Plug-in board DIN A4, STE	1
577 81	Variable resistor 4.7 kOhm, STE 2/19	1
578 48	Light emitting diode red, STE 2/19	1
579 06	Lamp holder E10, top, STE 2/19	1
505 08	Bulb 12 V/3 W, E10, set of 10	1
500 611	Safety connection lead 25 cm, red	1
500 59	Set of 10 safety bridging plugs, black	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
501 46	Connecting lead 19 A, 100 cm, red/blue, pair	2
501 48	Bridging plugs STE 2/19, set of 10	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 033EN	LIT: A2.3.3.1 Pre-Glow System	1

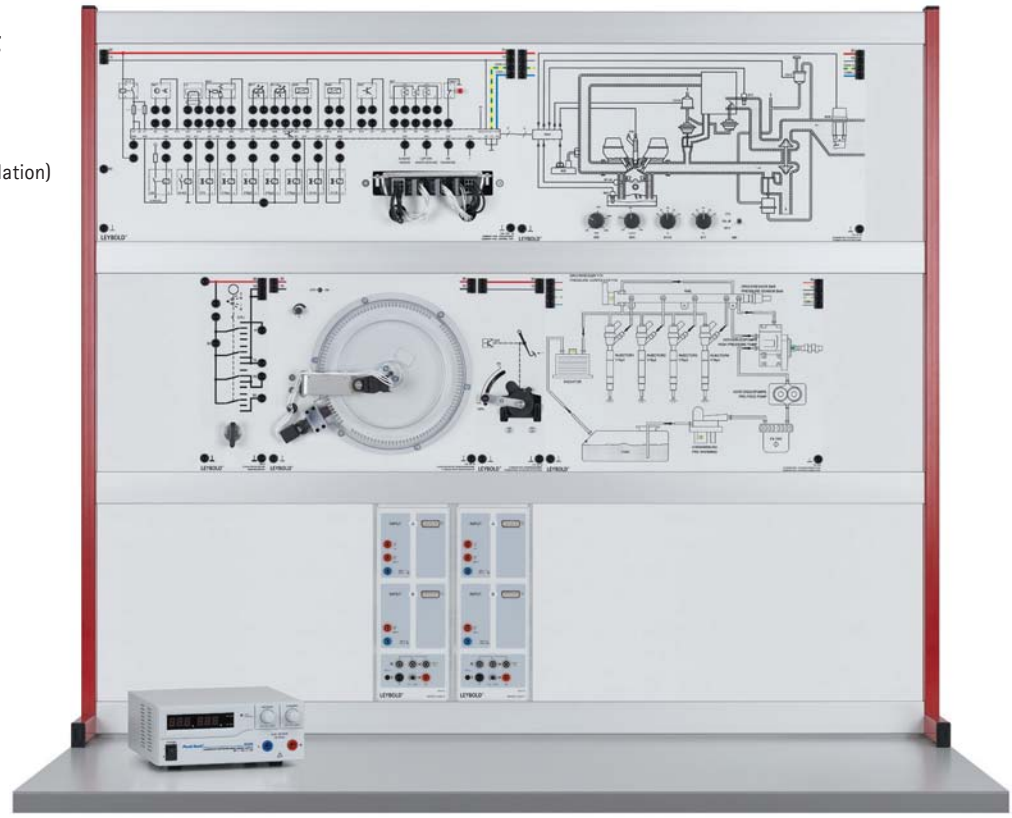
*additionally recommended

Diesel motors are piston engines with spontaneous ignition. The fuel must be injected directly into the combustion chamber to then be compressed and heated to between 700°C and 900°C. This temperature is enough to ignite the mixture. The need for constantly increasing injection pressure has led from the distributor-type fuel-injection pump to the high-pressure systems like a unit injector or common rail.

Diesel motors are compression ignition systems – at least in most cases. But in the winter and on cold days, the diesel is not as easily excited. The combustion chamber needs to be warmer for spontaneous ignition. The glow plug contributes to this – in particular the pencil-type glow plug. It sticks its heating element in the prechamber or swirl chamber so that the injected fuel evaporates onto the hot surface of the glow plug and ignites. The released heat initiates the combustion.
For a modern pencil-type glow plug, the heating element reaches a temperature exceeding 850°C within a few seconds. Igniting the diesel fuel in cold temperatures requires a lot of energy – particularly if the motor should start quickly. That requires more than just a glowing point at the end of the glow plug – especially since a plug can also be cooled when absorbing cold air during startup. In this environment, the plug works only if it has enough reserves, that is if there is enough incandescent volume to immediately deliver heat to the cooled zone.

Motor management diesel system

A2.3.3.3
Diesel direct injection (Simulation)



Diesel direct injection (Simulation) (A2.3.3.3)

Cat. No.	Description	A2.3.3.3
740 106	Common Rail with Hydr. Simulation	1
738 10	Ignition Switch	1
500 990	Adapter sockets, set of 2	1
738 027	Dig. Power supply 1 - 16 V/40 A	1
524 013S	Sensor-CASSY 2 Starter	1
524 013	Sensor-CASSY 2	1
524 076	AUTO-BOX i	1
738 9821	Safety experiment cables, set of 51	1
500 59	Set of 10 safety bridging plugs, black	1
738 491S	Automotive fault simulator, starter	1*
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 034EN	LIT: A2.3.3.2 Common Rail	1

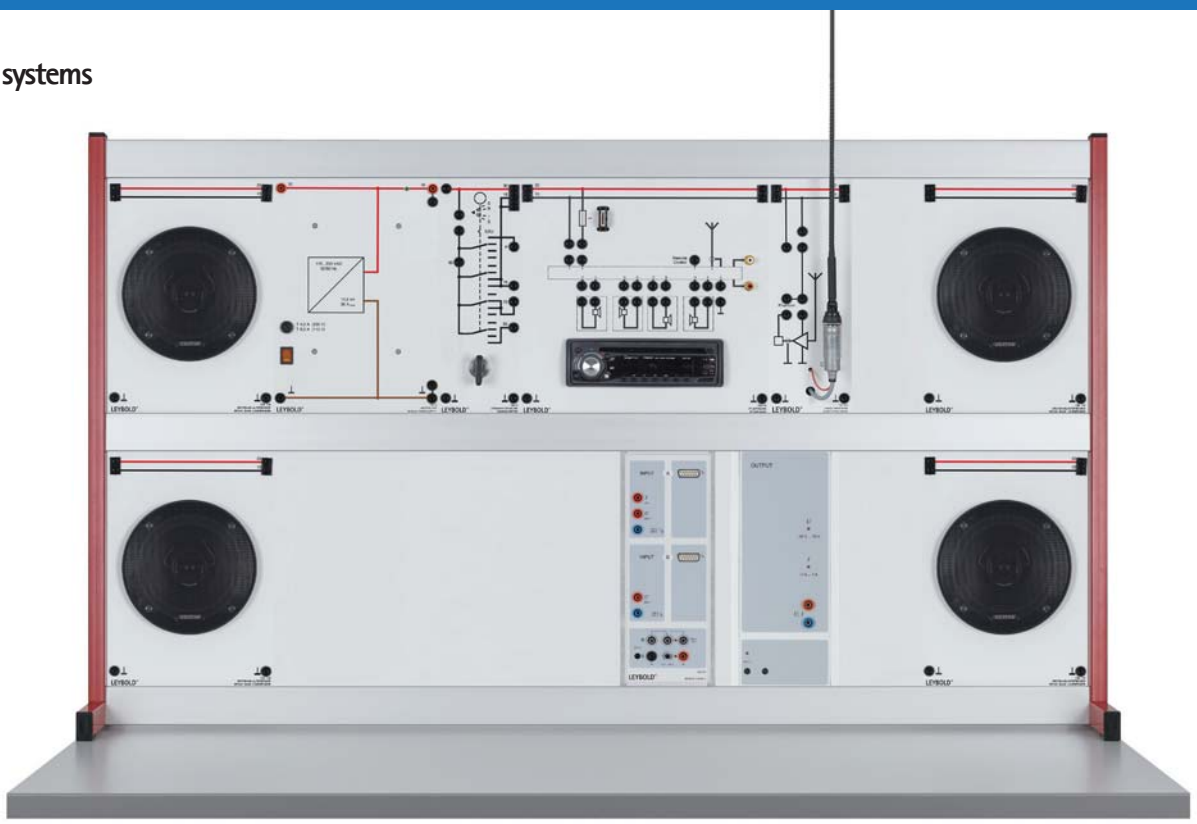
*additionally recommended

Diesel motors are piston engines with spontaneous ignition. The fuel must be injected directly into the combustion chamber to then be compressed and heated to between 700°C and 900°C. This temperature is enough to ignite the mixture. The need for constantly increasing injection pressure has led from the distributor-type fuel-injection pump to the high-pressure systems like a unit injector or common rail.
Set A2.3.3.3 simulates the hydraulic pump, the pressure accumulator's sensors and actuators and the magnetic valve injectors such that the installation is fully functional.

A 2.4 COMFORT AND DRIVER ASSISTANCE

Comfort systems

A2.4.1.1
Car radio



Car radio (A2.4.1.1)

Cat. No.	Description	A2.4.1.1
739 718	BT car radio	1
739 731	Broad Band Loudspeaker	4
739 7421	Short rod antenna	1
726 10	Panel frame T150, Two Level	1
738 02	Automotive power supply 13.8 V/36 A	1
738 10	Ignition Switch	1
524 013S	Sensor-CASSY 2 Starter	1
531 183	Digital Multimeter 3340	1
524 011USB	Power-CASSY USB	1
500 59	Set of 10 safety bridging plugs, black	4
738 9821	Safety experiment cables, set of 51	1
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
775 040EN	LIT: Car Radio A2.4.1.1	1
738 01	Cable and plug box	1*
739 736	Automotive Bass Loudspeaker	2*
739 735	MOST Loudspeaker	2*
738 06	12 V on-board socket	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 040EN	LIT: A2.4.1.1 Car Radio	1

*additionally recommended

Comfort systems, like safety systems, are part of the basic equipment in modern motor vehicles. In contrast to driver assistance systems, however, they do not actively intervene in the driving process, but they are only useful for information and comfort.

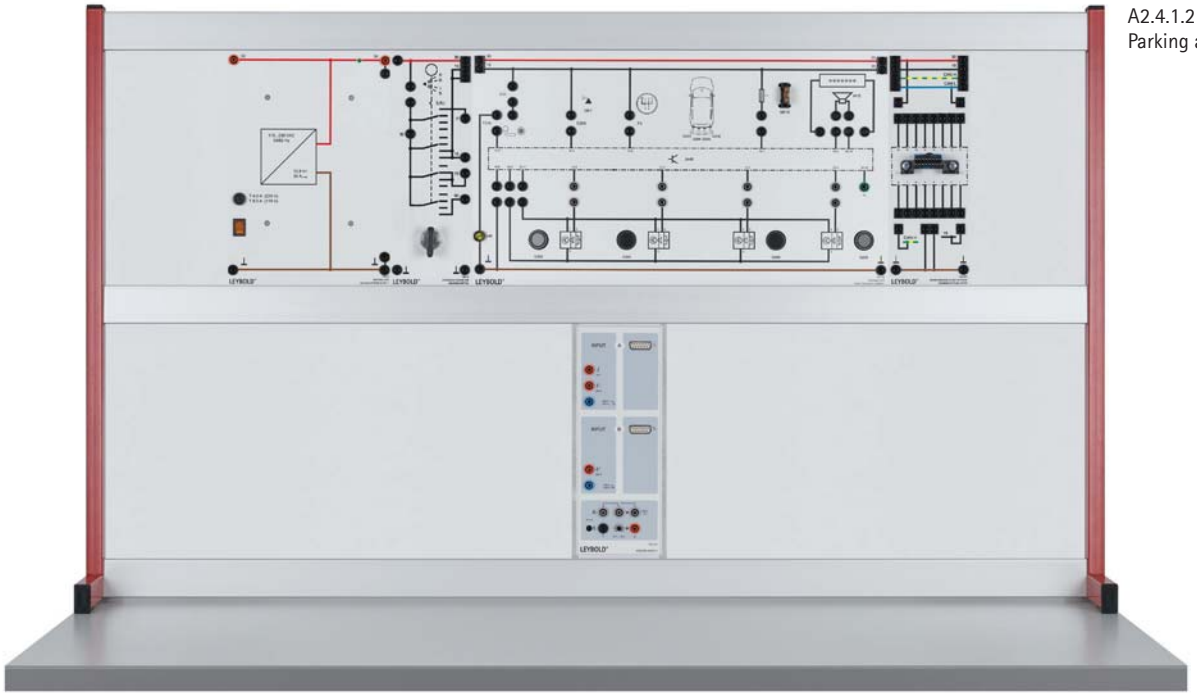
The development of the **car radio** was just as interesting as the components related to the motor. Starting in the form of a tube, there was already an FM car radio with station scanner in 1953. At the end of the 1950's, transistors no longer were tubes, which led to a significant reduction in weight and volume. Stereo reception appeared in 1969, followed by the compact cassette, and the first traffic report on the German ARI radio service began in 1974. Digital technology made its appearance at the beginning of the 1990's; digital displays, CD play back, RDS and DAB paved the way to an integrated multimedia system.
The educational system consists of a CD radio and features:

- four loudspeakers (connected in the back)
- a power antenna
- Bluetooth™ phone connection
- telephone muting, and
- Bluetooth™ audio transmission.

The car radio features two cinch connectors on the front to connect an external amplifier. To teach communications electronics, the system offers the possibility to measure the signal received by the antenna as well as to determine the loudspeaker impedance.

Comfort systems

A2.4.1.2
Parking aid



Parking aid (A2.4.1.2)

Cat. No.	Description	A2.4.1.2
739 750	Park distance control	1
416 000	Ultrasonic transducer 40 KHz	1
726 10	Panel frame T150, Two Level	1
300 02	Stand base V-shape, small	2
738 10	Ignition Switch	1
738 02	Automotive power supply 13.8 V/36 A	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
738 975	Diagnostic Plug 16 Pin	1
737 9803	OBD Adaptor CAN+USB	1
500 59	Set of 10 safety bridging plugs, black	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
500 644	Safety connection lead 100 cm, black	2
500 647	Safety Connection Lead 100 cm brown	2
500 593	Fault simulation plugs, black, set of 10	1*
738 01	Cable and plug box	1*
775 041EN	LIT: A2.4.1.2 Park Distance Control	1

*additionally recommended

Comfort systems, like safety systems, are part of the basic equipment in modern motor vehicles. In contrast to driver assistance systems, however, they do not actively intervene in the driving process, but they are only useful for information and comfort.
The **park distance control** - also known as back-up warning or Parkpilot - is a useful accessory in the area of comfort electronics. Complex or closed body designs restrict sight forward and backward in many vehicles. The park distance control uses ultrasound sensors to reliably measure the distance to all kinds of obstacles, in particular to children and pedestrians. An optical and acoustic warning protects the vehicle and external objects from damage.

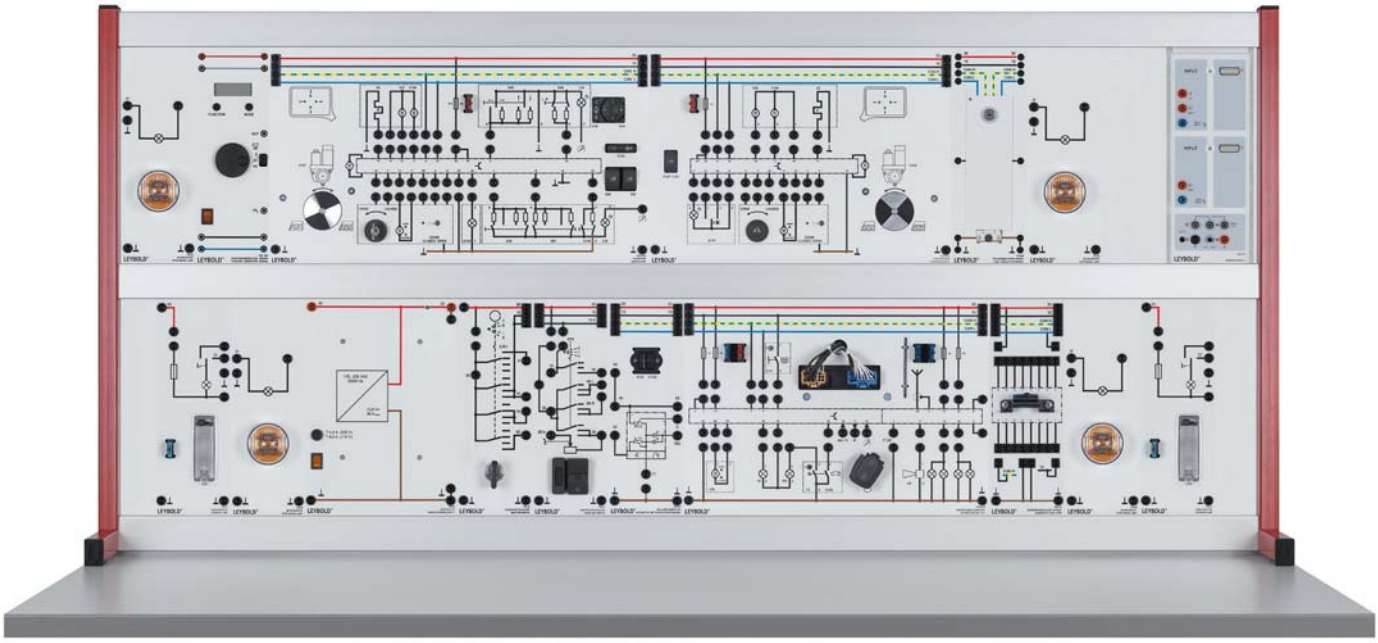
LEYBOLD has developed an experimental panel for the topic of park distance control, consisting of

- an original control unit
- four original ultrasound sensors, as well as
- an acoustic and
- an optical indicator.

Simulated engagement in reverse gear activates the application. When switched on, the sensors – built into the vehicle's bumper – send out ultrasound signals and receive the reflected echoes. The control unit calculates the distance of an obstacle down to the centimeter. The display shows the different distance ranges with light bars of different colors or with an acoustic distance warning with changing sound sequences.
The sensor connection cables and the ground wire to the control until are brought through bridging plugs in order to simply measure voltages and currents and simulate open circuit faults.

Comfort systems

A2.4.1.3 Comfortsystem with CAN-Bus



Comfortsystem with CAN-Bus (A2.4.1.3)

Cat. No.	Description	A2.4.1.3
739 58	Comfortsystem with CAN - Bus	1
726 10	Panel frame T150, Two Level	1
738 07	Interior Lamp	2
738 11	Head Lamp Switch	1
738 36	Turn Signal Lamp	4
739 581USB	CAN bus software USB	1
738 975	Diagnostic Plug 16 Pin	1
739 573	Automotive Set Point Potentiometer	1
739 585	Fault simulator CAN Bus	1
737 9803	OBD Adaptor CAN+USB	1
739 587	Software: CAN bus visualisation	1
738 02	Automotive power supply 13.8 V/36 A	1
726 961	Function Generator 200 kHz, 230 V	1
738 10	Ignition Switch	1
524 013S	Sensor-CASSY 2 Starter	1
524 078	CAN bus box	1
500 59	Set of 10 safety bridging plugs, black	4
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 9821	Safety experiment cables, set of 51	1
689 0801	Transmitting device for remote control	1*
738 01	Cable and plug box	1*
738 491S	Automotive fault simulator, starter	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 042EN	LIT: A2.4.1.3 CAN-Bus Comfort System	1

*additionally recommended

Comfort systems, like safety systems, are part of the basic equipment in modern motor vehicles. In contrast to driver assistance systems, however, they do not actively intervene in the driving process, but they are only useful for information and comfort.

The CAN bus comfort training system ... classic! Connecting individual "islands" with as few wires as possible and full functional range – that was the CAN data bus' basic comfort application. The "islands" are car doors, each equipped with a control unit. It operates the following:

- the power windows
- the central locking system
- the side mirror adjusting motors
- the side mirror heater
- the SAFE LED depending on the sensors' states
- the door lock
- the power window buttons
- the mirror adjustment buttons
- the central locking button
- the door switch.

The control units are linked together via the low-speed CAN data bus, so only two wires need to go from the door into the passenger compartment. The CAN bus features high data transmission rates, high security due to single-wire capability and common-mode rejection, as well as excellent EMC properties. Additional functions and components are:

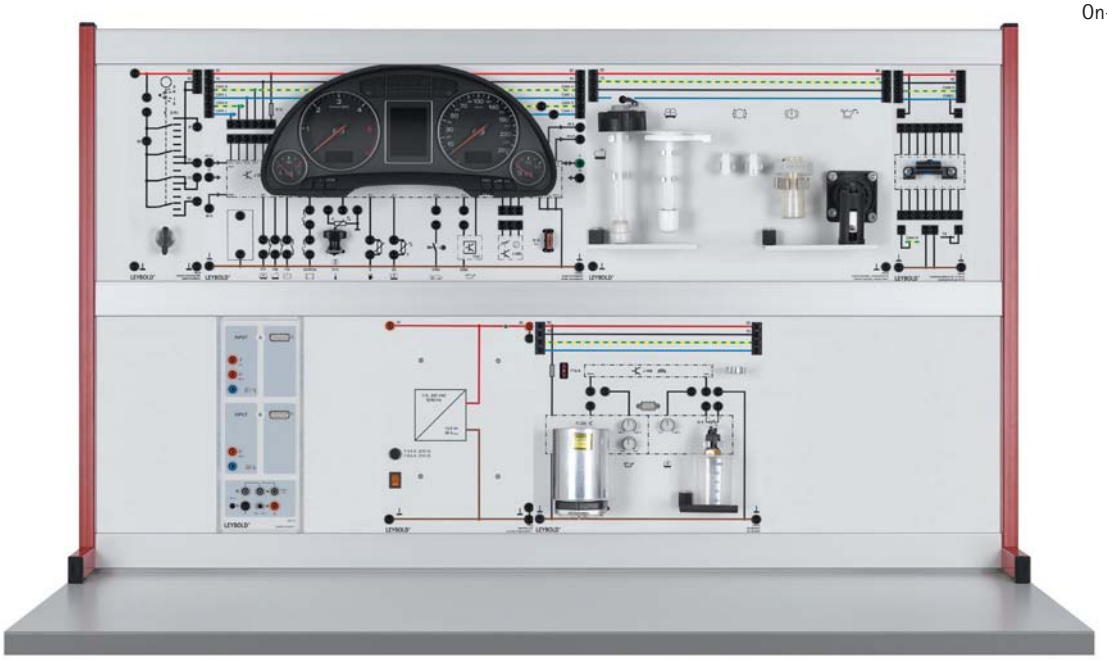
- Remote control
- Turn signal control
- Interior and trunk lights
- Alarm systems
- Brightness control of the instrument panel lighting
- Speed-dependent central locking.

As the training system is flawless in normal conditions, it is best suited for self-diagnosis with a corresponding tester. The following is supported:

- Fault memory query and deletion
- Measured value display
- Reprogramming
- Customization, and
- Actuator test

Comfort systems

A2.4.1.4
On-board computer



On-board computer (A2.4.1.4)

Cat. No.	Description	A2.4.1.4
739 701	Check Control, Sensor Panel	1
739 706	Oil sensor	1
739 6021	Instrument cluster unit	1
726 10	Panel frame T150, Two Level	1
738 975	Diagnostic Plug 16 Pin	1
577 79	Variable resistor 1 kOhm, STE 2/19	1
738 02	Automotive power supply 13.8 V/36 A	1
737 9803	OBD Adaptor CAN+USB	1
738 10	Ignition Switch	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
524 076	AUTO-BOX i	1
524 031	Current Source Box	1
524 044	Temperature sensor S, NTC	1
581 90	Capacitor (el.) 470 µF, STE 2/50	1
577 56	Resistor 10 kOhm, STE 2/19	1
578 51	Diode 1N 4007, STE 2/19	1
578 74	Transistor BD 138, PNP, e.t., STE 4/50	1
579 21	Relay with change-over switch, STE 4/50	1
579 13	Toggle switch STE 2/19	1
579 06	Lamp holder E10, top, STE 2/19	1
505 09	Bulb 12 V/1 A, E10, set of 10	1
501 48	Bridging plugs STE 2/19, set of 10	3
501 45	Connecting lead 19 A, 50 cm, red/blue, pair	1
576 74	Plug-in board DIN A4, STE	1
521 45	DC Power supply 0 to ±15 V	1
577 32	Resistor 100 Ohm, STE 2/19	1
577 35	Resistor 200 Ohm, STE 2/19	1
577 92	Potentiometer 1 kOhm, STE 4/50	1
650 671	Storage tray S24, STE	1
739 192	Set 7 Connecting Leads	1

Cat. No.	Description	A2.4.1.4
738 9821	Safety experiment cables, set of 51	1
500 59	Set of 10 safety bridging plugs, black	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 01	Cable and plug box	1*
738 491S	Automotive fault simulator, starter	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 043EN	LIT: A2.4.1.4 On-board computer	1

*additionally recommended

Comfort systems, like safety systems, are part of the basic equipment in modern motor vehicles. In contrast to driver assistance systems, however, they do not actively intervene in the driving process, but they are only useful for information and comfort.

Traditional monitoring of fill levels and temperatures occurs with modern control units. Current measurements in conductor loops give information on a worn brake pad.
Moreover, various fill level sensors provide data that is shown to the driver optically and/or acoustically. The „on-board computer" educational system monitors:

- the coolant and the windshield washer fluid levels,
- the brake fluid and motor oil levels,
- the wear on the brake pads,
- the motor oil and coolant temperatures.

All values can also be displayed in the self-diagnosis with the instrument cluster's diagnosis line; linearized values for oil level and temperature and coolant temperature are available with a 9-pole socket for the oil sensor for measurements or integration into a CAN bus system.

Comfort systems

A2.4.1.5
Air conditioning

Air conditioning (A2.4.1.5)

Cat. No.	Description	A2.4.1.5
FI3 9-305 - 230	Automotive Air Conditioning Trainer	1
FI3 9-320	TEV/FOT conversion kit for 39-305	1*
775 046EN	LIT:A2.4.1.5 Air-Conditioning 1	1

*additionally recommended

Features
- Uses actual automotive components
- Suitable for both technician and vocational teaching
- Portable design
- Uses non-ozone depleting HFC refrigerant
- Enables hands-on access to all components
- Simulates four common faults
- Variable speed motor simulates car engine
- Available for either 110V or 230V mains connection

Comfort systems, like safety systems, are part of the basic equipment in modern motor vehicles. In contrast to driver assistance systems, however, they do not actively intervene in the driving process, but they are only useful for information and comfort.

Have you ever wondered how the air-con system in your car actually works? The automotive air conditioning trainer enables students to find out how a typical system works whilst learning the principles of refrigeration. By using authentic components, students learn how to perform fault finding and servicing using a safe and accessible system. The product has been designed specifically with hands-on training in mind and it can also be used by students to perform the safe recovery and recharging of refrigerant.

Complete with compressor, condenser, receiver dryer, expansion valve and evaporator, the unit is pre-installed with R134a type refrigerant which is an HFC non-ozone depleting gas and is in line with global emissions guidelines. The system is furnished with high and low-side pressure service ports that facilitate easy connection of a gauge set or for the recovery and re-charging of refrigerant. These ports are typical quick coupler type as would be found on modern vehicles.

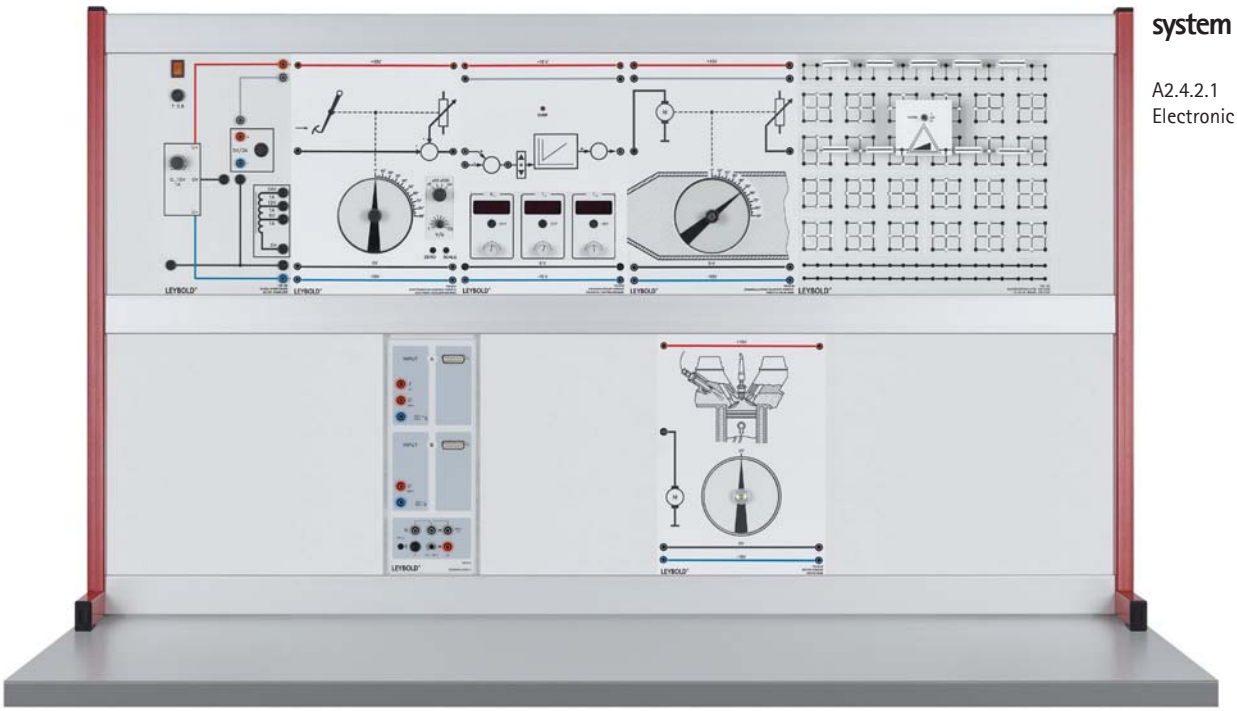
The speed of the motor which simulates the vehicle engine is variable by means of a electronic, digitally controlled three-phase inverter drive. This enables the demonstration of the effect that compressor speed has on the system performance. The system is designed to be bench mounted and run from either a 230 V or 110 V ac supply. There is a 12 V dc output socket which enables the connection of ancillary equipment, such as a UV leak detection lamp.

The provision of a sight glass enables students to observe the state of the refrigerant in the high pressure side of the system. This assists with the diagnosis of four simulated common faults which can be applied by the instructor. The following four simulated faults can be applied by setting the fault switch on the main control panel:
- Blocked TEV (Thermal Expansion Valve)
- Blocked receiver drier (TEV version only)
- Faulty valve plate
- Unit under condensing

The student will observe the effect of the faults by monitoring system pressures (using optional manifold gauges) changes in the cooling duty, observing changes on the digital thermometer and observing the state of the refrigerant in the sight glass. A high pressure cut-out switch shuts the compressor down if the high side pressure becomes abnormally high.

Driver assistance system

A2.4.2.1
Electronic gaspedal



Electronic gaspedal (A2.4.2.1)

Cat. No.	Description	A2.4.2.1
739 56	Electronic Gaspedal Accessory	1
734 064	PID Digital Controller	1
579 161	Simulation Incline, STE 4/50	1
313 17	Stopclock II	1
577 32	Resistor 100 Ohm, STE 2/19	1
577 35	Resistor 200 Ohm, STE 2/19	1
577 40	Resistor 470 Ohm, STE 2/19	1
578 51	Diode 1N 4007, STE 2/19	1
579 13	Toggle switch STE 2/19	1
734 10	Servo Setpoint Generator	1
734 13	Power Amplifier	1
734 14	DC-Servo	2
726 10	Panel frame T150, Two Level	1
726 50	Plug-in board 297 mm x 300 mm, STE	1
726 88	AC/DC Stabilizer	1
727 20	Automobile Meter Zero-Left	1
524 013S	Sensor-CASSY 2 Starter	1
539 000	Bridging plug, BST	10
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
501 46	Connecting lead 19 A, 100 cm, red/blue, pair	2
500 853	Set of 25 safety connecting leads	1
501 48	Bridging plugs STE 2/19, set of 10	2
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 044EN	LIT: A2.4.2.1 Electronic Gas Pedal	1

*additionally recommended

Controls and regulations have always had their place within motor vehicle technology. What began mechanically, e.g. with the ignition's vacuum adjustment, now works electrically/electronically as much as possible. The core curriculum states:

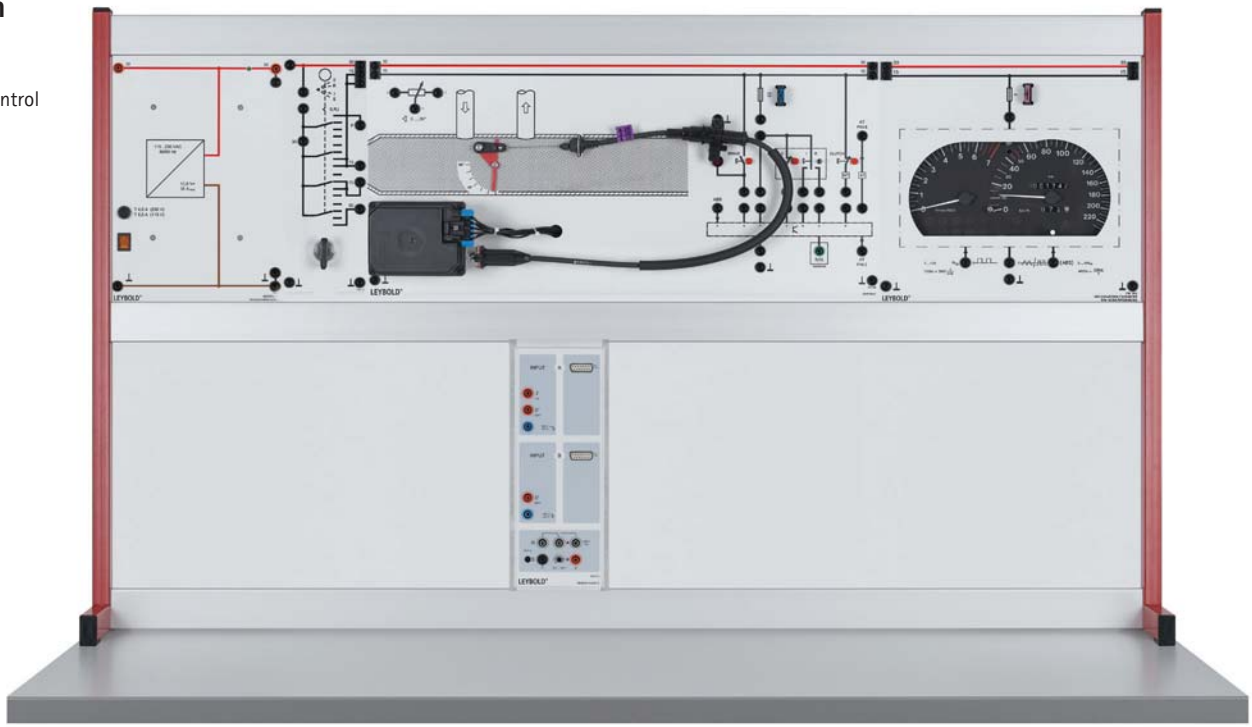
"[...] They (the students) distinguish between controls and regulations and assign hydraulic, pneumatic or electric/electronic systems to typical components and parts of vehicles. They analyze functional relationships and apply testing and measuring processes to study signal, material or energy flows."

LEYBOLD's educational system demonstrates on typical vehicle applications the fundamental theoretical relationships in control technology. Sensor-CASSY or multimeters can record the associated measurements. In particular, the following training contents are treated:

- Control technology systems' function in motor vehicles
- IPO principle: signal input, processing and output
- Control processes
- Reference variable and correcting variable
- Open and closed regulator circuits
- How the electronic throttle works
- Study of disturbances

Driver assistance system

A2.4.2.2
Speed control



Speed control (A2.4.2.2)

Cat. No.	Description	A2.4.2.2
739 350	Cruise Control	1
739 602	Tachometer/Speedometer	1
726 10	Panel frame T150, Two Level	1
738 10	Ignition Switch	1
738 02	Automotive power supply 13.8 V/36 A	1
579 162	Simulation ABS/Ti, STE 2/50	1
524 013S	Sensor-CASSY 2 Starter	1
524 076	AUTO-BOX i	1
500 59	Set of 10 safety bridging plugs, black	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 9821	Safety experiment cables, set of 51	1
500 411	Connecting lead 19 A, 25 cm, red	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
775 045EN	LIT: A2.4.2.2 Speed Control	1

*additionally recommended

Controls and regulations have always had their place within motor vehicle technology. What began mechanically, e.g. with the ignition's vacuum adjustment, now works electrically/electronically as much as possible. The core curriculum states:

"[...] They (the students) distinguish between controls and regulations and assign hydraulic, pneumatic or electric/electronic systems to typical components and parts of vehicles. They analyze functional relationships and apply testing and measuring processes to study signal, material or energy flows."

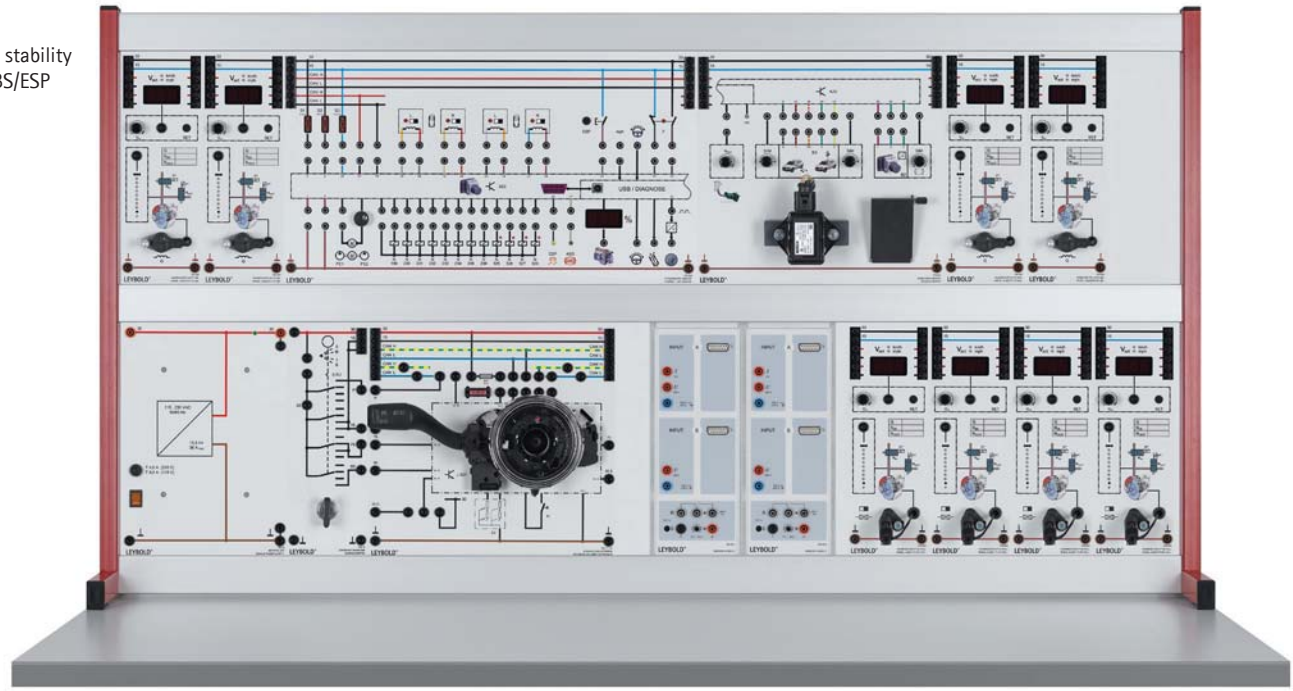
One of the most interesting regulations that can be useful to the driver is the cruise speed control. This function becomes particularly convenient over long stretches with a speed limit. The desired speed is sent to the control unit as a reference variable to be compared to the current speed. If the difference is negative, the throttle valve opens to try to increase the speed; on the other hand if the difference is positive, the throttle valve closes to try to reduce the speed.

LEYBOLD's educational system demonstrates control technology processes, data entry processes as well as the control unit's self-diagnosis options on this system. A workshop oscilloscope or Sensor-CASSY can record the measurements.

A 2.5
DRIVE TRAIN

Braking systems

A2.5.1.1
Electronic stability system ABS/ESP



Electronic stability system ABS/ESP (A2.5.1.1)

Cat. No.	Description	A2.5.1.1
739 650	ABS/ESP control unit	1
739 651	ABS/ESP sensors	1
739 652	Wheel replacement plate, inductive	4
739 654	Steering angle sensor	1
738 111-02	Steel column elektronics	1
726 10	Panel frame T150, Two Level	1
738 02	Automotive power supply 13.8 V/36 A	1
738 10	Ignition Switch	1
524 013	Sensor-CASSY 2	1
524 013S	Sensor-CASSY 2 Starter	1
738 985	Automotive meter	1
739 653	Wheel replacement plate, Hall	4
500 59	Set of 10 safety bridging plugs, black	5
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
500 595	Set of 10 4 mm branching bridging plugs, red	1
739 192	Set 7 Connecting Leads	1
738 9821	Safety experiment cables, set of 51	1
775 050EN	LIT: A2.5.1.1 Electronic Stability ABS/ESP	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
738 491S	Automotive fault simulator, starter	1*

*additionally recommended

The electronic stability program ESP is a control system in the brakes and in the power train that prevents the vehicle from slipping to the side. The ABS prevents the wheels from getting stuck when braking; ASR avoids wheels spinning on start-up. ESP ensures that the vehicle does not "slide" or become unstable.

The wheels' rotational speed is continuously detected by sensors and analyzed by the control unit. In case the wheel sticks, there are adjusting commands at the magnetic valves. The pressurization and depressurization phases follow. The braking effect is reduced and the wheel speeds up again. Our educational system demonstrates these phases. Entering a disturbance value can simulate a sudden blocking of a wheel.
The signal cabling reliably works through the back side so that the front remains clear. An oscilloscope or Sensor-CASSY can record measurements.

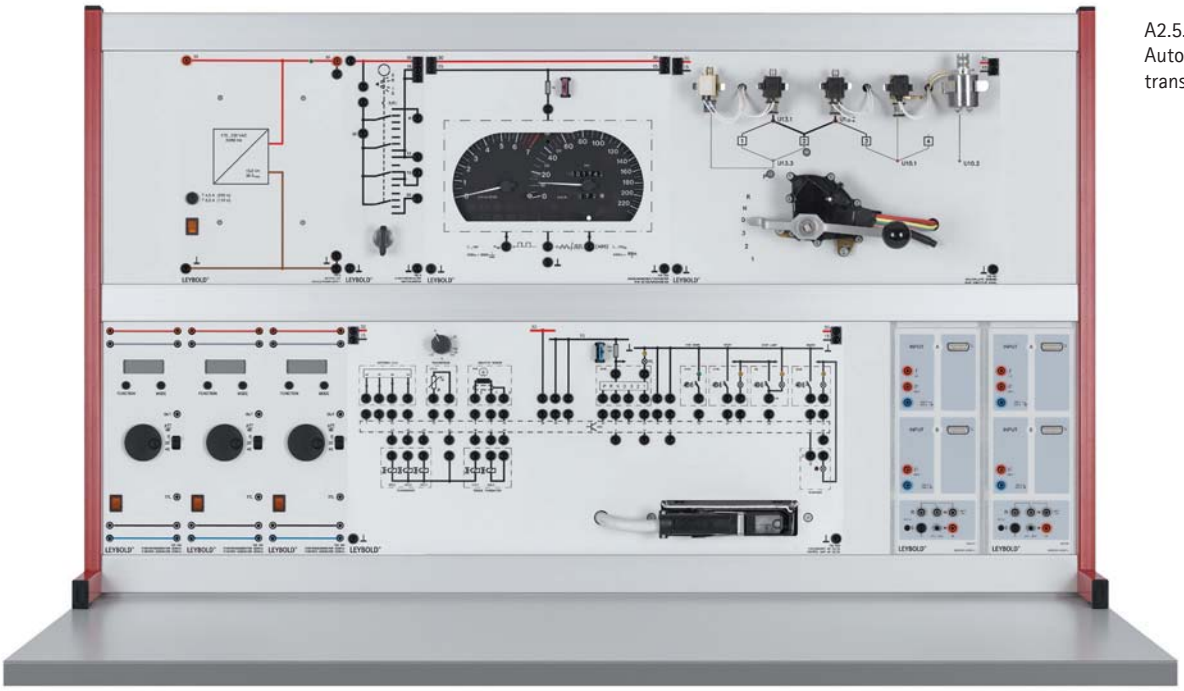
The self-diagnosis can be executed in combination with a PC, and typical driving situations can be retraced. A software self-diagnosis and drive simulation are thus available. These can simulate the following situations:

- Driving maneuver "Quick steering and countersteering"
- Driving maneuver "Lane change with emergency stop (moose test)"
- Driving maneuver "Steering and countersteering multiple times"
- Driving maneuver "Acceleration/deceleration in a tight curve"

Optionally, other student measuring stations (740050) can be connected to the control unit. The students can record and analyze all measurements on the installation at their workstations.

Gear

A2.5.2.1
Automatic
transmission system



Automatic transmission system (A2.5.2.1)

Cat. No.	Description	A2.5.2.1
739 600	Control Unit AR 25/35	1
739 601	Gear Substitute Panel	1
726 10	Panel frame T150, Two Level	1
738 02	Automotive power supply 13.8 V/36 A	1
739 602	Tachometer/Speedometer	1
738 10	Ignition Switch	1
726 961	Function Generator 200 kHz, 230 V	3
524 013S	Sensor-CASSY 2 Starter	1
524 013	Sensor-CASSY 2	1
524 076	AUTO-BOX i	1
500 59	Set of 10 safety bridging plugs, black	4
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 9821	Safety experiment cables, set of 51	1
739 192	Set 7 Connecting Leads	1
775 051EN	LIT: A2.5.2.1 Automatic Transmission	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*
738 491S	Automotive fault simulator, starter	1*

*additionally recommended

Convenience in the car: it has also been a standard in the USA, whereas in Germany it only came little by little - the automatic transmission.

The educational system is equipped with a 4-speed automatic transmission and consists of the control unit and a gear substitute panel. The sensor/actuator signal connections are reliably run to the back. The control unit includes the operation modes:

- Economy
- Sport
- Winter and
- Kick-Down.

The gear selector and the solenoids are on the gear substitute panel for:

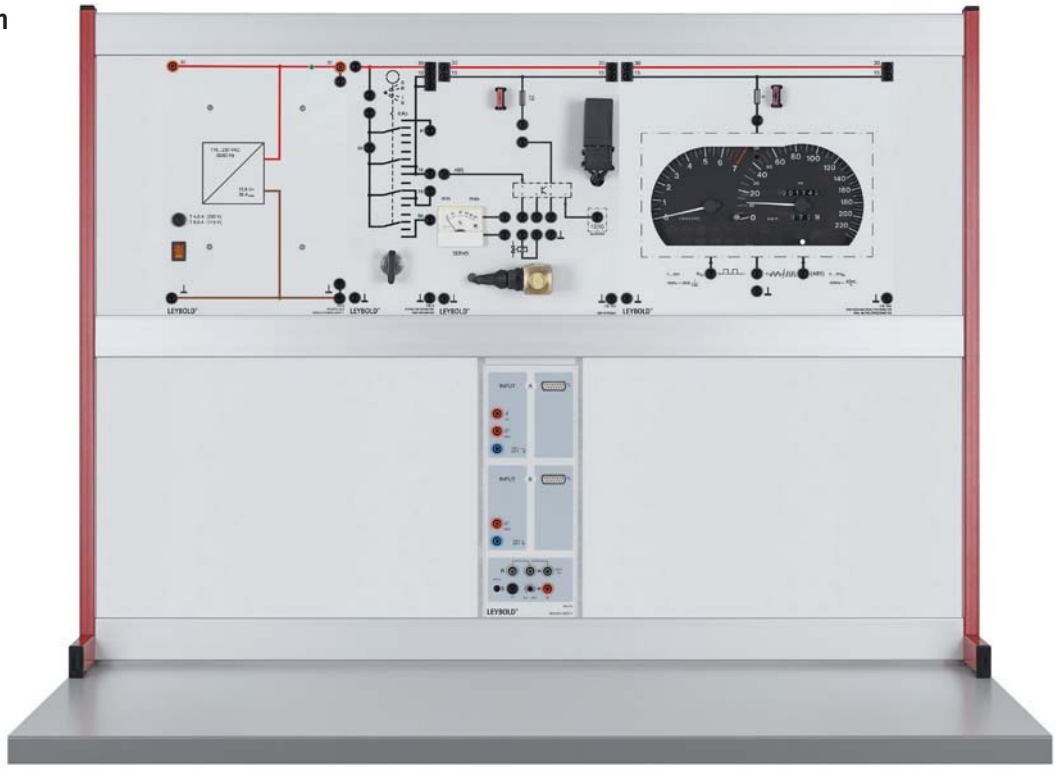
- 1-2/3-4 shift
- 2-3 shift
- band control
- electronic pressure control and
- TCC Lookup.

The following training contents are studied:

- Automatic transmission's function
- Gear selection
- "Kick-start" principle
- Gear selector's function
- Valves' purpose and control
- Dynamic adjustment of power-assisted steering

Steering system

A2.5.3.1
Steering booster



Steering booster (A2.5.3.1)

Cat. No.	Description	A2.5.3.1
739 500	Servotronic	1
739 602	Tachometer/Speedometer	1
726 10	Panel frame T150, Two Level	1
738 10	Ignition Switch	1
738 02	Automotive power supply 13.8 V/36 A	1
524 013S	Sensor-CASSY 2 Starter	1
524 076	AUTO-BOX i	1
579 162	Simulation ABS/Ti, STE 2/50	1
500 59	Set of 10 safety bridging plugs, black	2
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
500 411	Connecting lead 19 A, 25 cm, red	1
738 9821	Safety experiment cables, set of 51	1
775 052EN	LIT: A2.5.3.1 Servotronic	1
738 01	Cable and plug box	1*
500 593	Fault simulation plugs, black, set of 10	1*

*additionally recommended

Power steering: a comfort function that assists steering, in particular when driving slowly.

The control unit for the speed-dependent power steering controls a magnetic valve as a function of speed. The slower the car, the greater the steering assistance. The control unit is capable of self-diagnosis: the self-diagnosis function can be activated via the diagnostic interface with appropriate diagnosis software.

A 2.6 NETWORKING AUTOMOTIVE AND DIAGNOSIS SYSTEMS

Networking automotive systems

A2.6.1.1
Networking
automotive systems: Lighting

Networking automotive systems: Lighting (A2.6.1.1)

Cat. No.	Description	A2.6.1.1
739 5821	Training panel lighting NG	1
738 027	Dig. Power supply 1 - 16 V/40 A	1
500 990	Adapter sockets, set of 2	1
739 581USB	CAN bus software USB	1
739 587	Software: CAN bus visualisation	1
739 588	LIN BUS PC interface USB	1
737 9803	OBD Adaptor CAN+USB	1
524 013S	Sensor-CASSY 2 Starter	1
524 081	LIN bus box	1
524 078	CAN bus box	1
738 9821	Safety experiment cables, set of 51	1
739 5835	FS vehicle door	1*
775 060EN	LIT: A2.6.1.1 Networking Lighting	1
739 5836	Vehicle door PS	1*

*additionally recommended

Modern vehicles can no longer do without networked systems. CAN bus, LIN bus, MOST bus and recently FlexRay command the communication between control units in the vehicle.

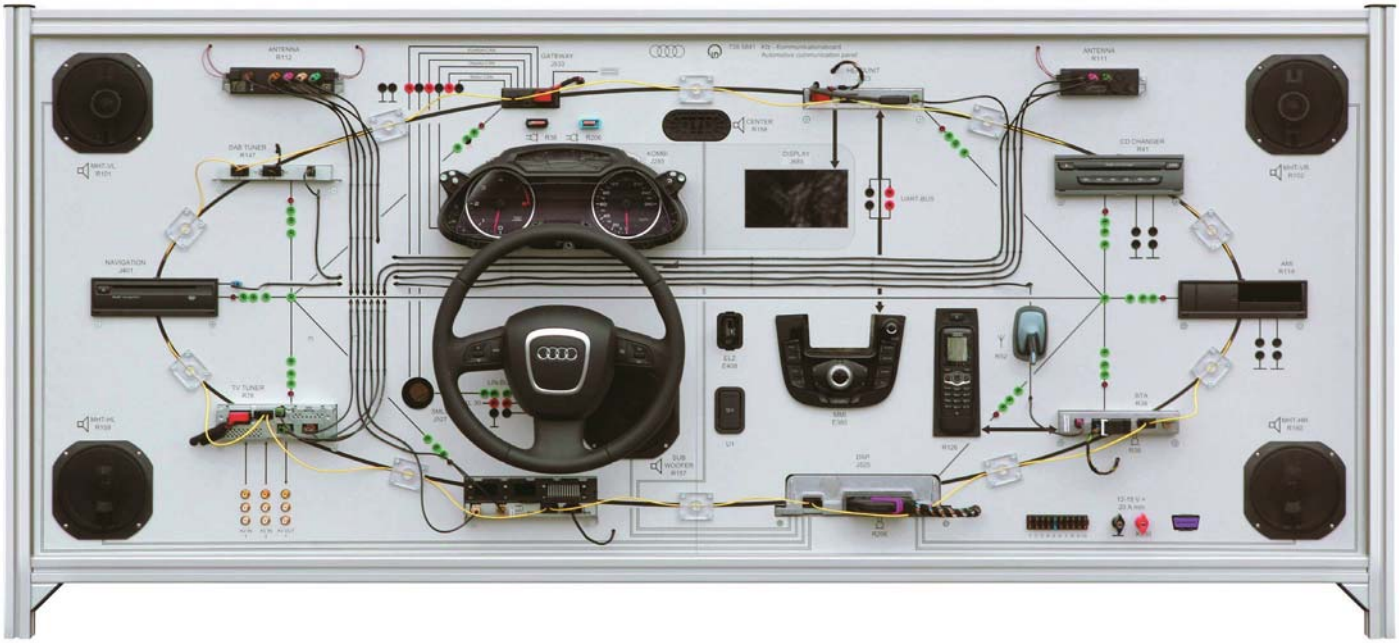
The **training panel in automobile electronics** consists of a modern instrument panel insert with electronic immobilizer, the full steering wheel electronics, the central control module for comfort system and the electronic and electric system. The lighting system and a windshield wiper motor round off the system. The basic vehicle electronics and modern data bus systems are clearly and simply represented. This approach places great value on the use of original vehicle parts. The focus is always on error detection, analysis and correction.
The following components are part of the training panel:

- the lighting unit
- the instrument cluster
- the electronic immobilizer
- the steering wheel electronics
- the control unit for automatic trailer detection
- a 13-pole trailer socket
- the central control module for comfort system (CAN bus)
- the electronic and electric system
- the windshield wiper motor
- the rain photosensor
- the relay strip
- the OBD diagnostic plug
- a CAN bus interface
- a fault switching box.

Models of a driver and/or passenger door can complement the training panel.

Networking automotive systems

A2.6.1.2
Networking automotive systems: Communication



Networking automotive systems: Communication (A2.6.1.2)

Cat. No.	Description	A2.6.1.2
739 5841	Training panel, vehicle communications	1
738 027	Dig. Power supply 1 - 16 V/40 A	1
500 990	Adapter sockets, set of 2	2
524 013S	Sensor-CASSY 2 Starter	1
524 078	CAN bus box	1
524 081	LIN bus box	1
739 588	LIN BUS PC interface USB	1
739 581USB	CAN bus software USB	1
737 9803	OBD Adaptor CAN+USB	1
740 2013	MOST PC USB Interface	1
740 2071	MOST Spare Control Unit ECU	1
739 587	Software: CAN bus visualisation	1
500 664	Safety connection lead 200 cm, black	1
500 667	Safety Connection Lead 200 cm brown	1
738 9821	Safety experiment cables, set of 51	1
775 061EN	LIT: A2.6.1.2 Networking Infotainment	1

Modern vehicles can no longer do without networked systems. CAN bus, LIN bus, MOST bus and recently FlexRay command the communication between control units in the vehicle.

The **communications training panel** includes a complete infotainment package networked via MOST (=Media Oriented Systems Transport) bus in Audi technology. The build includes:

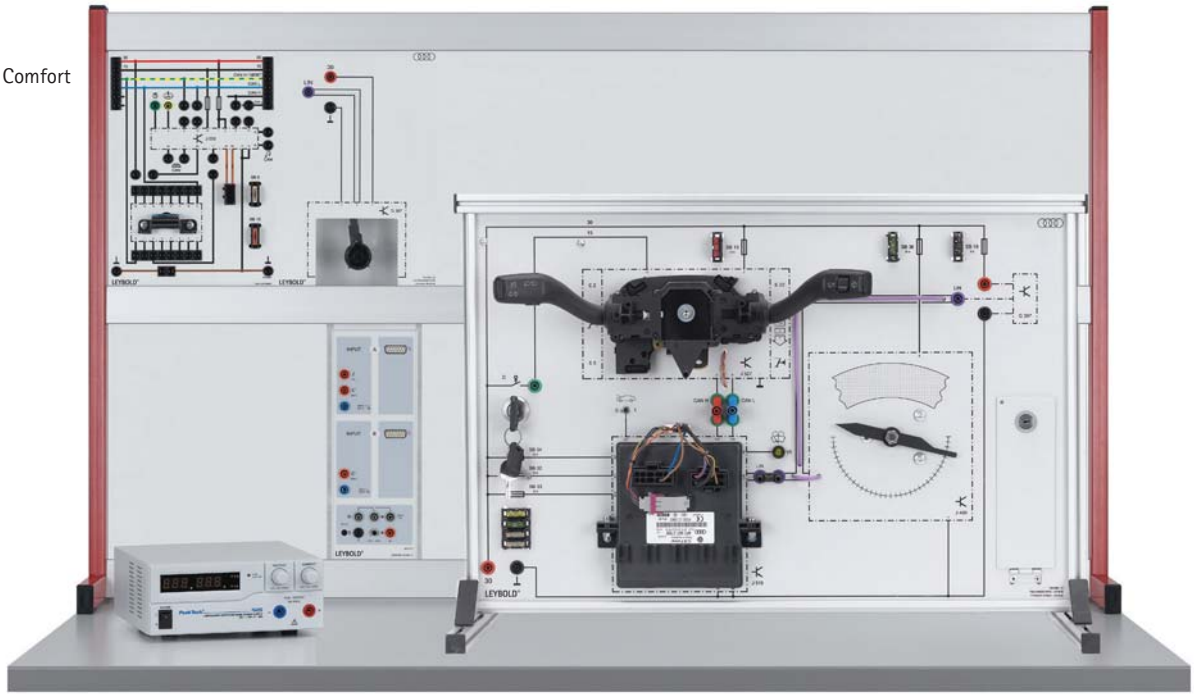
- an instrument cluster and gateway
- an antenna amplifier system
- a true-color display with control unit for information
- a multimedia operating unit
- a hybrid TV tuner*
- an MP3-capable CD changer
- a navigation system*
- an analog and a digital radio receiver*
- an OBD diagnostic plug
- a mobile phone connection*
- a voice-activated steering wheel remote control
- a MOST bus interface
- a CAN and LIN bus interface
- three fault switching boxes.

Specially for the vehicle communication electronics engineer, this board offers the possibility to record loudspeaker impedances, to determine the transmitting power of mobile phone antennas or to study AF and RF signals as well as to detect reception levels.

*the functional range may vary due to local conditions

Networking automotive systems

A2.6.1.3
Networking
automotive systems: Comfort



Networking automotive systems: Comfort (A2.6.1.3)

Cat. No.	Description	A2.6.1.3
739 586	Training panel LIN-Bus	1
739 5861	CAN Gateway	1
301 339	Stand bases, pair	1
500 990	Adapter sockets, set of 2	1
524 081	LIN bus box	1
524 078	CAN bus box	1
739 588	LIN BUS PC interface USB	1
738 027	Dig. Power supply 1 - 16 V/40 A	1
737 9803	OBD Adaptor CAN+USB	1
739 587	Software: CAN bus visualisation	1
524 013S	Sensor-CASSY 2 Starter	1
739 581USB	CAN bus software USB	1
726 09	Panel frame T130, Two Level	1
604 120	Spray bottle, 400 ml	1
604 2403	Photographic tray , red, 24 x 30 cm	1
500 59	Set of 10 safety bridging plugs, black	1
738 9821	Safety experiment cables, set of 51	1
775 062EN	LIT: A2.6.1.3 Networking Comfort Systems	1
738 01	Cable and plug box	1*

*additionally recommended

Modern vehicles can no longer do without networked systems. CAN bus, LIN bus, MOST bus and recently FlexRay command the communication between control units in the vehicle.
The **LIN bus training system** - his master's voice! As "subbus" to the CAN data bus, the LIN bus is a single-wire bus that, upon request by the CAN bus master, supplies sensor data or activates actuator outputs. In automatic intermittent windshield wiper mode, the rain sensor recognizes the precipitation's intensity and sends this information via LIN bus to the electrical system control unit. This activates the wiper's motor - likewise via LIN bus - at an interval corresponding to the amount of precipitation: little rain = rare repetitions, a lot of rain = frequent repetitions of the wiper's movement. Spraying from an aerosol can activate the rain sensor.

The training system includes:
- CAN-bus-capable steering column electronics with wiper lever
- a CAN and LIN-bus-capable electrical system control unit
- a LIN-bus-capable wiper motor
- a LIN-bus-capable rain sensor
- a fault switching box (CAN and LIN faults).

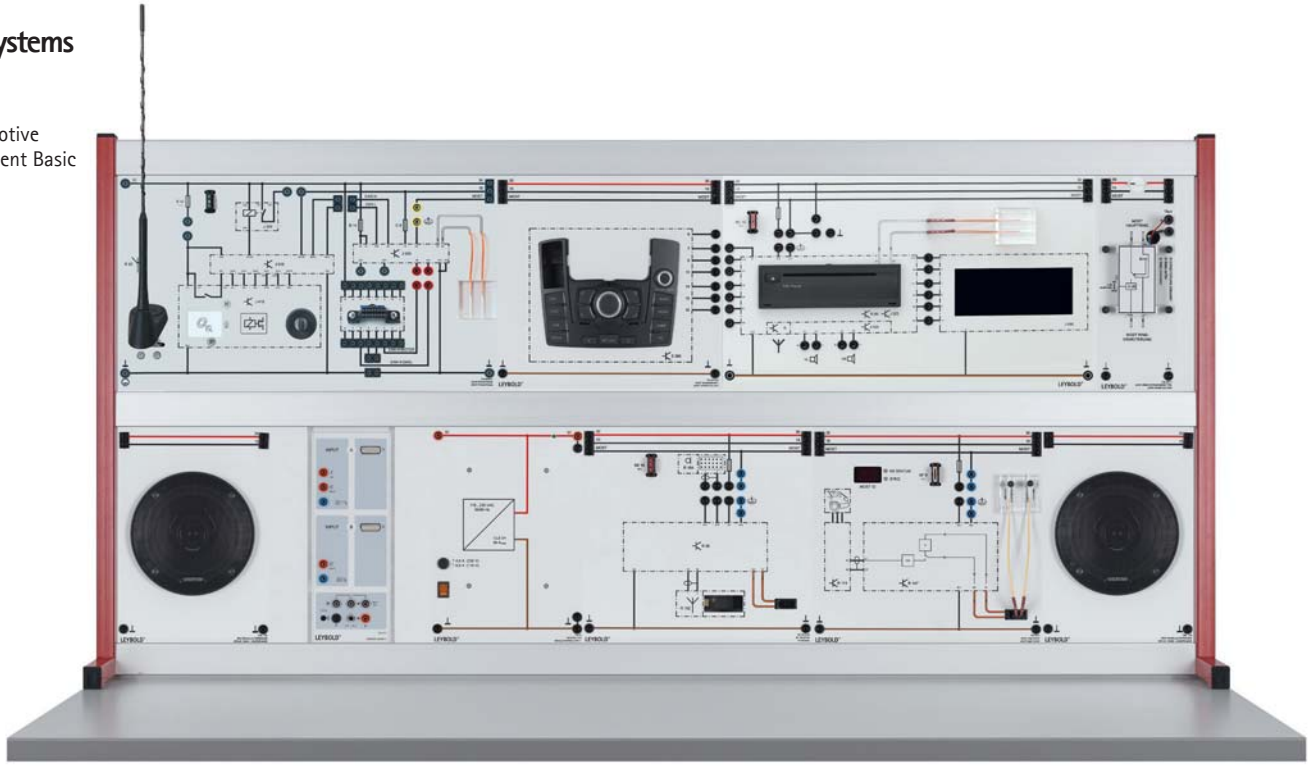
Networking automotive systems: MOST bus practical exercises (A2.6.1.4)

Cat. No.	Description	A2.6.1.4
740 2081	MOST pliers set	1
740 2082	MOST Accessory set	1
576 74	Plug-in board DIN A4, STE	1
578 486	STE MOST Transceiver	1
578 485	OWG coupler	1
577 44	Resistor 1 kOhm, STE 2/19	1
501 48	Bridging plugs STE 2/19, set of 10	1
501 46	Connecting lead 19 A, 100 cm, red/blue, pair	1
521 231	Low-voltage power supply	1
740 2088	Automotive fibre optic microscope	1
740 20821	MOST consumables	1
524 0512	Optical power sensor S	1
775 063EN	LIT: A2.6.1.4 Most-Bus Workshop	1
524 013S	Sensor-CASSY 2 Starter	1

Modern vehicles can no longer do without networked systems. CAN bus, LIN bus, MOST bus and recently FlexRay command the communication between control units in the vehicle.
The equipment and part sets listed here let the students assemble fiber optic lines typical in vehicles and the teacher evaluate their results. In contrast to FO tool cases like those used with the workshops, all these „consumable components" such as FO, crimp sleeves or polishing equipment come in great quantities so that the exercises can still be executed with many students.

Networking automotive systems

A2.6.1.5
Networking automotive systems: Infotainment Basic



Networking automotive systems: Infotainment Basic (A2.6.1.5)

Cat. No.	Description	A2.6.1.5
740 2010	MOST Basic equipment Basic	1
726 11	Panel frame T180, Two Level	1
738 02	Automotive power supply 13.8 V/36 A	1
524 013S	Sensor-CASSY 2 Starter	1
739 731	Broad Band Loudspeaker	2
737 9803	OBD Adaptor CAN+USB	1
740 2013	MOST PC USB Interface	1
740 2084	MOST POF 0.75 m with connector	2
740 20711	MOST repeater TPS	1
739 581USB	CAN bus software USB	1
739 587	Software: CAN bus visualisation	1
575 299	Digital Storage Oscilloscope 1522	1
501 02	BNC cable, 1 m	3
739 743	Digital rod antenna	1
740 2014	MOST DAB radio	1
740 2012-08	MOST BT Phone preparation	1
740 2085	MOST POF 1.5 m with connect	1
738 9821	Safety experiment cables, set of 51	1
775 064EN	LIT: A2.6.1.5 Infotainment Basic	1
739 5858	Set of 6 CAN Bus Fault Plugs	1*
738 01	Cable and plug box	1*
738 491S	Automotive fault simulator, starter	1*
500 593	Fault simulation plugs, black, set of 10	1*

*additionally recommended

Modern vehicles can no longer do without networked systems. CAN bus, LIN bus, MOST bus and recently FlexRay command the communication between control units in the vehicle.

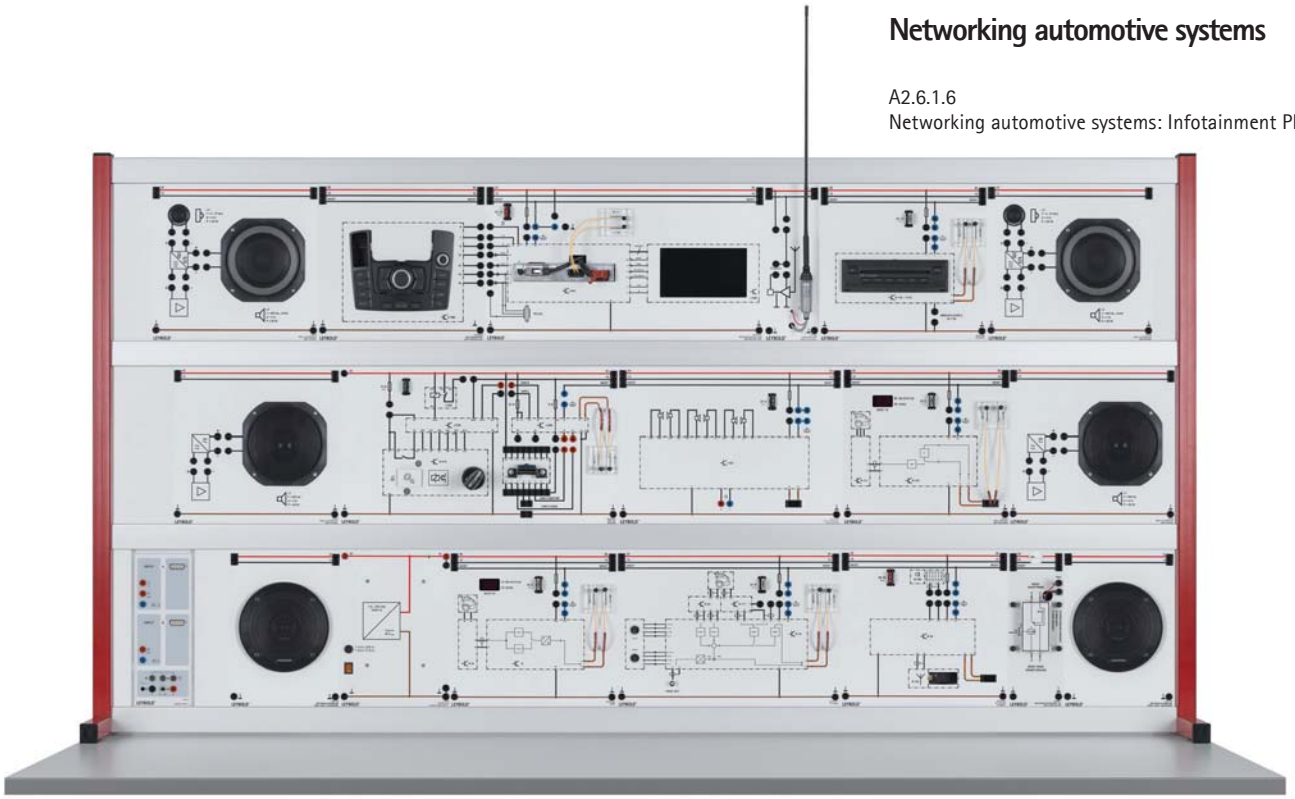
LEYBOLD's MOST starter system **Basic** sets the MOST bus to transmit audio and diagnostic signals with a transmission rate of 21.2 MBit/s. The setup includes:

- Monochrome display
- Central control unit for information
- Radio
- Amplifier
- CD player
- Operating unit
- Gateway with drive authorization system
- Antenna, and
- Loudspeakers.

The control unit for information is connected to the gateway by FO, optionally the MOST signal can be transmitted via the MOST transceiver block (578 486) and so observed electrically with an oscilloscope. The FO are connected to a plexiglass coupler so that defective connectors can simply be simulated. The light input and output can also be observed during wake-up, data transmission and ring disruption diagnosis. The ring disruption diagnosis line is accessible on all MOST extensions. The self-diagnosis can be done with a diagnostic device via the gateway.

Networking automotive systems

A2.6.1.6
Networking automotive systems: Infotainment Plus



Networking automotive systems: Infotainment Plus (A2.6.1.6)

Cat. No.	Description	A2.6.1.6
740 2012	MOST Basic equipment Plus	1
726 26	Panel frame VT180, Three Level	1
738 02	Automotive power supply 13.8 V/36 A	1
738 9821	Safety experiment cables, set of 51	1
739 735	MOST Loudspeaker	2
739 736	Automotive Bass Loudspeaker	2
524 013S	Sensor-CASSY 2 Starter	1
739 7421	Short rod antenna	1
737 9803	OBD Adaptor CAN+USB	1
740 2013	MOST PC USB Interface	1
575 299	Digital Storage Oscilloscope 1522	1
501 02	BNC cable, 1 m	3
739 5858	Set of 6 CAN Bus Fault Plugs	1*
739 581USB	CAN bus software USB	1
739 587	Software: CAN bus visualisation	1
739 743	Digital rod antenna	1
740 2014	MOST DAB radio	1
740 20711	MOST repeater TPS	1
740 2084	MOST POF 0.75 m with connector	1
740 2085	MOST POF 1.5 m with connect	1
775 065EN	LIT: A2.6.1.6 Infotainment Plus	1
738 01	Cable and plug box	1*
738 491S	Automotive fault simulator, starter	1*
500 593	Fault simulation plugs, black, set of 10	1*

*additionally recommended

Modern vehicles can no longer do without networked systems. CAN bus, LIN bus, MOST bus and recently FlexRay command the communication between control units in the vehicle.

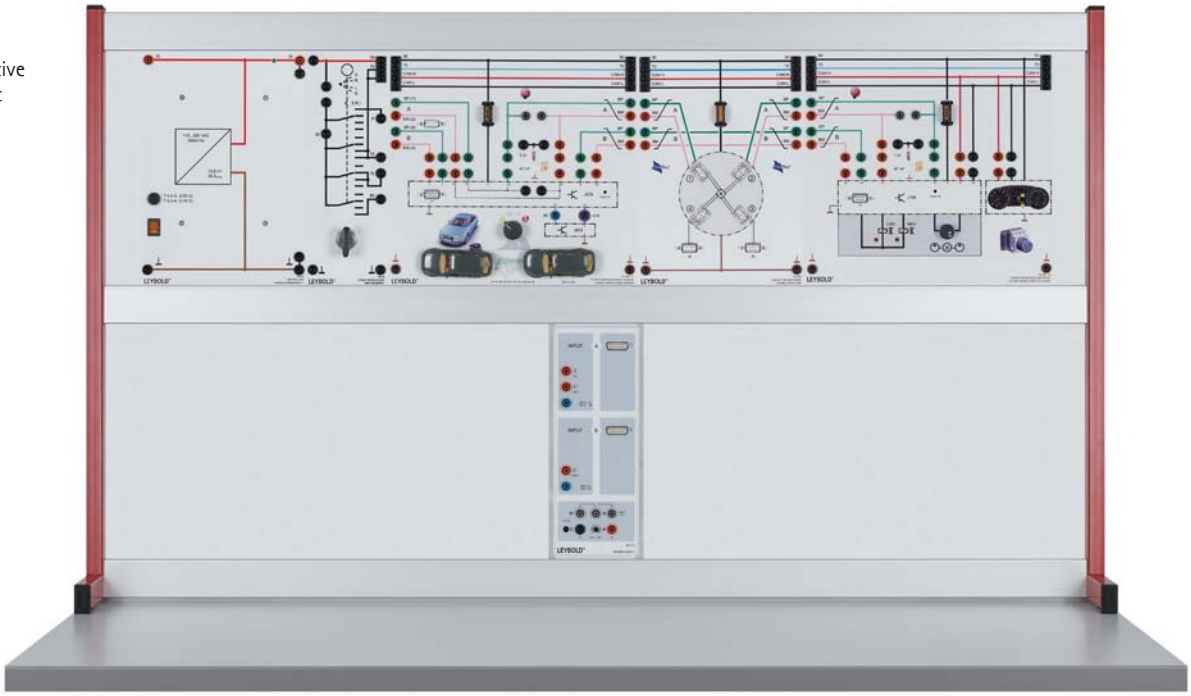
The MOST bus training system **Plus** - the highlight when it comes to optical data transmission in automotive networked systems!
The setup includes:

- Color display
- Central control unit for information
- Radio
- Audio amplifier
- 6-disc CD changer
- Operating unit
- Gateway with FBS
- Hybrid TV tuner (analog and digital)
- Bluetooth™ mobile phone preparation, and
- 2 broadband loudspeakers.

All devices are connected together by FO, so flexible ring extensions – with or without MOST spare control unit (740 2071) – are possible. The radio is thus equipped with a digital MOST address display and a ring status display.The 6-channel audio amplifier (audio package) and the mobile phone preparation are equipped with original FO line sockets on the front for professional practical exercises with FO. In combination with a Bluetooth™-capable mobile phone, users can make and receive calls through the integrated hands-free microphone.

Networking automotive systems

A2.6.1.7
Networking automotive systems: Brake assist



Networking automotive systems: Brake assist (A2.6.1.7)

Cat. No.	Description	A2.6.1.7
773 958	FlexRay brake assist	1
773 960	FlexRay interface USB	1
738 02	Automotive power supply 13.8 V/36 A	1
577 28	Resistor 47 Ohm, STE 2/19	4
575 299	Digital Storage Oscilloscope 1522	1
575 231	Probe 100 MHz, 1:1 / 10:1	2
524 013S	Sensor-CASSY 2 Starter	1
773 959	FlexRay active star	1
738 10	Ignition Switch	1
500 59	Set of 10 safety bridging plugs, black	3
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
775 066EN	LIT: A2.6.1.7 Brake Assist System	1
738 01	Cable and plug box	1*
738 491S	Automotive fault simulator, starter	1*
500 593	Fault simulation plugs, black, set of 10	1*
726 09	Panel frame T130, Two Level	1

*additionally recommended

Modern vehicles can no longer do without networked systems. CAN bus, LIN bus, MOST bus and recently FlexRay command the communication between control units in the vehicle.

The **FlexRay training system** contains a brake assistant function. It combines the following:

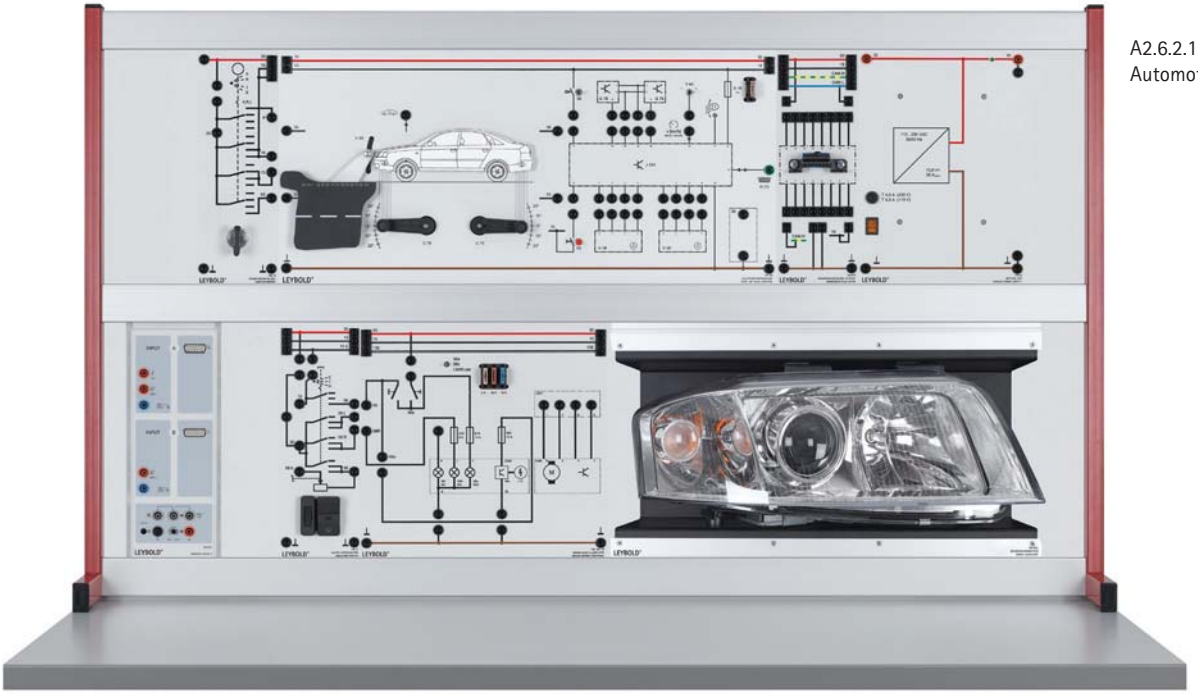
- a sensor control unit
- a road condition sensor
- an ABS/ESP control unit, and
- an instrument cluster.

Two model cars simulate two vehicles tailgating. The FlexRay data bus transfers this state to the control unit for ABS/ESP, which then triggers the brakes to establish the safe distance again. The default value depends on the road condition (dry, wet, slick). The LIN data bus transmits the roadway's condition to the radar sensor control unit. Activating the high-pressure switch valve and the pump displays the brake's function. A high-speed CAN bus connection controls the corresponding indicator lamp in the instrument cluster.

The system can be expanded to an „active star" (773 959) with FlexRay components. The sensor control unit also has an available connection for a FlexRay/USB interface (773 960) to analyze the protocol on the computer.
The FlexRay lines can be completed with external resistors and are set for signal registration with an oscilloscope.

Diagnosis

A2.6.2.1
Automotive self diagnosis



Automotive self diagnosis (A2.6.2.1)

Cat. No.	Description	A2.6.2.1
738 165	Headlamp level control	1
579 162	Simulation ABS/Ti, STE 2/50	1
738 975	Diagnostic Plug 16 Pin	1
737 9803	OBD Adaptor CAN+USB	1
726 10	Panel frame T150, Two Level	1
738 10	Ignition Switch	1
738 02	Automotive power supply 13.8 V/36 A	1
738 11	Head Lamp Switch	1
738 1821	Xenon headlight unit	1
524 034	Timer box	1
524 013S	Sensor-CASSY 2 Starter	1
500 411	Connecting lead 19 A, 25 cm, red	1
500 59	Set of 10 safety bridging plugs, black	3
500 592	Safety Bridging Plugs with Tap, black, set of 10	1
738 9821	Safety experiment cables, set of 51	1
775 067EN	LIT: A2.6.2.1 Vehicle Diagnostic	1
738 491S	Automotive fault simulator, starter	1*
500 593	Fault simulation plugs, black, set of 10	1*

*additionally recommended

Engine control unit self-diagnosis and OBD2/EOBD

The legislation requires automatic headlamp level control for xenon lamps. This educational system contains an **automatic-dynamic** headlamp level control to stabilize changes in the headlamp level due to the body changing angles with the integrated acceleration/braking simulation (switchable).
The sensor inputs

- level signals of the front and rear axles and
- speed signal are detected.

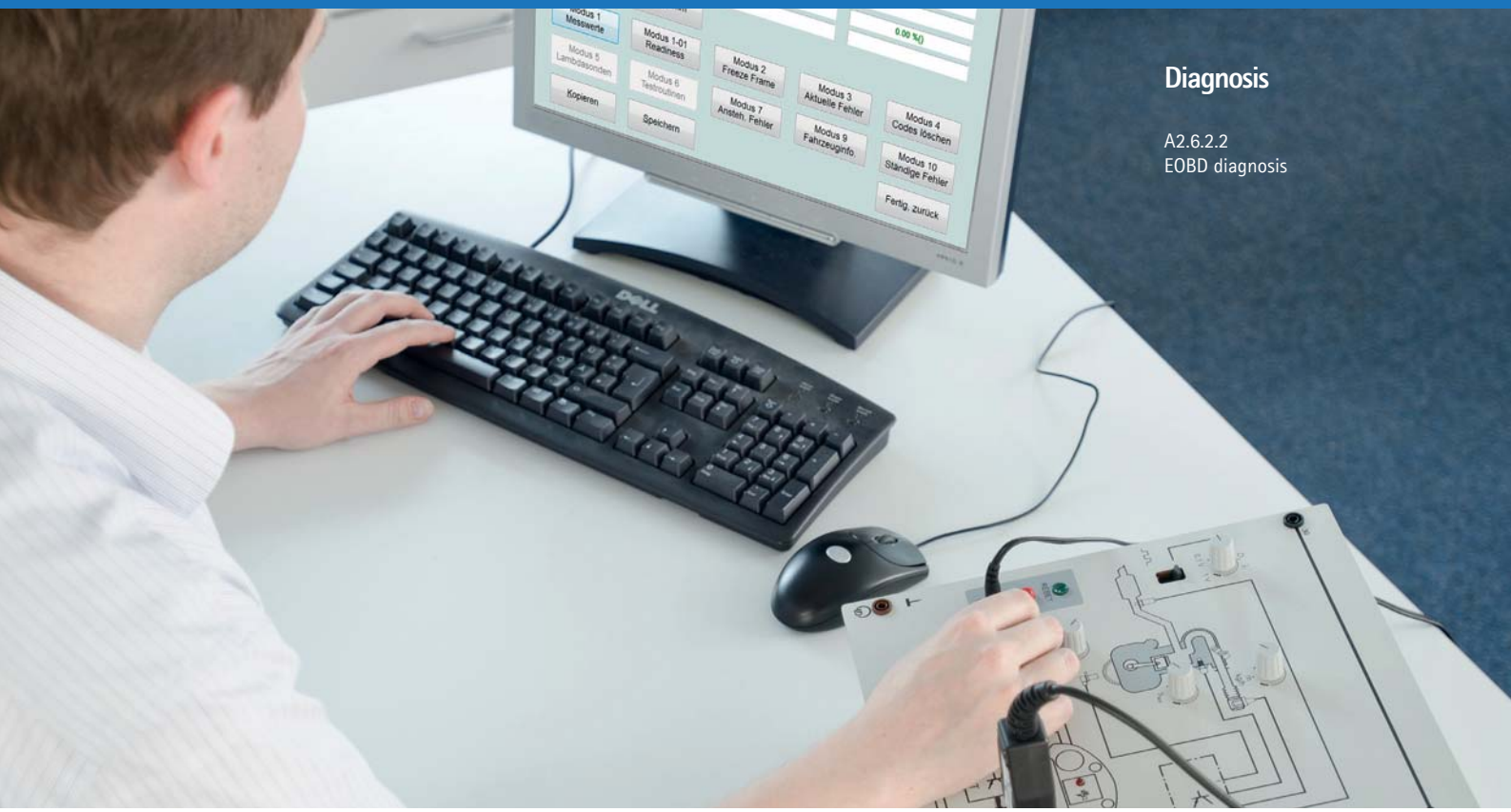
This generates control signals for the actuator outputs

- headlamps' actuator and
- the malfunction indicator.

The system can self-diagnose over the K line: with a diagnostic adapter, all available measured value blocks can be displayed, and the functions

- coding
- default setting
- actuator diagnostics, and
- error logging

are executed.



Diagnosis

A2.6.2.2
EOBD diagnosis

EOBD diagnosis (A2.6.2.2)

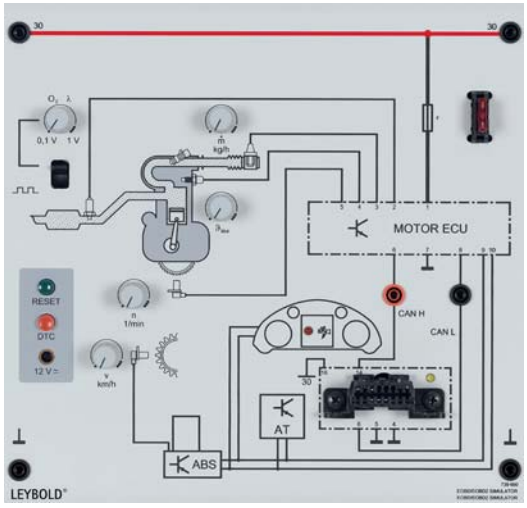
Cat. No.	Description	A2.6.2.2
739 660	EOBD/OBD2 Simulator	1
737 9803	OBD Adaptor CAN+USB	1
737 9804	OBD data logger CAN+USB	1
775 068EN	LIT: A2.6.2.2 EOBD Diagnosis	1
562 791	Plug-in power supply 12 V AC	1

Engine control unit self-diagnosis and OBD2/EOBD

Reproducible error conditions in the vehicle for the OBD2/EOBD analysis for exhaust gases – impossible? No, because LEYBOLD has developed an OBD2/EOBD simulator to learn these operational procedures that simultaneously simulates the engine control unit, the control unit for automatic transmission as well as ABS. The diagnosis CAN bus can set and a diagnostic adapter can read

- variable and
- fixed control unit data (PIDs)
- error codes (DTC), and
- the vehicle identification number (VIN)

Error codes are generated at the push of a button and signaled by illuminating the MIL indicator lamp.



EOBD/OBD2 Simulator

A 2.7 ALTERNATIVE DRIVE TECHNOLOGY

Electrical chemistry

A2.7.1.1
Fuel cell

Fuel cell (A2.7.1.1)

Cat. No.	Description	A2.7.1.1
666 479	Metal hydride reservoir (H_2), CPS	1
666 4811	PEM fuel cell stack, CPS	1
666 482	Aeration pump, controllable, CPS	1
666 483	Electric load, CPS	1
666 4792	Regulating valve for metal hydride reservoir	1
675 3400	Water, pure, 1 l	1
726 09	Panel frame T130, Two Level	1
500 421	Connecting lead 19 A, 50 cm, red	3
500 422	Connecting lead 19 A, 50 cm, blue	3
660 980	Fine regulating valve for Minican gas cans	1
660 997	Minican gas can, Hydrogen	1
661 015	Pressure reducing valve for hydrogen	1
661 0080	Hydrogen, compressed gas bottle, 2 l	1
666 4793	Filling adapter for metal hydride reservoir	1
524 013S	Sensor-CASSY 2 Starter	1
666 484	PEM electrolysis unit, CPS	1*
521 485	AC/DC Power supply 0...12 V/ 3 A	1*
775 070EN	LIT: A2.7.1.1 Fuel Cell	1
501 46	Connecting lead 19 A, 100 cm, red/blue, pair	1*

*additionally recommended

The hydrogen and oxygen gases can be stored and if needed transformed using a fuel cell into the more usable electric energy. In vehicles, fuel cells can, in combination with electric motors, replace the traditional combustion engine. Electric energy is thus gained directly from chemically bound energy without further transformation.

Our experimental equipment for this topic also includes new PEM fuel cells (PEM = Proton Exchange Membrane) built into the vehicle. The hydrogen (H_2) is initially split into H atoms at a catalytically active electrode. After losing an electron (– pole) the proton H^+ goes through the polymer membrane to the oxygen side, where water is produced as a result of electron gain (+ pole): $O_2 + 4\ H^+ + 4\ e^- \Rightarrow 2\ H_2O$.
Higher voltages are necessary for driving motors. Therefore, like for the battery, many (currently about 200) elements, each of about 1 volt, must be connected in series close to the so-called stack. Since the corresponding energy is not completely consumed directly, a battery is necessary for intermediate storage. However, it can be significantly smaller than for a pure electric drive, for example.

The educational system consists of:
- hydrogen storage (metal-hydride storage unit, content: 1 mol)
- a fuel cell stack of an aeration pump's 4 single cells for oxygenation, and
- an electric loading unit in the classic educational panel style.

Hybrid drives

A2.7.2.1
Electrical machines in hybrid and electrical cars

Electrical machines in hybrid and electrical cars (A2.7.2.1)

Cat. No.	Description	A2.7.2.1
563 04	Storage tray for ELM apparatus	1
563 115	ELM Coil 500 turns	3
563 16	Allen wrench	1
563 17	ELM Centering disc	1
563 18	Brush holder	1
563 13	ELM Brush	2
563 19	ELM Magnet rotor	1
563 22	ELM Two-pole rotor	1
563 28	ELM Magnetic needle rotor	1
727 811	Basic Machine Unit	1
727 812	Rotor position pick up	1
727 88	Driving Unit	1
563 091	ELM Pole piece for magnets	2
563 101	ELM Wide pole piece for coils	3
563 25	ELM Rotating field attachment	1
563 29	ELM Aluminium ring with iron disc	1
510 48	Magnets, 35 mm Ø, pair	1
726 10	Panel frame T150, Two Level	1
727 21	Automobile Meter Zero-Center	1
727 20	Automobile Meter Zero-Left	1
579 13	Toggle switch STE 2/19	1
524 0621	UIP-Sensor S	1
524 013S	Sensor-CASSY 2 Starter	1
739 589	Software: Vehicle diagnosis, german and english	1
725 721G	Three phase generator	1
563 31	Oil 100 ml in dropping bottle	1
563 191	EMTM Magnet rotor 4 pole	1
738 9821	Safety experiment cables, set of 51	1
775 071EN	LIT: A2.7.2.1 Basics Electric Machines	
738 01	Cable and plug box	1*

*additionally recommended

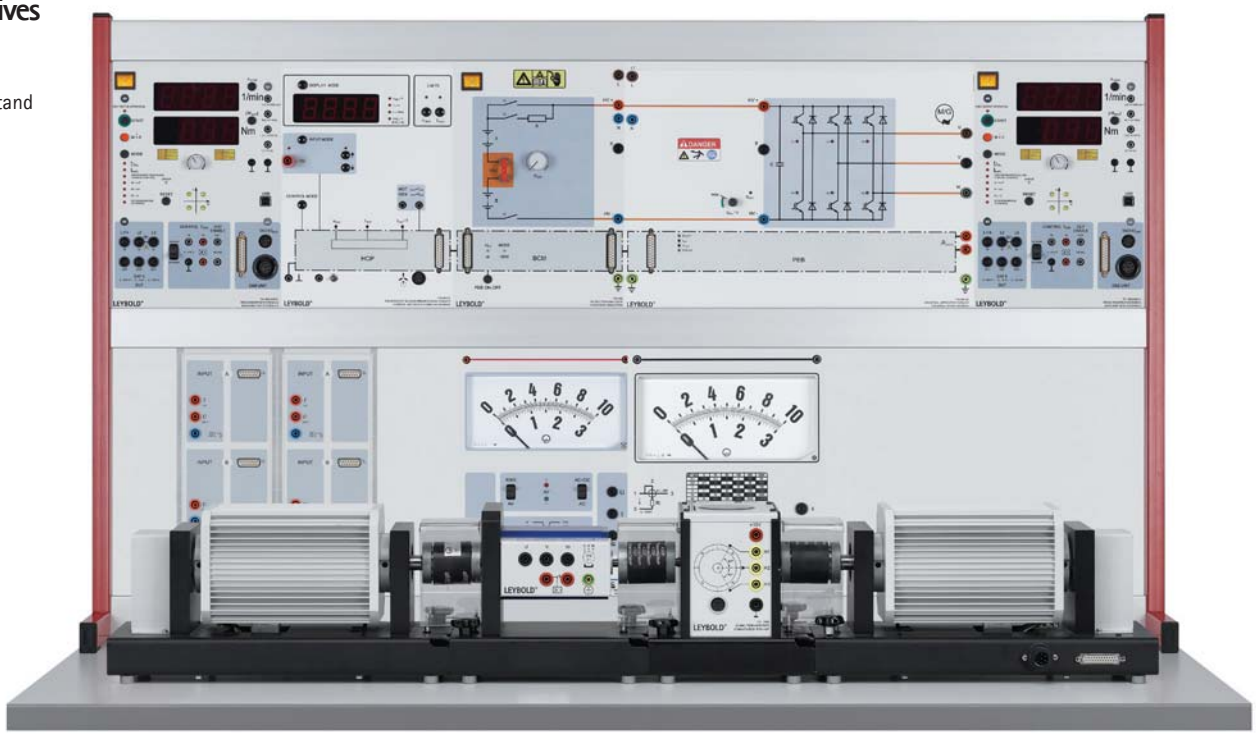
Study of the fundamentals of hybrid drive requires basic knowledge of the construction and function of electric machines. Thus, each of
- the direct current machines
- the alternating and induction machines, and
- the servomotor is among the motor and generator operation modes.

Additional knowledge of power electronics and energy storage technology allows comprehension of the new "hybrid drive technology" system.
Teachers and students must also be trained for or made aware of exposure to high voltages and the risks involved. Only then can the students be trained to become professionals skilled in electrics.

LEYBOLD uses components from the modular "ELM" electric training machine system for the trainees to be able to build the various types of machines by hand. This teaches basic knowledge and concepts, such as
- electromagnetism
- induction
- voltage generation
- motor
- generator etc.

Hybrid drives

A2.7.2.2
Experiment stand
hybrid drives



Experiment stand hybrid drives (A2.7.2.2)

Cat. No.	Description	A2.7.2.2
739 945	Experiment set hybride drives	1
727 10	RMS Meter	1
727 11	Power Meter	1
524 013S	Sensor-CASSY 2 Starter	1
524 013	Sensor-CASSY 2	1
775 072EN	LIT: A2.7.2.2 Demonstration Hybrid Drive	1
524 0621	UIP-Sensor S	1

Study of the fundamentals of hybrid drive requires basic knowledge of the construction and function of electric machines. Thus, each of

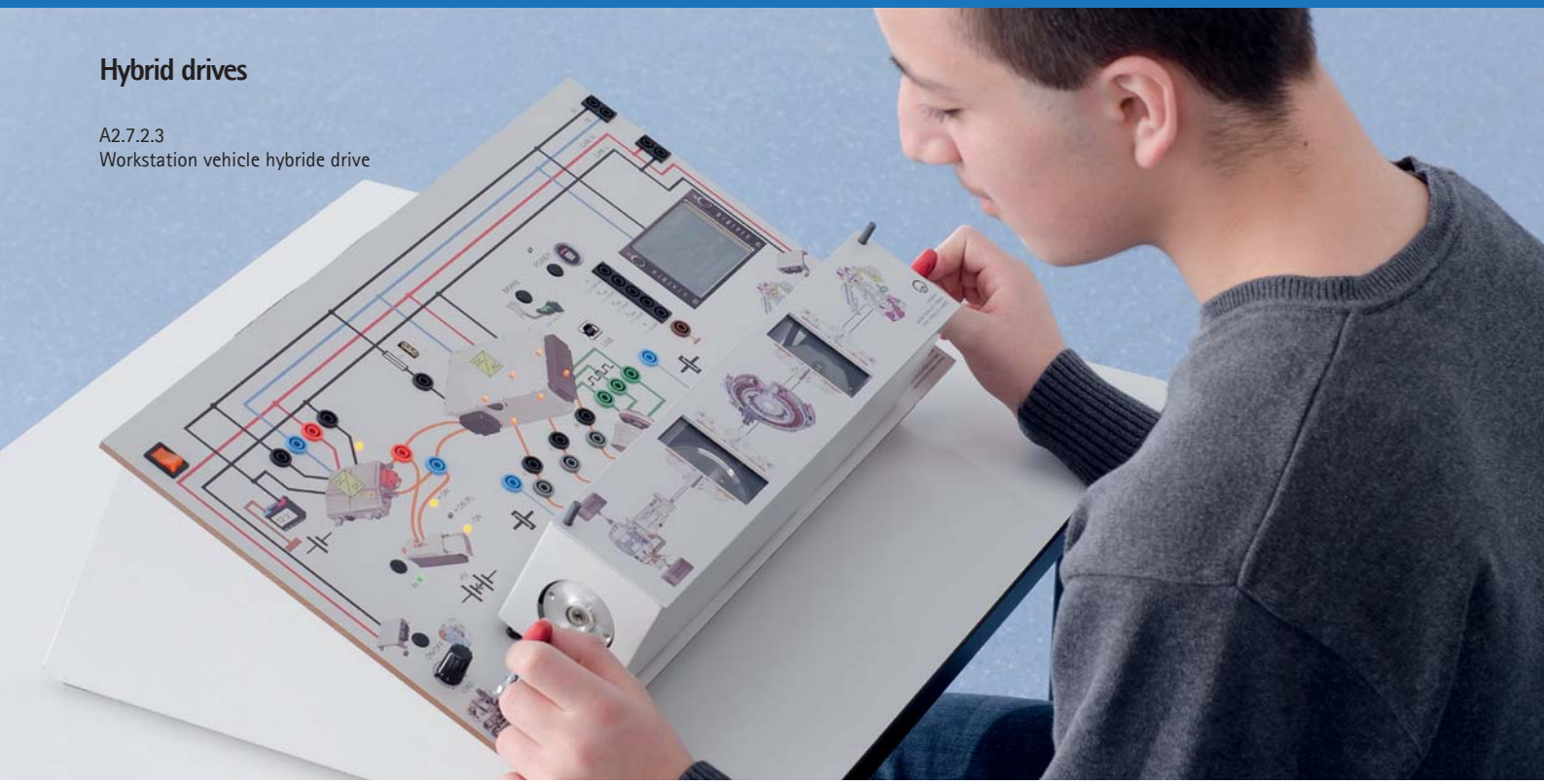
- the direct current machines
- the alternating and induction machines, and
- the servomotor is among the motor and generator operation modes.

Additional knowledge of power electronics and energy storage technology allows comprehension of the new "hybrid drive technology" system.
Teachers and students must also be trained for or made aware of exposure to high voltages and the risks involved. Only then can the students be trained to become professionals skilled in electrics.
The combination of combustion engine and electric motor in the power train enables new driving functions: start/stop function, purely electric driving, hybrid driving, generator operation, as well as regenerative brake operation. All these operation modes should ultimately have one aim: fuel economy and thereby reducing toxic emissions.
LEYBOLD here offers a demonstration plant that - completely run as a mobile experiment stand - precisely achieves the operation modes above as a parallel hybrid system with two couplings in the 300 W range. The electric drive uses a permanent-magnet synchronous machine (PMSM); a frequency converter motor adjusts the combustion engine, and the electrical machine test system raises the load (transmission, rolling friction, air resistance, etc.). The electric motor's central frequency converter can also be studied.

With parameterization of the drive and output components and by measuring the electric (V, I, P) and mechanical (n, T) values, the energy flows can be determined in terms of magnitude and direction. This also enables precise initiation of the individual operation modes and studying them in the experiment.
The set includes a mobile experimental rack 724876 and can be set up as a demonstration experiment.

Hybrid drives

A2.7.2.3
Workstation vehicle hybride drive



Workstation vehicle hybride drive (A2.7.2.3)

Cat. No.	Description	A2.7.2.3
739 940	Workstation vehicle hybride drive	1
524 013SKFZ	Sensor-CASSY 2 Starter, Automotive	1
775 073EN	LIT: A2.7.2.3 Workstation Hybride Drive	1
738 9821	Safety experiment cables, set of 51	1

Study of the fundamentals of hybrid drive requires basic knowledge of the construction and function of electric machines. Thus, each of
- the direct current machines
- the alternating and induction machines, and
- the servomotor is among the motor and generator operation modes.

Additional knowledge of power electronics and energy storage technology allows comprehension of the new "hybrid drive technology" system.
Teachers and students must also be trained for or made aware of exposure to high voltages and the risks involved. Only then can the students be trained to become professionals skilled in electrics.

In addition to the "hybrid propulsion" demo equipment, LEYBOLD has developed a student workstation that enables the study of all essential aspects in a smaller scale. Equipped with
- a PMSM as an electric motor
- an inverter
- a dual voltage electrical system, and
- a touchscreen display for the operation and to display energy flows.

The control units are networked with the motor CAN bus.
All common operation modes are adjustable:
- Start
- Electric drive
- Boost
- Regenerative brakes

The student can independently study the complex issue of hybrid technology. Thanks to overlays, various systems can be selected. The workstation can be linked to the PC.

INDIVIDUAL DEVICES

IN NUMERICAL ORDER

All individual devices are shown in order of their catalogue numbers on the following pages.

Stand base V-shape, small

Including pair of levelling screws and a rivit-shaped insertion providing a third support point.
V-shape
Jaw width for stand rods: 8 to 14 mm
Material: cast iron
Length of sides: 20 cm
Weight: 1.3 kg approx.
Levelling screws: Adjustment range 17 mm

300 02	Stand base V-shape, small

Stand rod 25 cm, 12 mm Ø

Made of solid corrosion-resistant special steel.
Diameter: 12 mm
Length 25 cm

300 41	Stand rod 25 cm, 12 mm Ø

Leybold multiclamp

max. span for rods: up to 14 mm
max. span for plates: up to 12 mm

301 01	Leybold multiclamp

Plug-in board holder STE

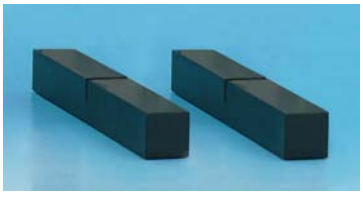
For mounting plug-in board DIN A4/A3 (576 74/75) on the frame (301 300) or the profile frame (726 03). For plug-in board DIN A2 (580 10) two plug-in carriers are necessary.
Dimensions: 30 cm x 20 cm

301 320	Steckplattenträger STE

Stand bases, pair

For mounting equipment on training panels,
Dimensions: each 20 cm x 2.5 cm x 2.5 cm
Insert slot: 0.5 cm x 1 cm (inclined)
Weight:0.3 kg

301 339	Stand bases, pair



Fishing line, 10 m, set of 2

Material: twisted Trevira line
Colour: black and white
Length: 10 m
Diameter: 0.5 mm approx.
Max. load: 6 kg

309 48ET2	Fishing line, 10 m, set of 2

Stopclock II

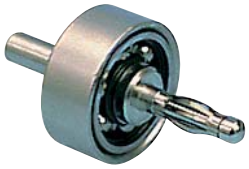
Adding stopclock with start, stop and reset button.
Range: 60 s / 30 min
Inaccuracy of reading: 0.2 s
with cord

313 17	Stopclock II

Weight with hook 0.5 kg

With suspension hook and traverse bar in the base of each weight for attachment of further weights.
Weight: 0.5 kg
Dimensions: 10.5 x 5 cm Ø
Material: cast iron

315 38	Weight with hook 0.5 kg



Ball bearing, for plugging in

for low-friction suspension of objects with a centre hole.
Plug: d = 4 mm
Axle: d = 5 mm

342 43	Ball bearing, for plugging in

Manual vacuum pump

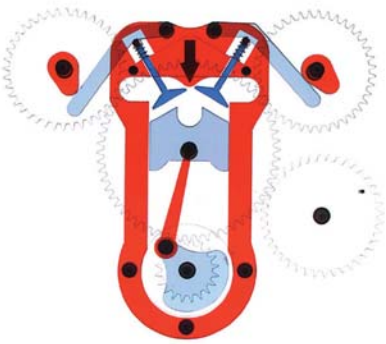
mechanical air pump with integrated ventilation valve and pointer manometer.
Volume flow rate: 16 ml/stroke
Ultimate pressure: approx. 100 hPa
complete with plastic hose
Dimensions: 27 cm x 16 cm x 4 cm

375 58	Manual vacuum pump

Four-stroke engine, sectional model

section model on base; with fly-wheel for explaining the operation of the valve control of a petrol engine; including incandescent lamp; without battery.
Power supply: 6 V DC via 4 mm sockets
Dimensions: 25 cm x 25 cm x 45 cm
Weight: 2.5 kg

388 51	Four-stroke engine, sectional model



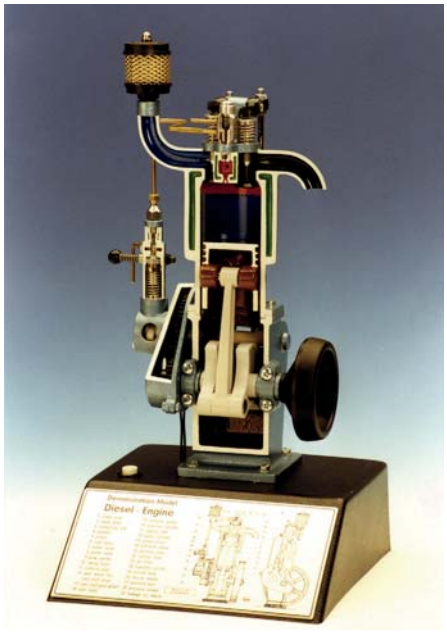
Cutaway models for overhead projector

Cat.No	Designation
388 552	Diesel engine, model for OHP
388 512	Four-stroke engine, model for OHP
388 542	Two-stroke engine, model for OHP
388 562	Rotary engine, model for OHP

Diesel engine, sectional model

section model on base; with fly-wheel for demonstration of the valve control and fuel injection; including incandescent lamps; without battery.
Supply: 6 V C, via 4-mm sockets
Dimensions: 25 cm x 25 cm x 45 cm
Weight: 4 kg

388 55	Diesel engine, sectional model



Ultrasonic transducer 40 KHz

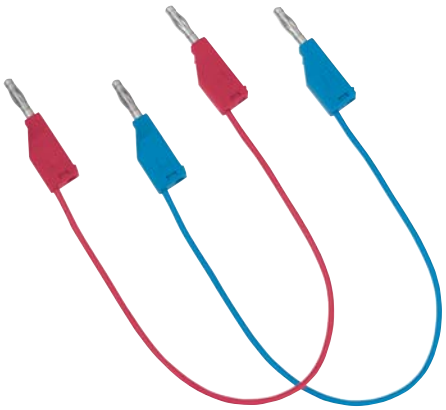
Piezoelectric air ultrasonic transducer for experiments in the areas of geometric and wave-mechanical acoustics. The transducer is used as transmitter and receiver. In housing, on stand rod, with coax. connection cable.
Resonance frequency: 40 kHz
Bandwidth: approx. 6 kHz
Capacitance: 2000 pF
Connection: 1 m coax. cable with 4 mm sockets
Housing: 48 mm x 27 mm Ø
Stand rod: 20 cm x 10 mm Ø

416 000	Ultrasonic transducer 40 KHz

Compact spectrometer USB, physics

Compact spectral photometer for computer-assisted recording of emission and absorption spectra, light inlet through a freely movable optical fibre waveguide.
Inside the spectral photometer the light is split up by means of a fixed grating and projected onto a silicon CCD array. Thus, the intensity of all wavelengths is measured simultaneously allowing measurements of even rapidly changing processes such as flame tests.
For absorption measurements first of all a reference spectrum is measured, then one of the absorbers to be investigated in the path of the light. The software calculates the difference and therefrom values such as transmission, absorption, etc.
Typical experiments are emission spectra, e.g. gas discharge, flame tests, Fraunhofer lines in the solar spectrum, Wien's law, LED spectra, etc. or absorption spectra together with an external light source, e.g. of filters; sodium vapour.
With fibre holder (460 251) for use on an optical bench.
Scope of delivery:
Spectral photometer
Software
Optical fibre waveguide
Technical data:
Setup: Czerny-Turner
Detector: silicon CCD array
Wave length range: 350 – 1000 nm
Resolution: 2048 channals, optical band width 2 nm (FWHM)
Integration time: 3 ms to 1 s
Computer connection: USB
Power supply: via USB
Fibre connection: SMA 905
Dimensions: 89 mm x 63 mm x 34 mm
Mass: 190 g

467 251	Compact spectrometer USB, physics



Connection leads / Safety connection leads

Cat.No	Designation
500 401	Connecting lead 19 A, 10 cm, red
500 402	Connecting lead 19A, 10 cm, blue
500 411	Connecting lead 19 A, 25 cm, red
500 421	Connecting lead 19 A, 50 cm, red
500 422	Connecting lead 19 A, 50 cm, blue
501 45	Connecting lead 19 A, 50 cm, red/blue, pair
501 46	Connecting lead 19 A, 100 cm, red/blue, pair
500 611	Safety connection lead 25 cm, red
500 641	Safety connection lead 100 cm, red
500 644	Safety connection lead 100 cm, black
500 647	Safety Connection Lead 100 cm brown
500 664	Safety connection lead 200 cm, black
500 667	Safety Connection Lead 200 cm brown

Bridging plug

Cat.No	Designation
500 59	Set of 10 safety bridging plugs, black
500 592	Safety Bridging Plugs with Tap, black, set of 10
500 593	Fault simulation plugs, black, set of 10
500 595	Set of 10 4 mm branching bridging plugs, red
500 596	Safety bridging plug STE 2/19, set of 10
501 48	Bridging plugs STE 2/19, set of 10
539 000	Bridging plug, BST

Automobile protection measuring adaptor

Two-pole test adapter with 4 mm sockets and test leads to be inserted into an automotive fuse holder. To connect a multimeter for measuring the current consumption of connected equipment or measuring the leakage currents without the need to disconnect a wire or electrical feeds-in.

- Plug spacing: 21 mm
- Max. current: 20 A
- Color: black

500 597	Automobile protection measuring adaptor

Safety connecting leads, set of 25

Consisting of:
100 cm: two cables black, grey, brown and yellow/green and one cable red and blue
50 cm: two cables black, grey, brown and yellow/green
25 cm: one cable black, grey, brown and yellow/green
10 cm: three cables black

All cables 2.5 mm² with 4-mm safety plugs, 32 A, 1000 V Cat II

500 853	Set of 25 safety connecting leads

Adapter sockets, set of 2

for conversion of equipment with 4-mm sockets for safe use in the low-tension range, with Allen wrench for fast and easy installation.

500 990	Adapter sockets, set of 2

BNC cable, 1 m

Plug: BNC/BNC; Impedance: 50 Ohm

501 02	BNC cable, 1 m

Measuring junction box

For connecting an ammeter and a voltmeter into circuits whose loads are connected directly to the mains supply via earthed plugs; complete with safety connection plugs.
Outputs: 1 earthed socket, 4 safety sockets
Cable length: 1.80 m
Connection: via earthed plug
Supply voltage: 240 V
Current max. 15 A
Connected load: 3600 VA
Dimensions: 13.5 cm x 7.5 cm x 6.0 cm

502 05	Measuring junction box

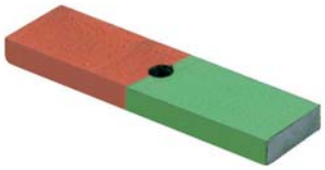
Light

Cat.No	Designation
505 08	Bulb 12 V/3 W, E10, set of 10
505 09	Bulb 12 V/1 A, E10, set of 10
505 272	Bulb 230 V/40 W, E14, set of 2
505 36ET10	Glow lamp 115 V, E10, set of 10

Magnet with bore, poles marked

Dimensions: 70 mm x 19 mm x 6 mm

510 17	Magnet with bore, poles marked



Magnets, 35 mm Ø, pair

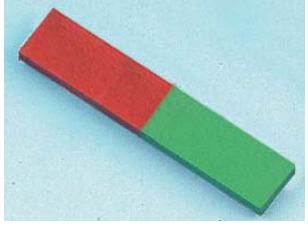
cylindrical shape with axial hole (d = 6.2 mm).
Poles: coloured
Material: ferrite
Dimensions: d = 35 mm, h = 20 mm

510 48	Magnets, 35 mm Ø, pair

Bar magnet 60 x 13 x 5 mm, 2 pieces

made of AlNiCo, with coloured north pole marking

510 50ET2	Bar magnet 60 x 13 x 5 mm, 2 pieces



Rotary support

plug on bearing with rotatable disc and 2 clamping springs for holding of round and plate material.
Plug: Ø 4 mm
Clearance range under spring: 4 to 10 mm

510 51	Rotary support

Low-voltage power supply

Power supply for experiments on electricity and simple electronics experiments. Output voltage adjustable in steps; overload-protected with bimetallic switch.
Output voltage: 3/6/9/12 V AC/DC
Maximum load capacity: 3 A
Connection voltage: 230 V, 50/60 Hz
Power consumption: 60 VA
Protection: thermal overload protection
Dimensions: 21 cm x 9 cm x 17 cm
Mass: 2.6 kg

521 231	Low-voltage power supply

DC Power supply 0 to ±15 V

Symmetrical, adjustable DC voltage source for electronics circuits, 5 V DC voltage source for digital circuits; current-limited. With 2 ½ digit display of adjustable DC voltage, including overload indicator (LED).
Output voltages:
(1) 0 to ±15 V DC
(2) 0 to 30 V DC
(3) 5 V
via 4-mm safety sockets
Maximum load capacity:
(1) 1.5 A (short-circuit proof)
(2) 0.5 A (short-circuit proof)
Residual ripple at full load: ≤ 5 mV_{pp}
Stabilization at full load: 0.3 %
Stabilization for = 10 % fluctuation in mains voltage: 0.1 %
Connection voltage: 230 V, 50/60 Hz
Protection: T 0.5 primary
Power consumption: 80 VA
Fuses: T 1.0 B
Dimensions: 20 cm x 14 cm x 23 cm
Weight: 2.6 kg

521 45	DC Power supply 0 to ±15 V

AC/DC Power supply 0...12 V/ 3 A

with variable and regulated output voltage and analog display instrument, additional 4 AC voltage outputs. AC and DC voltage outputs electrically isolated, therefore especially suitable for students and practical experiments.
Technical Data:
Output voltages:
DC: 0 - 12 V, continuously adjustable
Stabilization: < 1 %
Residual ripple: approx. 2 mV
AC: 3, 6, 9, 12 V
Output current: max. 3 A
Overload protection, short circuit-proof, safe from external voltage
Connections: 4-mm safety sockets
Connection voltage: 230 V, 50/60 Hz
Primary fuse: T 1
Dimensions : 23 cm x 12 cm x 19 cm
Weight : 5.2 kg

521 485	AC/DC Power supply 0...12 V/ 3 A

Power-CASSY USB

Cascadable interface device as programmable current or voltage source (power function generator) with integrated current or voltage measurement.

- For connection to the **USB-port** of a computer, another CASSY module or the CASSY Display
- Sensor CASSY and Sensor CASSY USB can be mixed cascadable
- Electrically isolated up to a potential difference of 500 V
- Microprocessor-controlled via the CASSY operating system (complete with software update functionality for fast, easy performance enhancements)
- Can be set up as a benchtop, console or demonstration unit (also suitable for CPS/TPS panel frames)
- Voltage supply 12 V AC/DC via cannon plug or an adjacent CASSY module

Technical data:
1 programmable voltage source with simultaneous current measurement
(e.g. for recording characteristic curves)
Resolution: 12 bit
Output range: ± 10 V
Measuring range: ± 0.1/0.3/1 A
Accuracy: ± 1% plus 0.1 % maximum range value
Sampling rate: max. 200,000 values/s (= 100,000 values/s current and voltage)
Memory: max. 32,000 values (= 16,000 values for current and voltage)
1 programmable current source with simultaneous voltage measurement
(can be activated alternatively to voltage source)
Output range: ± 1 A
Measuring range: ± 1/3/10 V
See voltage source for additional data
1 USB port for connection to a computer
1 CASSY bus for connecting additional CASSY modules or the CASSY Display
Dimensions (WxHxD): 115 mm x 295 mm x 45 mm
Weight: approx. 1 kg
Scope of Delivery:
1 Power-CASSY
1 CASSY Lab software without activation code for Windows 95/98/NT/2000/XP (full functionality for 20 sessions, then usable only as demo version).
1 Installation manual
1 USB cable
1 Plug-in supply unit 230/12 V 1,6 A

524 011USB	Power-CASSY USB

Sensor-CASSY 2

Cascadable interface device for recording measurement data

- For connection to the USB-port of a computer, another CASSY module or the CASSY display.
- Sensor CASSY 2 and Power CASSY can be mixed cascadable
- 3-fold electrical isolation (4-mm-inputs A and B, relay R)
- Measurement possible parallel at 4-mm-inputs and sensor box connector sites (4 channels)
- Cascading of up to 8 CASSY module possible (to expand the inputs and outputs)
- Up to 8 analog inputs per Sensor-CASSY retrofittable using sensor boxes
- Automatic sensor box detection (plug and play) by CASSY Lab 2 (524 220)
- Microprocessor-controlled with CASSY operating system (easily updatable via software for function enhancements)
- For use as a benchtop, console or demonstration unit (also in CPS/TPS panel frames)
- Voltage supply 12 V AC/DC via cannon plug or adjacent CASSY module
- Developper Information and LabVIEW™ driver available through our internet homepage

Technical data

- **5 Analog inputs**
  2 Analog voltage inputs A and B on 4-mm safety sockets (electrically isolated)
  Resolution: 12 bits
  Measuring ranges: ± 0.1/0.3/1/3/10/30/100/250 V
  Measurement error: ± 1 % plus 0.5 % of range end value
  Input resistance: 1 MΩ
  Scanning rate: up to 1 MHz per input
  Amount of measured values: nearly unlimited (dependent on PC) up to 10,000 values/s, at higher measuring rate max. 200,000 values
  Pre trigger: up to 50,000 values per input
  1 Analog current input A on 4-mm safety sockets (alternatively to voltage input A)
  Measuring ranges: ± 0.03/0.1/0.3/1/3 A
  Measurement error: voltage error plus 1 %
  Input resistance: < 0.5 Ω
  Scanning rate: up to 1 MHz per input
  See voltage inputs for further data
  2 Analog inputs at sensor box connector sites A and B
  (All CASSY sensor boxes and sensors can be connected)
  Measuring ranges: ± 0.003/0.01/0.03/0.1/0.3/1 V
  Input resistance: 10 kΩ
  Scanning rate: up to 500 kHz per input
  See voltage inputs for further data
  The technical data will change depending on a connected sensor box. In this case CASSY Lab 2 automatically detects the possible measurement quantities and ranges when a sensor box is attached.
- **4 Timer inputs** with 32-bit counters at sensor box sites A and B (e.g. for BMW box, GM box or timer box)
  Counting frequency: max. 1 MHz
  Time resolution: 20 ns

- **5 LED status indicators** for analog inputs and USB-port
  Colours: red and green, according to status
  Light intensity: adjustable
- **1 Changeover relay** (switching indication via LED)
  Range: max. 250 V / 2 A
- **1 Analog output** (LED switching state indicator, e.g. for holding magnet or supplying experiment)
  Variable voltage range: max. 16 V / 200 mA
  (load ≥ 80 Ω)
- **12 Digital inputs** (TTL) on sensor box sites A and B (at present only used for automatic sensor box detection)
- **6 Digital outputs** (TTL) on sensor box sites A and B (at present only used for automatic switching of a sensor box measuring range)
- **1 USB-port** for connection to a computer
- **1 CASSY bus** for connecting additional CASSY modules
- Dimensions (WxHxD): 115 mm x 295 mm x 45 mm
- Weight: 1.0 kg

Scope of supply:
1 Sensor-CASSY 2
1 CASSY Lab 2 software, without activation code,
with comprehensive help
function (20 full-functionality sessions
free, then usable as demo version)
1 USB cable
1 Plug-in supply unit 230 V, 12 V / 1.6 A

524 013	Sensor-CASSY 2

Sensor-CASSY 2 Starter

Package consist of:
Sensor-CASSY 2 (524 013)
Cascadable interface device for recording measurement data

- For connection to the USB-port of a computer, another CASSY module or the CASSY display.
- Sensor CASSY 2 and Power CASSY can be mixed cascadable
- 3-fold electrical isolation (4-mm-inputs A and B, relay R)
- Measurement possible parallel at 4-mm-inputs and sensor box connector sites (4 channels)
- Cascading of up to 8 CASSY module possible (to expand the inputs and outputs)
- Up to 8 analog inputs per Sensor-CASSY retrofittable using sensor boxes
- Automatic sensor box detection (plug and play) by CASSY Lab 2 (524 220)
- Microprocessor-controlled with CASSY operating system (easily updatable via software for function enhancements)
- For use as a benchtop, console or demonstration unit (also in CPS/TPS panel frames)
- Voltage supply 12 V AC/DC via cannon plug or adjacent CASSY module
- Developper Information and LabVIEW™ driver available through our internet homepage

Technical data

- **5 Analog inputs**
  2 Analog voltage inputs A and B on 4-mm safety sockets (electrically isolated)
  Resolution: 12 bits
  Measuring ranges: ± 0.1/0.3/1/3/10/30/100/250 V
  Measurement error: ± 1 % plus 0.5 % of range end value
  Input resistance: 1 MΩ
  Scanning rate: up to 1 MHz per input
  Amount of measured values: nearly unlimited (dependent on PC) up to 10,000 values/s, at higher measuring rate max. 200,000 values/s
  Pretrigger: up to 50,000 values per input
  1 Analog current input A on 4-mm safety sockets (alternatively to voltage input A)
  Measuring ranges: ± 0.03/0.1/0.3/1/3 A
  Measurement error: voltage error plus 1 %
  Input resistance: < 0.5 Ω
  Scanning rate: up to 1 MHz per input
  See voltage inputs for further data
  2 Analog inputs at sensor box connector sites A and B
  (All CASSY sensor boxes and sensors can be connected)
  Measuring ranges: ± 0.003/0.01/0.03/0.1/0.3/1 V
  Input resistance: 10 kΩ
  Scanning rate: up to 500 kHz per input
  See voltage inputs for further data
  The technical data will change depending on a connected sensor box. In this case CASSY Lab 2 automatically detects the possible measurement quantities and ranges when a sensor box is attached.
- **4 Timer inputs** with 32-bit counters at sensor box sites A and B (e.g. for BMW box, GM box or timer box)
  Counting frequency: max. 1 MHz
  Time resolution: 20 ns

- **5 LED status indicators** for analog inputs and USB-port
  Colours: red and green, according to status
  Light intensity: adjustable
- **1 Changeover relay** (switching indication via LED)
  Range: max. 250 V / 2 A
- **1 Analog output** (LED switching state indicator, e.g. for holding magnet or supplying experiment)
  Variable voltage range: max. 16 V / 200 mA
  (load ≥ 80 Ω)
- **12 Digital inputs** (TTL) on sensor box sites A and B (at present only used for automatic sensor box detection)
- **6 Digital outputs** (TTL) on sensor box sites A and B (at present only used for automatic switching of a sensor box measuring range)
- **1 USB-port** for connection to a computer
- **1 CASSY bus** for connecting additional CASSY modules
- Dimensions (WxHxD): 115 mm x 295 mm x 45 mm
- Weight: 1.0 kg

Scope of supply:
1 Sensor-CASSY 2
1 CASSY Lab 2 software, without activation code,
with comprehensive help
function (20 full-functionality sessions
free, then usable as demo version)
1 USB cable
1 Plug-in supply unit 230 V, 12 V / 1.6 A
and
CASSY Lab 2 (524 220)
Improved development of the successful CASSY Lab software for recording and evaluating measurement data acquired using the CASSY family, with comprehensive integrated help functionality and many operable experiment examples

- Supports up to 8 Sensor-CASSYs 2, Sensor-CASSYs and Power-CASSYs at a USB-port respectively at one serial interface
- Supports Pocket-CASSYs or Mobile-CASSYs at different USB-ports
- Supports Joule and Wattmeter and Universal Measuring Instruments Physics, Chemistry and Biology
- Supports all CASSY sensor boxes
- Additionally supports numerous devices via the serial interface (e.g. VideoCom, IRPD, balance)
- „Plug and play" enabled for easy use: the software automatically detects the connected CASSYs and sensor boxes and displays these graphically, inputs and outputs are activated simply by pointing and clicking and typical experiment parameters are automatically loaded (depending on the connected sensor box)
- Measurement data can be displayed in the form of analog/digital instruments, tables and/or diagrams (also simultaneously, with user-definable axis assignment)
- Measured values can be recorded manually (at keystroke) or automatically (choice of time interval, measured time, lead time, trigger or additional measurement condition)
- Powerful evaluation functions including various fits (straight line, parabola, hyperbola, exponential function, free fitting), integrals, diagram labeling, calculation of user-definable formulas, differentiation, integration, Fourier transforms
- Experiment files in XML-data format (can also import experiment files which are prepared with CASSY Lab 1)
- Convenient exporting of measurement data and diagrams via the clipboard
- „Logbook" function lets you briefly document other experiment information in the experiment file
- Complete with more than 150 experiment examples from physics, chemistry and biology with detailed descriptions
- Graphical display of CASSY, sensor box and connector allocation when the experiment file is loaded
- Free updates and demo version available through our inernet homepage
- PC Requirements: Windows XP/Vista/7, free USB-port (USB apparatus) resp. free serial interface (serial apparatus), supports multicore processor

524 013S	Sensor-CASSY 2 Starter

Sensor-CASSY 2 Starter, Automotive

Package consist of:
Sensor-CASSY 2 (524 013)
Cascadable interface device for recording measurement data

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- Sensor CASSY 2 and Power CASSY can be mixed cascadable
- 3-fold electrical isolation (4-mm-inputs A and B, relay R)
- Measurement possible parallel at 4-mm-inputs and sensor box connector sites (4 channels)
- Cascading of up to 8 CASSY module possible (to expand the inputs and outputs)
- Up to 8 analog inputs per Sensor-CASSY retrofittable using sensor boxes
- Automatic sensor box detection (plug and play) by CASSY Lab 2 (524 220)
- Microprocessor-controlled with CASSY operating system (easily updatable via software for function enhancements)
- For use as a benchtop, console or demonstration unit (also in CPS/TPS panel frames)
- Voltage supply 12 V AC/DC via cannon plug or adjacent CASSY module
- Developper Information and LabVIEW™ driver available through our internet homepage
- and **a licence for the automotive-diagnostic-software, 739 589**

- *Scope of supply:*
  1 Sensor-CASSY 2
  1 CASSY Lab 2 software, without activation code,
  with comprehensive help
  function (20 full-functionality sessions
  free, then usable as demo version)
  1 USB cable
  1 Plug-in supply unit 230 V, 12 V / 1.6 A

524 013SKFZ	Sensor-CASSY 2 Starter, Automotive

Current Source Box

For operating any sensor in which the resistance changes as a function of the physical quantitiy, e.g. LDR, NTC, PTC resistors.
Measuring ranges: 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ
Saturation voltage: 10 V
Connections: 4-mm-sockets

524 031	Current Source Box

Timer box

Sensor box with two TTL and light barrier inputs for CASSY (technical data for the inputs see timer inputs from Sensor- or Pocket-CASSY.
Input E can be used as a counter, timer and frequency input
Both inputs E and F can be used as timer inputs for measuring the time between selected edges (e.g. measuring the transit time from E to F, measuring the obscuration time at E and/or F)
Connections: two 6-pin sockets (for 501 16) and three 4-mm-sockets

524 034	Timer box

30 A box

For electrically isolated current measurement in extra-low voltage circuits
Contact resistance: <0.01 Ω
Measuring ranges: ±1 A, ±3 A, ±10 A, ±30 A
Measurement error: ±1.5 %
Connection: 4-mm-sockets
Dimensions: 42 mm x 92 mm x 30 mm
Mass: 100 g.

524 043	30 A box

Temperature sensor S, NTC

For direct connection to the Sensor-CASSY, incl. NTC-sensor in the stainless steel tube.
Measuring range: -20°C ... 120°C
Resolution: 0.1°C
Dimensions (without sensor): 70 mm x 50 mm x 25 mm
Weight: 100 g

524 044	Temperature sensor S, NTC

Optical power sensor S

Sensor to be put on the Pocket-CASSY (524 006), Mobile-CASSY (524 009) or Sensor-CASSY (524 013). This sensor allows the measurement of the absolute and relative optical power in dBm/dB. By use of Pocket-CASSY or Sensor-CASSY and the software CASSY Lab the measuring data can be transferred comfortably in the PC, explained and evaluate.
Sensor: Si (7 mm^2)
Connections: FSMA, unmanufactured fibers PMMA (2.2 mms) about provided adaptor
Wavelengths: 665, 820 nm
Measuring area absolutely:-5 ...-55 dBm
Measuring area relatively: 50...-50 dB
Resolution: 0.1 dB
Absolute exactness: 1 dB
Dimensions: 50 mm x 25 mm x 60 mm
Mass: 0.1 kg

524 0512	Optical power sensor S

UIP-Sensor S

for simultaneous and potential-free measurement of voltage U and current I as well as their effective values with Pocket-CASSY or Mobile-CASSY.
Voltage measurement:
Measuring ranges: ±0.1 V, ±0.3 V, ±1 V, ±3 V, ±10 V, ±30 V
Measurement error: ±1 % plus 0.5 % of the range limit value
Input resistance: 0.8 MΩ
Current measurement:
Measuring ranges: ±0.1 A, ±0.3 A, ±1 A, ±3 A
Measurement error: ±2 % plus 0.5 % of the range limit value
Input resistance: < 0.5 Ω (except by overload)
Overload protection: automatically put back fuse
Potential difference: 40 V max. (between U and I)
Scanning frequency:
with Pocket-CASSY:
approx. 8000 values/s (single-channel),
approx. 2000 values/s per channel (two-channel)
with Mobile-CASSY: approx. 5 values/s
Dimensions (WxHxD): 50 mm x 25 mm x 60 mm
Weight: 0.1 kg

524 0621	UIP-Sensor S

Pressure sensor S, ± 2000 hPa

For relative pressure measurements with CASSY. Connection to the experiment via two hose nozzles (4 mm Ø). Incl. PVC tubing (667 192) and two connectors with nipple (604 520).
Measuring ranges: ±20 hPa, ±60 hPa, ±200 hPa, ±600 hPa, ±2000 hPa
Resolution: 0.05 % of the measuring range
Dimensions: 70 mm x 50 mm x 25 mm
Weight: 75 g

524 064	Pressure sensor S, ± 2000 hPa

AUTO-BOX i

For measuring automotive related signals using the inductive-type pulse pick-up (738986) and the workshop TDC pick-up (738989). Additionally, a PWM input can be used for determination of the pulse width and the frequency of a square wave signal or the fuel injector signal.
Measuring ranges:
* Speed 700 ... 6000 rpm
* Ignition angel -50 ... +20 °KW
* Duty cycle 0 ... 100 %
* On/Off switching time: 0...100 ms
* Frequency: 0...1000 Hz
* Injection time 0 ... 20 ms
Sockets:
* TDC pick-up 3 pole with bayonet catch
* Inductive pulse 3 pole with screw catch
* PWM/ti two 4 mm safety sockets
CASSYLab software required!

524 076	AUTO-BOX i

AUTO-BOX Z

Provides a means to measure the primary and secondary voltages in vehicle ignition systems. Primary voltage is sensed directly across two 4 mm safety sockets. Secondary voltage is measured indirectly over a capacitive clip (738987).
Measuring ranges:
* Primary voltage: -200...+600 V
* Secondary voltage: -2...+15 kV
* Dwell period: 0...100 %
* Speed: 0...7000 rpm
Sockets:
* Capacitive pick-up via 3-pole DIN socket with bayonet catch
* Primary voltage via two 4 mm safety sockets
CASSYLab software required!

524 077	AUTO-BOX Z

CAN bus box

Provides a connection to a CAN bus (class B) for oscilloscope recording as well as for evaluating the signal; triggering possible on a freely selectable identifier with simultaneous protocol analysis. Includes optical indicator for CAN bus errors (LED).

Technical Specifications:
Connection: 4 mm safety sockets

524 078	CAN bus box

LIN bus box

Provides a connection to a LIN bus for oscilloscope recording as well as for evaluation of the message signal; triggering on a freely selectable identifier with simultaneous protocol analysis.

524 081	LIN bus box

Multimeter METRAmax 12

With digital and analog display in LCD field, measured-value storage, acoustic warning signal when range end value is exceeded, automatic battery cut-out after approx. 30 min.
5 voltage measuring ranges: 400 mV to 600 V AC/DC
Internal resistance: 10 to > 20 MOhm, switchable to 400 kOhm
Overload rating: 720 V
3 current measuring ranges: 40 mA to 10 A AC/DC
Overload ratings: 0.48 A, 12 A
6 resistance measuring ranges: 400 Ohm to 40 MOhm, with continuity tester
Diode tester: 3 V
5 capacitance measuring ranges: 4 nF to 40 µF
5 frequency measuring ranges: 100 Hz to 400 kHz
LCD field: 50 mm x 30 mm
Digital display: 3 ½ digits = 3999 steps
Digit height: 10 mm,
analog indicator (bar) - scale length: 40 mm
Dimensions: 92 mm x 154 mm x 25 mm
Weight: approx. 0.2 kg

531 090	Multimeter METRAmax 12

Multimeter LDanalog 20

High overload-capacity measuring instrument with integrated protection against damage due to improper handling; specially designed for student's and practical experiments. The moving coil instrument is protected against damage with two anti-parallel diodes. Automatic battery cut-out after approx. 45 min.
DC voltage ranges: 8 ranges: 0.1 V ... 300 V
AC voltage ranges: 5 ranges: 3 V ... 300 V
DC current ranges: 6 ranges: 0.1 mA ... 3 A
AC current ranges: 6 ranges: 0.1 mA ... 3 A
Input resistance: 10 MΩ
Accuracy: Class 2 (=) / 3 (~)
Zero point: left/Center (switchable)
Mirror scale: yes
Battery (in scope of delivery): 9 V/IEC 6 F 22 (200 72 583)
Overload capacity/Fuses: Fuses F 3.15 A/300 V
Dimensions: 10 cm x 14 cm x 3.5 cm
Weight: 270 g

531 120	Multimeter LDanalog 20

Digital Multimeter 3340

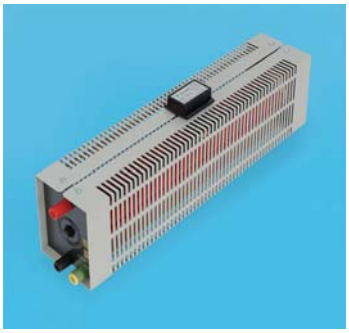
- Safety: IEC-1010-1; CAT II 1000 V
- 39 mm, 3 ¾ digit LCD display; max. indication: 4000, with backlight
- Auto power off, Auto ranging
- Data hold function, Relative mode
- Continuity test and diode test
- Accessories: Test leads, Type-K- Thermocouple probe, battery and operation manual in German and English

DC voltage: 400 mV/4/40/400/1000 V
- 0.1 mV; ± 0.5% + 2 dgt.
AC voltage: 4/40/400/700 V
- 1 mV; ± 1.2% + 3 dgt.
DC current: 400 µA/4/40/400 mA/4/20 A
- 0.1 µA; ± 1% + 3 dgt.

AC current: 400 µA/4/40/400 mA/4/20 A
- 0.1 µA; ± 1.5% + 5 dgt.
Resistance: 400 Ω/4/40/400 kW/4/40 MΩ
- 0.1 Ω; ± 1% + 2 dgt.
Capacitance: 40/400 nF/4/40/100 µF
- 10 pF; ± 3% + 5 dgt.
Frequency: 5/50/500 Hz/5/50/500 kHz/5 MHz
- 0.001 Hz ± 1.2% + 3 dgt.
Temperature: -20°C...+760°C
± 1°C; ± 3% + 3 dgt.
Operating Voltage: 9 V Battery
Dimensions (W x H x D): 92 x 195 x 38 mm
Weight: 380 g

531 183	Digital Multimeter 3340

Rheostat 10 Ohm



Resistance wires wound on a special cement core, perforated cover for touch protection, electrical connections via three safety sockets allowing applications as fixed resistor, variable resistor and potentiometer.
Connection: 4-mm safety sockets
Resistance: 10 Ω
Current:
constant: up to 5.7 A
maximum: 8.0 A (15')
Dimensions: 450 x 95 x 150 mm

537 32	Rheostat 10 Ohm

Iron wire, 0.20 mm Ø, 100 m

For measuring the electric resistance as a function of material, length and cross-section. On reels, can be cut to length.
Material: Iron
Length: 100 m
Diameter: 0.20 mm
Cross-sectional area: 0.03 mm^2
Resistance/m: 3.3 Ω
Specific resistance: 0.1 Ω x mm^2 x m^{-1}

550 51	Iron wire, 0.20 mm Ø, 100 m

Plug-in power supply 12 V AC

Primary: 230 V AC, 50/60 Hz
Secondary: 12 V AC, 20 VA
Connection: female

562 791	Plug-in power supply 12 V AC

Model ignition system

For demonstrating how an igniton spark is generated between the contacts of a spark plug and the ignition of an air-fuel mixture. Training panel with ignition coil, spark plug and interruptor; transparent explosion tube with stopper.
Dimensions: 20 cm x 29.7 cm x 18 cm
Connection: 12 V/4 A DC with 4-mm-socket

562 901	Model ignition system

Storage tray for ELM apparatus

Specially moulded;
Dimensions: 55 cm x 28.5 cm x 5 cm

563 04	Storage tray for ELM apparatus

ELM Pole piece for magnets

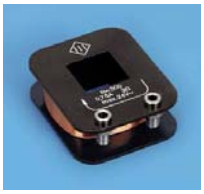
For assembly with a pair of magnets; with Allen screw M6 x 35;
Dimensions: 83 mm x 60 mm x 9 mm

563 091	ELM Pole piece for magnets

ELM Wide pole piece for coils

With spigot; for use with coils;with Allen screw M6 x 35; Dimensions: 83 mm x 60 mm x 30 mm

563 101	ELM Wide pole piece for coils



ELM Coil 500 turns

For use with pole pieces.
Current: 0.7 A
Connection: 4-mm sockets
Dimensions: 50 mm x 60 mm x 20 mm

563 115	ELM Coil 500 turns

ELM Brush

Hard carbon contact with press-on spring and 4-mm plug; for use in brush holder. Current: max. 1.5 A

563 13	ELM Brush

Allen wrench

For fastening the pole piece with a magnet or a coil to a base plate.

563 16	Allen wrench

ELM Centering disc

For optimizing the distance between the pole pieces and rotors.

563 17	ELM Centering disc

Brush holder

For 5 brushes; for attachment of the rotors to the axle on the base board; complete with retaining screw.

563 18	Brush holder

ELM Magnet rotor

With permanent magnets and belt disc; Rotor: D = 90 mm

563 19	ELM Magnet rotor

EMTM Magnet rotor 4 pole

With 4 permanent magnets and belt disc

563 191	EMTM Magnet rotor 4 pole

ELM Two-pole rotor

Twin T armature with belt disc;
Number of turns: 2 x 380; current: max. 1.5 A;
Speed: max. 5000 min^{-1};
Rotor: D = 90 mm

563 22	ELM Two-pole rotor

ELM Rotating field attachment

With two threaded holes for the atachment of magnets and magnetic pole pieces for the generation of a rotating magnetic field. The short-circuit ring can be attached to the collectors of the coil rotors so that these then operate as short-circuits rotors Lenght: 175 mm

563 25	ELM Rotating field attachment

ELM Magnetic needle rotor

For detection of a slowly rotating magnetic field; L = 90 mm

563 28	ELM Magnetic needle rotor

ELM Aluminium ring with iron disc

Rectangular frame with pivot bearing and matching iron disk. Model of a short-circuit rotor; D = 90 mm

563 29	ELM Aluminium ring with iron disc

Oil 100 ml in dropping bottle

Acid-free machine oil.

563 31	Oil 100 ml in dropping bottle

Wrapping plate for wires

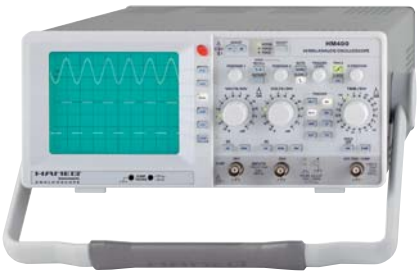
for mechanical fixture and electrical connection of resistance wires on the plug-in board.Made of heat-resistant material,with toothed edges for defined number of windings.Wire fixture at the ends by knurled-head screws.
Wire length: up to 2 m
Number of turns: 25
Connection: via 4-mm plugs
Dimensions:16.5 cm x 4 cm x 3.5 cm

567 18	Wrapping plate for wires

Two-channel oscilloscope 400

Bandwidth: 0...40 MHz (-3 dB)
Input impedance: 1 MOhm, 15 pF, max. 400 V
Screen: 8 x 10 cm with internal graticule
Vertical deflection: 1 mV/cm...20 V/cm (14 steps)
Time base: 0.1 µs/cm...0.2 s/cm (20 steps),
with X-magnification x10 to 10 ns/cs
Trigger sources: Ch1, Ch2, line, ext.
Operating modes:
Ch1, Ch2, Ch1+Ch2 (alternate or chopped), Ch1/Ch2 sum or difference, Ch2 inv., XY-Mode
Built-in component tester
Dimensions: 28.5 x 12.5 x 38.0 cm (WxHxD)
Mains supply: 105...253 V, 50/60 Hz ±10%, Cat II
Without probes

575 212	Two-channel oscilloscope 400



Probe 100 MHz, 1:1 / 10:1

Switchable; including spring loaded hook tip, trimmer key, BNC adapter, probe tip, insulating covering, ground lead and 4-mm plug.
Input impedance: 1 MOhm / 10 MOhm
Bandwidth: 10 MHz / 100 MHz
Connection: BNC plug
Cable length: 1.2 m

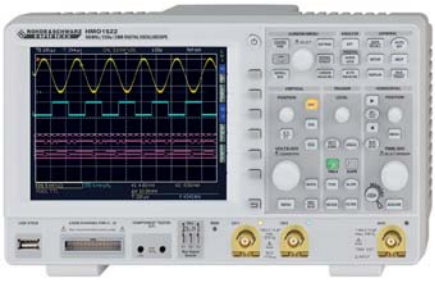
575 231	Probe 100 MHz, 1:1 / 10:1

Screened cable BNC/4 mm plug

Coax cable with separate connection plug for shield.
Length: 1.15 m
Impedance: 50 Ohm
Cable capacitance: 120 pF

575 24	Screened cable BNC/4 mm plug

Digital Storage Oscilloscope 1522



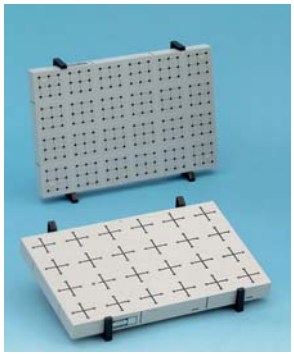
Frequency range: 0...150 MHz (-3 dB)
Input impedance: 1 MΩ, 14 pF, max. 200 V
Display: 16.5 cm (6.5") VGA Color TFT
Storage modes: refresh, average, envelope, Peakk-detect, Roll (unsolicited/triggered), filter, HiRes
Cursor measurements: □U, □t, □f , peak to peak, average, effektive, ...
Dual USB B/RS 232, 2 x USB A
Vertical amplifier: 1 mV/div. ... 10 V/div. (12 steps)
Offset: ± 0.2 ... ± 20 V
DC-amplifiersaccuracy: 2 %
Timerange: 2 ns/div. ... 50 s/div.
Accuracy: 50 ppm
Triggering: Ch1, Ch2, Ch1 alt. Ch2, line and external
Resolution: vert. 25 points/cm, horiz. 200 points/cm
Component tester, Frequency with FFT
Connection voltage: 100...240 V, 50/60 Hz, Cat II
Safety I (EN61010-1)
Dimensions: 28.5 x 17.5 x 14.0 cm
Weight: 2.5 kg

575 299	Digital Storage Oscilloscope 1522

Plug-in board section STE

section of a rastred socket panel for introductory students experiments with the plug-in system;
2 socket areas with two conducting crosses and 10 sockets, Dimensions: 10 cm x 5 cm x 2.4 cm

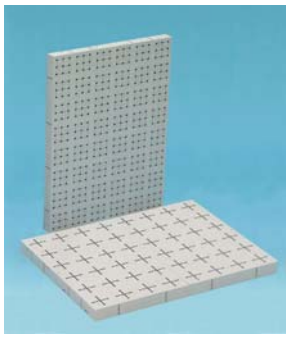
576 71	Plug-in board section STE



Plug-in board DIN A4, STE

for clearly arranged assembly of electrical circuits with plug-in units (STE).
24 symmetrically arranged socket areas with
24 conducting crosses and 120 4-mm sockets on the front side, as well as 24 conducting squares and 216 4-mm sockets on the rear side
Dimensions: 30 cm x 20 cm x 2.4 cm

576 74	Plug-in board DIN A4, STE



Plug-in board DIN A3, STE

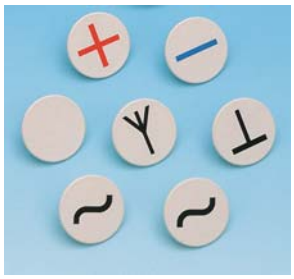
for clearly arranged assembly of electrical circuits with plug-in units (STE); 48 symmetrically arranged socket areas with 48 conducting crosses and 240 4-mm sockets on the front side, as well as 48 conducting squares and 432 4-mm sockets on the rear side.
Dimensions: 40 cm x 30 cm x 2.4 cm

576 75	Plug-in board DIN A3, STE

Board holders STE, pair

for inclined and vertical arrangement of DIN A4 size rastered socket panels

576 77	Board holders STE, pair



Plug-in symbols, set of 10

Round plastic labels with plastic pins and graphic symbols on the front for labelling the measuring points in experimental circuits. The labels are fixed on the plugs of the connecting leads.
Symbols: A, V, +, -, 2x ~, earth, antenna, 2x blank plates for making one's own symbols
Symbol plate: 3.5 cm Ø
Pins: for 4-mm sockets

576 791	Plug-in symbols, set of 10

Monocell holder STE 2/50

Plug-in unit 2/50
Dimensions: 7 x 3.8 x 4.7 cm

576 86	Monocell holder STE 2/50

Empty housing STE

For auto-equipment with electronic components; only for low voltage, with 4 mm plugs. Without impression.

Cat.No	Designation	Useful internal measurements	Plug spacing	max. load	Supply package
576 92	Plug-in units empty, STE 2/19, set of 10	30 mm x 13 mm x 26 mm	19 mm	2 W	10 base plates with two 4-mm plugs built into each 10 clamp-fit housing covers
580 15	Plug-in units empty, STE 2/50, set of 5	57 mm x 28 mm x 26 mm	50 mm	4 W	5 plates with two 4-mm plugs and threaded pieces each 10 solder lugs 5 clamp-fit housing covers
576 94	Plug-in units empty, STE 4/50, set of 5	57 mm x 57 mm x 26 mm	50 mm	5 W	5 plates with four 4-mm plugs and threaded pieces each 20 solder lugs 5 clamp-fit housing covers
580 16	Empty housing STE 4/100, set of 5	110 mm x 110 mm x 26 mm	100 mm	10 W	5 plates with four 4-mm plugs and threaded pieces each 20 solder lugs 5 clamp-fit housing covers

Resistors, STE 2/19

Cat.No	Resistor	Rating	Tolerance
577 15	0.1 Ω	2 W	5 %
577 16	0.22 Ω	2 W	10 %
577 18	0.68 Ω	2 W	10 %
577 19	1 Ω	2 W	5 %
577 21	5.1 Ω	2 W	5 %
577 20	10 Ω	1.4 W	5 %
577 23	20 Ω	2 W	5 %
577 24	22 Ω	2 W	5 %
577 28	47 Ω	2 W	5 %
577 30	62 Ω	2 W	5 %
577 33	82 Ω	2 W	5 %
577 32	100 Ω	2 W	5 %
577 321	120 Ω	0.5 W	2 %
577 34	150 Ω	2 W	5 %
577 35	200 Ω	2 W	5 %
577 36	220 Ω	2 W	5 %
577 38	330 Ω	2 W	5 %
577 40	470 Ω	1.4 W	5 %
577 41	510 Ω	1.4 W	5 %
577 42	680 Ω	2 W	5 %
577 43	820 Ω	2 W	5 %
577 44	1 kΩ	2 W	5 %
577 45	1.2 kΩ	2 W	5 %
577 46	1.5 kΩ	2 W	5 %
577 47	1.8 kΩ	2 W	5 %
577 48	2.2 kΩ	2 W	5 %
577 486	2.7 kΩ	2 W	5 %
577 50	3.3 kΩ	2 W	5 %
577 51	3.9 kΩ	2 W	5 %
577 52	4.7 kΩ	2 W	5 %

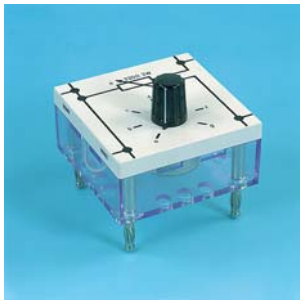
Cat.No	Resistor	Rating	Tolerance
577 53	5.6 kΩ	2 W	5 %
577 55	6.8 kΩ	2 W	5 %
577 56	10 kΩ	0.5 W	1 %
577 58	15 kΩ	0.5 W	1 %
577 59	20 kΩ	0.5 W	5 %
577 60	22 kΩ	0.5 W	1 %
577 606	27 kΩ	0.5 W	1 %
577 61	33 kΩ	0.5 W	1 %
577 62	39 kΩ	0.5 W	1 %
577 087	40.2 kΩ	0.5 W	1 %
577 64	47 kΩ	0.5 W	1 %
577 657	68 kΩ	0.5 W	1 %
577 096	80.6 kΩ	0.5 W	1 %
577 69	82 kΩ	0.5 W	1 %
577 68	100 kΩ	0.5 W	1 %
577 70	150 kΩ	0.5 W	1 %
577 71	220 kΩ	0.5 W	1 %
577 73	330 kΩ	0.5 W	1 %
577 74	470 kΩ	0.5 W	1 %
577 75	680 kΩ	0.5 W	1 %
577 76	1 MΩ	0.5 W	1 %
577 78	10 MΩ	0.5 W	2 %
577 00	100 MΩ	0.7 W	1 %
577 02	1 GΩ	0.5 W	5 %
577 03	10 GΩ	0.5 W	10 %

Regulation resistors, STE 2/19

Adjustable by knurl.

Cat.No	Resistor	Rating
577 79	1 kΩ	1 W
577 81	4.7 kΩ	1 W
577 80	10 kΩ	1 W
577 82	47 kΩ	1 W
577 83	100 kΩ	1 W
577 86	470 kΩ	1 W

Potentiometer, STE, 4/50



Linear adjustment with indicator knob and graduation, usable as adjustable resistance, voltage divider and alternating current generator.

Cat.No	Resistor	Rating
577 90	220 Ω	3 W
577 91	470 Ω	3 W
577 92	1 kΩ	1 W
577 95	4.7 kΩ	1 W
577 925	10 kΩ	1 W
577 94	22 kΩ	0.5 W
577 945	47 kΩ	1 W
577 96	100 kΩ	1 W
577 964	1 MΩ	1 W

Resistance decade 10 Ohm...11.1 kOhm, STE 4/50/100

plug-in unit 4/50/100; with three individually adjustable pointer knobs and decade scales, can be used singly and in combination; adjustment ranges:
a) 0 to 10 x 10 Ohm, 200 mA max.
b) 0 to 10 x 100 Ohm, 65 mA max.
c) 0 to 10 x 1 kOhm, 20 mA max.

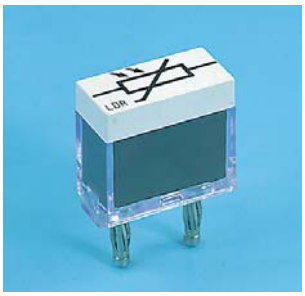
577 97	Resistance decade 10 Ohm...11.1 kOhm, STE 4/50/100

VDR resistor STE 2/19

plug-in unit 2/19; voltage dependent.
Characteristic voltage at 1 mA (DC): 8.2 V ± 30%

578 00	VDR resistor STE 2/19

Photoresistor LDR 05, STE 2/19



Plug-in unit 2/19; illumination dependent CdS photoresistor.
Bright resistance: 100 Ω approx.
Dark resistance: 10 MΩ approx.
Dissipated power: 0.2 W max.

578 02	Photoresistor LDR 05, STE 2/19

NTC resistor 150 Ohm, STE 2/19

plug-in unit 2/19; temperature dependent
resistance at 25 °C: 150 Ohm
resistance at 100 °C: 14 Ohm

578 03	NTC resistor 150 Ohm, STE 2/19

NTC probe 4.7 kOhm, STE 2/19

plug-in unit 2/19; thermistor in rod-type probe at the end of a 40 cm long cable.
Resistance at 25 °C: 4.7 kΩ
Resistance at 100 °C: 280 Ω
Dissipated power: 0.5 W max.

578 04	NTC probe 4.7 kOhm, STE 2/19

NTC resistor 2.2 kOhm, STE 2/19

Plug-in unit 2/19; thermistor with external rod-type sensor.
Resistance at 25 °C: 2.2 kOhm
Resistance at 100 °C: 120 Ohm
Dissipated power: 0.45 W

578 05	NTC resistor 2.2 kOhm, STE 2/19

PTC probe 30 Ohm, STE 2/19

plug-in unit 2/19; PTC-resistor in rod-type probe at the end of a 40 cm long cable.
Resistance at 25 °C: 30 Ω
Resistance at 100 °C: >10 kΩ
Dissipated power: 1 W max.

578 06	PTC probe 30 Ohm, STE 2/19

PTC resistor 100 Ohm, STE 2/19

plug-in unit 2/19; temperature dependent
Resistance at 25 °C: 100 Ω
Max. temperature: 150°c

578 07	PTC resistor 100 Ohm, STE 2/19

Capacitors, STE 2/19

Cat.No	Capacitor	Tolerance	max. permissible voltage
578 182	4.7 pF	10 %	500 V
578 19	10 pF	20 %	160 V
578 20	22 pF	20 %	160 V
578 21	47 pF	20 %	160 V
578 22	100 pF	20 %	630 V
578 23	220 pF	20 %	160 V
578 24	470 pF	20 %	160 V
578 25	1 nF	20 %	160 V
578 252	1.5 nF	10 %	100 V
578 26	2.2 nF	20 %	160 V
578 262	3.3 nF	10 %	100 V
578 27	4.7 nF	5 %	100 V
578 28	10 nF	20 %	100 V
578 10	10 nF	5 %	250 V
578 09	22 nF	20 %	100 V
578 11	47 nF	5 %	100 V
578 31	0.1 µF	20 %	100 V
578 13	0.22 µF	5 %	250 V

Cat.No	Capacitor	Tolerance	max. permissible voltage
578 33	0.47 µF	20 %	100 V
578 35	1 µF	20 %	100 V
578 15	1 µF	5 %	100 V
578 36	2.2 µF	5 %	63 V
578 16	4.7 µF	5 %	63 V
578 37	10 µF Elko	20 %	35 V
578 34	22 µF Elko	20 %	16 V
578 38	47 µF Elko	20 %	40 V
578 39	100 µF Elko	20 %	40 V
578 392	100 µF Elko bipolar	20 %	40 V
578 41	220 µF Elko bipolar	20 %	16 V
578 40	470 µF Elko	20 %	16 V

Diodes STE

Cat.No	Designation
578 43	Light emitting diode red, 220 Ohm, STE 2/19
578 44	Diode BY 255, STE 2/19
578 45	Z-Diode 3.9, 2 W, STE 2/19
578 46	Z-Diode 6.2, 2 W, STE 2/19
578 47	Light emitting diode yellow, STE 2/19
578 48	Light emitting diode red, STE 2/19
578 483	LED for light waveguide, STE 2/19
578 49	Infrared diode lateral, STE 2/19
578 50	Diode AA 118, Germanium, STE 2/19
578 51	Diode 1N 4007, STE 2/19
578 52	Varicap diode BB 212, STE 4/50
578 53	Z-Diode 3.3, STE 2/19
578 54	Z-Diode 9.1, STE 2/19
578 55	Z-Diode 6.2, STE 2/19
578 553	Z-Diode 5.6, STE 2/19
578 554	Z-Diode 8.2, STE 2/19
578 56	Z-Diode 18, STE 2/19
578 57	Light emitting diode green, STE 2/19
578 58	Light emitting diode red, lateral, STE 2/19
578 59	Diac D 3202 Y, STE 2/19
578 60	Diode SKN 2.5/0.8, STE 2/19

OWG coupler

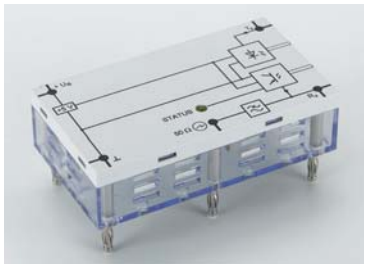
STE 4/50 element; Plexiglas coupling for optical waveguides (2.3 mm diameter) for the simulation of coupling faults and for demonstrating the aperture angle.

578 485	OWG coupler

STE MOST Transceiver

STE 6/50/100 element; MOST transceiver for the connection of typical car multimedia components with status LED and electrical transformation of the MOST signal for measuring using an oscilloscope.

578 486	STE MOST Transceiver



Phototransistor lateral, STE 2/19

Plug-in unit 2/19, without a base terminal, to serve as a light-sensitive switch in light barriers. Equipped with a side window.
Operating voltage: max. 32 V
Current load: max. 100 mA
Power dissipation: max. 300 mW

578 61	Phototransistor lateral, STE 2/19

Phototransistor STE 2/19

Plug-in unit 2/19. Phototransistor used as a light-sensitive switch.
Photosensitivity: 420 - 1130 nm, maximum at 850 nm
Operating voltage: 35 V max.
Current: 50 mA max.
Dissipated power: 200 mW max.

578 611	Phototransistor STE 2/19

Phototransistor for light waveguide, w/o base, STE 2/19

Plug-in element STE 2/19. Receiver transistor without base terminal, with special design for plugging in the light wave-guides (579 44). The integrated lens and design-based preset adjustment result in high coupling power with the waveguide.
Photosensitivity: max. at 850 nm
spectral range: 400 nm...1100 nm
Current I_C: max. 50 mA
Voltage U_{CE}: max. 50 V
Power loss P_{tot}: max. 200 mW

578 612	Phototransistor for light waveguide, w/o base, STE 2/19

Phototransistor for light waveguide, STE 4/50

Plug-in element STE 4/50. With base connection for investigating the electrical properties as a function of illumination. Transistor with special design for plugging in the light waveguides (579 44), so that this component can be illuminated using the transmitter diodes (578 482/483).
Photosensitivity: max. at 850 nm
spectral range: 400 nm...1100 nm
Current I_C: max. 50 mA
Voltage U_{CE}: max. 50 V
Power loss P_{tot}: max. 200 mW
Current gain: 500

578 613	Phototransistor for light waveguide, STE 4/50

Photodiode for light waveguide, STE 2/19

Plug-in element 2/19. For investigating the electrical properties as a function of illumination. Diode with special design for plugging in the light wave-guides, so that this component can be illuminated using the transmitter diodes (578 482/483).
Photosensitivity: max. at 850 nm
spectral range: 400 nm...1100 nm
Reverse voltage: 30 V
Power loss: max. 100 mW

578 615	Photodiode for light waveguide, STE 2/19

Solar cell STE 2/19

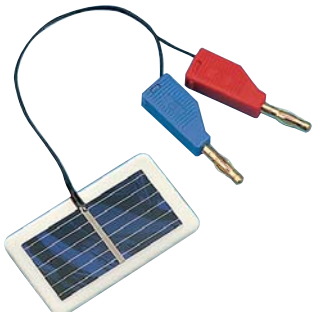
Silicon solar cell shielded against ambient light and equipped with a side window for entry of light beams.
Photosensitive area: 1.8 cm²
Open-circuit voltage: 0.5 V
Short-circuit current: 13 mA

578 62	Solar cell STE 2/19

Solar cell 0.5 V/0.3 A

Silicon semiconductor element for converting radiant energy into electrical energy.
Light-sensitive surface area: 2,5 cm x 5 cm (12.5 cm^2)
No-load voltage: 0.5 V
Short-circuit current: 0.3 A

578 622	Solar cell 0.5 V/0.3 A



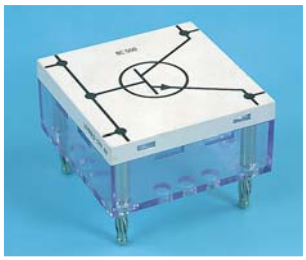
Solar module 2 V/0.3 A, STE 4/100

Plug-in unit 4/100, with four pairs of series connected silicon solar cells; for conversion of light in to electrical energy.
Light-sensitive area: 50 cm^2
No-load voltage per pair: 1 V
Short-circuit current per pair: 0.3 A
External series connection: 2 V / 0.3 A
External parallel connection: 1 V / 0.6 A

578 63	Solar module 2 V/0.3 A, STE 4/100

Transistors, STE 2/50

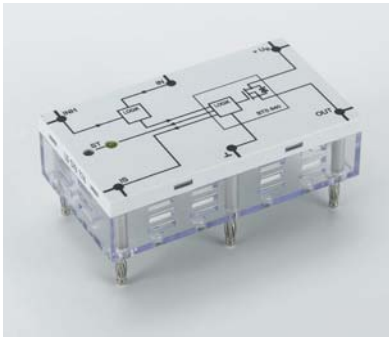
Cat.No	Designation
578 65	Transistor BD 130, NPN, e.b., STE 4/50
578 67	Transistor BD 137, NPN, e.b., STE 4/50
578 68	Transistor BD 138, PNP, e.b., STE 4/50
578 69	Transistor BC 550, NPN, e.b., STE 4/50
578 70	Transistor BC 560, PNP, e.b., STE 4/50
578 71	Transistor BC 550, NPN, e.t., STE 4/50
578 72	Transistor BC 560, PNP, e.t., STE 4/50
578 74	Transistor BD 138, PNP, e.t., STE 4/50
578 755	Transistor (MOSFET) BUZ 73, STE 4/50
578 76	Transistor BC 140, NPN, e.b., STE 4/50
578 761	Transistor BC 160, PNP, e.b., STE 4/50
578 77	Transistor (field effect) BF244, STE 4/50



Power Switch BTS640 12 A/12

STE 6/50/100 plug and socket element; intelligent power semiconductor (IPD) BTS 640 for switching ohmic resistances, inductive or capacitative loads in car applications
Ub = 5 ... 34 V
IL(ISO) = 12.6 A

578 774	Power Switch BTS640 12 A/12



Transistor (Darlington) TIP 162, STE 4/50

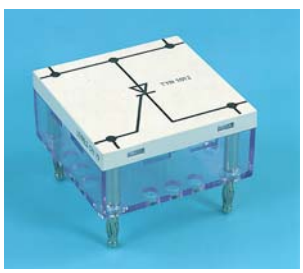
plug-in unit 4/50; NPN transistor combination
for sensor switches;
current gain: 200 approx.;
max. dissipated power: 3 W

578 78	Transistor (Darlington) TIP 162, STE 4/50

Thyristor TYN 1012, STE 4/50

Plug-in unit 4/50. For use as a controllable rectifier, zero-crossing switch and in phase clipping control circuits.
On-state current: 8 A

578 79	Thyristor TYN 1012, STE 4/50



Triac BT 137/800, STE 4/50

Plug-in element 4/50. Used in conjunction with a diac for phase-angle control and as a controlled AC switch.
On-state current: 3 A

578 811	Triac BT 137/800, STE 4/50

Forked light barrier STE 4/50

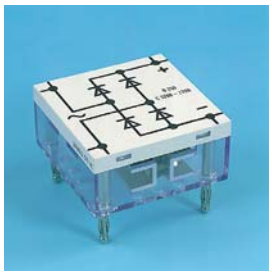
Plug-in element STE 4/50, for experiments on the function and application of a light barrier.
Fork width: 4 mm
Transmitter: infrared diode
Conducting-state current: max. 50 mA
Receiver: NPN phototransistor
Power loss: max. 100 mW
Supply voltage: 5 V DC

578 835	Forked light barrier STE 4/50

Op-amp LM 7805, STE 4/50

plug-in element 4/50

578 861	Op-amp LM 7805, STE 4/50



Bridge rectifier B250/C3700, STE 4/50

plug-in unit 4/50; power full-wave
bridge rectifier; reverse volatge: 250 V;
continuous forward current: 2.2 A max.

578 92	Bridge rectifier B250/C3700, STE 4/50

High Frequency coil 150 µH, STE 2/19

579 031	High Frequency coil 150 µH, STE 2/19

Lamp holder E10, lateral, STE 2/19

Plug-in unit 2/19

579 05	Lamp holder E10, lateral, STE 2/19

Lamp holder E10, top, STE 2/19

plug-in unit 2/19

579 06	Lamp holder E10, top, STE 2/19

Transistor socket 3 pin, STE 4/50

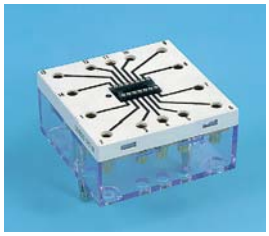
plug-in unit 4/50 with three-pole socket
and transistor symbol for mounting of
ordinary transistors

579 07	Transistor socket 3 pin, STE 4/50

IC socket 14 pin, STE 4/50

plug-in unit 4/50 with 14-pole DIL socket for integrated circuits of the DIL type; with 14 numbered 4-mm connection sockets

579 08	IC socket 14 pin, STE 4/50



IC socket 16 pin, STE 4/50

plug-in unit 4/50 with 16-pole DIL socket for integrated circuits of the DIL type; with 16 numbered 4-mm connection sockets

579 09	IC socket 16 pin, STE 4/50

Key switch (NO), STE 2/19

plug-in unit 2/19
Mechanical pushbutton switch with two positions: ON - OFF

579 10	Key switch (NO), STE 2/19

Key switch (NC), STE 2/19

plug-in unit 2/19; mechanical pushbutton switch with two positions: ON - OFF

579 11	Key switch (NC), STE 2/19

Toggle switch STE 2/19

Plug-in unit 2/19
Mechanical pushbutton switch with two positions: ON - OFF

579 13	Toggle switch STE 2/19

Change-over switch, two-pole, STE 4/50

plug-in unit 4/50; mechanical toggle switch with two mechanically coupled change-over switches with three positions for two separate circuits.
Positions:
2 x ON - OFF,
2 x change-over,
2 x OFF - ON,
2 x ON - OFF - ON

579 14	Change-over switch, two-pole, STE 4/50

Change-over switch STE 2/50

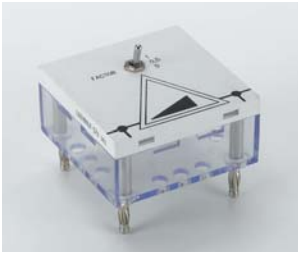
plug-in unit 2/50; mechanical toggle switch with indication of the two switching positions; positions: ON - OFF, OFF - ON, change-over

579 15	Change-over switch STE 2/50

Lamp relay STE 4/50

plug-in unit 4/50

579 16	Lamp relay STE 4/50



Simulation Incline, STE 4/50

plug-in unit 4/50; with 2 diodes for a defined voltage drop in the actual-value feedback loop.

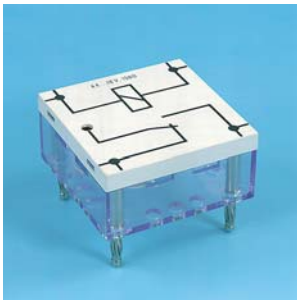
579 161	Simulation Incline, STE 4/50

Simulation ABS/Ti, STE 2/50

Plug-in element STE 2/50 with LED and two potentiometers for setting the duty cycle and frequency for simulating the ABS signal or the injection time Ti for automotive control units.

- Operating voltage: 12 ... 15 VDC
- Duty cycle: 0 ... 100 %
- Frequency: 55 ... 1200 Hz

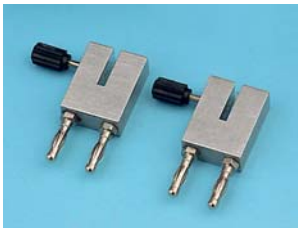
579 162	Simulation ABS/Ti, STE 2/50



Relay with change-over switch, STE 4/50

plug-in unit 4/50; electromagnetic switch with two positions with no. and nc. contacts.
Positions: ON - OFF, OFF - ON
Changeover control voltage: 4 to 10 V dc
Coil resistance: 150 Ohm approx.
Switched power: 50 VA max.

579 21	Relay with change-over switch, STE 4/50



Plug-in holder STE

STE plug-in element 2/19, for clamping plate material of up to 2.5 mm thickness, e.g. leaf springs, contact strips or bimetallic strips.

579 331	Plug-in holder STE

Light waveguide, set of 2

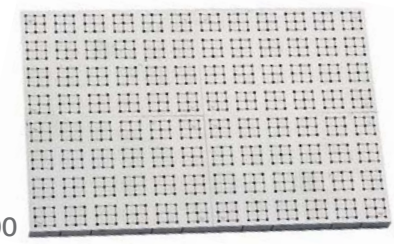
For basic experiments in optoelectronics with the transmitting and receiving diodes.
Jacketed waveguide:
Outside diameter: 2.2 mm
Core diameter: 1 mm
Numeric aperture A_n: 0.47
Bare waveguide:
Outside diameter: 2 mm
Core diameter: approx. 2 mm
Numeric aperture A_n: 0.50
Length: 2 m
Structure: stepped-index profile
Core material:plastic

579 44	Light waveguide, set of 2

PTC resistor 150 Ohm, STE 2/19

plug-in element 2/19
Temperature-dependent resistance with positive temperature coefficient (PTC thermistor).
Resistance at 25 °C: 150 Ohm

579 60	PTC resistor 150 Ohm, STE 2/19



Plug-in board DIN A2, STE

for clearly arranged assembly of electrical circuits with plug-in units (STE); 96 symetrically arranged socket areas with 96 conducting crosses and 864 4-mm sockets.
Dimensions: 60 cm x 40 cm x 2.4 cm

580 10	Plug-in board DIN A2, STE

STE DEMONSTRATION

Variable resistor 10 kOhm, STE 2/50

plug-in unit 2/50; adjustable via knurled knob

581 10	Variable resistor 10 kOhm, STE 2/50

Variable resistor 47 kOhm, STE 2/50

plug-in unit 2/50; adjustable via knurled knob

581 12	Variable resistor 47 kOhm, STE 2/50

Variable resistor 100 kOhm, STE 2/50

plug-in unit 2/50; adjustable via knurled knob

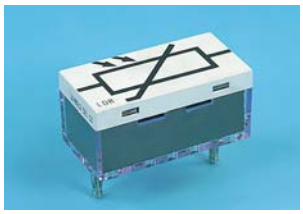
581 13	Variable resistor 100 kOhm, STE 2/50

Potentiometer, STE, 4/100

Linear adjustment with indicator knob and graduation, usable as adjustable resistance, voltage divider and alternating current generator.

Cat.No	Resistor	Rating
581 40	220 Ω	3 W
581 42	1 kΩ	1 W
581 46	100 kΩ	1 W

Photoresistor LDR 05, STE 2/50



plug-in unit 2/50; illumination dependent
CdS photoresistor;
bright resistance: 100 Ohm approx.;
dark resistance: 10 MOhm approx.;
dissipated power: 0.2 W max.

581 53	Photoresistor LDR 05, STE 2/50

NTC resistor 150 Ohm, STE 2/50

plug-in unit 2/50; temperature dependent
resistance at 25 deg. C: 150 Ohm
resistance at 100 deg. C: 14 Ohm

581 54	NTC resistor 150 Ohm, STE 2/50

NTC probe 4.7 kOhm, STE 2/50

plug-in unit 2/50; thermistor in rod-type
probe at the end of a 40 cm long cable;
resistance at 25 deg. C: 4.7 kOhm
resistance at 100 deg. C: 280 Ohm;
dissipated power: 0.5 W max.

581 55	NTC probe 4.7 kOhm, STE 2/50

NTC resistor 2.2 kOhm, STE 2/50

plug-in unit 2/50; thermistor with
external rod-type sensor;
resistance at 25 deg. C: 2.2 KOhm
resistance at 100 deg. C: 120 Ohm;
dissipated power: 0.45 W

581 57	NTC resistor 2.2 kOhm, STE 2/50

PTC probe 30 Ohm, STE 2/50

plug-in unit 2/50; PTC-resistor in rod-type
probe at the end of a 40 cm long cable;
resistance at 25 deg. C: 30 Ohm;
resistance at 100 deg. C: >10 kOhm;
dissipated power: 1 W max.

581 59	PTC probe 30 Ohm, STE 2/50

Heating element 100 Ohm, 2 W, STE 2/50

plug-in unit 2/50 with opening at the side for inserting a thermometer or NTC or PTC probe.
Depth of opening: 10 mm
Diameter of opening: 9 mm

581 65	Heating element 100 Ohm, 2 W, STE 2/50

Capacitors, STE 2/50

Cat.No	Capacitor	Tolerance	max. permissible voltage
581 81	0.1 µF	20 %	100 V
581 83	0.47 µF	20 %	250 V
581 85	1 µF	5 %	63 V
581 86	4.7 µF	5 %	63 V
578 12	10 µF	5 %	100 V
581 87	10 µF Elko	20 %	63 V
581 88	47 µF Elko	20 %	40 V
581 89	100 µF Elko	20 %	40 V
581 90	470 µF Elko	20 %	40 V
578 42	1000 µF Elko	20 %	40 V

Light emitting diode red, STE 2/50

plug-in unit 2/50

581 98	Light emitting diode red, STE 2/50

Infrared diode for light waveguide, STE 2/50

Type: SFH 450; plug-in element STE 2/50

581 992	Infrared diode for light waveguide, STE 2/50

Photodiode for light waveguide, STE 2/50

Type: SFH 250; plug-in element 2/50

581 995	Photodiode for light waveguide, STE 2/50

Phototransistor for light waveguide, w/o base, STE 2/50

Type: SFH 350; plug-in element STE 2/50
wavelength of max. sensitivity: 850 nm

581 996	Phototransistor for light waveguide, w/o base, STE 2/50

Phototransistor for light waveguide, STE 4/100

Type: SFH 350; plug-in element STE 4/100;
wavelength of max. sensitivity: 850 nm,
current amplification factor: 500

581 997	Phototransistor for light waveguide, STE 4/100

LED for light waveguide, STE 2/50

Plug-in element STE 2/50. Transmitter diode with special design for plugging in the light waveguides. The integrated lens and design-based preset adjustment result in high coupling power with the waveguide.
Type: SFH 756
Wavelength: 660 ± 25 nm (red)
Output power: 200 µW

581 998	LED for light waveguide, STE 2/50

Diode AA 118, Germanium, STE 2/50

plug-in unit 2/50 for rf rectification and
demodulation in receiver circuits;
reverse voltage: 90 V
continuous current: 50 mA max.

582 06	Diode AA 118, Germanium, STE 2/50

Diode 1N 4007, STE 2/50

plug-in unit 2/50 for rectfier and reverse
voltage protection circuits; reverse voltage:
100 V; continuous current: 1 A

582 07	Diode 1N 4007, STE 2/50

Z-Diode 9.1, STE 2/50

plug-in unit 2/50; dissip. power: 0.5 W max.

582 10	Z-Diode 9.1, STE 2/50

Z-Diode 6.2, STE 2/50

plug-in unit 2/50; dissip. power: 0.5 W max.

582 11	Z-Diode 6.2, STE 2/50

Light emitting diode green, STE 2/50

plug-in unit 2/50 with LED MV 5454;
diode built into the symbol

582 17	Light emitting diode green, STE 2/50

Transistor BC 550, NPN, e.b., STE 4/100

plug-in unit 4/100, for preminary stage and small-signal switch.
Current gain: 420 to 800
Dissipated power: 0.5 W

582 25	Transistor BC 550, NPN, e.b., STE 4/100

Transistor BD 137, NPN, e.b., STE 4/100

plug-in unit 4/100, for driver and power output stages as well as power switches.
Current gain: 40 to 250
Dissipated power: 8 W

582 28	Transistor BD 137, NPN, e.b., STE 4/100

Transistor BD 138, PNP, e.b., STE 4/100

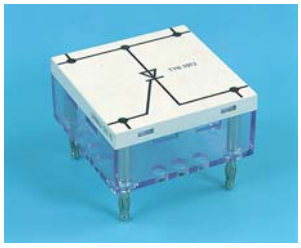
plug-in unit 4/100, for driver and power output stages as well as power switches.
Current gain: 40 to 250
Dissipated power: 8 W

582 29	Transistor BD 138, PNP, e.b., STE 4/100

Transistor (Darlington) TIP 162, STE 4/100

plug-in unit 4/100; NPN transistor
combination for sensor switches;
current gain: 200 approx.;
max. dissipated power: 3 W

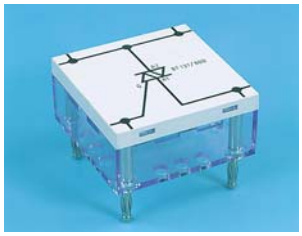
582 30	Transistor (Darlington) TIP 162, STE 4/100



Thyristor TYN 1012, STE 4/100

plug-in unit 4/100; for use as a
controllable rectifier, zero-crossing switch
and in phase clipping control circuits;
max. current: 8 A

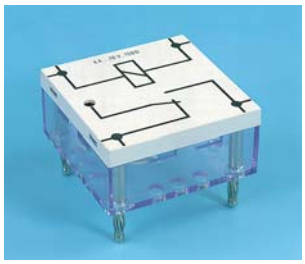
582 41	Thyristor TYN 1012, STE 4/100



Triac BT 137/800, STE 4/100

plug-in unit 4/100; used in connection with a
diac in phase clipping control circuits and
as a controlled ac switch;
max. current: 3 A

582 43	Triac BT 137/800, STE 4/100



Relay with change-over switch, STE 4/100

plug-in unit 4/100; electromagnetic switch with two positions with normally open and normally closed contacts.
Positions: ON -OFF, OFF - ON, changeover
Control voltage: 4 to 10 V DC
Coil resistance: 150 Ohm approx.
Switching power: 50 VA max.

582 60	Relay with change-over switch, STE 4/100

Sensors

Cat.No	Designation
582 621	Light sensor STE 4/50
582 6211	Throttle valve potentiometer STE 4/50
582 6212	Rotary angle pick up STE 4/50/100
582 622	Automotive Hall distributor STE 4/50
582 6231	Pressure sensor STE 4/50
582 624	Automotive Hall Sensor STE 4/50
582 625	Automotive Inductive sensor STE 4/50
582 6271	Oxygen sensor adaptor STE 4/50/100

Automotive trigger wheel STE

Plug-in element STE

582 628	Automotive trigger wheel STE

Air mass flowmeter STE 4/100/200

Plug-in element equipped with an electronic original automotive air mass meter, a fan intake for simulation and a throttle

582 629	Air mass flowmeter STE 4/100/200

Lamp holder E10, top, STE 2/50

plug-in unit 2/50

582 70	Lamp holder E10, top, STE 2/50

Lamp holder E10, lateral, STE 2/50

plug-in unit 2/50

582 72	Lamp holder E10, lateral, STE 2/50

Key switch (NO), STE 2/50

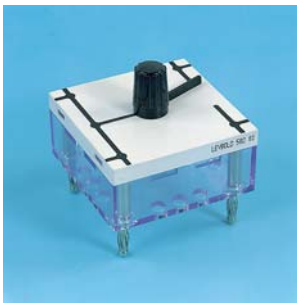
plug-in unit 2/50; mechanical pushbutton
switch with two positions: ON - OFF

582 76	Key switch (NO), STE 2/50

Toggle switch STE 2/50

plug-in unit 2/50; mechanical pushbutton
switch with two positions: ON - OFF

582 79	Toggle switch STE 2/50



Change-over switch STE 4/50

Plug-in unit 4/50
Mechanical toggle switch with indication of the two switching positions.
Positions: ON - OFF, OFF - ON, change-over

582 81	Change-over switch STE 4/50

Automotive fuse 10 A

STE 2/19 plug and socket element; car fuse 10 A

582 831	Automotive fuse 10 A

Iron core, 18 x 18 x 55 mm

solid, nickel-plated;
dimensions: 5.5 cm x 1.8 cm x 1.8 cm

590 85	Iron core, 18 x 18 x 55 mm

Coil, STE, 2/50

Cat.No	Turns	L	I_{max}	R DC
590 86	50	0.04 mH	7.1 A	0.1 Ω
590 821	250	1.1 mH	2.9 A	0.6 Ω
590 89	300	1.6 mH	1.9 A	1.4 Ω
590 83	500	4.4 mH	1.1 A	4 Ω
590 84	1000	18 mH	0.5 A	18 Ω

Transformer core, demountable

for the assembly of electromagnetical models.
Contents: U-core, yoke and clamping screw
Material: transformer sheet metal
Cross section: 1.8 cm x 1.8 cm

593 21	Transformer core, demountable

E-core, demountable

Fits coils (590 821-89); for assembling a three-phase transformer; only for extra-low voltages.

- Material: dynamo lamination sheets, riveted
- Cross-section: 18 mm · 18 mm
- Dimensions: 12 cm x 21 cm x 1.8 cm

Scope of delivery:
2 E-cores, 2 clamping screws

593 22	E-core, demountable

Spray bottle, 400 ml

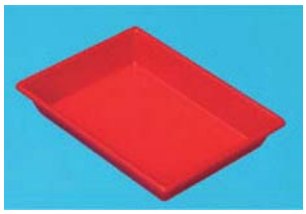
from polyethylen, clear, with adjustable hose nozzle, suitable for chromatographic, disinfection purposes or cleansing purposes.

604 120	Spray bottle, 400 ml

Photographic tray , red, 24 x 30 cm

of impact resistant plastic, resistant to acid, heat resistant to 80 °C, with ground grooves and sink nose.
Dimensions: 325 x 260 x 65 mm

604 2403	Photographic tray , red, 24 x 30 cm



Rubber Tubing 4 mm Ø

made of red natural rubber, according to DIN 128 65.
Inside diameter: 4 mm
Wall thickness: 1.5 mm
Length: 1 m

604 481	Rubber Tubing 4 mm Ø

Connector with nipple

plastic.
Form: straight
Length: 86 mm
Ø: 4 - 8 / 8 - 12 mm

604 520	Connector with nipple

Adapter T form PP Ø 6-7mm

604 541	Adapter T form PP Ø 6-7mm

Storage tray S33, STE

Deep, double-layered plastic tray, stackable for neat and compact storage of plug-in elements, components and accessories; without contents.
Storage capacity:
90 plug-in units STE 2/19 or
32 plug-in units STE 2/50 or
20 plug-in units STE 4/50 or
6 plug-in units STE 4/100 or
any combination of plug-in elements
Material: polystyrene 3/2 mm thick
Color: gray 851
Width: 320 mm, Depth: 480 mm, Height: 81/82 mm

650 67	Storage tray S33, STE

Storage tray S24, STE

Deep, double-layered plastic tray, stackable for neat and compact storage of plug-in elements, components and accessories.
Storage capacity:
75 plug-in units STE 2/19 or
15 plug-in units STE 4/50 or
24 plug-in units STE 2/50 or
6 plug-in units STE 4/100 or
15 plug-in units STE 2/50 or
any combination of plug-in elements.
Tray dimensions: 24 cm x 48 cm x 8 cm.
Stackable

650 671	Storage tray S24, STE

Hydrogen, compressed gas bottle, 2 l

- Purity: 5.0
- Colour: red
- Pressure: 200 bar

661 0080	Hydrogen, compressed gas bottle, 2 l

Pressure reducing valve for hydrogen

according to DIN, with two pressure gauges, normal thread, fits compressed gas bottles.
Control range: 0...10 bar

661 015	Pressure reducing valve for hydrogen

Funnel, plastic, 100 mm Ø

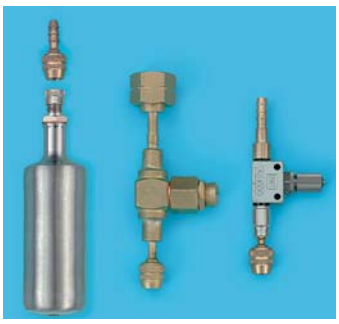
Polypropylene, 60° angle, plastic
Diameter: 100 mm
Height: 155 mm

665 010	Funnel, plastic, 100 mm Ø

Metal hydride reservoir (H_2), CPS

for simple and safe storage and dispensing of hydrogen, e.g. for use in fuel cells. The hydride reservoir is refillable (see accessories). For use in the Chemistry Panel System (CPS).
Capacity: 20 l H_2 (2 g)
Max. filling pressure: 10 bar
Discharge pressure: approx. 1.5 bar
Connections: 3 hose adapters
Dimensions:
105 x 30 mm Ø (without panel)
100 x 297 x 80 mm Ø (with panel)
Weight: 0.5 kg

666 479	Metal hydride reservoir (H_2), CPS



Regulating valve for metal hydride reservoir

For 666 479 und 661 005. For precise regulation of dispensed quantity, e.g. for operating a fuel cell.
Hose connection: 5 mm Ø
Dimensions: 60 x 40 mm

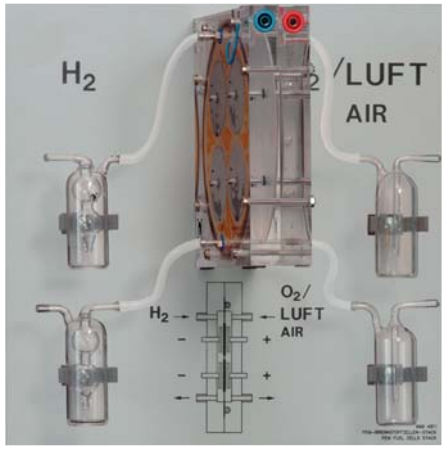
666 4792	Regulating valve for metal hydride reservoir

Filling adapter for metal hydride reservoir

For refilling of metal hydride reservoirs with hydrogen gas. The hydride reservoir can be connected directly by means of the filling adapter using the reduction valve to an H2 cylinder and in this way it is re-filled.
Connection: left-hand thread for the H2 reduction valve and connection for the metal hydride reservoir,
Dimensions: 93 cm x 3 cm Ø

666 4793	Filling adapter for metal hydride reservoir

PEM fuel cell stack, CPS



For use in the Chemistry Panel System (CPS). This new PEM (proton exchange membrane) fuel cell stack enables up to four cells to be connected either in series or in parallel. The fuel cell stack is operated wih hydrogen H_2 and oxygen O_2 or air. The hydrogen and oxygen react at the polymer membrane to form water, releasing electrical energy in the process. When four fuel cells are connected in series, the fuel cell stack generates a no-load voltage of approx. 3.6 V and a maximum power of 5 watts. These high voltage and power values are sufficient to e.g. power standard lamp types (e.g. halogen lamps).
No-load voltage: 3.6 V
Max. current: 3 A
Max. power. 4000 mW
Area of electrodes: 80 cm^2
Dimensions: 300 x 297 x 100 mm
Weight: 2.0 kg

666 4811	PEM fuel cell stack, CPS

Aeration pump, controllable, CPS

For continuous aeration. The pump can also be used to create a partial vacuum. The flow rate can be controlled either manually (via a control knob) or externally (by means of a control voltage 0...10 V).
Pump capacity: 0...3 l/min, manually set or externally controllable
Max. pressure: 2 bar
Partial vacuum: min. 380 mbar
Supply voltage: 13 V/1.3 A via enclosed plug-in supply unit (230 V, 50/60 Hz)
Dimensions: 100 x 297 x 130 mm
Weight: 1.3 kg

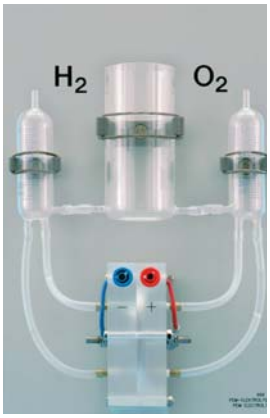
666 482	Aeration pump, controllable, CPS

Electric load, CPS

For use in the Chemistry Panel System (CPS). Contains a motor with propeller, a lamp and two adjustable load resistors as electrical loads (consumers). These load elements permit a defined discharge of a component and the recording of characteristics.
Load elements:
adjustable resistor 5 Ohm, 4 W
adjustable resistor 50 Ohm , 4 W
Motor: U_{max} = 10 V
I_{max} = 150 mA
Lamp: U_{max} = 1,2 V
I_{max} = 220 mA

666 483	Electric load, CPS

PEM electrolysis unit, CPS



For use in the Chemistry Panel System (CPS) and as benchtop unit. All that is necessary for generating current is to put distilled water in the reservoir vessel. The gases are collected in graduated containers. The electrical energy required for electrolysis can be provided using a solar cell module (e.g. 664 431) or via a power supply (e.g. 521 35). The gases produced can be channeled directly to a PEM fuel cell.
Voltage: 1.8 ... 2.0 V
Max. current: 2.0 A
Gas generation: 20ml/min (H_2) 10 ml/ min (O_2)
Connections: 5 mm Ø
Dimensions: 200 x 297 x 100 mm
Weight: 1.8 kg

666 484	PEM electrolysis unit, CPS

Universal clamp 0...80 mm

clamps with cork padding

666 555	Universal clamp 0...80 mm

Butane gas burner

with air regulation and valve, incl. base, without cartridges.
Height 220 mm, Weight 0.3 kg

666 711	Butane gas burner

Butane cartridge, 190 g, set of 3

for butane gas cartridge burner and butane soldering torch

666 712ET3	Butane cartridge, 190 g, set of 3

Piezoelectric Gas Igniter

220 mm long

666 733	PIEZOELECTRIC GAS IGNITER

Water, pure, 1 l

675 3400	Water, pure, 1 l

Battery 1.5 V (D), set of 5

Dimensions: 60 mm x 33 mm Ø

685 48ET5	Battery 1.5 V (D), set of 5

Transmitting device for remote control

689 0801	Transmitting device for remote control

COM3LAB Software

Cat.No	Designation
700 00CBTDE	COM3LAB software German
700 00CBTEN	COM3LAB software English
700 00CBTFR	COM3LAB software french
700 00CBTIT	COM3LAB software Italian
700 00CBTPT	COM3LAB software Portuguese
700 00CBTRU	COM3LAB software russian
700 00CBTSP	COM3LAB software Spanish

COM3LAB Master Unit (USB)

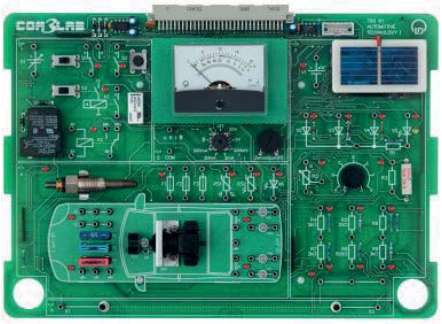
For the mounting and power supply of the experiment boards. The master unit is connected to the USB Port of a personal computer for the recording of measured values and for remote control of its built-in functions.
Integrated measuring instruments and functions:
-2 digital multimeter:
Voltage: AC/DC 2/20 V
Current: AC/DC 0.2/2 A
Resistance: 2/20/200 kOhm, 2 MOhm
Autorange for all measurement ranges
One button operation
LC display 3.5 digit with special characters
-1 digital function generator:
digitally stored signal types
sinusoidal, square-wave, triangular, DC
0.5 Hz...100 kHz
max. ± 10 V, max. 250 mA
Operation via two pushbuttons and
incremental shuttle
LC display 4-digit with special characters
The following devices have no display of their own and are operated remotely by the connected PC and through the training programs. The measured values are displayed on the PC monitor.

-1 digital storage oscilloscope:
two differential voltage inputs with 8-bit
A/D converter
Meas. ranges: 20/50/100/200/500 mV, 1/2/5 V
per division
Sampling frequency: 200 Hz to 1 MHz
Digital trigger with pre- and post-function
-1 digital analyzer:
9 digital inputs, TTL compatible
Sampling frequency: 200 Hz to 1 MHz, up to
4 MHz with limited trigger resolution
Triggering to any combination of input
states
Memory depth 2048 words with 9 bits

Oscilloscope and analyzer operation alternately possible. All of the measuring equipment and function generator are connectable via 2-mm sockets.
USB-Port for connection to the PC is included.

Included in the scope of supply:
1 USB cable
1 Set of cables consisting of connecting leads
of 40 cm and 5 cm length and equipped with
2-mm plugs
1 Table-top power supply 100...250 V,
50...60 Hz with mains connection cable and
earthing-pin connector for power supply to
the master unit
Dimensions: 380 x 282 x 65 mm (L x W x H)

700 00USB	COM3LAB Master Unit (USB)



COM3LAB Course: Automotive Technology I

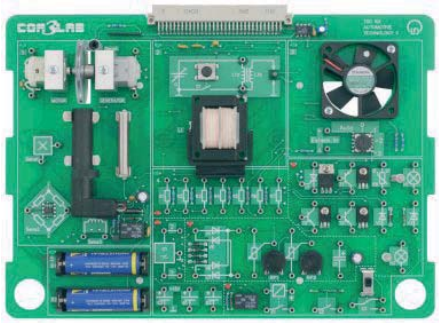
This COM3LAB course covers the basics of automotive electrical and electronic systems in an understandable way. Physical, chemical and mathematical properties of „Electricity" lead to a comprehensive understanding of the electrical processes and events in vehicles.

It consists of an experiment board with various circuits for mounting into the master unit and a Multimedia CD with interactive training program.

Experiment topics:

Subject areas:
Voltage
Current
Resistance
Ohm's law
Electrical power
Circuits
Series and parallel circuits
Complex circuits
Measuring instruments in general
Analog / digital measuring instruments
Measurements on components/onboard network
Assemblies:
Switches and relays
Analog multi-meter
Resistors
Solar cells
Diodes
Onboard network and lighting

700 61	COM3LAB Course: Automotive Technology I



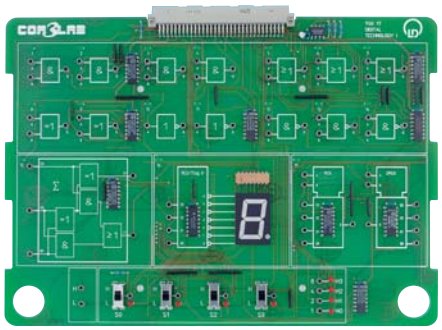
COM3LAB vehicle sensors

This CBT course prepares and conveys advanced principles of vehicle electric/electronics in a comprehensible manner. The physical, chemical and mathematical properties of electricity lead to a comprehensive understanding of electronic flows and processes in the vehicular environment. Measuring techniques as well as troubleshooting and problem remedies round out the training content.

Subjects

- Components:
  switches, resistors, capacitors, diodes and Zener diodes, relays.
- Schematics:
  reading vehicle schematics
- Sensors:
  inductive sensors, magnetic-field sensors.
- Batteries and accumulators:
  Interconnecting cells, accumulator types.
- Ignition:
  capacitors, relays, induction, ignition coil.
- Generators and motors:
  rectification, alternator, permanent-magnet generator.
- Transistors in the vehicle:
  transistor, checking transistors, monitoring features in vehicles, amplifier circuits, application circuits.

700 62	COM3LAB vehicle sensors



COM3LAB Course: Automotive Digital Technology I

In the COM3LAB course digital technology for vehicle occupations the bases of the switch algebra are treated with the help of logic linkings. Animations and interactions make clear the bases of modern bus systems. The subjects areas are in line with standard usage and are tuned related to application to the vehicle technology.

Subjects

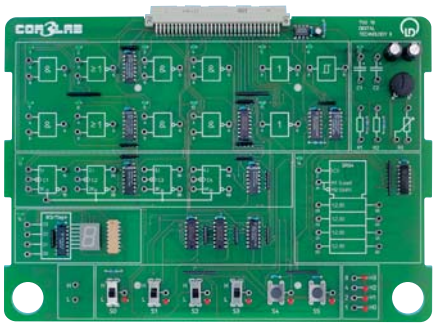
- TTL-AND
- TTL-OR
- TTL-NOT
- TTL-XOR
- TTL-NAND
- Boolean operations
- Coding
- Multiplexer
- Fundamentals CAN Bus

Components

- Logic gates: AND, OR, XOR, NOR, NAND
- Seven-segment display
- Multiplexer
- Input switches
- LED's

700 64	COM3LAB Course: Automotive Digital Technology I

COM3LAB Course: Automotive Digital Technology II



In the COM3LAB course digital technology for vehicle occupations the bases of the switch algebra are treated with the help of logic linkings. Animations and interactions make clear the bases of modern bus systems. The subjects areas are in line with standard usage and are tuned related to application to the vehicle technology.

Subjects
-Flip-Flop
-RS-Flip-Flop
-JK-Flip-Flop
-Shift register
-Counter
-Multivibrators
-Impulse diagram

Components
-AND, NOR, NAND
-Inverter
-Shift register
-Switches
-LED's

700 65	COM3LAB Course: Automotive Digital Technology II

Mobile cable holder

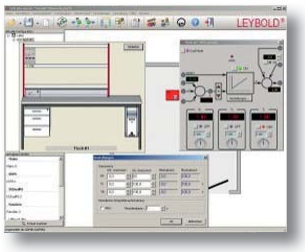
For the organized, space-saving and mobile suspension of experiment cables. Two additional side receptacles for thicker cables (e.g. power cable, PC connecting cable, ...)
Material: rectangular steel, powder coated in DB gray; four light-weight casters; cable troughs in light gray
Cable troughs: 58
Dimensions (WxDxH): 550 x 404 x 1322 mm

724 733	Mobile cable holder

Experiment Stand-M 1300, Mobile

Mobile experiment stand for demonstration purposes
- robust construction of rectangular steel tubing
- mounted on 4 rubber casters, 2 casters equipped with locking mechanism
- Large equipment tray; chipboard with PVC edge bands, width: 1202 mm, depth: 600 mm, thickness: 19 mm
- coated with melamine resin in accordance with DIN 68 765, scratch resistant, heat resistant
- 4 aluminium panel rails for the mounting of training panels in three levels
- Colour: Equipment tray gray RAL 7035
- Tubing: raspberry-coloured, surface coated with pulver
- Width: 1242 mm, height: 1941 mm, depth: 600 mm

724 876	Experiment Stand-M 1300, Mobile



Software: Leylab.control Lite

Software for the operation of one of the LAN-controlled power supplies of the LEYLAB.net series or the training panels of the TPS.net series. Edit mode for the generation of location plans, including the feature to equip the desks with available devices and to build instrumentation groups.

Scope Of Delivery:

Single device license

725 007	Software: Leylab.control Lite

System requirements
PC with Microsoft OS Windows XP/Vista/7
Screen resolution: 1024*768 (min.)

Three phase generator

for generating DC, AC or 3~ AC voltages for the ELM system. Setup in a 19" housing equipped with:
illuminated mains switch

- output: 6 4-mm-safety sockets
- output voltage AC: 0...15 V/ 1.5 A
- output voltage DC: 0...15 V/ 1.5 A
- input: 6 pole DIN socket for rotor position pick-up
- display: 2 digital displays (height 12.4 mm) to display voltage, frequency, speed or position
- width: 49 PU

Technical Specifications:
Power supply 230 V, 50/60 Hz

725 721G	Three phase generator

Experiment frame

Cat.No	Designation	Stand	Execution
726 09	Panel frame T130, Two Level	T-Base	Standard
726 10	Panel frame T150, Two Level	T-Base	Standard
726 11	Panel frame T180, Two Level	T-Base	Standard
726 18	Panel frame T130, Three Level	T-Base	Standard
726 19	Panel frame SL85, One Level	L-Base	angled
726 256	Panel frame VT160, Three Level	T-Base	heavy duty
726 26	Panel frame VT180, Three Level	T-Base	heavy duty

Equipment Platform 500 mm

Sturdy construction out of lacquered steel plate for integration of measurement instruments and power supply units into the experiment set ups. Suitable for all panel frames.
Width: 500 mm
Depth: 440 mm

726 22	Equipment Platform 500 mm

TFT Monitor frame TPS

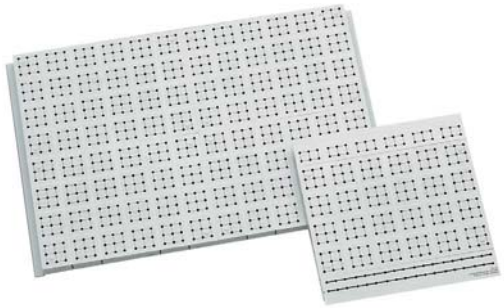
726 241	TFT Monitor frame TPS

Plug-in board 297 mm x 300 mm, STE

for panel frames, for clear and comprehensive understanding of the assembly of an electric circuit with plug-in elements (STE); with 4 mm-sockets for STE-type.

Technical Specifications:

- 24 socket grids with 24 conducting squares and 216 sockets
- 6 socket grids with 36 sockets
- 2 conducting paths with 18 sockets each
- Pin no./spacing: 2/19, 2/50, 4/50 or 4/100
- Dimensions: 297 mm · 300 mm · 24 mm



726 50	Plug-in board 297 mm x 300 mm, STE

Plug-in board 634 mm x 400 mm, STE

for panel frames, for clear and comprehensive understanding of the assembly of an electric circuit with plug-in elements (STE); with 4 mm-sockets for STE-type.

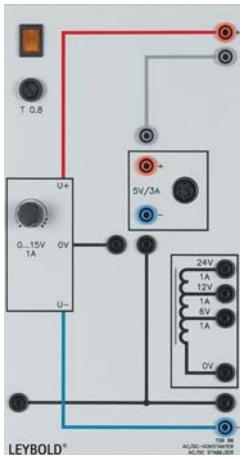
Technical Specifications:

- 96 socket grids with 96 conducting squares and 864 sockets
- Pin no./spacing: 2/19, 2/50, 4/50 or 4/100
- Dimensions: 634 mm · 400 mm · 24 mm

726 54	Plug-in board 634 mm x 400 mm, STE

AC/DC Stabilizer

Lab power supply unit with DC and AC voltage outputs, equipped with:
Illuminated mains switch
DC Outputs:
-fixed voltage: 5 V / 3 A floating ground
residual ripple: 1 mV RMS
-tracking stabilizer: ± 0...15 V / 1 A
floating ground
residual ripple: < 3 mV RMS
AC Outputs:
-AC voltage: 6/12/24 V / 1 A floating ground
Output: via 4 mm sockets and 6pin DIN-socket
Mains connecting cable with euro plug



726 88	AC/DC Stabilizer

Function Generator 200 kHz, 230 V

Microprocessor-controlled signal generator.

- Functions: sine/triangular/square-wave/DC
- Square-wave signal: duty cycle 10 %...90 %, adjustable in steps of 5 %
- Frequency range: 1 Hz...200 kHz
- Resolution: 1 mHz...100 Hz, frequency-dependent
- Output voltage: 0...20 V_{pp} continuous
- DC offset: ± 10 V
- Display: 4-digit LC display for signal parameters and functions
- Attenuator: 0 dB, -20 dB, -40 dB
- Output: Impedance 50 Ohm
- Trigger output: TTL level
- Output: via 4-mm safety sockets
- Supply voltage: 230 V, 50/60 Hz with mains connection cable and earthing-pin plug

726 961	Function Generator 200 kHz, 230 V

RMS Meter

Demonstration meter for measuring the true RMS voltages and currents.

- Types of measurement:
  - RMS - AC + DC total true RMS
  - RMS - AC alternating true RMS
  - AV - AC + DC arithmetic average value

Switchover is possible for all ranges and types of measurement at any time.

Measurement ranges for all types of measurement:

- Voltage: 3/10/30/100/300/1000 V, R_i = 10 MOhm
- Current: 0.1/0.3/1/3/10/30 A, R_i = 10 mOhm
- AV-Polarity indicator: 2 LEDs
- Instrument:
  - moving coil
  - class 2.5
  - 192 x 96 mm (W x H)
  - Scale division: 0...10 and 0...3
  - Scale length: 119 mm
- Continuous overload protection in all
- measurement ranges up to 1000 V and 30 A
- Mains supply: 110/130/220/240 V, 50 Hz*
- Weight: 1,4 Kg

*60 Hz on inquiry!!

727 10	RMS Meter

Power Meter

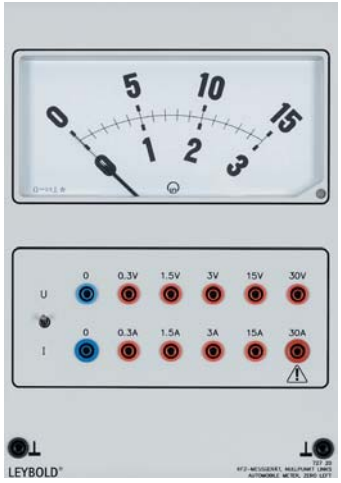
Demonstration meter for active power and capacitive and inductive reactive power, in the range 0.3 W (var) to 30 kW (kvar).

Measurement ranges:

- Voltage: 3/10/30/100/300/1000V
- R_i = 10 MOhm
- Current: 0.1/0.3/1/3/10/30 A
- R_i = 10 mOhm
- Frequency range:
  - Active power: 0...20 kHz
  - Reactive power: 50 Hz sin
- LED indicator for:
  - active power consumption
  - active power output
  - capacitive reactive power
  - inductive reactive power
  - overload voltage
  - overload current
- Instrument:
  - moving coil
  - class 1.5
  - 192 x 96 mm (W x H)
  - Scale division: 0...10 and 0...3
  - Scale length: 119 mm
- Continuous overload protection in all measurement ranges up to 1000 V and 30 A
- Mains supply: 110/130/220/240 V, 50 Hz

727 11	Power Meter

Automobile Meter Zero-Left



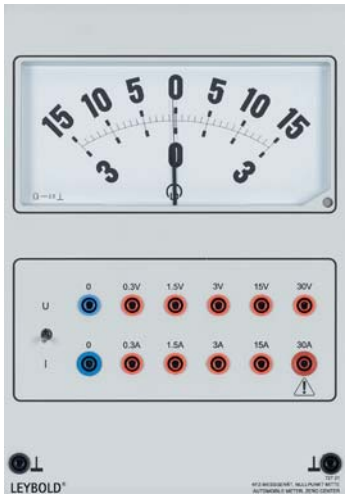
Demonstration moving coil multimeter with 10 measurement ranges for DC voltages and current. The measurement range is determined
by selecting the appropriate sockets. The mode of measurement is chosen with a toggle switch.

Measurement ranges:

- DC voltage: 0.3/1.5/3/15/30 V
- DC current 0.3/1.5/3/15/30 A
- Instrument: 192 x 96 mm (W x H)
- Class 1.5
- Scale division: 0...15 and 0...3
- Scale length: 119 mm
- Overload protection in all ranges.

727 20	Automobile Meter Zero-Left

Automobile Meter Zero-Center



Demonstration moving coil multimeter with
10 measurement ranges for DC voltages and
current. The measurement range is determined
by selecting the appropriate sockets. The mode
of measurement is chosen with a toggle switch.
Measurement ranges:
Dc voltage: ± 0.3/1.5/3/15/30 V
DC current: ± 0.3/1.5/3/15/30 A
instrument: 192 x 96 mm (W x H)
Class 1.5
Scale division: 15...0...15 and 3...0...3
Scale length: 119 mm
Overload protection in all ranges.

727 21	Automobile Meter Zero-Center

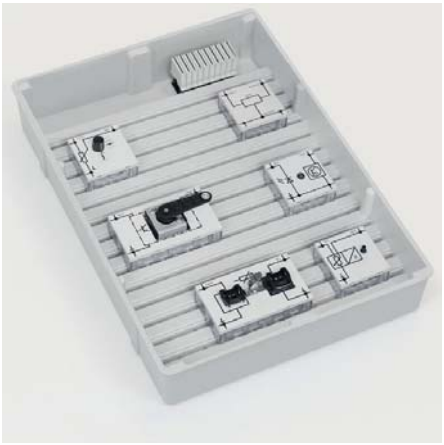
Vehicle sensors 1, STE, set

„Sensoric in the automobile"
supplementary set consisting of:

Components:
2 Transistors BC 550, e.b., NPN
2 Transistors BC 560, e.b., PNP
1 Simulation ABS/Ti
1 Bar magnet 60 x 13 x 5 mm
1 Rotary support
1 STE Automotive Hall distributor
1 STE Automotive Hall Sensor
1 STE Automotive Inductive sensor
1 STE Automotive trigger wheel
1 Automotive fuse 10 A
2 Set of 10 Bridging Plugs
1 STE Tray

727 5182	Vehicle sensors 1, STE, set

Vehicle sensors 2, STE, set



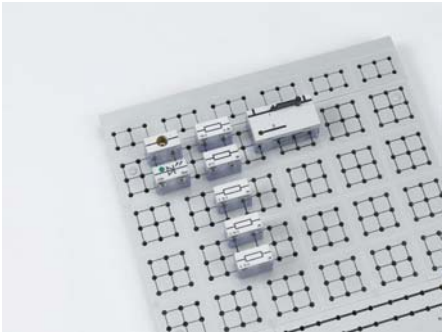
STE supplementary set to 7275182 consisting of:

Scope Of Delivery:

- Rotary angle pick up
- Light sensor
- Pressure sensor
- Throttle valve potentiometer
- Oxygen sensor adaptor
- Voltage regulator +5 V
- Tray
- Set of 10 bridging plugs

727 5183	Vehicle sensors 2, STE, set

Basic set automotive sensorics, STE



„Basic set automotive sensorics"
Set consisting of:

Components:
1 Bulb, 12 V/0.1 A, E10, set of 10
1 Resistor 470 Ω
1 Resistor 680 Ω
2 Resistors 1 kΩ
1 Resistor 10 kΩ
1 LED, green
1 Lamp holder E10, top
1 Toggle switch, single pole

727 5185	Basic set automotive sensorics, STE

Equipment Set A1.1.1.1, STE

„Basics of Automotive Electrical Engineering and Electronics"

Equipment set consisting of:
2 Mono cells 1.5 V
2 Plug-in battery holder
4 Light bulbs 4 V/0.16 W/E10
4 Light bulbs 12 V/3 W/E10
4 Light bulbs 12 V/1.2 W/E10
1 Glow lamp 110 V/E10
1 Bar magnet 60 X 13 X 5 mm
1 Rotary support for bar magnet
1 Resistor 10 ohm, 2 W
1 Resistor 47 ohm, 2 W
2 Resistors 100 ohm, 2 W
2 Resistors 200 ohm, 2 W
1 Resistor 330 ohm, 2 W
1 Resistor 470 ohm, 2 W
1 Resistor 1 kohm, 2 W
1 Resistor 2.2 kohm, 2 W
1 Resistor 4.7 kohm, 2 W
2 Resistors 10 kohm, 0.5 W
1 Resistor 22 kohm, 0.5 W
1 Resistor 47 kohm, 0.5 W
1 Resistor 220 kohm, 0.5 W
1 Potentiometer 220 ohm, 3 W
1 Variable resistor 10 kohm, 1 W
1 Variable resistor 47 kohm, 1 W
1 Variable resistor 470 kohm, 1 W
1 Photoresistor LDR 05
1 NTC-Resistor 2.2 kohm
1 PTC-Resistor 100 ohm
2 Capacitors 10 nF, 100 V
1 Capacitor 0.1 µF, 100 V
1 Capacitor 0.22 µF, 250 V
1 Capacitor 1 µF, 100 V
1 Capacitor 100 µF, 35 V
2 Capacitors 470 µF, 16 V
1 Ge diode AA 118
4 Si diodes 1N 4007
1 Z diode ZY 6.2
1 Light emit. diode green, LED 1, top
1 Light emit. diode red, LED 2, top
2 Transistors BD 137 (NPN), e.b
1 Transistor BD 138 (PNP), e.t.
1 Darlington transistor TIP 162
1 Thyristor TYN 1012
1 Lamp holder E10, lateral
4 Lamp holders E10, top
1 Pushbutton switch, single-pole, n.o.
1 Toggle switch, single-pole
1 Lampe current relay
1 Relay with single-pole change over switch
2 Clamping plugs
1 Iron wire 0.2 mm dia., 100 meters
1 Coil 500 turns
1 Coil 1000 turns
1 Transformer core, demountable
1 Tray STE

727 520N	Equipment Set A1.1.1.1, STE

Compact set ‚Basics of automobile electrical engineering' in the case

consisting of:
Components:
2 Mono cells 1.5 V
2 Plug-in battery holder
4 Light bulbs 4 V/0.16 W/E10
4 Light bulbs 12 V/3 W/E10
4 Light bulbs 12 V/1.2 W/E10
1 Glow lamp 110 V/E10
1 Bar magnet 60 X 13 X 5 mm
1 Rotary support for bar magnet
1 Resistor 10 ohm, 2 W
1 Resistor 47 ohm, 2 W
2 Resistors 100 ohm, 2 W
2 Resistors 200 ohm, 2 W
1 Resistor 330 ohm, 2 W
1 Resistor 470 ohm, 2 W
1 Resistor 1 kohm, 2 W
1 Resistor 2.2 kohm, 2 W
1 Resistor 4.7 kohm, 2 W
2 Resistors 10 kohm, 0.5 W
1 Resistor 22 kohm, 0.5 W
1 Resistor 47 kohm, 0.5 W
1 Resistor 220 kohm, 0.5 W
1 Potentiometer 220 ohm, 3 W
1 Variable resistor 10 kohm, 1 W
1 Variable resistor 47 kohm, 1 W
1 Variable resistor 470 kohm, 1 W
1 Photoresistor LDR 05
1 NTC-Resistor 2.2 kohm
1 PTC-Resistor 100 ohm
2 Capacitors 10 nF, 100 V
1 Capacitor 0.1 µF, 100 V
1 Capacitor 0.22 µF, 250 V
1 Capacitor 1 µF, 100 V
1 Capacitor 100 µF, 35 V
2 Capacitors 470 µF, 16 V
1 Ge diode AA 118
4 Si diodes 1N 4007
1 Z diode ZY 6.2
1 Light emit. diode green, LED 1, top
1 Light emit. diode red, LED 2, top
2 Transistors BD 137 (NPN), e.b
1 Transistor BD 138 (PNP), e.t.
1 Darlington transistor TIP 162
1 Thyristor TYN 1012
1 Lamp holder E10, lateral
4 Lamp holders E10, top
1 Pushbutton switch, single-pole, n.o.
1 Toggle switch, single-pole
1 Lampe current relay
1 Relay with single-pole change over switch
2 Clamping plugs
1 Iron wire 0.2 mm dia., 100 meters
1 Coil 500 turns
1 Coil 1000 turns
1 Transformer core, demountable

Accessories:
1 Case Large, with Equipment:
1 Rastered socket panels DIN A3
1 AC/DC Stabilizer
1 Function generator 200 kHz
3 Sets of 10 Bridging Plugs
1 Connecting Lead 10 cm Red
1 Connecting Lead 10 cm Blue
3 Pair cables 50 cm, red/blue

727 520K0F	Compact set ‚Basics of automobile electrical engineering' in the case

STE universal case

Universal case for storage of STE-elements as well as one plug-in board A3 or two A4 Plug-in boards and cables in the lid. Size: 60 cm x 40 cm x 14 cm

727 585	STE universal case

Basic Machine Unit

For construction of generators and motors, has a metal disk with threaded holes for pole pieces and axle for the rotors.
With connector for rotor position pick up.

727 811	Basic Machine Unit

Rotor position pick up

Electronic device to pick up the position of the rotors 56319 and 563191. The rotor position pick up is mounted on the basis machine unit.

727 812	Rotor position pick up

Driving Unit

For generator experiments, with universal motor and phase angle control for continuous changing of the speed from 0...3000 min^{-1}.
Mains connection: 230 V, 50 Hz with mains connection cable and earthing pin plug including drive belt 144 x 5 mm

727 88	Driving Unit

Lamp Socket E27

Built-in socket E27 for incandescent light bulb max. 100 W.

729 13	Lamp Socket E27

Magnetic Powder Brake 1.0

Serves in connection with the control unit to record the torque in 1.0 kW electrical machines. The current supply is provided by the control unit via a connecting cable with a multi-pin plug. The brake is protected from overloading by separate ventilation and a thermo-switch.
Braking torque: max. 20 Nm
Mains connection for ventilator: 220 V, 50 Hz

732 54	Magnetic Powder Brake 1.0

Control Unit 1.0

For the supply, control and regulation of the magnetic powder brake. The recording of characteristics (speed/torque) is possible in automatic or manual operation. Equipped with:

- Illuminated mains switch,
- operating mode switch,
- start and reset pushbutton,
- 10-turn potentiometer for brake control,
- 2 potentiometers to set M_{max} and n_{min} in automatic mode
- overtemperature indicator of the brake
- mains cable

Indicators:
2 moving coil circular-scale instruments with measurement range switch for:

- speed: 1500/3000/6000 min^{-1}
- torque: 10/30 Nm

Connections via 4 mm safety sockets for tacho generator, pen-lift for XY-recorder
External control: 0...10 V DC, Output for speed/torque: 0...10 V DC, adjustable

- Mains voltage: 220 V / 50 Hz

732 55	Control Unit 1.0

Coupling 1.0

Rubber coupling sleeve for mechanical connection of two electrical machines of the 1.0 kW series.

732 56	Coupling 1.0

Coupling Guard 1.0

Attachable guard for protection against contact with electrical machine rotating parts of the 1.0 kW series.

732 58	Coupling Guard 1.0

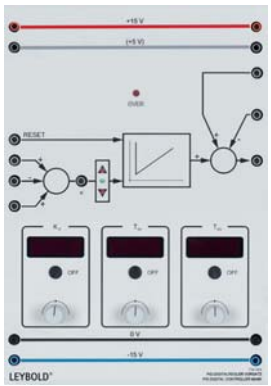
Tacho Generator 1.0

For registering the speed of electrical machines of the 1.0 kW series.

- Output voltage: ± 1 V / 1000 min^{-1}

732 59	Tacho Generator 1.0

PID Digital Controller



Standard industrial compact controller with fast microprocessor support for use as e.g. P, PI, PD or PID controller for continuous closed-loop controls. With input summing point for two reference variables and one controlled variable, measurement point for error signal, tendency indication of the error signal with 3 LEDs. P, I and D elements can be switched off individually, I element can be reset via separate input (RESET). Including output summing point for adding or subtracting operations of disturbance variables.

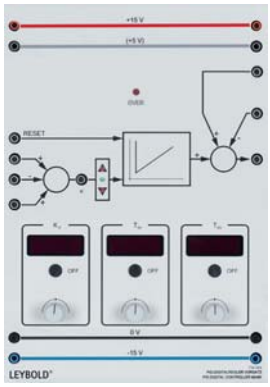
Technical data:

- Signal voltage range: -10 V...+10 V
- Sampling interval: 50 µs
- Proportional rate K_P: 0,01...100
- Correction time T_N: 0,01 s...100 s
- Rate time T_V: 0,1 s...100 s

Selection of controller parameters with button s and digital encoder. Representation of actual parameters on 7-segment displays. LED overload indication.
Supply voltage: ± 15 V DC

734 064	PID Digital Controller

PID Digital Controller Net



Standard industrial compact controller in 32-Bit architecture for integration into the LeyLab network. The internal ARM microprocessor excels in a high sampling rate and a fast control response. The controller is used for continuous closed-loop systems e.g. in P, PI, PD or PID configuration. With input summing point for two reference variables and one controlled variable, measurement point for error signal, tendency indication of the error signal with three LEDs. P,I and D elements can be switched off individually. The I element can be reset via separate input (RESET). Including an output summing point for adding or subtracting of two external and one internal disturbance variables. The internal disturbance variable can be activated via the LAN.

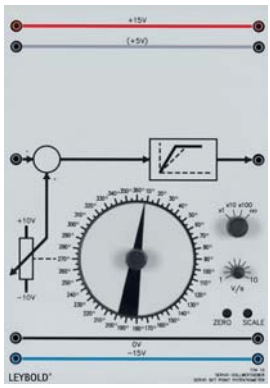
Technical data

- Supply voltage: ± 15 V DC
- Signal voltage range: -10 V...+10 V
- Sampling rate: 50 µs
- Proportional rate K_p: 0,01...100
- Correction time T_i: 0,01 s...100 s
- Rate time T_d: 0.01 s...100 s

Manual selection of controller parameters with buttons and digital encoders. Representation of actual parameters on three four digit 7-segment displays. Overload indication with a three colors LED.
Equipped with a RJ45 socket for LAN operation. Internal control by the software *LEYLAB.control* 725006 or *LEYLAB.control Lite* 725007 to set and record the controller parameters from a central master PC and to gernerate pertubations.

734 064N	PID Digital Controller Net

Servo Setpoint Generator

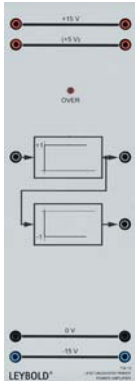


Position pick-up with rotating angular disk for application in servo systems. With input summing point for forward feeding of disturbance variables or for setpoint variable change and with connectable rate-of-change limiter with rise times of 1 V/s up to 1000 V/s.

- Signal voltage range: -10 V...+10 V
- Rotating angle:
  - Mechanical 360° without limit stop
  - Electrical 340° ± 5°
- Fine setting of zero-point and scale factor.
- Coarse setting with rotary switch
- Fine setting with potentiometer
- Supply voltage: ± 15 V DC

734 10	Servo Setpoint Generator

Power Amplifier

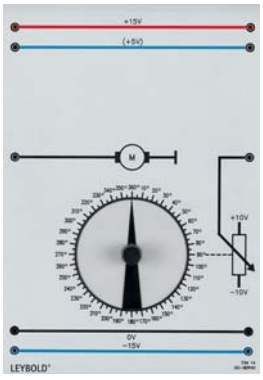


Used for operating the simulated controlled system models. Two amplifier stages each with a voltage gain of +1 and -1, symmetrical
operation possible with $V_U = 2$.

- Signal voltage range: -10 V...+10 V
- Output voltage range: -10 V...+10 V with respect to earth or symmetrical 0...± 20 V,
- Output power: max. 30 W, short-circuit proof
- Supply voltage: ± 15 V DC

734 13	Power Amplifier

DC-Servo



Motor potentiometer with 360° mechanical rotation angle without limit, electrical rotation angle 340° ± 5°, with DC motor and friction wheel drive, as model of an integral controlled system without compensation with negligible dead time, can also be used in a closed-loop positioning control system.

- Controlled system output signal (controlled variable): -10 V...+10 V
- Supply voltage: ± 15 V DC

734 14	DC-Servo

OBD Adaptor CAN+USB

Vehicle diagnose adapter for evaluating the on-board diagnostics and self-diagnostics of vehicle control units.
The computer-end connection is to a USB interface; the control unit end is connected to a 16-pole OBD interface.
Support is provided for the CAN bus protocols over the diagnose lines as well as the ISO 9141, KWP-1281 and KWP-2000 protocols over the K and L line. This adapter can be operated with LD control units, function motors and original vehicles from VAG.
The software provides access to control units. Functions like: read fault, fault reset, display measurement value blocks, graphic presentation, recode control unit, adapt control unit, and much more can be performed. German and english software license is already integrated for VCDS software!

- USB connection to PC
- OBDII-EOBD support
- Self-activation
- Automatic data transmission rate detection
- integrated hardware acceleration
- Support of Audi, VW, Skoda and Seat vehicles
- ODB function for all supported cars
- USB 1.1 and 2.0
- Plug & Play
- Software VCDS in German and English

Diagnosis adaptor USB

Scope of delivery

- Software
- Diagnostic adaptor USB

737 9803	OBD Adaptor CAN+USB

OBD data logger CAN+USB

The recorder is a remote diagnostic tool developed with car owners in mind. It can collect engine data when the car is driven on the road. The recorded data is then fed into the client terminal via a USB interface.
Plug-and-play tool with compact design Automatic recording of date without human interference User-friendly interfaces and clear display of data

Technical Specifications:

- Connector OBDII / CANBUS (16 pole)
- Supported Protocols:
  OBDII:ISO9141,SAEJ1850VPW,SAEJ1850PWM
  EOBD:ISO14230 KPW
  CANBUS:ISO15765

Scope of delivery

- Data recorder module
- USB cable
- Manual

737 9804	OBD data logger CAN+USB

Workshop diagnosis unit (EN)

Original worshop diagnosis adaptor to evaluate the onboard and self diagnosis function of automotive electronic control units (ECU). Equipped with color display, rechargable battery and soft touch buttons for easy handling and operation.
The following functions are supported:

- Read fault memory
- Erase fault memory
- Actuator test
- Measurement reading

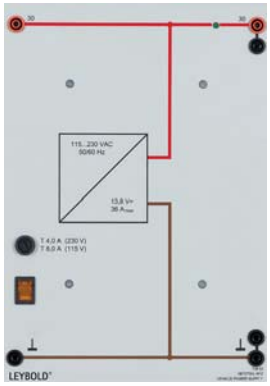
According to EOBD (Fuel >2001, Diesel >2004) including support of subsystems.
The device can be updated using a memory card.
User interface language: English
Keys for VW/Audi, Mercedes and Opel are included.

737 9806	Workshop diagnosis unit (EN)

Cable and plug box

Box that can be hung in a frame. The box itself is intended for stowing cables, jumpers and other accessories.

738 01	Cable and plug box



Automotive power supply 13.8 V/36 A

Fixed voltage automotive power supply in switched-mode technology with functional display and double tap. The device is overload protected and short circuit checked.

Technical Specifications:

- Output tension: 13.8 V
- Output current: 36 A_{max}
- Power supply: 115/230 V, 50/60 Hz

738 02	Automotive power supply 13.8 V/36 A

Battery Charger, Automatic

Electronic charger for 12 V batteries, indicator lamp for incorrect polarity, 12 V indicator lamp, battery cable with battery clamps.

Technical Specifications:

- Charging current: 1 A min
- Supply voltage: 220 V, 50 Hz with mains connecting cable and Euro-plug

738 021	Battery Charger, Automatic

Dig. Power supply 1 - 16 V/40 A

Compact switched-mode DC Power Supply providing variable voltages of 1 V to 16 V under 40 A continuous operation.

- Overload protection by current foldback circuitry and over temperature protection
- Over voltage protection and high RFI stability
- Cooling by a fan
- Safety: IEC-1010-1, EN 61558, EN 60950
  EMV acc. to EN 55011
- Accessories: Power cord, Users manual
  3 user defined preset voltages
- 2 4 mm safety sockets (5 A max) on the front
- 2 4 mm sockets (40 A) on the rear

Technical Specifications:

- Display: Digital 11 mm green LED-display
- Output : 40 A
- Residual Ripple: 5 mV rms
- Efficiency: > 85%
- Operating Voltage: 230 V AC, 50/60 Hz
- Dimension (WxHxD): 200 x 90 x 260 mm

738 027	Dig. Power supply 1 - 16 V/40 A

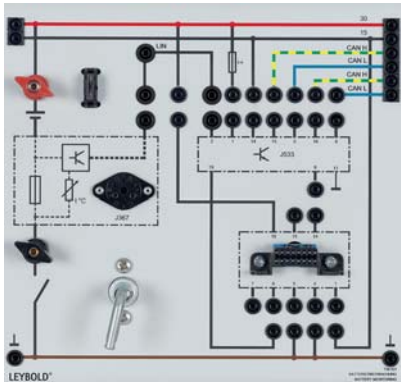
Battery Connection Unit

With main switch, 2 electrode terminals, thermal protection switch 25 A and additional 4-mm sockets.

738 03	Battery Connection Unit

Battery monitoring

Consisting of battery connector panel with „Diagnosis interface for data bus" with the functionality of battery power management and the battery data module (BDM), which is located directly at the negative battery pole and via a LIN bus line connected to the diagnostic interface. The 16 pole OBD connector is compatible to other systems and supports the CAN bus and the K-line.



738 031	Battery monitoring

Car Battery 12V

>36 Ah, >175 A, with connector terminals, maintenance free.

738 04	Car Battery 12V

Battery pole-clamp set

Set of battery clamps for connecting cable set 738 05 or 738 88 to a standard starter battery.

738 042	Battery pole-clamp set

Set of Connection Leads I

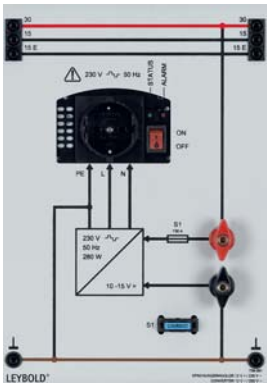
4 Connecting leads 6 mm² with spade connectors,
2 x red, 1 x blue, 1 x black

738 05	Set of Connection Leads I

12 V on-board socket

Illuminated 12 V cigarette lighter and on-board socket.

738 06	12 V on-board socket



Inverter 12/230 V

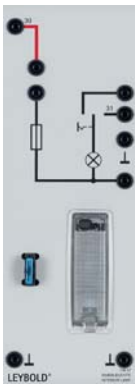
Car inverter producing a 230 V alternating voltage from the 10 – 15 V DC on-board network, for powering conventional mains-powered devices in the car. With over/under-voltage and temperature protection and status LEDs. Connection cables for the on-board network socket (cigarette lighter) and the battery clamps are included.
Output: 1 earthed socket 230 V/10 A
Power: 200 VA

738 061	Inverter 12/230 V

Car connection cable for CASSY

Helical cable for connecting the CASSY supply voltage to a 12 V car socket (European standard socket or BSK 12), with control LED

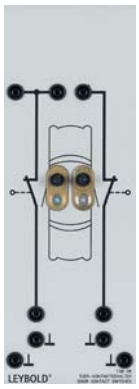
738 062	Car connection cable for CASSY



Interior Lamp

With changeover switch for external door contact switches and interior lamp.
Lamp data: 10 W / SV 8,5-8

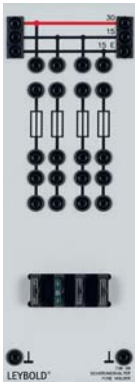
738 07	Interior Lamp



Door Contact Switch

Twofold, for switching of the interior lamps.

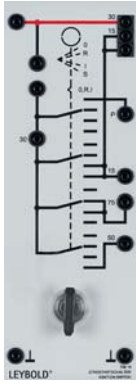
738 08	Door Contact Switch



Fuse Holder

With 4 automotive blade fuses.

738 09	Fuse Holder



Ignition Switch

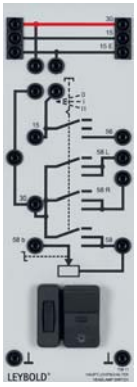
With starter and radio functions, outputs T 15, T 50, T 75 and P.

738 10	Ignition Switch

Head Lamp Switch

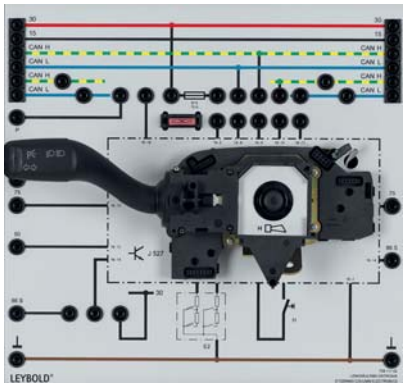
To switch on head lamps and side lamps.

738 11	Head Lamp Switch



Intelligent automotive lighting management system

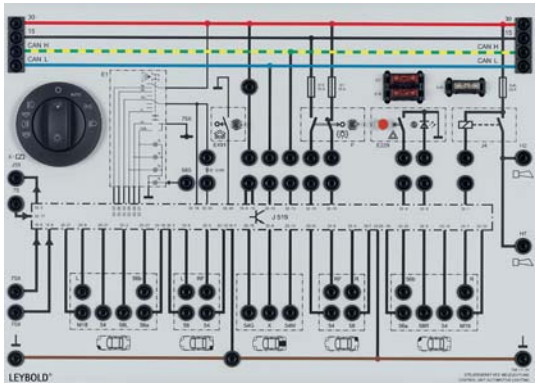
CAN data bus capable light control consisting of:
Control unit automotive lighting:



Control unit for vehicle electrical system controlling the vehicle's exterior lights with the following functions:

- Hazard warning and turn signal lights control
- Control of horn and support relais
- Parking-/Side lights (L/R)
- High beam (L/R) and headlight flasher
- Number plate lights
- Dipped beam headlights (L/R)
- Automatic light control
- Fog and rear fog lights
- Reversing lights (only with 738 112)
- Brake lights (left, right, center)
- Daytime running lights (optional)

with individual outputs to the loads. The light control signal is transmitted via CAN data bus from the control unit steering wheel column or from the main light switch directly.



Steering column electronics:

Control unit detecting the signals of the ignition switch, the position of the turn signal switch (voltage encoded) and the horn switch.

The terminals

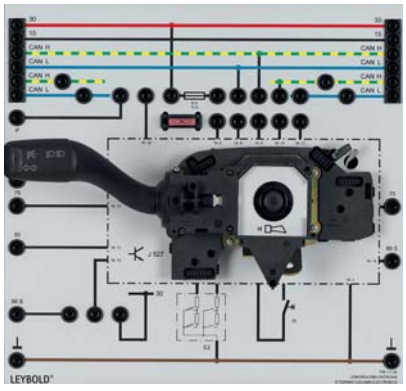
- P - Parking lights
- 86s - Key contact
- 75 - Support relais
- 15 - Ignition on
- 50 - Starter

are connected via conventional wires to the control unit. They are mirrored on the convienence CAN databus.
System:
H7 or Xenon lamps can be used. Self diagnosis functions are available using 7381121 and 7379803. CAN databus access requires 739581USB and 739587.

Scope Of Delivery:
One training panel with control unit lights and one training panel with steering column control unit

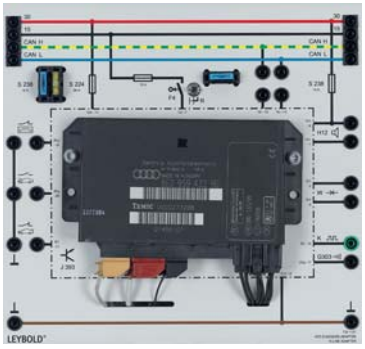
738 111	Intelligent automotive lighting management system

Steel column elektronics



Control unit for recording the signals from the ignition switch, the position of the indicator switches (voltage-encoded) and the horn button. Via the comfortable CAN bus, the information is transmitted to the control unit for the car lights. In addition, the steering angle sensor 739 654 can be installed; the steering angle is output on the motor bus.

738 111-02	Steel column elektronics



OBD Adaptor

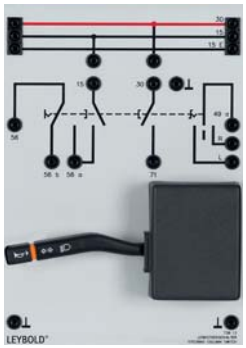
Control device for the evaluation of the back driving light switch and to the connection of a OBD adaptor (e.g. 7379802) about the OBD socket 738975 to the system A2.1.3.1, Light control with CAN-Bus.

738 1121	OBD Adaptor

Multi-Purpose Switch

To activate brake lamps and reversing lamps.

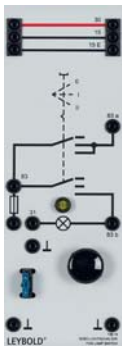
738 12	Multi-Purpose Switch



Steering Column Switch

Functions: turn signal indicator, warning lamps, flasher, high and low beam switch-over.

738 13	Steering Column Switch

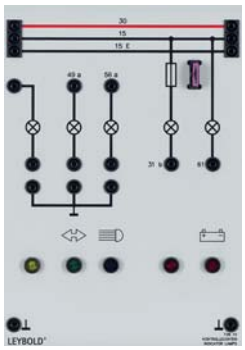


Fog Lamp Switch

For step by step switching of the front and rear fog lamps, with monitor lamp.

- Lamp data: 2 W / BA 7s

738 14	Fog Lamp Switch



Indicator Lamps

To monitor operations:
high beams, turnsignal indicators, oil pressure, battery charge, pre-heating.

Technical Specifications:

- Lamp data: 2 W / BA 7s.

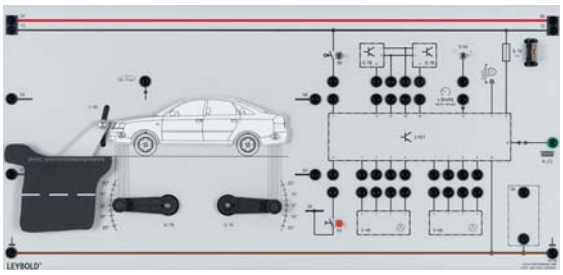
738 15	Indicator Lamps

Main Headlamp with Side Lamp

Lamp data:
Main Headlamp: 12 V, 60/55 W / H4
Side Lamp: 12 V, 4 W / BA 9s

738 16	Main Headlamp with Side Lamp

Headlamp level control



On the other hand, the complete system automatic-dynamic luminous width regulation shows the deviation control of luminous width changes on account of a change caused by loading of the bodywork on the one hand and they, caused by dynamic vehicle changes as for example braking and acceleration. In addition the control device receives the level signals from front axle and rear axle (integrates) as well as the speed signal (externally, e.g., from 579 162).
After evaluation of these signals the set engines are headed in the floodlights and thus the vehicle level-changes are compensated. In the simulation of a passenger car all situations can be adjusted faithfully and the effect on the illuminated floodlight cone be observed.
The system is about the K management self-diagnosis capable and owns an emergency run quality which is indicated about a LED. About a diagnosis adaptor (e.g., 737 980) let themselves indicate all available measuring value blocks as well as carry out the functions coding, basic setting, set limb diagnosis and mistake evaluation.
The experimental panel is prepared for the connection of external original-xenon floodlights.

738 165	Headlamp level control

Headlights right

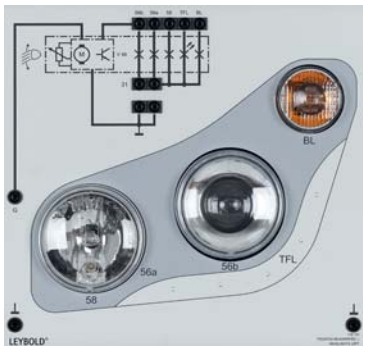
Headlight with side lamp, headlamp leveling, LED daytime running lights and turn signals right.
Complete front lighting unit with headlight range control and the following components:

- Flashing light PY 21W
- Low beam H7 55W
- Beam H7 55W
- Parking light T 4W
- Daylight white 5 x LED
- Servo motor for headlamp leveling

Technical Specifications:
Power supply: 12 VDC

738 166	Headlights right

Headlights left



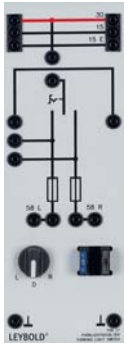
Headlight with side lamp, headlamp leveling, LED daytime running lights and turn signals left.
Complete front lighting unit with headlight range control and the following components:

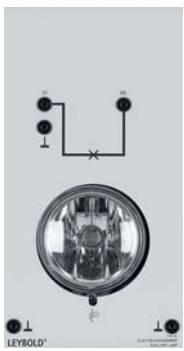
- Flashing light PY 21W
- Low beam H7 55W
- Beam H7 55W
- Parking light T 4W
- Daylight white 5 x LED
- Servo motor for headlamp leveling

Technical Specifications:
Power supply: 12 VDC

738 167	Headlights left

Parking Lamp Switch





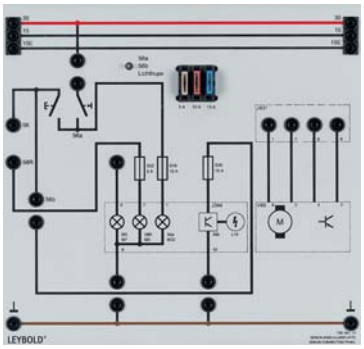
Switching of parking lamps in connection with main lamp switches.

738 17	Parking Lamp Switch

Auxiliary Headlamp

For assembly of circuits with fog lamps and high beams.
Lamp data: 12 V, 55 W / H3

738 18	Auxiliary Headlamp



Xenon headlight unit

Original Xenon headlamp with connecting panel as an add-on to 738111 or 738165.
The high voltage ignition unit is included.

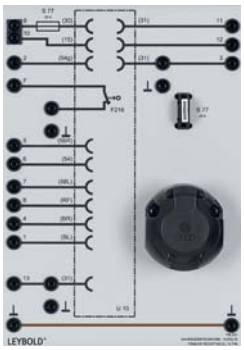
Technical Specifications:
- Voltage: 12 V
- Nominal power: 35 W
- Lamp: Xenon D2S

738 1821	Xenon headlight unit

Rear lights

Automotive rear lights unit consisting of:
2 indicators with lamp BAU15s
2 brake lights LED
2 back lights
2 back-up lights
2 rear fog lamps
1 3-rd stoplight
1 sign lighting

738 190	Rear lights



Trailer Socket 13 pole

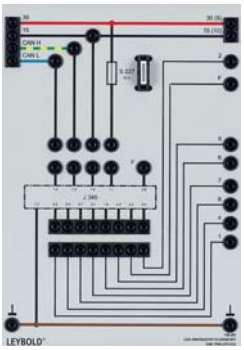
- with bayonet fastener for towing vehicle
- terminal 30 (Pin 9) fused with 25 A
- with switch for rear fog light deactivation
- ground connection can be disconnected separately

738 251	Trailer Socket 13 pole

Adapter 13/7 Pole

From 13-pole vehicle to 7-pole trailer.

738 262	Adapter 13/7 Pole



CAN Trailer ECU

Control unit detecting a trailer and controlling its light components. With integrated emergency function and automatic disabling the rear fog lights of the towing vehicle.

738 263	CAN Trailer ECU

Trailer lights

Multifunctional set of lamps for trailer lighting, built and ready to connect with plate light and 13 pole plug.
Including:

- Tail Light
- Brake Light
- Flashlight
- Triangle reflector
- Rear fog lamp
- Reversing spotlights
- License plate light

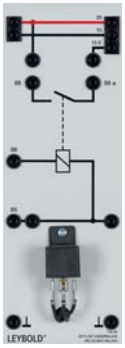
Supply voltage: 12 V
Cable length: 3 meters, can be pulled out of the housing
Finish: Clear glass or textured glass

738 27	Trailer lights

Relieving Relay

1 NO contact / 30 A
to switch from main lamps to parking lamps when starting.

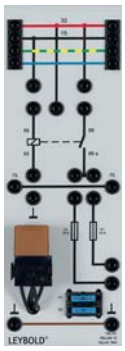
738 28	Relieving Relay



Relay 1NO

1 NO contact / 30 A.
for switching headlamps and systems.

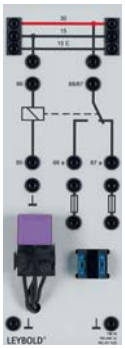
738 291	Relay 1NO



Relay 1 CO

1 change-over contact / 20 A; for switching auxiliary headlamps and systems.

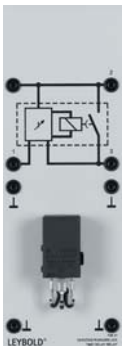
738 30	Relay 1 CO



Time Delay Relay

1 NC contact / 12 A.
delayed-off switch for the interior lamp.

738 31	Time Delay Relay



Normal and High Volume Horn

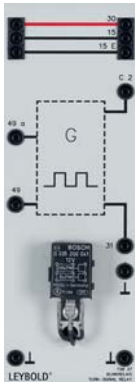
50 W / 335 Hz, 60 W / 375 Hz with change-over switch.

738 35	Normal and High Volume Horn

Turn Signal Lamp

Usable for front, left or right turns.
Lamp data: 21 W / BA 15s.

738 36	Turn Signal Lamp



Side turn signal light LED

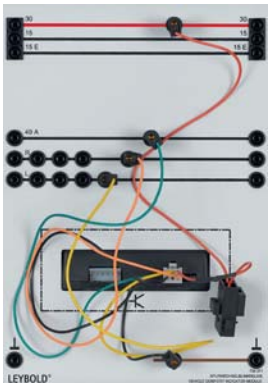
Side flashing light in LED technology to the direct connection with 12 V.
Color: orange

738 361	Side turn signal light LED

Turn Signal Relay

2 + 1 (6) x 21 W with connection for a second monitoring lamp.

738 37	Turn Signal Relay



Automotive 1 tip/3 flash relay

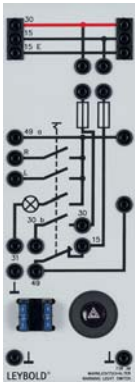
Comfort indicator relay for the practical retrofit of standard indicator circuits (positively switched or earth-switched).
After installation of the control device, the indicator will blink 3 times after the indicator lever has been briefly pushed once to indicate a lane change.

738 371	Automotive 1 tip/3 flash relay

Warning Lamp Switch

With monitoring lamp.
Lamp data: 1.2 W / W 2 x 4.6 d
(in connection with the turn signal relay)

738 38	Warning Lamp Switch



Standard Ignition Coil

For generating higher voltages with a normal spark frequency.

738 40	Standard Ignition Coil

Distributor Breaker-Triggered

For 4 cylinder engines, with centrifugal force and vacuum advance of ignition timing.

738 42	Distributor Breaker-Triggered

Flywheel with Sensor Holder

Engine substitute for all systems with static ignition distributor system and electronic diesel injection with mounting facility for CPS-sensor for detection of the engine speed and crankshaft position. Service TDC pick-up to determine the ignition timing.

- Speed control: 0.... 4000/6000 min ±1
- Power supply: 230 V/50-60 Hz with mains connection cable and earthing-pin connector

738 431	Flywheel with Sensor Holder

Spark plug holder

Equipped with 4 spark plugs to demonstrate the arc formation in an engine cylinder

738 441	Spark plug holder

Single pressure chamber

Equipped with 1 spark plug and with quick action coupling to demonstrate the relationship between air pressure and ionization.

738 442	Single pressure chamber

Pencil coil system

Pencil ignition coil with spark plug in a pressure chamber

738 443	Pencil coil system

Spark Gap

Permits the demonstration of the ignition coil quality, the ignition reserve as well as the effects of series and shunt resistors in a high voltage circuit.

738 45	Spark Gap

Accessory Set Ignition System

Consisting of:
4 ignition cables with spark plugs
1 ignition cable to connect the ignition coil
to the distributor

738 46	Accessory Set Ignition System

Distributor Cap, Transparent

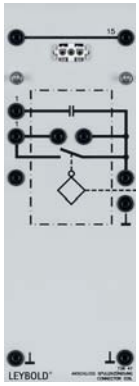
For the observation of the spark gaps and voltage distribution to individual cylinders in a high voltage distributor. Not suitably for distributor TZ-I (Cat. No. 73855).

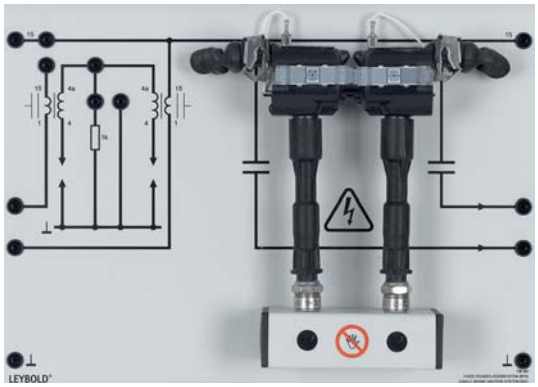
738 461	Distributor Cap, Transparent

Coil Connector Unit

Provides connection from distributor to the transistor switching unit or to the ignition coil and is used to measure the various electrical parameters.

738 47	Coil Connector Unit





Single Spark Ignition System (SSI)

Training panel with two ignition units to demonstrate the function of a distributor-less single spark ignition system. The following parameters can be measured:

- Primary current curve
- Ignition voltage curve in the secondary circuit
- Ignition failure

The measurements in the secondary circuit are performed indirectly via a measurement resistor. For reasons of safety, the operation is only possible in conjunction with the universal ignition module (Cat. no. 738 516).

738 481	Single Spark Ignition System (SSI)

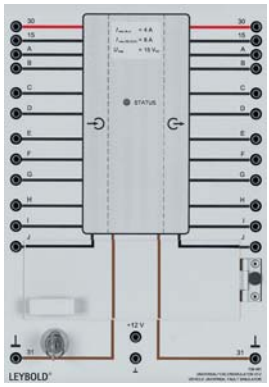
Fault Simulator Automotive

For the simulation of typical faults in the primary circuit of a breaker-triggered coil ignition system and their effects. In conjunction with the equipment set A2.3.1.1, the following can be investigated:

- series connection R and C
- accidental ground capacitor
- voltage drop at the contact
- shorted ignition coil

The faults are switched on with two toggle switches located behind a lockable cover.

738 49	Fault Simulator Automotive



Automotive fault simulator

Microcomputer controlled universal fault simulator for all automotive equipments for individual switching of the faults
- interruption
- transition/contact resistance
- conclusion after cl. 30
- Earthing
- short-circuit between two lines

for the front-laterally ground through signals. The fault is programmed over keys and LED displays, behind a lockable flap are. In addition back a 7 pin cable connection can be ground through, on its contacts likewise individual error combination (interruption/transition/resistance short-circuit) is possible. All attitudes are stored after switching the equipment off.
The faults of one or several faults simulators can be activated also over a LD radio BUS connection wirelessly from (teacher) a PC.

738 491	Automotive fault simulator

Automotive fault simulator, starter

Micro-computer-controlled universal fault simulator for all automotive equipment for the individual switching on of the faults:

- interruption
- contact resistance
- class 30 contact
- body contact
- short circuit between two lines for the signals looped through the front.

The fault is programmed using buttons and LED indications which are located behind a lockable cover. In addition, on the back a 7-pole connection cable can be looped through, the contacts of which also allow connection to individual faults (interruption/contact resistance/short circuit). Using the enclosed radio adapter the fault-simulations identified in the laboratory can be remotely controlled via the enclosed software. In order to help with the preparation of lessons, all settings are retained after the device is switched off.

Delivery includes configuration software and the USB transmitter unit for the teacher PC.

738 491S	Automotive fault simulator, starter

Control Unit TI-H

For a transistorized ignition system with a Hall generator TI-H, with dwell angle control, current limiting and quiescent current switch-off.

738 50	Control Unit TI-H

Ignition Coil TI-H/I

High performance ignition coil for transistorized ignition systems.

738 51	Ignition Coil TI-H/I

Crankshaft Position Sensor (CPS)

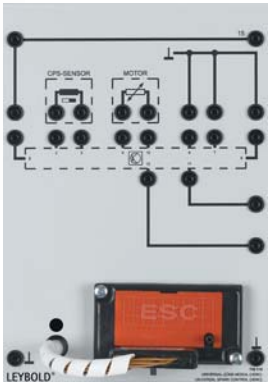
Inductive pulse generator for recording the engine speed and the crankshaft position.

738 515	Crankshaft Position Sensor (CPS)

Universal Ignition Module (UESC)

Ignition map control unit for DIS ignition system; control of ignition timing as a function of speed and crankshaft position data supplied by CPS sensor, with engine-dependent data (load, temperature) taken into consideration.

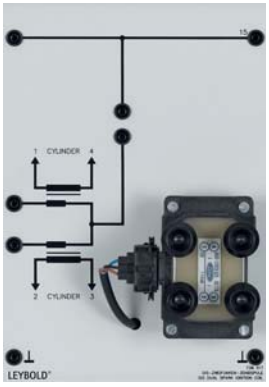
738 516	Universal Ignition Module (UESC)



DIS-Two Spark Ignition Coil

Double spark ignition coil for the generation of two ignition sparks each for cylinder pairs 1 and 4 as well as 2 and 3.

738 517	DIS-Two Spark Ignition Coil



DIS-Ignition Cable Set

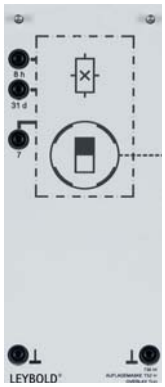
consisting of four special ignition cables with integrated, lockable connector for connection to the DIS-ignition coil. Connecting nuts for M4 spark plugs are contained in the scope of delivery.

738 518	DIS-Ignition Cable Set

Distributor TI-H

Hall generator TI-H with centrifugal force and vacuum advance of ignition timing

738 531	Distributor TI-H



Overlay TI-H

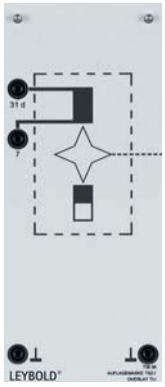
For the coil connector unit 73847; to connect the components of the TI-H ignition system according to the circuit diagram and determination of measurement points.

738 54	Overlay TI-H

Ignition Distributor TI-I

With an induction type pulse generator TI-I, with centrifugal and vacuum advance of ignition timing, included 4 TZ-I ignition cable with spark plug connector.

738 55	Ignition Distributor TI-I



Overlay TI-I

For the coil connector unit 73847; to connect the components of the TI-I ignition system according to the circuit diagram and determination of measurement points.

738 56	Overlay TI-I

Control Unit TI-I, TD

With TD signal for transistorized ignition system with induction type pulse generator TI-I, with dwell angle control, current limiting, and quiescent current switch-off.

738 58	Control Unit TI-I, TD

Motor f. Generator Experiments, 1.0 kW

Threephase asynchronous machine with integrated frequency converter for speed control (0 - 3900 rpm) with rotating direction switch (cw/ccw), start/stop button, analogue output for the speed (1 V/1000 rpm) and RS 485 interface for PROFIBUS/DP connection. Mains supply via fixed assembled cable with german 16 A CEKON plug.
P = 1,1 kW
U = 380 - 480 V
I = 2,5 A
f = 50 - 60 Hz
m = 18 kg

738 631	Motor f. Generator Experiments, 1.0 kW

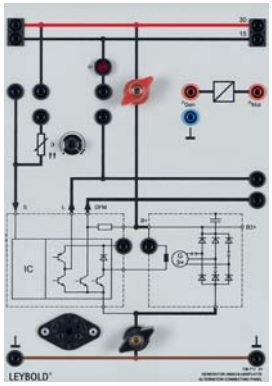
Belt drive for vehicle 1:3

Belt drive for interposing between **„Motor for Generator Experiments 1.0 kW"** (738631) and **„Compact Alternator"** (738711).

Technical Specifications:
n_{1max} = 4000 min^{-1}
n_{2max} = 12000 min^{-1}

738 632	Belt drive for vehicle 1:3

Compact alternator



Alternator with hybrid multifunction controller consisting of the generator and the connecting panel, which are connected via a control cable. The main power cables are connected via screwed type plugs. The generator is driven by the Motor for Generator Experiments, 738631.

738711-01, compact Alternator

On the generator power Zener diode are on 4-mm safety sockets for measuring and interrupting as accessible as the three-phase winding.

738711-02, Connecting panel

On the connecting plate the excitation current and the voltage can be monitored, further connections for battery monitoring (sensing), the load recognition and fault detection are available. Additionally, the generator control light and a speed signal are available. The output voltage of the generator can be controlled depending on the temperature or by the engine control unit.

With corresponding loads the speed-dependent characteristics can be recorded, as well as being represented to diagnose good and error images.

Technical Specifications:

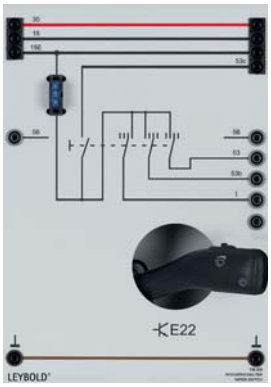
- U_N = 14 V
- I_N = 75 A
- n_{max} = 12.000 1/min

Scope Of Delivery:

- Compact alternator
- Connecting panel
- Connecting cable 6pole

738 711	Compact alternator

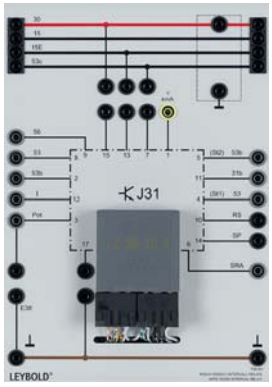
Wiper Switch



For 2 speeds, automatic mode, wash and wipe-wash interval switching and for step by step switching of the wiper motor and the washing system.

738 830	Wiper Switch

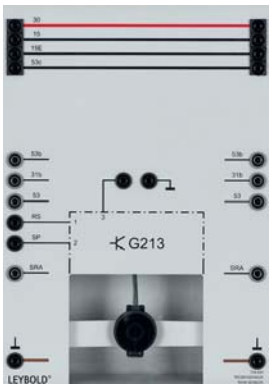
Wipe-Wash Interval Relay



For wiper operation with rain sensor. Use of additional electronics in the windshield wiper circuit.

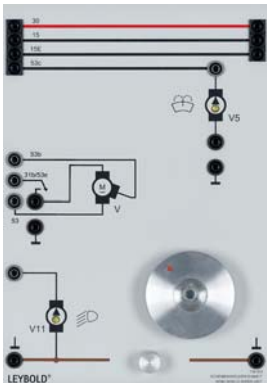
738 831	Wipe-Wash Interval Relay

Rain sensor



Optical rain sensor to control the wipe-wash interval relais 738831.

738 832	Rain sensor



Windshield Wiper Unit

with motor for two speeds, wiper and washer simulation for windschield and headlamp.

738 833	Windshield Wiper Unit

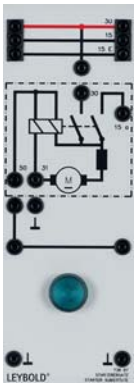
Pre-Engaged Drive Starter, Perman.-Excited

With permanently-excited motor and planetary gear.

Technical data

- Rated power: 0.95 kW
- Voltage: 12 V DC

738 851	Pre-Engaged Drive Starter, Perman.-Excited



Starter Substitute

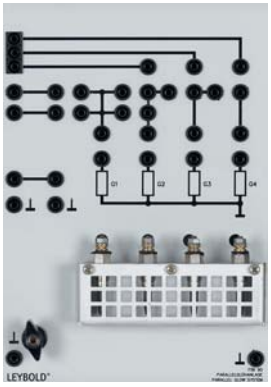
Simulation of starter, indication of starting by means of a control lamp.

738 87	Starter Substitute

Set of Connecting Leads II

3 connecting leads 16 mm² with spade connectors.

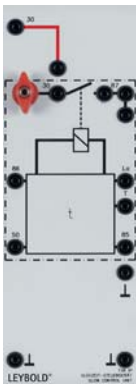
738 88	Set of Connecting Leads II



Parallel Glow System

With 4 sheathed-element glow plugs.

738 90	Parallel Glow System



Glow Time Control Unit Temperature

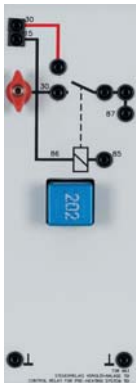
For the temperature dependent control and monitoring of pre-heating or post-heating stages.

738 91	Glow Time Control Unit Temperature

TDI Control Relay for Preheating System

For switching operations of the parallel preheating system.

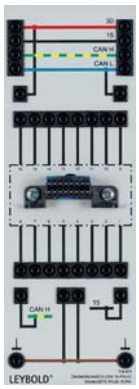
738 963	TDI Control Relay for Preheating System



Diagnostic Plug 16 Pin

As adapter module between the control unit and the standard workshop system tester. Suitable for all diagnostic protocols including diagnosis CAN databus.

738 975	Diagnostic Plug 16 Pin



Silicone Oil M3, 1 Liter

As fuel substitute for all injection systems.

738 981	Silicone Oil M3, 1 Liter

Safety experiment cables, set of 51

Consisting of:
3 x 25 cm, red
2 x 25 cm, blue
2 x 25 cm, black
2 x 25 cm, yellow
1 x 25 cm, green

4 x 50 cm, red
3 x 50 cm, blue
4 x 50 cm, black
2 x 50 cm, yellow
1 x 50 cm, green
4 x 50 cm, grey
4 x 50 cm, brown
1 x 50 cm, white

2 x 100 cm, red
2 x 100 cm, blue
5 x 100 cm, blackrz
1 x 100 cm, yellow
1 x 100 cm, green
4 x 100 cm, grey
2 x 100 cm, brown
1 x 100 cm, white

738 9821	Safety experiment cables, set of 51

Set 102 safety experiment cables

Consisting of:
6 x 25 cm, red
4 x 25 cm, blue
4 x 25 cm, black
4 x 25 cm, yellow
2 x 25 cm, green

8 x 50 cm, red
6 x 50 cm, blue
8 x 50 cm, black
4 x 50 cm, yellow
2 x 50 cm, green
8 x 50 cm, grey
8 x 50 cm, brown
2 x 50 cm, white

4 x 100 cm, red
4 x 100 cm, blue
10 x 100 cm, blackrz
2 x 100 cm, yellow
2 x 100 cm, green
8 x 100 cm, grey
4 x 100 cm, brown
2 x 100 cm, white

738 9831	Set 102 safety experiment cables

Automotive oscilloscope

Portable 2 channel 40 MHz of workshop oscilloscope with color LCD display and touchscreen as well as integrated multimeter. The oscilloscope is completely menu controlled using a surface similar to Windows. Accumulator or net adaptor as well as a print function over an Ethernet belong to the standard version.
Technical Specifications:
Voltage sensitivity: 2.5 mV – 200 V / DIV
Time base: 1 ns – 200 s/DIV
Scanning: 12 bits, 25 GS/s

738 9841	Automotive oscilloscope

Automotive meter

Digital auto workshop multimeter with 3½ digit display, automatic ranging and enhancements for special vehicle measurements. With the central rotary switch the functions DC voltage and AC voltage, direct current and AC current,
resistance, frequency, diode test & continuity test as well as in particular temperature,
speed, dwell angle, duty cycle and injection duration can be chosen.
- DC and AC voltage measuring range:
  600 V
- DC and AC current measuring range:
  10 A, 20 A for max. 30 sec.
- Frequency measuring range: 20 kHz
- Temperature measuring range:
  -20°C – 500°C (K type)
- Speed measuring range: 30 – 20000 min^{-1}
- Dwell angle measuring range:
  0.0 ° - 360.0 °, 0% - 100%
- Injection duration measuring range:
  0.05 ms – 250.0 ms, 0% - 100%

738 985	Automotive meter

Inductive-Type Pulse Pick-Up

for connection to the CASSY AUTO-Box I (524 076) , designed to trigger on cylinder 1.

738 986	Inductive-Type Pulse Pick-Up

Capacitive-Type Pick-Up

for connection to the CASSY AUTO-Adapter s (524 077) , designed to measure the secondary voltage (terminal 4).

738 987	Capacitive-Type Pick-Up

Standard Workshop TDC Pick-Up

Recommended for speed and precise ignition timing measurement used together with an original motor tester or CASSY Auto-Box I (524 076).

738 989	Standard Workshop TDC Pick-Up

Automotive Voltage Tester

With cable testing device
Voltage range: 3...48 V DC
Indicator: 2 red LED for voltage and polarity
current consumption: 1.5 mA
Testing device: Test probe and needle with slide mechanism on one side and crocodile clamp on the other side
Cable length: approx. 130 cm

738 991	Automotive Voltage Tester

Ignition Timing Light

For dwell angle control of all spark-ignition engines with bright xenon light and clamp for connection to ignition cables

738 992	Ignition Timing Light

CASSY automotive measuring set

Set of modules and sensors for the computer-assisted recording of automotive applications in vocational training and workshops, sorted in a hard bowl storage suit-case.
consisting of:
1 x 524013 Sensor CASSY USB
1 x 739589 Software Vehicle diagnosis
1 x 524076 Auto-Box i
1 x 524077 Auto-Box Z
1 x 738986 Inductive-Type Pulse Pick-Up
1 x 738987 Capacitive-Type Pick-Up
1 x 738989 Standard Workshop TDC Pick-Up
1 x 50135 Connecting lead 200 cm red
1 x 50138 Connecting lead 200 cm black
2 x 50183 Sets of 6 insulated crocodile-clips
Technical Specifications:
Plug-in power supply 230 V, 50/60 Hz

738 997	CASSY automotive measuring set

Pressure pump, foot-operated

With pressure gauge 0 - 6/10 bar

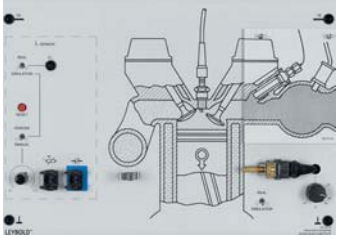
738 998	Pressure pump, foot-operated

DC/AC Clamp on current probe

Current probe for DC and AC for a measurement range of 0.5 to 600 A
Output signal: 1 mV per 1 A AC or DC
Current range:
0.5 - 400 A~RMS, 600 A peak
0.5 - 600 A=
Error limits: < 2 %
Conductor diameter: max. 1 x 30 mm

738 9991	DC/AC Clamp on current probe

Knocking Sensor



Delivers an electric signal corresponding to the sound emission in the cylinder block.

739 03	Knocking Sensor

Substitute Engine Panel

With schematic representation of the intake and exhaust system, with simulated and actual use of the Lambda sensor and the engine temperature sensor, including KE-jetronic and LU-jetronic/motronic overlays.

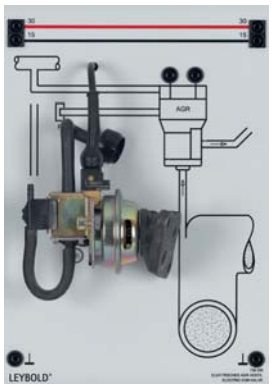
739 191	Substitute Engine Panel

Set 7 Connecting Leads

1,5 m long, both ends equipped with 6-pin universal connectors for the connection of control units with the appropriate sensors and actuators.

739 192	Set 7 Connecting Leads

Rotary Idle Actuator



For idle speed stabilization. Single winding actuator.

739 253	Rotary Idle Actuator

Electric EGR valve

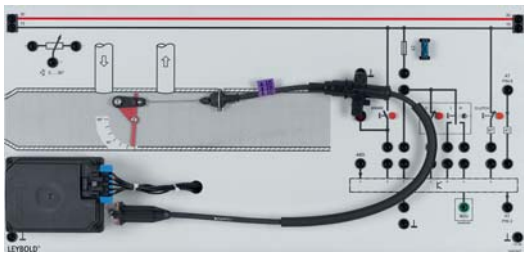
Electric exhaust gas return valve (EGR) for LH-Motronic.

739 255	Electric EGR valve

Lambda Sensor, heated

For recording of the actual mixture of flue gas stream. With 2 pole plugs for heating and voltage.

739 271	Lambda Sensor, heated



Cruise Control

Automatic electronic speed controller for all internal combustion engines/transmission combinations. A Bowden wire connects the servo motor of the cruise control to the throttle valve and thus permits a defined speed. The automatic speed control offers the following possibilities:

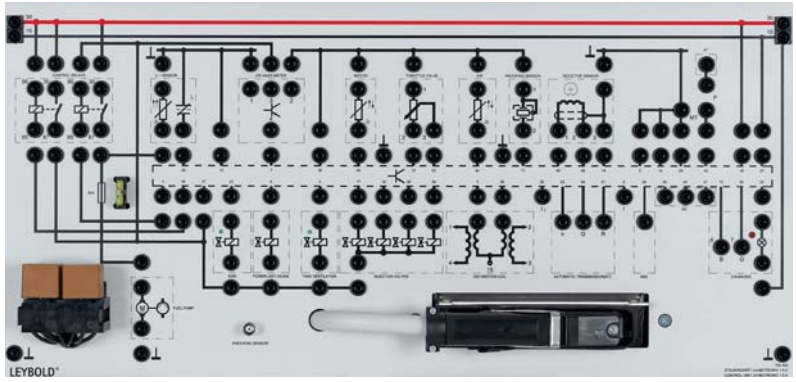
- Constant speed
- Acceleration
- Delay during overrun
- Step-by-step increase or decrease of the currently set vehicle speed
- Recall of the last stored vehicle speed

739 350	Cruise Control

Evaluation Unit Motronic and LU-Jetronic

With fuel tank, fuel pump, fuel filter, system pressure manometer, distributer pipe, pressure regulator, 4 solenoid-operated injection valves and 4 flow-through meters.

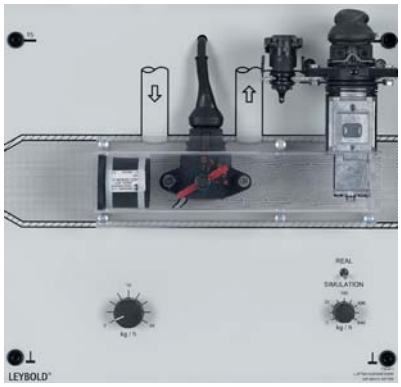
739 37	Evaluation Unit Motronic and LU-Jetronic



Control Unit, LH Motronic (M 1.5.4)

Digital control unit with integrated fault storage unit and with the aid of programmed engine characteristics for the ignition, the air fuel management, the idle speed stabilisation and the fuel vapour retention system.

739 402	Control Unit, LH Motronic (M 1.5.4)



Air Mass Meter, LH Motronic

For measuring the following parameters:

- Air mass via hot-film sensor
- Intake air temperature via NTC
- Throttle valve angle via potentiometer

739 411	Air Mass Meter, LH Motronic

Crank Angle Sensor

Inductive speed and reference mark pulse sensor, detects operation data such as: Motors speed and crankshaft position and supplies this data to the control unit.

739 42	Crank Angle Sensor

Cable for Crank Angle Sensor

To connect the crankshaft angle sensor to the control unit motronic.

739 421	Cable for Crank Angle Sensor

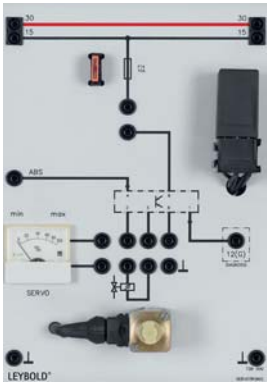
Distributor Drive Universal

Used as substitute for engine with flywheel and camshaft, for distributor controlled ignition systems (CI, TI-I, TI-H), distributorless ignition systems (DIS) and Motronic.

Technical Specifications:

- Speed control: 0...4000 min^{-1}, can be switched to: 0...7000 min^{-1}
- Drive motor: 220 V, 50-60 Hz
- Control voltage: 12 V
- Supply voltage: 220 V, 50-60 Hz, with mains cable and Schuko plug

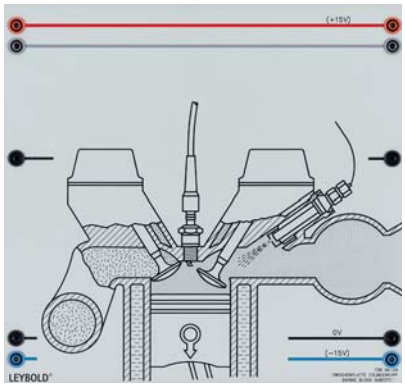
739 43	Distributor Drive Universal



Servotronic

Microprocessor-controlled hydraulic power steering system, whose steering assistance is automatically controlled as a function of the speed. The power steering operation is demonstrated via an integrated display instrument.

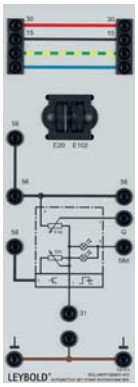
739 500	Servotronic



Electronic Gaspedal Accessory

5 overlays and 1 complimentary panel with symbol representation of the electronic gaspedal components.

739 56	Electronic Gaspedal Accessory



Automotive Set Point Potentiometer

For the manual adjustment of the headlamp vertical aim and the brightness of switches and instrumentation

739 573	Automotive Set Point Potentiometer

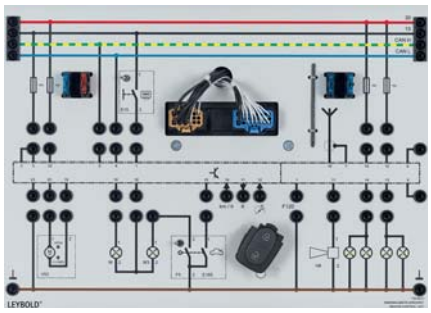
Comfortsystem with CAN – Bus

Laboratory system for the following applications:
Comfort electronics

- Central locking system
- Motor for car window
- Outside mirror adjustment
- Interior lighting

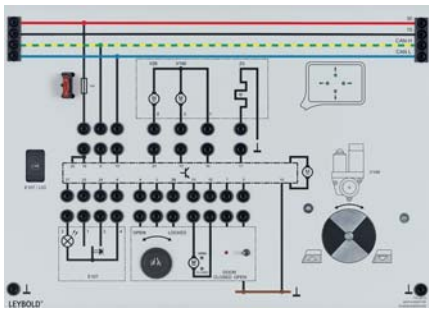
CAN-BUS Technology (only in combination with the Software CAN-BUS (739581) and a PC)

- Sleep function
- Basics on CAN-BUS-Protocol
- Analysis of the Protocol
- Control with CAN-BUS
- Warning system against theft
- Release of the alarm
- Save Modus
- Activation of the warning system



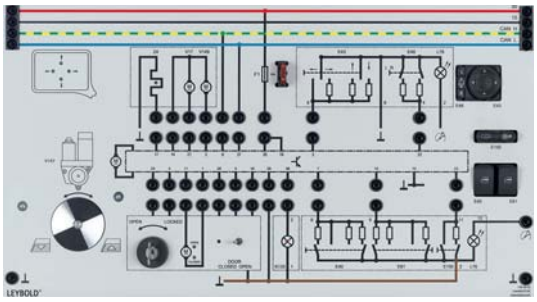
The system consists fo three experimental boards:

73958 01 **Comfort system Main Control Device** with the following functions:



- Outside mirror heating
- Central locking system tailgate
- Boot lamp
- Interior lighting
- Alarm bell
- Turn signal lamps front/rear position
- Radio remote control
- Monitoring of the door lock

73958 02 **Comfort system Driver Door**



- Central locking system
- Control lamp central locking system
- Motor for car window
- Indication mirror adjustment
- Indication mirror heating
- Switch mirror adjustment
- Switch for car window motor
- Switch for locking system

73958 03 **Comfort system Front-Seat Passenger**

- Central locking system
- Motor for car window
- Indication mirror adjustment
- Indication mirror heating
- Switch for car window motor

739 58	Comfortsystem with CAN - Bus

Databus detector

Handheld compact universal tool for contactless detection of various vehicle signals like CAN databus. Output via optical indicator and sound generator. With torch function.

739 580	Databus detector

CAN bus software USB

consisting of:

Software CAN – View (German and English)
The program CANView enclosed to the package is a CAN-BUS Viewer for Windows. It allows transmitting and receiving CAN messages. With CANView existing networks can be checked or set up fast.
Hardware PCAN – Dongle
For connection to the PC's USB port.
The connecting cable provided (9-pole D-sub-connector and 4 mm safety connector) serves as connection to CAN-BUS system.

739 581USB	CAN bus software USB

Training panel lighting NG

The training panel consists of a modern dash panel insert with electronic immobilizer, complete steering wheel, the central module comfort system and the electronic central electronics module. The lighting system and a wiper motor complete the system. Fundamentals of automotive electronics and modern databus systems are presented clearly and logically. Great importance is attached to this concept by using original vehicle componen
The error detection, fault analysis and correction are on the focus.
For data acquisition and analysis of the data messages the CASSY system is used. The data messages a and interpreted on an oscilloscope basis. Using the CAN bus box (524078) and the LIN bus box (52408 a complete bus protocol analysis can be performed and with the software LDCANExplorer (739587), th be visualized on the PC. The system is self-diagnostic capability, an appropriate diagnostic tester (737 played through all the diagnostic possibilities.
The training system includes:

- Lighting system with automatic headlight activation
- instrument cluster
- electronic immobilizer
- Steering wheel with steering wheel controls (LIN)
- Control unit for the automatic car identification
- 13-pin trailer socket
- Convenience system central module (CAN bus)
- Central electronic module
- Rain/Light sensor (LIN)
- Wiper motor with automatic control
- relay carrier
- OBD II diagnostic connector
- CAN/LIN databus interfaces
- Fault switching box

Includes: test stand, CD-ROM

739 5821	Training panel lighting NG

DS vehicle door

Original driver's door Audi A4
Driver door (painted) with:

- window lifter
- door lock
- Electric rearview mirror
- Switching panel window lifter and mirror
- unlocking doors

mounted on 4 wheels
Self-diagnostic capability via the control unit „Central comfort electronics"

Scope Of Delivery:

Includes cable set CAN H/L, terminal 30, 31 and ZKE on 4-mm safety plugs, cable length: 2 m

739 5835	DS vehicle door

PS vehicle door

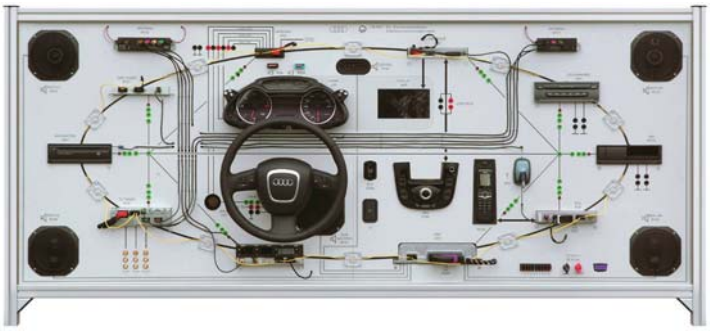
Original passenger door Audi A4 as a complement to the DS vehicle door, 7395835.
Passenger door (painted) with:

- window lifter
- door lock
- Electric rearview mirror
- Switching panel window lifter and mirror
- unlocking doors

mounted on 4 wheels
Self-diagnostic capability via the control unit „Central comfort electronics"

739 5836	PS vehicle door

Training panel, vehicle communications



This training panel includes a complete Infotainment package networked over a MOST bus in the latest Audi A4 technology.
Included are:

- an instrument cluster and gateway
- an antenna amplification system
- a true-color display with controller for information
- an operator unit for multimedia
- a hybrid TV tuner*
- a MP3-capable CD changer
- a navigation system*
- an analog and a digital radio receiver*
- an OBD diagnose socket
- a cell phone adapter*
- a steering wheel operating unit with voice control
- a MOST bus interface
- a CAN bus interface and a LIN bus interface
- a fault-switch box.

Especially for the vehicle communications electrician; this board offers options for detecting loudspeaker impedance, assessing transmission power-level of cell phone antennas, performing AF and HF signal investigations and detecting reception signal levels.

The optical characteristics of MOST bus' optical fiber guide connectors can be investigated in more detail with the optical bench (736 415). With equipment set A2.6.1.5/6, supplementary practical exercises can be carried out on the subject of „Making up optical fiber guides". Oscilloscope investigation of the MOST signal is made possible by the STE MOST transceiver (578 485). Practice-oriented detection of defective MOST control units can be done with the MOST replacement controller (740 2071). In combination with a diagnose adapter (737 9802/3) or an original workshop tester, the system has self-diagnostic capabilities over the CAN diagnose bus.

Configured as a mobile unit, completely enabled and with two keys

739 5841	Training panel, vehicle communications

*the functional range may vary due to local conditions! Navigation for Europe only!

Fault simulator CAN Bus

Simulation of typical CAN data bus malfunctions. All 8 faults according to ISO and 3 additional faults can be activated:

- Interruption of CAN_H / CAN_L
- Connection to ground of CAN_H / CAN_L
- Connection to battery voltage of CAN_H / CAN_L
- Shortcircuit of CAN_H and CAN_L
- Missing/wrong termination resistance
- Mixed up data lines
- Faults can be activated via individual switches, covered by a lockable door.

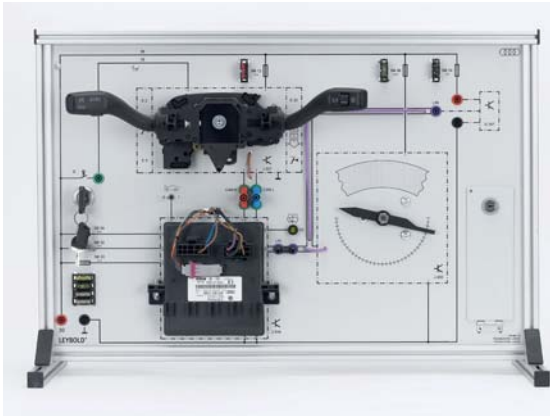
739 585	Fault simulator CAN Bus

Set of 6 CAN Bus Fault Plugs

Set consisting of six 6-pole round plugs, in each a typical CAN bus error is connected; in order to put on the MOST FBS (7402010-01 or 7402012-01).
The following faults are connected:
1. Short circuit CAN L after mass
2. Short circuit with a line resistance of 2 kOhm from H CAN to T 30
3. Short circuit of CAN H and CAN L
4. Short circuit of CAN H and CAN L with 1 kOhm
5. Short circuit of CAN L to T 30
6. Short circuit with a line resistance of 23 Ohm from of CAN L to ground

739 5858	Set of 6 CAN Bus Fault Plugs

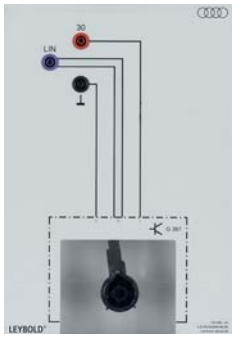
Training panel LIN-Bus



The LIN bus is a single-wire bus typically implemented as a „sub-bus" to the CAN data bus. At the request of the CAN bus master, it fetches sensor data or activates actuators. In automatic windshield wiper interval operation, the rain sensor detects the intensity of precipitation and reports this via the LIN bus to the on-board network controller unit. In turn, the on-board network controller unit activates the wiper motor – also via the LIN bus – with an interval period commensurate with the amount of precipitation; for minimum rain = less frequent, heavy rain = frequent repetitions of the wiper's cycle. The rain sensor can be activated with spray from a spray bottle. The CASSY system from LD Didactic is used for data telegram measurement data acquisition and evaluation. CASSY's oscilloscope facility permits data telegrams to be recorded and interpreted. The lockable fault-switch box can be used to introduce CAN and LIN faults.

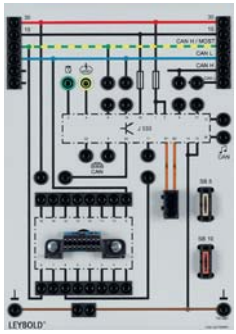
This training system includes:

- CAN bus capable steering column electronics with wiper lever
- an on-board network controller unit with CAN and LIN bus capabilities
- a LIN bus controlled wiper motor
- a LIN bus controlled rain sensor
- a fault-switch box (CAN and LIN faults).



739 586	Training panel LIN-Bus

CAN Gateway



Diagnosis gateway to the connection of the diagnosis adaptor 7379802 or 7379803 to the training board LIN bus (739586).

739 5861	CAN Gateway

Software: CAN bus visualisation

The LDCANExplorer is a universal software for visualization and analysis of data traffic in CAN and LIN bus systems. Monitoring software to display and evaluate the CAN bus data in conjunction with the CAN-Bus software (739581 or 739581USB). The CAN bus data traffic can be recorded (trace function) or displayed continuously in a table. In addition, any messages can be sent.
For the intelligent lighting management (738111), the software can be used in addition to the visualization of the instrument cluster. Here, the lights and the lamp failure monitoring messages are displayed graphically on the PC. It also enables you to perform various self-diagnostic capabilities and implements the release of enhanced functions „Coming Home" and „Leaving Home".
Additionally, the LIN databus topology of the system 739586 can be visualized and the LIN data can be displayed using the LIN databus adaptor 739588.

Features CAN bus:
- Display receivable CAN messages including the ID, length, data bytes, the receiving interval and the number of received messages
- Copy the received CAN messages to the clipboard is possible
- Hexadecimal representation of the information
- Display of the total number of all CAN messages in the system
- Transmission of CAN messages at fixed intervals
- Periodic transmission of up to 1 ms accuracy
- Real-time monitoring of multiple CAN signals
- Representation of logged CAN data with time stamp, type, ID, length and data bytes
- Support any number of logging windows
- Accuracy of the time stamp of the logged data 10-6 s
- Logging of errors is possible
- Save the logged CAN data is possible
- Filtering and color coding of logged data according to the CAN ID
- Printing of the logged data is possible

Features LIN bus:
- Display receivable LIN messages indicating the ID, length, data bytes, the checksum, the reception interval and the number of received messages
- Switching between the display of the ID and the ID field
- Parallel display of the associated LDF file
- Hexadecimal display of data
- Display of the transfer rate
- Real-time monitoring of multiple LIN signals
- LIN calculator to calculate the ID and the ID field, the parity bits of conversion of binary data in hexadecimal and vice versa
- Sending symbolic LIN messages for the wiper system is possible

Features of the software:
- Automatic detection of the connected training Systems
- For a better presentation on a projector, the image will automatically change the font
- Variable buffer size
- Graphical representation of the topology of the CAN or LIN network with CBT functions
- Support for self-diagnostic capabilities of selected systems
- Running on Windows (32-bit) 2000, XP, Vista and 7

Scope of delivery:
CD-ROM with the installation file and the help files in German and English as a PC-based single-user license

739 587	Software: CAN bus visualisation

LIN BUS PC interface USB

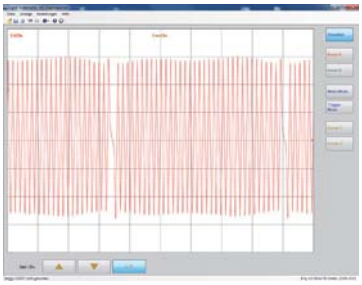
Galvanically isolated adaptor to the connection with a LIN databus system (e.g. 739586) on the one hand and a PC's USB interface, on the other hand. With the attached software it is possible to record the LIN bus data of the system and to evaluate them. In addition LIN data with the software LDCANExplorer 739587 can receive, sent and are visualized. The box supports the LIN versions 1.2, 1.3 as well as 2.0. In addition, future LIN changes can be taken into consideration about a proficient product update. Connecting leads for the LIN bus and the PC are enclosed.

- Integrated 32-bit CPU
- 8 Kbytes of program memory
- Transfer rates up to 20 kbit / s
- Meets the LIN specification 1.2, 1.3, 2.0 and 2.1
- Power supply via USB bus or LIN
- galvanic isolation
- Connections 4-mm safety cables: Brown = ground, black = Terminal 30 and purple = LIN bus
- Compatible with USB 1.1 and 2.0

Scope of delivery:
- LIN Bus Adapter USB, electrically isolated
- USB cable
- Cable terminal on 4-mm safety plugs, length 100 cm
- Program CD with a license of the software LDCANExplorer

739 588	LIN BUS PC interface USB

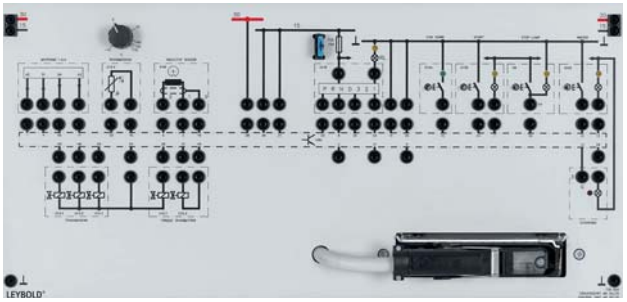
Software: Vehicle diagnosis, German and English



CASSY Diagnosis software for vehicles in German and English. This software provides an operating skin for the Sensor-CASSY which is felt to an original-diagnosis tester. Digital multimeter (DMM) and digital storage oscilloscope (DSO) with adaptation to voltage and current as well as ohmic resistance, temperature, pressure, injection time or ignition angle using appropriate sensor boxes.

739 589	Software: Vehicle diagnosis, German and English

Control Unit AR 25/35



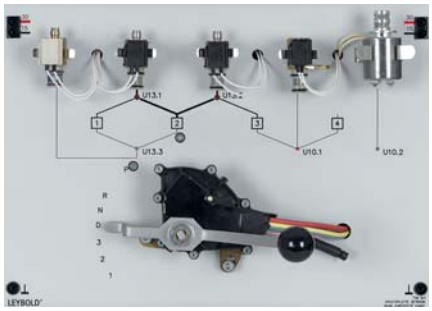
For 4-speed automatic drive.
Operating modes:

- Economy
- Sport
- Winter
- Kick-Down

Display of the operating states performed by LEDs. The control unit is capable of self-diagnosis with the aid of a standard workshop system tester, e.g. KTS.

739 600	Control Unit AR 25/35

Gear Substitute Panel



Original component made of the „electronic 4-speed gear box" permits hands-on approach to the switching processes, with selector control positioning switch for P, R, N, D, 1, 2, 3. Controls the solenoid valve for switching 1-2/2-4 or 2-3 gears as well as the solenoid valve for converter coupling, pressure regulator and brake strap. The operating states are indicated via LEDs.

739 601	Gear Substitute Panel

Tachometer/Speedometer

- Rpm indicator: 0...7000 min^{-1}
- Speedometer: 0...230 km/h
- With total kilometer and daily kilometer counter.

Tachometer signal input:
Square-wave 7...10 V; 100 Hz = 3000 min^{-1}
Speedometer signal input:
Sinusoidal/square-wave 5...10 V_{pp}; 400 Hz = 60 km/h

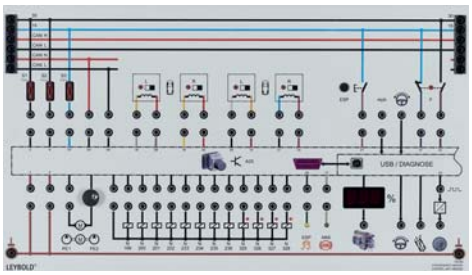
739 602	Tachometer/Speedometer

Instrument cluster unit

Instrument cluster with tachometer, speedometer, temperature and fuel stock announcement with high-resolution graphic display to the announcement of driver's informations. Suitable to the connection with Highspeed and Lowspeed CAN bus, with integrated gateway and own diagnosis management. Especially suitably to the connection with the system A2.1.3.1, automotive lighting by CAN bus!

739 6021	Instrument cluster unit

ABS/ESP control unit



ABS/ESP control unit. On the sensor side 4 rotational speed sensors (Hall or inductive) attached to the wheel, rotational and lateral acceleration sensors and a brake pedal can be connected. On the output side the actuator signals of the recirculation pump, of the 4 inlet and the 4 outlet valves and of the high pressure switch valves can be recorded. The steering angle is recorded via CAN bus from the steering column electronics 738111-02 and 739 654. The experiment described below can be carried out:

- **ABS**
  Pressure change in the wheel brake cylinder (increase, hold, release)
  Full brake application on a non-slip road
  Full brake application on a slippery road

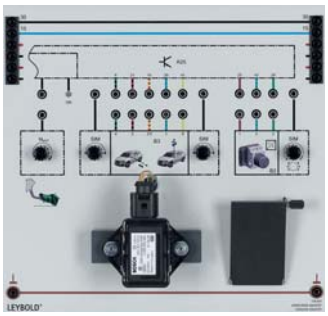
- **ESP**
  Driving manoeuvre: „rapid steering and correction"
  Driving manoeuvre: „track change with full brake application (Elk test)"
  Driving manoeuvre: „multiple steering and correction"
  Driving manoeuvre: „acceleration / braking in a tight curve"

For the recording of the measurement of the diagrams, the control unit is equipped with additional analogue outputs:

- Percentage of engine intervention
- Steering angle
- Sideslip angle
- Vehicle speed v

For performing simulations driving situation, the control unit can be connected via USB to a PC. It is equipped with an fault memory and is self-diagnostic capable.
The conversion from **km/h** or **mph** for speed's display and **Pa** to **psi** for pressure's display is possible by coding.

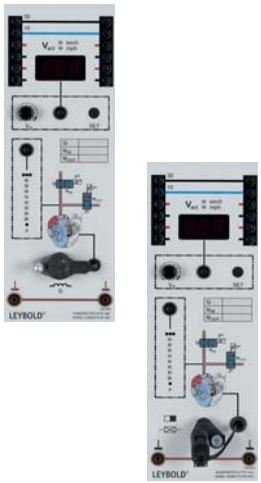
739 650	ABS/ESP control unit



ABS/ESP sensors

Sensors for connection to the ABS/ESP control unit consisting of a simulated gas pedal for setting the desired engine torque, a rotary and a lateral acceleration sensor and a brake pedal. The acceleration sensor is installed so that it can be moved and the signals be generated, but alternatively it can be simulated by means of a rotary encoder. The brake pedal can be pressed in order to simulate the brake pressure or it can be simulated by means of a rotary encoder.

739 651	ABS/ESP sensors



Wheel replacement plate, inductive

Wheel replacement plate with inductive wheel sensor and option to set the wheel speed via a rotational encoder. The pressure in the wheel brake cylinder and the wheel speed are displayed optically and are made available as analogue values at 4-mm sockets so that they can be measured. The status of the inlet and the outlet valves are displayed by means of LEDs. The displays can be switched between km/h and mph and between Pa and psi.

739 652	Wheel replacement plate, inductive

Wheel replacement plate, Hall

Wheel replacement plate with active Hall wheel sensor and option to set the wheel speed via a rotational encoder. The pressure in the wheel brake cylinder and the wheel speed are displayed optically and are made available as analogue values at 4-mm sockets so that they can be measured. The status of the inlet and the outlet vales are displayed by means of LEDs. The displays can be switched between km/h and mph and between Pa and psi.

739 653	Wheel replacement plate, Hall

Steering angle sensor

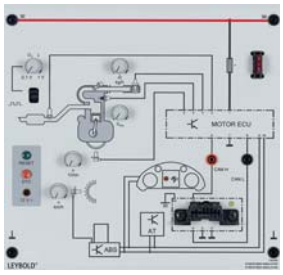
Photo-electric steering angle sensor only as a complement to the steering column module 738 111 02 in conjunction with the instrument cluster unit 739 6021 for measuring the steering angle via the motor CAN-bus (high-speed).

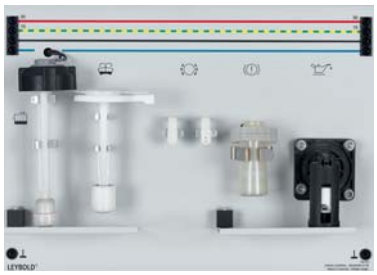
739 654	Steering angle sensor

EOBD/OBD2 Simulator

The training panel simulates 3 EOBD related ECUs and can generate for this live data as well as error messages. These can be transferred via a OBD adapter (7379803) to the computer or using a data logger (7379804) recorded for later analysis.

739 660	EOBD/OBD2 Simulator





Check Control, Sensor Panel

With sensor for oil level, brake fluid level, coolant level, cleaning fluid level and brake lining strength.

739 701	Check Control, Sensor Panel

Oil sensor

Oil level and temperature sensor and coolant temperature sensor for connection to the instrument cluster (7396021) via rear 6-pin connection cable.
Oil level and temperature sensor (TOG)
The TOG is mounted in an aluminum cup, which can be filled with warm oil to investigate the sensor under real conditions. Alternatively, the signal „oil level" and „oil temperature" can be simulated by a potentiometer. The encoding of information by means of PWM and PFM.
Engine coolant temperature gauge
The temperature sensor is a NTC type resistor and mounted above a beaker, which can be filled with hot water. Additionally a clamp for an additional temperature sensor is provided so that the characteristic of the NTC can be recorded. Alternatively, the temperature can be simulated using a potentiometer.
The data is available in addition to a 9-pin D-Sub connector for external measurement peripherals.

Technical Specifications:
Ranges

- Oil temperature: -50 °C ... +130 °C (-58 °F ... +266 °F)
- Oil level: 0 mm ... 56 mm (0 in ... 2.21 in)
- Coolant temperature: 0 °C ... +130 °C (+32 °F ... +266 °F)

739 706	Oil sensor

BT car radio

with CD player (with MP3), RDS traffic program (TP) and Auto Preset button assignments (AS). The training panel includes sockets for an electric antenna and the speaker systems. Furthermore, via a Bluetooth™ interface a mobile phone can be connected.

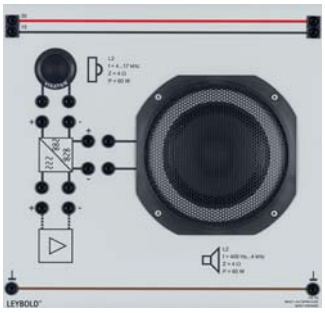
739 718	BT car radio

The functional range may vary due to local conditions!

Broad Band Loudspeaker

2-way system; diameter approx. 120 mm; music signal power: max. 35 Watt at 4 Ohm.

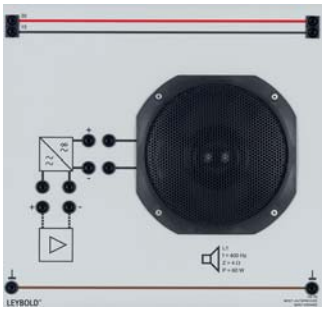
739 731	Broad Band Loudspeaker



MOST Loudspeaker

Especially on the MOST-teaching system coordinated loudspeaker unity consisting of high and middle tone loudspeaker, separate or in parallel about 4-mm sockets or back-sided loudspeaker cables connectable.

739 735	MOST Loudspeaker



Automotive Bass Loudspeaker

- f< 400 Hz
- Z = 4 Ω
- P = 60 W

739 736	Automotive Bass Loudspeaker

Short rod antenna

with built-in amplifier, capable of a „phantom" supply, with BNC connector on the rear side.

Scope Of Delivery:

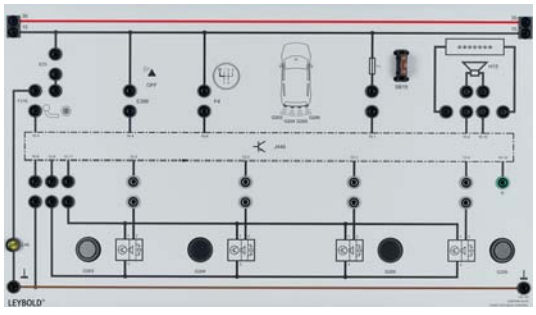
- Antenna
- Connecting cable BNC

739 7421	Short rod antenna

Digital rod antenna

Passive rod antenna for receiving digital radio (DAB) signals and television (DVBT) signals with adapter to BNC plug incl. phantom power adapter.

739 743	Digital rod antenna

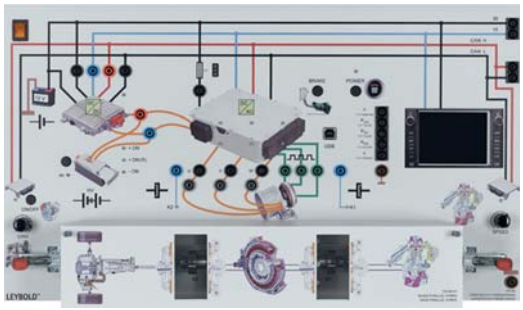


Park distance control

Training panel, consisting of an original control unit with self-diagnosis and four original ultrasonic sensors. After activating the built-in bumper sensors transmit ultrasonic signals and receive the reflected echoes from which the control unit calculates the distance to the obstacle.

739 750	Park distance control

Workstation vehicle hybride drive



The workstation includes a hybrid engine with rotor position sensor, a (surrogate) combustion engine as well as a propulsion unit (combining gears, roll resistance of the tires and air resistance) in 24 V technology as parallel hybrid. By a mechanism the hybrid engine can be decoupled from the combustion engine and from the gears separately. The engine speed and power and therewith the moment distribution of the engines can be adjusted individually by potentiometer with the integrated power electronics (pulse-controlled inverter). Thus following operating conditions can be analyzed experimentally:

- Hybrid drive
- Electric drive
- Boost
- Generator mode
- Recuperation by braking

Both the engines and the power electronics can be connected to measurement devices. In addition to a multi colour touch screen interface a PC can be connected for control and interpretation via an integrated USB interface. Firmware updates are also possible.
Additionally the workstation includes an exemplary high-voltage vehicle electrical system and the 14 V vehicle power supply. Moreover the high-voltage vehicle electrical system powers the 14 V vehicle power supply via an integrated DC/DC converter.

Technical Specifications:
Power supply 230 V, 50/60 Hz

739 940	Workstation vehicle hybride drive

Experiment set hybride drives

Complete set of a 300 W hybrid car simulator. The torque distribution and the control of a vehicle driven by a parallel hybrid system can be investigated.
Operating modes like:

- Electrical drive (motor)
- Electrical load (generator)
- Regenerative braking (recuperation)
- Boost mode

can be realized.
Consisting of:

1. simulation of the combustion engine and simulation of the load
2. rotor position pick up
3. permanent magnet 3~ motor
4. inverter unit
5. simulation of a HV battery
6. hybrid control unit
7. set of hybrid masks

Simulation of the combustion engine and the load each consisting of Electrical machine test system 300 W,
Technical Specifications:
Electrical connection: 230 VAC, 50/60 Hz

Scope Of Delivery:

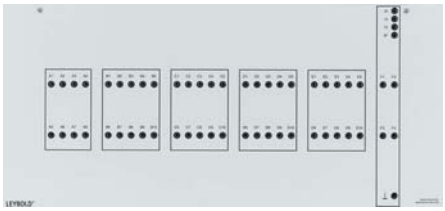
incl. couplings, covers, connecting material and moveable rack

739 945	Experiment set hybride drives

Didactic engines

Cat.No	Designation
740 010	Engine OTTO
740 011	Training Engine (OTTO) with measuring unit
740 013	Mask Engine Otto (student)
740 040	Engine Diesel
740 041	Engine Diesel with Evaluation Module
740 043	Mask Diesel Engine (student)

Student Measuring Adaptor



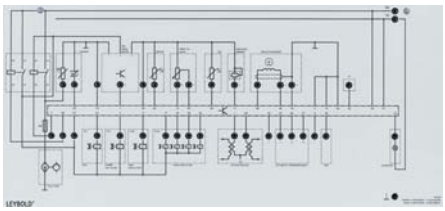
Experiment panel with 5 m cable set to be used with:

- Function motor (directly connected to the engine's measurement adaptor)
- Function vehicle (directly connected to the engine's measurement adaptor)
- Various A2 control units

The mask belonging to the engine is additonally required!

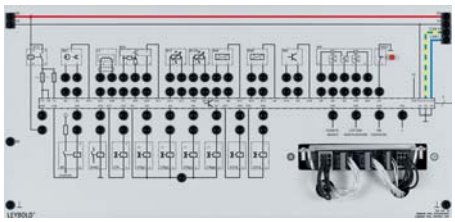
740 050	Student Measuring Adaptor

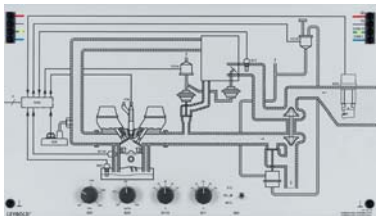
Supporting masks

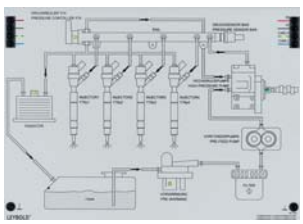


For student measuring stations.

Cat.No	Designation	for
740 052	Mask LH Motronic (Student)	739402
740 0531	Mask CR (student)	740105+106
740 0551	Mask ABS/ESP	739650
740 059	Mask AR (student)	739600







Common Rail with Hydr. Simulation

Modular training panel system with Daimler Chrysler technology including a simulated injection system.
Experiment setup Common Rail
consisting of:
Common rail control unit
To control the fuel injection valves after recording and evaluating the relevant ambient parameters. All parameters can be read out and evaluated at the 'Common Rail Control Unit' experiment board.
Common rail system board
A measurement and evaluation module for common rail system test stands to carry out measurements and simulate states and faults; universal terminal board with safety sockets (experiment board DIN A4). All analog signals can be modified through corresponding simulations.
Common rail accelerator pedal sensor
Flywheel with sensor holder assembly
Substitute engine for common rail system with a holder for sensors that record rotational speed, crankshaft position and TDC.
Rotational speed control: 0.....4000/6000 rpm
Input power: 230 V/50 - 60 Hz
Common rail hydraulic simulation
To record / generate the control signals for the control units.
Graphic panel display with engine symbols, exhaust gas recirculation and turbocharger as well as sensors for suction pipe pressure, coolant, charge air, fuel temperature, engine speed, injection quantity etc.

Panel Frame, Two Level
width: 1242 mm, height: 730 mm, depth: 150 mm

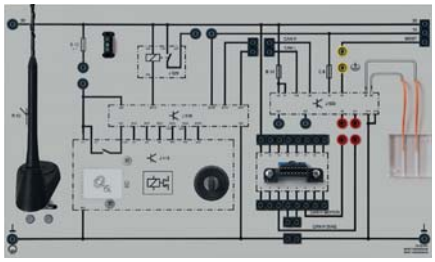
in addition, are included:
4 Sets of 10 safety bridging plugs, black
1 Set of 10 safety bridging plugs with Tap
1 Safety connection lead 50 cm red
1 Safety connection lead 50 cm black
1 Safety connection lead 50 cm brown
1 Instruction sheet

740 106	Common Rail with Hydr. Simulation

MOST Basic equipment Basic

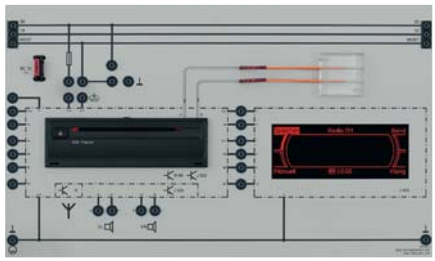
MOST training system consisting of the following system components:

MOST antenna FBS 7402010-01
Actively registered driving authorization system with ignition switch and control device for access and start authorization for the adaptation of the component protection of the other control devices. In addition, the gateway exists as an active MOST component and as a diagnosis interface for the OBD socket. Both control devices are connected by the comfort CAN bus which is accessible via 4-mm sockets. Using a rear side coded plug faults can be switched to the comfort CAN bus. The integrated FM antenna is connected on the rear side to the radio receiver 7402010-03. The ring break diagnosis line can be monitored for fault finding by means of a diagnosis tester.



MOST operating unit 7402010-02
Central operating unit multimedia-key pad (MMI) with 9 functional keys and 8 control keys. The unit is connected via 4-mm-bridgeing plugs with the control unit for information.

MOST Main unit Low 7402010-03
Central processing unit „Basic Plus" to be connected to the optical MOST bus consisting of the central control unit for information (Head-Unit) with integrated radio* and CD player as well as a plexiglass-protected 7 "-monochrome-display to display the information and menus. The connection to the MOST bus is realised via POF coupler on the front side and POF sockets on the rear side. The ring break diagnosis line is available for fault finding.



MOST Amplifier 7402012-04
Digital 6 channel audio amplifier to be connected to the optical MOST bus. 6 loudspeakers can be connected on the rear side using loudspeaker cables as well as a microphone on two 4-mm-safety sockets on the front panel. For diagnosis purposes with the spare control unit 7402071 an original POF plug is used.

Scope of Delivery:
Set of safety bridging plugs, set of POFs, antenna cable and CD ROM

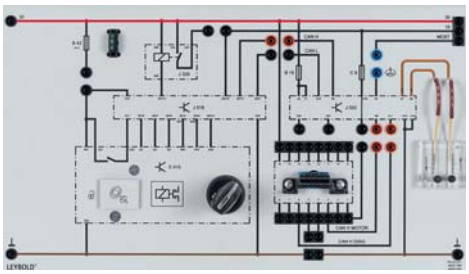
*the functional range may vary due to local conditions

740 2010	MOST Basic equipment Basic

MOST Basic equipment Plus

MOST training system consisting of the following system components:

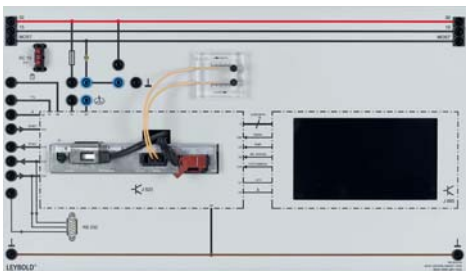
MOST ESA 7402012-01
Actively registered driving authorization system with ignition switch and control device for access and start authorization for the adaptation of the component protection of the other control devices. In addition, the gateway exists as an active MOST component and as a diagnosis interface for the OBD socket. Both control devices are connected by the comfort CAN bus which is accessible via 4-mm sockets. Using a rear side coded plug faults can be switched to the comfort CAN bus. The ring break diagnosis line can be monitored for fault finding by means of a diagnosis tester.

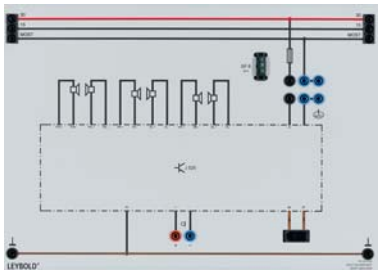


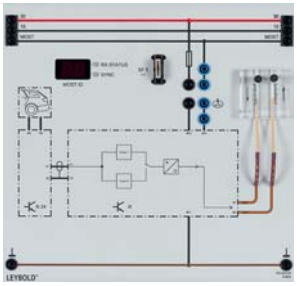
MOST Operating unit 7402012-02
Central operating unit multimedia-key pad (MMI) with 9 functional keys and 8 control keys. The unit is connected via 4-mm-bridgeing plugs with the control unit for information.

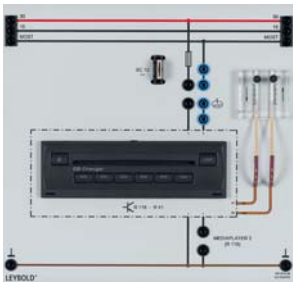
The coupling of the devices-03 to-08 to the MOST ring is set up using a POF coupler which serves at the same time as a fault simulator. The ring break diagnosis management is led out by all devices fault finding by means of a diagnosis tester.

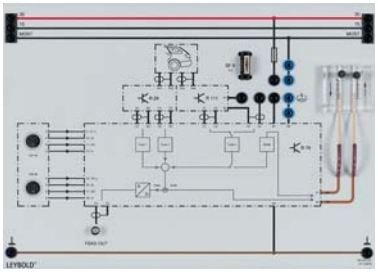
MOST Main unit High 7402012-03
Central processing unit „High" to be connected to the optical MOST bus consisting of the central control unit for information (Head-Unit) as well as a protected 7 "-TFT- full color display to display information, menus and the TV picture. The data line to the operating unit 7402012-02 is accessible via an interface RS232 and thus can be connected to the PC. The state of the ring break diagnosis line is indicated optically.

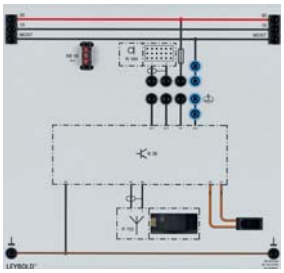












MOST Amplifier 7402012-04
Digital 6 channel audio amplifier to be connected to the optical MOST bus. 6 loudspeakers can be connected on the rear side using loudspeaker cables as well as a microphone on two 4-mm-safety sockets on the front panel. For diagnosis purposes with the spare control unit 7402071 an original POF plug is used.

MOST K-Box 7402012-05*
Radio-module AM/FM with twin tuner RDS to be connected to the optical MOST bus. The antenna amplifier module is connected via two HF cables on the rear side. For diagnosis purposes a POF coupler is available. The device has a two-digit display to show the MOST address as well as two LEDs for the ring break diagnosis.

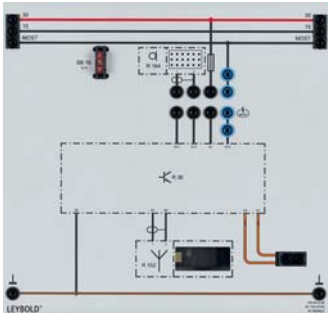
MOST CD Player 7402012-06
6-fold auto-changer (MP3 capable) to be connected to the optical MOST bus. The ring position can be set by a bridging plug to either „Mediaplayer 1" or „Mediaplayer 2".

MOST TV tuner 7402012-07*
Hybrid TV tuner with integrated antenna amplifier module to receive analogoue and digital (DVB T, only on the regional level availably!) television signals. Connected to the optical MOST bus to transmit control and audio signals. On the front panel a BNC socket for the FBAS signal is located as well as two 6-pole DIN connectors for external AV input signals. Antenna input and output is availabe via HF sockets on the rear side. For diagnosis purposes a POF coupler is used as well as the signal of one antenna can be interrupted using a 4-mm bridging plug.

MOST BT Mobile 7402012-08*
Bluetooth mobile phone preparation (delivery without mobile phone and mobile phone adaptor!) to be connected to the optical MOST bus in combination with 7402012, MOST central processing unit High or as an optional supplement to 7402010, MOST central processing unit Low. With integrated handsfree microphone. Optionally, an external microphone can be connected via two 4-mm sockest. The Bluetooth antenna is visible behind a plexiglass cover.

740 2012	MOST Basic equipment Plus

*the functional range may vary due to local conditions



MOST BT Phone preparation

Bluetooth mobile phone preparation (delivery without mobile phone and mobile phone adaptor!) to be connected to the optical MOST bus in combination with 7402012, MOST central processing unit High or as an optional supplement to 7402010, MOST central processing unit Low. With integrated handsfree microphone. Optionally, an external microphone can be connected via two 4-mm sockest. The Bluetooth antenna is visible behind a plexiglass cover.

740 2012-08	MOST BT Phone preparation

MOST PC USB Interface

Menu-driven interface for connecting to a MOST25 network for recording (logging) and analyzing the data.
The transmitted communication of the real system or previously recorded data can be analyzed interactively.
The functions trace, data and audio window with filter function and generator block for outgoing messages are available.

Interactive online protocol analysis
In the trace window the data transmitted via MOST of the control channel including the (composite) segmented data, such as AMS or MOST High Protocol are displayed.

- Important MOST events are marked in color.
- The Central Registry describes the current ring in which the device is registered as a node.
- Important hardware and network conditions such as light, locked state or node address are displayed.
- Representation of current radio texts in the radio control channel monitor. This automatically displays the composite data.
- Messages can be sent using the generator block.
- The Audio window gives you an overview of the channel reservation in the area of synchronous data from MOST and allows to select individual connections and listen to them or put in audio signals.

Interactive offline protocol analysis
The Offline mode helps you in interactive or automated analysis of previously recorded logging files. The log files can be loaded as a real measurement in the program and can be evaluated.

Displays and menu items on the device
Physical location of the device in the MOST ring

- Logical address of the device in the MOST ring
- Synchronous Bandwidth
- Audio output
- Audio input
- Block trigger
- Data capture
- Info

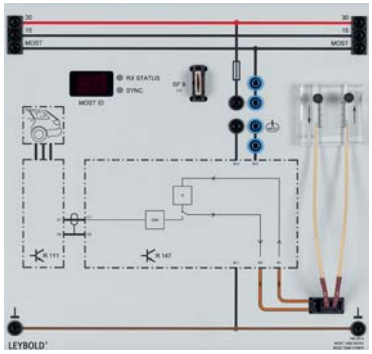
Technical Specifications:
Plug-in power supply 230 V, 50/60 Hz

Scope Of Delivery:

12 V power supply, POF with one plug, audio cable 3.5 mm, USB cable.

740 2013	MOST PC USB Interface

MOST DAB radio



Digital radio for integration in the MOST ring with digital address indicator and original fibre optic cable socket.
The system continuously checks whether the DAB transmitter is also received as an analogue signal and automatically switches to the most powerful transmitter.

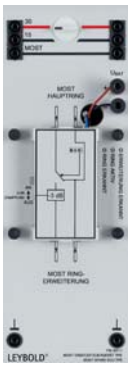
740 2014	MOST DAB radio

Operation requires proper free local DAB signal

MOST Spare Control Unit ECU

MOST 2-fold hub to display the transmission activity, extraction of optical signals and binding / extension of additional components into the MOST ring with the possibility to damp the optical power by 3 dB. Connections for 12 V, ground as well as a status. This control device can replace either control unit for fault finding purposes in the MOST ring.
4 POF couplers and 2 POFs fitted with connector housings at one end

740 2071	MOST Spare Control Unit ECU



MOST repeater TPS

MOST double hub for the display of the transmission activity, extraction of optical signals and connection/extension by additional components in the MOST ring with the option to dampen the optical power by 3 dB. The device is fitted with a detachable holder and can therefore be used in both the experimentation frame setup or in a real car. Connections for +12 V, a ground connection and a status output are available. This control device can be used for the fault diagnosis instead of any other control device in the MOST ring.
Incl. 4 optical wave guide couplings and 2 optical wave guides fitted with connector housings.

740 20711	MOST repeater TPS

MOST pliers set

Pliers set consisting of a manual MOST stripper/cutter for optical fiber guide material and a manual MOST crimping tool for fastening brass contacts to optical fiber guide ends.

Scope Of Delivery:

Delivered in a plastic case.

740 2081	MOST pliers set

MOST Accessory set

Accessories set for carrying out practical exercises in „Making up MOST optical fiber guides" consisting of:
-100 pieces POF metal inserts,
-50 pieces fiber optic carrier housing,
-50 pieces fiber optic housing,
-1 piece fiber optic inline housing 2fold,
-6 pieces fiber optic inline housing 1fold,
-2 pieces fiber optic coupling 2fold,
-50 m POF orange,
-1 polishing aid and
-0.2 m polishing linen (grain 600)

740 2082	MOST Accessory set

MOST consumables

Consumables for carrying out practical exercises in „Making up MOST optical fiber guides"
Set consisting of:
-100 pieces POF metal inserts,
-100 m POF orange
-1 polishing aid and
-0.2 m polishing linen (grain 600)

740 20821	MOST consumables

MOST POF 0.75 m with connector

A pair of MOST optical wave guides each 75 cm long. One end is premanufactured with connector housings, the other end is open with polished surfaces to be connected using the POF couplers.

740 2084	MOST POF 0.75 m with connector

MOST POF 1.5 m with connect

A pair of MOST optical wave guides each 150 cm long. Both ends are fitted with POF connectors.

740 2085	MOST POF 1.5 m with connector

Fibre optic cable, transparent

Transparent plastic fibre optic cable without protective jacket reinforced on one side with a brass sleeve, for illustrating the optical losses caused by bending an optical fibre.
Length 10 m
External diameter 1 mm (980/1000)

740 2086	Fibre optic cable, transparent

Automotive fibre optic microscope

This instrument is used to assess the quality of fiber end surfaces on large-core optical wave guides such as, for example, HCS 200/230 or PMMA 980/1000. This microscope has a 30-times magnification factor and built-in illumination. The illuminating lamp is automatically switched on when the instrument is opened.

740 2088	Automotive fibre optic microscope

Tool set spark plug

Set of tools for professional practice exercise „spark plugs" consisting of:

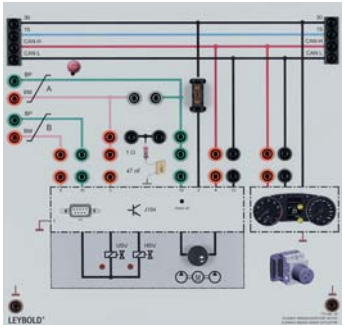
- Torque Wrench 1/2 "
- Socket Extension 1/2 "
- Spark plug socket wrench 1/2 ", W 21 mm
- Setter 0.05 to 1.00 mm
- spark plug brush

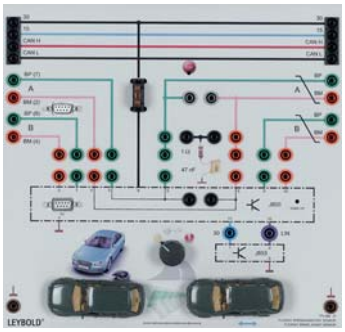
747 800	Tool set spark plug

Automotive cutaway model

Cat.No	Designation
773 806	Cutaway model of a mechanical roots blower
773 807	Cutaway model of a sport differential
773 808	Cutaway model of a distribution gear
773 809	Cutaway model of a two stage volume controlled oil pump
773 810	Cutaway model of an adjustable cam shaft actuator

FlexRay Brake Assist



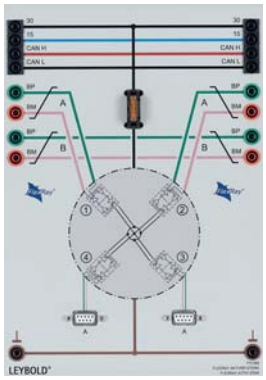


Automotive distance control system to keep a minimum distance between two cars using FlexRay databus transmission consisting of:

- 773 958-01, Brake assist sensor and
- 773 958-02, Brake assist actuator
- 773 958-01, Brake assist sensor

Using two model cars the tight ascend of two vehicles is simulated. This state is passed over the FlexRay bus to the control unit ABS / ESP, which then triggers a braking action in order to achieve the safety distance again. This is set according to the road conditions (dry, wet, slippery) to various default values and is transmitted via the LIN data to the radar sensor controller.
773 958-02, Brake assist actuator
The braking function is visualized by the actuation of the high pressure control valves and the pump. Via a high-speed CAN bus connection in the instrument cluster, the corresponding indicator light is activated.
For monitoring of the databus protocol the following can be used:
CAN databus: 739582USB with 739587
LIN databus: 739588 with 739587 and
FlexRay databus: 773960

773 958	FlexRay Brake Assist



FlexRay Active Star

FlexRay Active Star point for use in safety-related systems. It increases the reliability and availability of the application.

- 4 FlexRay databus interfaces, two as 4-mm-safety sockets and two on a D-Sub connector
- Active data transmission
- Galvanic isolation
- Extension of the databus system

773 959	FlexRay Active Star

FlexRay interface USB

FlexRay USB adapter to record the FlexRay messages on the PC.

- USB 2.0 PC interface
- Display of databus activity via LEDs
- Bus interface for FlexRay V2.1A A+B through D-sub connector
- Asynchronous mode for recording messages without FlexRay synchronisation
- Combined asynchronous and synchronous mode
- Software (32-bit) for Windows 2000, XP, Vista and 7

Scope Of Delivery:

USB cable, Software (32-Bit) for Windows 2000, XP, Vista und 7

773 960	FlexRay interface USB

Exhaust gas analysis unit

Gas Analyser for free measurements on vehicles with diesel and petrol engines.

- AU on vehicles with petrol and diesel engine
- AU to EOBD vehicles with petrol and diesel engine
- Display on a large color display
- Compatible with AU PLUS
- Print function for printout
- Mobile version
- including scanners

Additionally recommended: Mounting and commissioning 774011

774 001	Exhaust gas analysis unit

Tyre changer

Tyre Changer mechanical swiveling back post.

- bead breaker
- adjustable mounting head
- Self-centering chuck
- Outer clamping range up to 20 "
- Pedal-controlled tilt back post after locked in working position; manually tilted forward

Technical Specifications:
Electrical connection: 200 - 415 VAC, 3~, 50/60 Hz

774 002	Tyre changer

1. Consumables for tire mounting (eg, fat) not included!
2. Additionally recommended: installation and commissioning 774012

Wheel balancer

Car Wheel Balancer with automatic input of distance rim / machine and rim diameter

- Behind-weight mode
- Machine with motor
- Clear display
- Clamping of wheel on integrated flange with quick nut
- Automatic braking after measurement
- Pedal-operated parking brake
- including wheel protection

Technical Specifications:
Electrical connection: 200 - 240 VAC, 1~, 50/60 Hz

1. Consumables for correction (eg. weights) not included!
2. Additionally recommended: installation and commissioning 774013

774 003	Wheel balancer

Car wheel aligner

Aligner for measuring vehicles

- Use on different alignment bays
- A-arm adjustment
- Thrust angle
- Caster, camber, toe live
- OEM specs
- PC with TFT display
- printer
- Long-lasting lithium-ion batteries

Scope Of Delivery:

- including pair turntable
- including pairs of sliding plates
- including target

1. In conjunction with 4-post lift 774006
2. Additionally recommended: installation and commissioning 774014

774 004	Car wheel aligner

Two-post lift for vehicles

Two post lift without base frame with two mechanically synchronized driving motors, designed to lift cars, vans and light trucks up to 3000 kg.

- Frame free
- Asymmetrical design, car door access on two sides
- low clearance height
- Electromechanical drive
- Robust long-life column profile
- Roll thread lifting spindles
- Including lubrication system
- Incl. 4 pick-up pads vertically adjustable
- Two mechanically synchronized drive motors

Technical Specifications:
Electrical connection: 400 - 415 VAC, 3~, 50/60 Hz

1. Concrete quality least C20/C25
2. Additionally recommended: installation and commissioning 774015

774 005	Two-post lift for vehicles

Four post lift for vehicles

4-post lift is ideal as acceptance, wheel alignment and platform and offers a lot of space around the vehicle.

- Runway-type lift for vehicles up to 4.000 kg
- Runway length> 4000 mm
- hydraulic drive
- Cylinder under the roadway
- Rails for jacking beam (side)
- Adjustable height bars for wheel alignment

Technical Specifications:
Electrical connection: 400 - 415 VAC, 3~, 50/60 Hz

1. To operate 8 liter hydraulic oil are required which are not included!
2. Concrete quality least C20/C25

774 006	Four post lift for vehicles

Air-Conditioning Service Unit

Fully automatic working air conditioning service equipment.

- Fully automatic operation
- powerful vacuum pump
- easy to read fittings
- large coolant tank
- Filters for water and contaminants
- Mobile version

Technical Specifications:
Electrical connection: 220 - 240 VAC, 1~, 5 0/60 Hz

1. Consumables for air-conditioning service (eg. refrigerant) not included!
2. Additionally recommended: installation and commissioning 774017

774 007	Air-Conditioning Service Unit

LITERATURE

Cat.No	Designation
775001EN	LIT: A1.1.1 Electrics/Electronics
775010EN	LIT: A2.1.1.1 Energy Monitoring
775011EN	LIT: A2.1.1.2 Three-phase Alternator
775012EN	LIT: A2.1.2 Vehicle Lighting systems
775013EN	LIT: A2.1.3 CAN-Bus Lighting Control
775014EN	LIT: A2.1.4 Backfitting Electrical systems
775020EN	LIT: A2.2.1 Electrical Motors
775030EN	LIT: A2.3.1 Coil Ignition System
775032EN	LIT: A2.3.2.1 Air/Fuel Management Benzine
775033EN	LIT: A2.3.3.1 Pre-Glow System
775034EN	LIT: A2.3.3.3 Common Rail
775040EN	LIT: A2.4.1.1 Car Radio
775041EN	LIT: A2.4.1.2 Park Distance Control
775042EN	LIT: A2.4.1.3 CAN-Bus Comfort System
775043EN	LIT: A2.4.1.4 On-board computer
775046EN	LIT: A2.4.1.5 Air-conditioning
775044EN	LIT: A2.4.2.1 Electronic Gas Pedal
775045EN	LIT: A2.4.2.2 Speed Control
775050EN	LIT: A2.5.1.1 Electronic Stability ABS/ESP
775051EN	LIT: A2.5.2.1 Automatic Transmission
775052EN	LIT: A2.5.3.1 Servotronic
775060EN	LIT: A2.6.1.1 Networking Lighting
775061EN	LIT: A2.6.1.2 Networking Infotainment
775062EN	LIT: A2.6.1.3 Networking Comfort Systems
775063EN	LIT: A2.6.1.4 Most-Bus Workshop
775064EN	LIT: A2.6.1.5 Infotainment Basic
775065EN	LIT: A2.6.1.6 Infotainment Plus
775066EN	LIT: A2.6.1.7 Brake Assist System
775067EN	LIT: A2.6.2.1 Vehicle Diagnostic
775068EN	LIT: A2.6.2.2 EOBD Diagnosis
775070EN	LIT: A2.7.1.1 Fuel Cell
775071EN	LIT: A2.7.2.1 Basics Electric Machines
775072EN	LIT: A2.7.2.2 Demonstration Hybrid Drive
775073EN	LIT: A2.7.2.3 Workstation Hybride Drive

Mobile Experiment stand 1300

dimension 1320 x 650 mm, height 815 mm
mobile experiment stand for demonstration, wooden lower cabinet with 4 drawers and 2 swinging doors, lockable, 3 compartments with grooved mats for storing experiment panels, bench top, laminate 30 mm thick with surrounding plastic edge banding, colour light grey RAL 7035 with 2 M8 threaded inserts for mounting a panel frame or assembly grid, 4 wheels , 2 lockable

854 883	Mobile Experiment stand 1300

Automotive Air Conditioning Trainer

This product is an authentic vehicle air conditioning system mounted on a frame for teaching purposes. It teaches the principles of the refrigeration cycle and the function of the component parts of the system.
The unit has four switchable faults that simulate actual faults found on vehicle air conditioning systems. The unit refrigerant charge can be recovered and recharged into the system.
This unit is charged with R134a non-ozone depleting refrigerant.

Features
- Uses actual automotive components
- Suitable for both technician and vocational teaching
- Portable design
- Uses non-ozone depleting HFC refrigerant
- Enables hands-on access to all components
- Simulates four common faults
- Variable speed motor simulates car engine

Technical Specifications:
Power supply: 230 VAC, 1~, 50/60 Hz

FI39-305 - 230	Automotive Air Conditioning Trainer

TEV/FOT conversion kit for 39-305

Enables the automotive air conditioning trainer 39-305 to be changed from TEV control to FOT control (or vice-versa).

FI39-320	TEV/FOT conversion kit for 39-305

Digital Stopwatch

in plastic case with cord and renewable battery. With start and stop function, intermediate times, alarm function and hourly beep.
Division: 1/100 sec. to 30 min., 1 sec to 24 hours
Battery: type UCC392, Renata 2 or Toshiba LR 41

LDS00001	Digital Stopwatch

PHYSICS | CHEMISTRY BIOLOGY | ENGINEERING

LD DIDACTIC

GENERAL TERMS AND CONDITIONS OF SALE

as of: 09.01.2012

1. General

1.1 The following terms of sale apply exclusively for all deliveries, services and offers made by LD Didactic GmbH (hereinafter: LD) with respect to entrepreneurs, legal entities under public law or public separate assets (hereinafter: buyer). An entrepreneur is any natural or legal person exercising his/her commercial or independent occupational interests by concluding a legal transaction. Buyer conditions which are contrary to, or deviate from, these terms of sale are only recognized if they have been given express consent. The buyer's general terms of business shall also not be deemed applicable even though these General Terms and Conditions provide no applicable stipulation, are incomplete or ineffective.
1.2 These terms and conditions of sale shall also apply to all future business with the buyer to the extent they represent legal transactions of a related nature, even then when they have not again been expressly agreed.

2. Offer and acceptance period

2.1 Offers made by LD are subject to change and non-binding. An agreement between LD and the buyer materializes only then when LD accepts the buyer's order.
2.2 LD reserves the right to accept buyer orders within a period of three weeks after receipt of the buyer's order. With acceptance of the offer a binding contract is concluded.

3. Scope of performance

3.1 The quality as stated in the order confirmation (performance specification) is completely and finally determinant for the characteristics of the subject of delivery. In particular, the general public statements made by LD or the statements made by a supplier, his vicarious agents or any third party do not represent any supplementary or modifying description of the delivery subject.
3.2 Details contained in catalogues, brochures and quotation documents are non-binding to the extent they are not explicitly designated as binding.
3.3 In individual cases LD is entitled to structural modifications and the use of different materials when these measures are not adverse to any buyer interests meriting protection.
3.4 LD retains the property and proprietary rights to all documents furnished in conjunction with the buyer's order; such as calculations, drawings and so forth. These documents may not be made available to third parties without the written consent of LD.
3.5 Upon request, all documents which were furnished by LD shall be returned without delay. It shall not be necessary to request the return of such documents in the event the order is not issued to LD or LD declines order confirmation.

4. Pricing and terms of delivery

4.1 Prices shall be understood to be ex-works (INCOTERMS 2000). Installation and commissioning as well as additional deliveries and services will be additionally charged at cost price.
4.2 For orders delivered within Germany, shipping charges will be waived if the order amount equals or exceeds €150. For orders delivered within Germany amounting to less than €150, a flat rate of €15 net for shipping and handling will apply.
4.3 It should be noted that for foreign orders (i.e. outside Germany), the shipment to foreign delivery addresses and bank transfers for payment may result in additional taxes or costs which are not collected by LD or placed in the invoice.
4.4 LD shall additionally charge transaction taxes (turnover tax, etc.) in accordance with the given effective legal regulations.
4.5 Notwithstanding an express agreement to the contrary, LD shall, at the buyer's expense, insure ordered goods against the standard transport risks, including damage by breakage. Insofar as assembly, assembly supervision or commissioning is to be performed, the relevant LD terms and conditions shall apply additionally.

5. Transfer of risk

5.1 Upon contractual delivery, the risk of accidental deterioration or accidental destruction shall pass to the buyer.
5.2 In the event of a sale to destination according to buyer's instructions, the risk of accidental loss or deterioration shall pass to the buyer along with transfer to the person responsible for transport but not later than departure of the goods from the plant/warehouse. This also applies in the case of partial deliveries and when LD has assumed responsibility for other services.
5.3 If shipping is delayed due to circumstances for which LD is not responsible, the risk shall pass to the buyer when he is notified the delivery is ready for shipment.

6. Terms of delivery

6.1 Delivery dates or periods can be agreed in writing as binding or non-binding. Disregard for the written form has no influence on the effectiveness of the agreement. LD may exceed non-binding delivery periods by up to six weeks. LD is only in delay of performance after the six week grace period if a reminder is received from the buyer. If subsequent order changes are agreed then a new delivery date must also be agreed. Otherwise the delivery period shall be deemed extended for a reasonable amount of time.
6.2 The delivery period only begins after all commercial and technical prerequisites for executing the order have been clarified with the buyer, any documents to be procured by the buyer have been received by LD, any necessary permits and releases have been issued, and agreed advance payments have been credited to an LD bank account. The delivery deadline shall be deemed met when, up to its expiration – providing the buyer has fulfilled the above contractual obligations – the delivery item is turned over to the first carrier or the buyer has been advised the delivery is ready for shipment. Partial deliveries shall be admissible unless they are of no interest to the buyer. Delivered items, even when they exhibit minor defects, are to be accepted by the buyer; the delivery deadlines are thus deemed as met.
6.3 Delivery and performance delays due to Acts of God, natural catastrophes or because of blameless work conflicts, blameless transportation or business disturbances, blameless material defects, export permits not issued, and similar grounds at LD and/or its suppliers entitle LD to rescind the order

completely or in part or to postpone the delivery deadline until the cause of delay has been alleviated – but not longer than two months – without recourse for the buyer against LD for neglect of duty. The buyer is entitled to withdraw from the order if the aforementioned grounds persist for longer than two months. The buyer remains free to exercise his legal rights of cancellation at an earlier point in time – for instance due to frustration of contract or blameless impossibility of performance on the part of LD.

7. Terms of payment

7.1 The net invoice amount is payable, without any discount, immediately upon receipt of invoice unless another payment period has been explicitly agreed. Partial deliveries shall entitle LD to invoice the respective partial delivery.
7.2 If the order purchase price is over €20,000 the buyer shall make a down payment equal to 50 % of the purchase price. If the order purchase price is over €50,000 the buyer shall make full payment in advance.
7.3 The buyer is in default, without reminder, 14 days after the due date of LD entitlement and receipt of the invoice or delivery. In the event of default, LD is entitled, to demand interest at a rate of eight percentage points over the base interest rate of the European Central Bank. Proof of even higher damages incurred by LD is permissible anytime. The buyer is at liberty to prove the damages incurred by LD were lower.
7.4 Payments shall be effected exclusively to one of the appointed LD payment offices. They are to be effected on the date due on a postage- and expense-free basis without any deductions. Charges, expenses or other costs which may be incurred by LD in consequence of a separately agreed acceptance of bill of exchanges or checks shall be debited to the buyer. For payments of any kind, the day upon which LD is able to dispose over the amount in question shall be deemed the date of performance.
7.5 Offsetting balances and rights of lien may only be asserted with indisputable or legally established counterclaims.
7.6 LD is entitled to assign its claims against a buyer arising from a contract relationship in advance and/or subsequently, in particular for financing purposes.

8. Retention of title

8.1 Delivered items remain the property of LD until such time as all liabilities arising from the business relationship, including future or conditional claims, have been settled in full. In the event the buyer defaults on payment, LD is entitled to repossess the delivery item at issue (hereinafter: conditional commodity) without issuing a payment reminder demand. Insofar as the validity of retention of title is subject to mandatory special or legal prerequisites, the buyer shall ensure they are fulfilled.
8.2 To the extent he is not in default, the buyer shall be entitled dispose over the delivery item in the ordinary course of business. Claims which accrue to the buyer during the period of retention of title on the basis of resale or other legal grounds (including all balance receivables in current accounts) shall irrevocably be ceded in full amount to LD in advance as a form of security. Subject to revocation by LD, the buyer is empowered to collect such claims on a trust basis.
8.3 At the request of the buyer, LD shall undertake to release securities to which it is entitled, provided the value of such securities exceeds the unsettled claims to be secured by more than ten one-hundredths.
8.4 The buyer shall process and treat the delivery item on behalf of LD without giving rise to any obligation on the part of LD. If the delivery item is treated or combined, mixed or blended with objects which do not belong to LD (§§ 947 et seq. German Civil Code), LD shall be entitled to a coownership share in the new object at the ratio of the value of the delivery item to the other processed goods at the point in time before they were treated, combined mixed or blended. If the buyer acquires sole ownership pursuant to law, he hereby grants LD an appropriate co-ownership share or preserves the object for LD to this end. The provisions contained in item 8 also apply respectively to such co-ownership share.
8.5 The buyer shall immediately inform LD about any levy of distress or third party seizures with respect to the conditional commodities.
8.6 During retention of title, the buyer is obliged to adequately insure the delivery item at his own expense against theft, breakage, fire and water damage and, at the request of LD, furnish evidence to this effect. In the requested evidence is not presented within a reasonable period, LD shall be entitled to insure the delivered item at the expense of the buyer.

9. Warranty

9.1 For defects in the delivery item detected prior to the transfer of risk, LD is, at its own option, entitled to either rectify such defects or make a replacement delivery (supplementary performance). The buyer shall bear the cost of return shipment for the defective item insofar as this cost is not disproportionate to the value of the item.
9.2 If supplementary performance proves to be unsuccessful, the buyer is entitled to request cancellation of sale or reduction of purchase price without prejudice to potential damage compensation claims. Supplementary performance is deemed to have failed when the defect has not been remedied after the third supplementary performance attempt.
9.3 Notification about defects must be made upon delivery without delay. Notification about hidden defects shall take place promptly after their discovery. Such notifications shall state which defects have been detected and whether they were noticed immediately or only after further processing of the parts at issue. LD is entitled to have their own personnel inspect the deficiency.
9.4 When a claim for damage compensation is not involved, defect claims become time-barred after 24 months for users and after 12 months for companies, both stated periods beginning with delivery of the goods. Claims for damage compensation as a consequence of redhibitory defects lapse 12 months after delivery of the goods except in cases of personal injury damages, deliberate neglect of duty or gross neglect of duty. The statutory limit for legal claims under a right of recourse remains unaffected.
9.5 The buyer does not have the right to withdraw from contract except in the case of neglect of duty for which LD is blameless. The right of termination pursuant to § 649 German Civil Code remains unaffected. If LD is to carry out an adaptation of performance in order to comply with the buyer's order requirements (contract for work), the buyer must provide adequate compensation if he chooses to withdraw from the contract by termination. The amount of compensation shall be commensurate with the necessary overhead already exerted at the point in time the declaration of withdrawal is made, maximum compensation being the agreed contract price. The purchaser is at liberty to prove that less overhead was incurred.

10. Liability for usage other than originally intended

10.1 None of the products sold by LD are intended for private consumers (private end users) but rather intended exclusively for use in educational institutions such as general and vocational schools, technical colleges, universities, private or public training centers and industrial operations (intended use).
10.2 If the buyer allows third-party private usage of the goods, either occasionally or continuously, regardless of the manner or lawful reason then the buyer has abandoned intended use.
10.3 In this case the buyer releases LD from all contractual or legal obligations, claims and duties, including claims under the product liability law, that were associated with original intended use.

11. Liability for property right infringements
11.1 Insofar as LD makes no special notification, the delivery item is deemed to be free of thirdparty property rights with respect to awareness of state-of-the-art technology in the Federal Republic of Germany. However, if the delivery item or a part of the same should, at the point in time of contract conclusion, infringe on a property right which has already been issued and published in the Federal Republic of Germany, or if the delivery item explicitly incorporates a particular protected procedural right or infringes on a corresponding procedural right, and consequently results in the instigation of legal proceedings against the buyer then, at its own option and within a reasonable period, LD shall either obtain for the buyer the right of continued utilization, modify the delivery item, part or procedure such that an infringement of third-party rights no longer exists, or withdraw from the contract. LD does not accept any further liability, particularly for procedures, applications and products, etc. Claims against LD for liability due to property right infringements are limited to
foreseeable damages.
11.2 In the event third-party property rights are infringed upon by drawings or details furnished by the buyer, the buyer shall be responsible for such infringement and indemnify LD against claim.

12. Repairs
Repairs and returns will be handled by LD exclusively under the following conditions. LD does not recognize any deviating buyer
conditions.
12.1. Order / cost estimate / repair
12.1.1 LD will perform repairs only after receiving a written order.
12.1.2 LD will issue an order confirmation for the device received.
12.1.3 Cost estimates will only be created at the express request of the ordering party. A cost estimate lump-sum fee of 51.00 Euro will be levied for devices having a replacement value less than 500.00 Euro and 151.00 Euro when replacement value is over 500,00 Euro. When a repair order is issued the cost estimate lump-sum fee will be waived.
12.1.4 Repairs made under guarantee will only be performed if a completely filled out return form accompanies the repair return shipment. In this
case, the established General Standard Terms and Conditions shall apply.
12.1.5 Necessitated by organizational grounds, LD reserves the right to delegate repair work to an LD authorized contract workshop.
12.1.6 Repair orders are accepted subject to the procurement of replacement parts.
12.2. Shipment
12.2.1 If an order is not placed within one month of the date when the cost estimate is issued, the
device will be returned without repair.
12.2.2 Incurred shipping charges for devices returned without repair, when neither a cost
estimate nor a repair order has been issued, shall be borne by the recipient.
12.2.3 Return shipment of all devices is carried out at the expense and risk of the customer. On request, LD will insure the device against
transport damage and loss at the customer's expense. If transport damage or breakage is determined, application is to be made to the carrier for an assessment of facts. Entitlement to claims for damage will otherwise be lost. 12.3 Defect claims and liability
12.3.1 Repair service defects apparent within a period of limitation which were already present
prior to the transfer of risk will be reworked by LD within a reasonable time at no charge.
12.3.2 If the rework fails, the buyer can withdraw from the contract or reduce remuneration.
12.3.3 Entitlement to make defect claims expires 12 months after acceptance.
12.3.4 After the transfer of risk, there is no entitlement to defect claims for normal wear, for
damage ensuing from excessive stresses, for unsuitable equipment or for damage due to exceptional external influences for which the contract has no provisions.
12.3.5 If the buyer or third parties make unauthorized modifications or repairs then there shall be no recourse to defect claims arising from these or any consequences thereof.
12.3.6 Buyer claims for damage and reimbursement of expenses are excluded, regardless of legal grounds, but in particular with
respect to pre-contractual breach of duty, breach of duty arising from indebtedness and tortuous liability. This does not apply insofar as liability is mandatory, e.g. in cases of intent and gross neglect, with respect to harm of life, limb or health and for violation of essential contract obligations. However, damage claim compensation for violation of essential contract obligations is limited to contract-typical foreseeable damages insofar as intent or gross negligence is not given.
The above provisions do not imply a change in the burden of proof to the detriment of the buyer.
12.3.7 No liability is accepted for consumables included with delivery, such as film material, batteries, etc.

13. Other liabilities / liability exclusions
13.1 With respect to breaches of contractual and extra-contractual obligations, particularly due to impossibility, delay, and tortuous trade, LD – and/or its vicarious agents – shall be liable only in cases of intent and gross negligence, limited to contract-typical damage foreseeable when the contract was concluded.
13.2 These limitations do not apply for culpable breach of essential contractual obligations by LD, if fulfillment of the purpose of the contract is endangered, in cases of mandatory liability under the product liability law, by harm to life, limb or health (personal injury), and also not then when LD has deceitfully concealed defects or guaranteed their absence. The rules of burden of proof remain unaffected by this. Essential contract obligations are those LD obligations that enable proper execution of the contract in the first place and on whose observance the buyer can generally expect to have trust.

14. Place of performance, jurisdiction, severability clause
14.1 The place of performance shall be Hürth, Germany, unless specified to the contrary in the order confirmation.
14.2 The place of jurisdiction is that of the business headquarters for LD Didactic GmbH, currently Hürth, Germany.
14.3. Should a provision of these Terms and Conditions or a condition in the context of other agreements be or become invalid, this shall not
impair the validity of all remaining provisions or agreements.

15. Applicable law
The laws of the Federal Republic of Germany shall apply. The application of the standard UN Convention on Contracts for the International Sale of Goods (CISG) is excluded.

Note pursuant to the Federal Data Protection Act LD stores and processes customer data.

LD Didactic GmbH

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