PHYSICS
CHEMISTRY
BIOLOGY
ENGINEERING

LD DIDACTIC

AUTOMOTIVE TECHNOLOGY SYSTEM

CATALOG T3

LEYBOLD®

VEHICLE TECHNOLOGY SYSTEM

New training system for vocational training and education in vehicle electric & electronics

Content overview

COM3LAB COURSES IN VEHICLE TECHNOLOGY

T 3.1 BASICS OF AUTOMOTIVE ELECTRICAL ENGINEERING AND ELECTRONICS

T 3.2.2 ON-BOARD POWER SUPPLY SYSTEMS

T 3.2.3 LIGHTING AND SIGNAL SYSTEMS

T 3.2.4 IGNITION SYSTEMS

T 3.2.5 AIR/FUEL MANAGEMENT SYSTEMS

T 3.2.6 OPERATION AND SAFETY ELECTRONICS

T 3.2.7 COMMUNICATION AND COMFORT ELECTRONICS

T 3.2.8 GENERATORS AND ELECTRICAL MOTORS

T 3.2.9 STARTING AIDS FOR DIESEL ENGINES

T 3.2.10 CLOSED-LOOP ELECTRONIC DIESEL CONTROL

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T 3.2.12 BUS-SYSTEMS AND DIAGNOSTIC

T 3.2.13 ELECTRONICALLY CONTROLLED POWER TRAIN AND RUNNING GEAR SYSTEMS

T 3.2.14 ALTERNATIVE DRIVE SYSTEMS

T 3.2.17 MODELS

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T 3.2.91 WORKSHOP TRAINING FOR VEHICLE

COMPUTER AIDED MEASUREMENTS AND EVALUATIONS IN VEHICLES

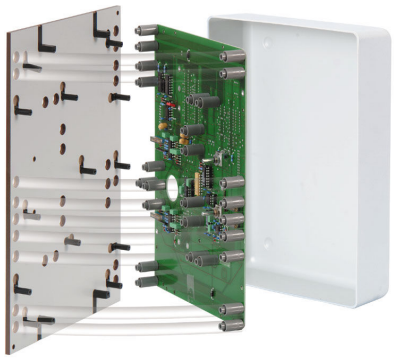
STUDENT MEASURING ADAPTORS AND MASKS

VEHICLE TEST AND MEASUREMENT EQUIPMENT

VEHICLE TECHNOLOGY SYSTEM

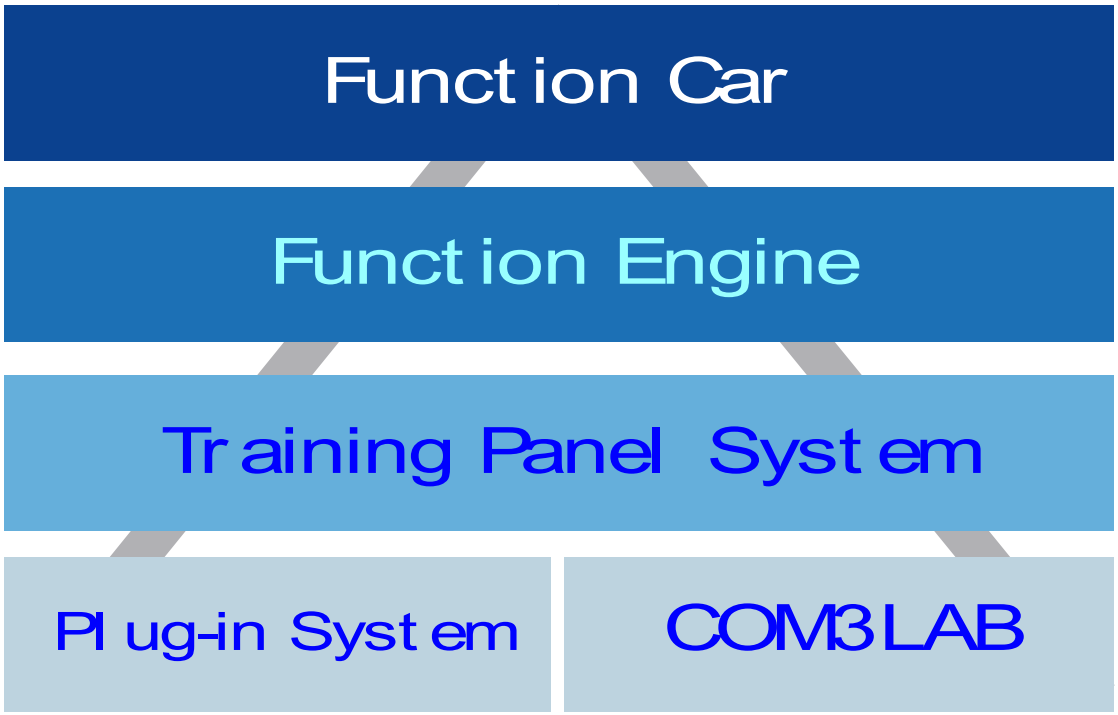
New training system for primary and advanced education in Vehicle electric & electronics

Aside from a mastery of conventional vehicle technology, the introduction of electronics and microprocessor techniques are increasingly confronting vehicle mechanics and electricians with completely new challenges both in the trade environment as well as in industry. The manner in which these electronic assemblies function individually as well as their functional interaction must be understood. These assemblies include ABS, DME ignition, motor electronics, common rail, on-board systems management, etc. as well as the conventional mechanical, hydraulic and pneumatic assemblies. The handling of modern diagnostic computers also requires a familiarity based on a foundation of solid knowledge.



In conjunction with the "*Zentralverband des Kfz-Handwerks* (ZdK)" [central association of vehicle trades] and the vehicle manufacturers industry, LD Didactic has developed a new training and educational system for the fundamentals and applications of vehicular electric systems and electronics. A breadboard system (STE) was developed especially for the basic training equipment set T 3.1, consisting of one base set and 2 complementary sets. These sets are available in two different plug-in element sizes to accommodate both compact training setups as well as large area demonstration setups.

Expanding on the fundamentals learned with the T 3.1 breadboard system, the newly developed experimenter board system for vehicle electric/electronic - T 3 - permits advanced topics to be dealt with, such as conventional circuits for lights and signals, generators, ignition systems, starter, etc. but in particular the new functional elements for the engine, safety, testing, comfort and communications electronics.



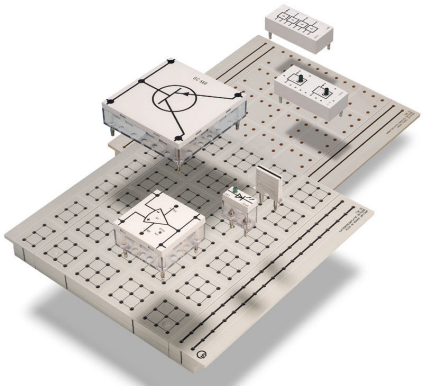
New training system for primary and advanced education in vehicle electric & electronics

In close cooperation with the automobile industry, a series of multimedia courses for the LD Didactic COM3LAB have been developed as companion materials for the vehicle mechatronic training program. In conjunction with the breadboard system, this CBT program with hardware coupling lays the foundation for the training. The complete theory for all vehicle-specific sub-sections can then be taught in the subsequent "clean" portion of instruction that utilizes the study panel system. This equipment set is equally well suited as a demonstration stand as it is for practical exercises to be carried out by the students. Solid functional motors or didactically prepared complete vehicles are available for workshop practice training instruction. Both of these equipment types are fitted with instrument adapters for recording measurement data.

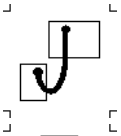
The training field covered under each topic area in this catalog is printed at the bottom right of each double-page.

The individual themes and the contents of equipment sets can be found on the following pages of this catalog; the required measuring instruments are found on the final pages.

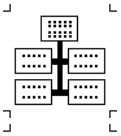
The structure and content of this program are presented here in this catalog. All equipment sets in the study panel system require the basic set T 3.2.2.1, "Main Connection"! Some experiments do require additional equipment sets, these requirements are clearly indicated on the following pages.



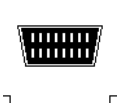
Legend:



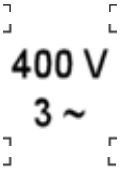
Sensor/actuator connection, rear side



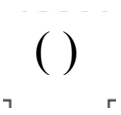
Student test station connectable



Self-diagnosis capability



Three-phase voltage (400 V, 50 Hz, 3~) required



Quantities specified in ( ) in the equipment set tables indicate optional or alternative components!

T 3.1 Fundamentals of Vehicle Electric/Electronics

Optimized equipment set to carry out experiments from the following topic groups:

T 3.1.1 Basics of Electrical Engineering
T 3.1.2 Electronic Components and Basic Electronic Circuits
T 3.1.3 Applied Automotive Electronic Circuits

Training Objectives

- simple circuit
- ohmic resistance
- current and voltage sources
- capacitor
- inductor and transformer
- diode and Zener diode
- transistor and thyristor
- special resistances (NTC, PTC, ...)

T 3.1 Basics of automotive electrical engineering and Electronics

Optimized equipment set to carry out experiments from the following topic groups:

T 3.1.1 Basics of Electrical Engineering
T 3.1.2 Electronic Components and Basic Electronic Circuits
T 3.1.3 Applied Automotive Electronic Circuits

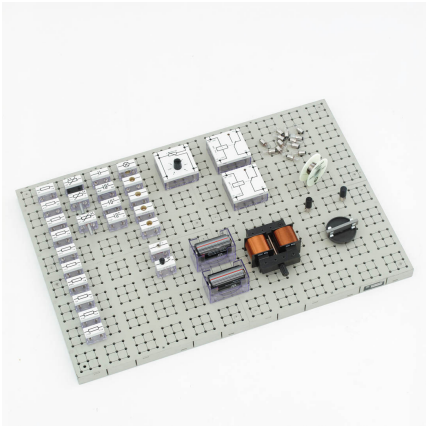
Our breadboard system equipment set is used to convey the fundamentals of electricity, electronics with special attention toward vehicle-type applications. Available as a practice or as a demonstration equipment set, this breadboard system represents the ideal introduction to the topic areas. Additional outstanding features of this set are: ▪ conventional electronic components in transparent housings ▪ particularly robust design and ▪ elements arranged as a circuit on the breadboard visually relate to a corresponding circuit diagram having ▪ ISO compliant symbol component representations.

The basic set alone covers: ▪ the electric circuit concept ▪ ohmic resistance ▪ current and voltage sources ▪ the capacitor ▪ the inductor ▪ the transformer ▪ the relay and ▪ special resistances such as NTC, PTC or LDR. The T 3.1.2 assortment treats the components: ▪ diode ▪ Zener diode ▪ LED ▪ transistor and ▪ thyristor. Finally, the T 3.1.3 equipment set can be used to configure and examine application circuits used in vehicle electronics such as: ▪ an electronic tachometer ▪ an electronic voltage regulator for alternators or ▪ a transistor control unit for contact-controlled ignition systems.

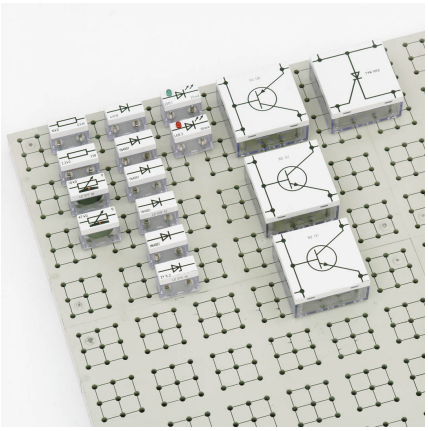
EQUIPMENT LIST, T 3.1

Basics of automotive electrical engineering and Electronics

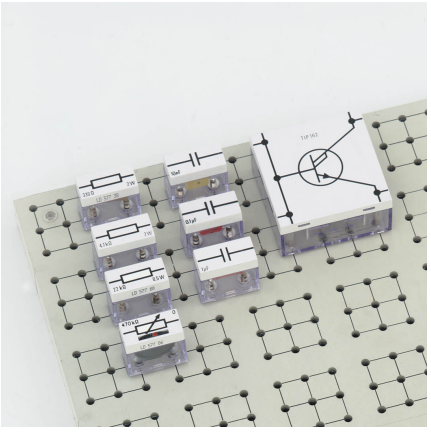
QTY.	CATALOG NO.	DESIGNATION
1	727 520N	Complete Equipment Set T 3.1
1	565 662	**Book**: Basic Principles of Automotive Electronics T 3.1.1
1	565 692	**Book**: Basic Principles of Automotive Electronics T 3.1.2
1	565 702	**Book**: Basic Principles of Automotive Electronics T 3.1.3



Basic set T 3.1.1



Components to set T 3.1.2



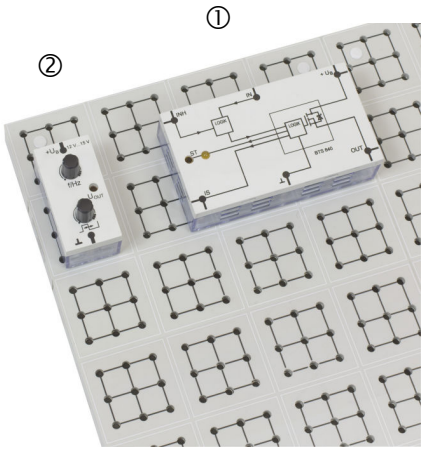
Components to set T 3.1.3

T 3.1 Fundamentals of Vehicle Electric/Electronics

Supplementary equipment to T3.1.3

Supplementary equipment

As supplements to existing STE sets and as upgrades to current state-of-the-art technology, we would like to present these supplements to you which, in the meantime, have been included in our delivery complement.
An electronic switch is used to permit investigation of lamp control by way of on-board network control units. In combination with a square-wave generator, this switch can drive lamps with a PWM signal to change their brightness.



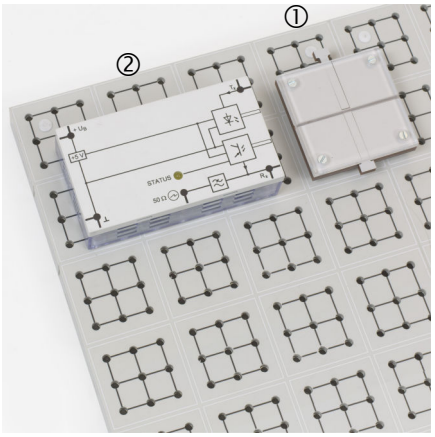
Supplementary to T 3.1.3

SUPPLEMENTARY LIST TO T 3.1.3

Applied Automotive Electronic Circuits

QTY.	CATALOG NO.	DESIGNATION	
1	578 774	Power Switch BTS640 12 A/12 V	①
1	579 162	Simulation ABS-Ti	②
1	579 13	Toggle switch, single-pole	

To supplement "MOST-bus Vehicle Communications Technology" sets we offer two plug-in elements for use in real work situations as well as with the training system.
The **578 485 OWG coupler** can connect the loose ends of optical fiber guides to simulate plug-in connectors as well as their error modes (by disconnecting the coupler). This coupler can also make output light visible.
In order to investigate electric signals on the MOST data bus, use the **MOST Transceiver component, 578 486**. This component converts light-wave signals into electric signals that can be viewed with an oscilloscope. You can set up your own optical transmission lines by coupling two of these components. This setup can be used to feed any electric signals.



Supplementary to T 3.1.3

SUPPLEMENTARY LIST TO T 3.1.3

Applied Automotive Electronic Circuits

QTY.	CATALOG NO.	DESIGNATION	
1	578 485	STE OWG coupler	①
1	578 486	STE MOST Transceiver	②

T 3.1 Fundamentals of Vehicle Electric/Electronics

T 3.1.5 Basic vehicle circuits

T 3.1.6 Vehicle sensors

Similar to STE sets used, for example, by **VW** in advanced training; LD Didactic offers equipment sets T 3.1.5, **Basic Vehicle Circuits** and T 3.1.6, **Vehicle Sensors**.
The "Basic Circuits" collection allows the configuration of practice-oriented examples for ▪ simple DC circuits ▪ Ohm's law ▪ non-linear resistance ▪ capacitors in DC circuits ▪ the use of inductors in DC circuits ▪ semiconductor diodes and ▪ semiconductor LEDs.

Set Basic vehicle circuits T 3.1.5

EQUIPMENT LIST, T 3.1.5

Basic vehicle circuits

QTY.	CATALOG NO.	DESIGNATION
1	727 5181	Equipment set T 3.1.5

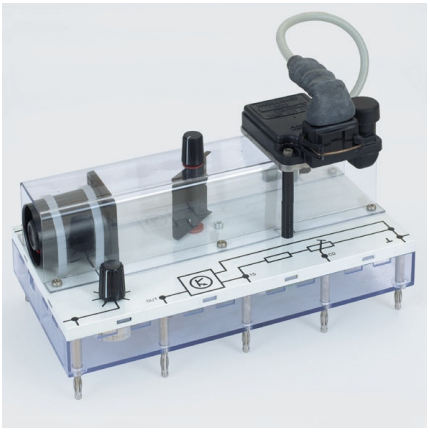
The supplementary equipment set "Vehicle Sensors" permits the investigation of typical transducers and their circuitry. The contents of this set allows the configuration of experiments with ▪ bipolar transistors ▪ ABS Hall-effect sensors ▪ Hall-effect distributor element ▪ Inductive sensors and ▪ line protection with fuses.

Set vehicle sensors T 3.1.6

EQUIPMENT LIST, T 3.1.6

Vehicle sensors

QTY.	CATALOG NO.	DESIGNATION
1	727 5182	Equipment set T 3.1.6
	Optional additionally:	
(1)	582 629	STE Air Mass Meter

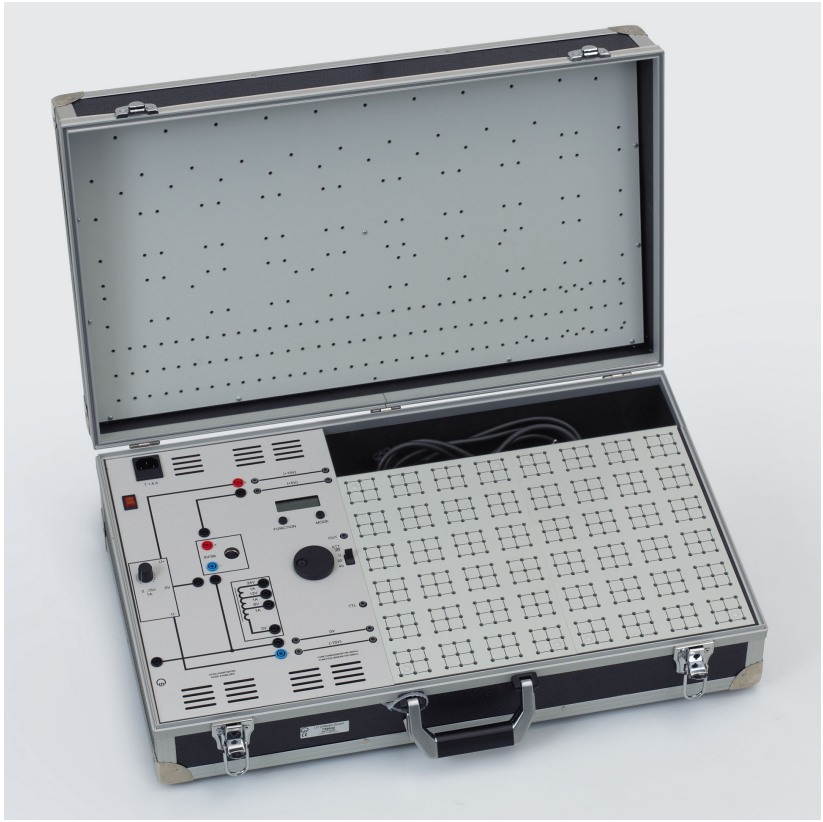


STE Air Mass Meter 582 629

T 3.1 Fundamentals of Vehicle Electric/Electronics

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

The STE case is ideal for storage as well as a trainee work place. Its lid serves as a receptacle for various pieces of STE equipment and it can also be used when conducting experiments in a normal classroom. The lid can be disconnected from the bottom section.



Case equipped with STE elements

739 932

Case Large, equipped

Automotive STE storage and experiment case with integrated power supply ± 0...15 V and +5 V, function generator 200 kHz for triangle, sine and square waves, STE storage sockets in the upper shell and 2 DIN A4 plug-in boards in the base shell.
Input power: 220 ... 240 V~
Delivery without STE elements!

EQUIPMENT LIST, T 3.1 (Compact Set)

Fundamentals of Vehicle Electric/Electronics

QTY.	CATALOG NO.	DESIGNATION
1	727 520KOF	Compact set 'Basics of automobile electrical engineering' in the case T 3.1

T 3.2.2 On-board Power Supply Systems
T 3.2.2.1 Main Connection

All study panel system device configurations are based on the basic set presented here. This includes a power supply, connections and associated cables as well as diverse circuit components. Please note that free-floating operation, as in actual vehicle installations, is only possible by using a battery without any power supply unit! Ideally, the battery is complemented by connecting an AC adapter in parallel.

738 04

Starter Battery 12 V/50 Ah

50 Ah, 540 A, maintenance free

738 026

Digital Power Supply 3-15 V/40 A

Compact Switching Mode DC Power Supply providing variable voltages of 3 V to 15 V under 40 A continuous operation; with switch for fixed output voltage of 13.8 V

738 03

Battery Connection Unit

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

738 05

Set of Connection Leads I

4 Connecting leads 6 mm^2 with spade connectors, 2 x red, 1 x blue, 1 x brown

738 06

12 V on-board socket

Illuminated 12 V cigarette lighter and on-board socket

T 3.2.2 On-board Power Supply Systems
T 3.2.2.1 Main Connection

738 10

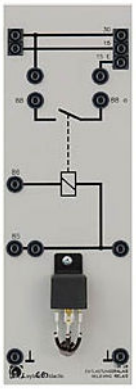
Ignition Switch

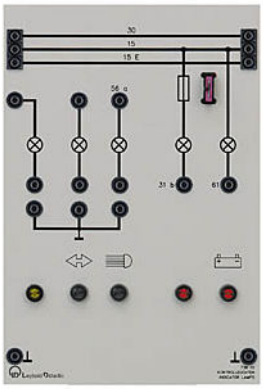
with starter and radio functions, outputs T 15, T 50, T 75 and P

738 28

Relieving Relay

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





738 15

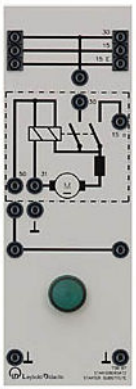
Indicator Lamps

To monitor operations:
high beams, turnsignal indicators, oil pressure, battery charge, pre-heating
Lamp data: 2 W / BA 7s

738 87

Starter Substitute

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



EQUIPMENT LIST, T 3.2.2.1

Main Connection, Basic set

QTY.	CATALOG NO.	DESIGNATION
1	738 01	Cable and plug box
1	738 03	Battery Connection unit
1	738 04	Starter Battery 12 V/50 Ah
1	738 06	12 V on-board socket
1	738 026	Digital Power Supply 3-15 V/40 A
	For hook-up with safety experiment cables to the power supply	
(1)	500 990	Set of 2 adapter sockets
1	738 05	Set of Connection Leads I
	For hook-up with connecting wires 738 05	
(1)	738 042	Set battery-cable terminals
1	738 10	Ignition Switch
1	738 15	Indicator Lamps
1	738 28	Relieving Relay
1	738 87	Starter Substitute

T 3.2.2 On-board Power Supply Systems

T 3.2.2.1 Main Connection

T 3.2.2.2 Intelligent On-board computer (Additional equipment)

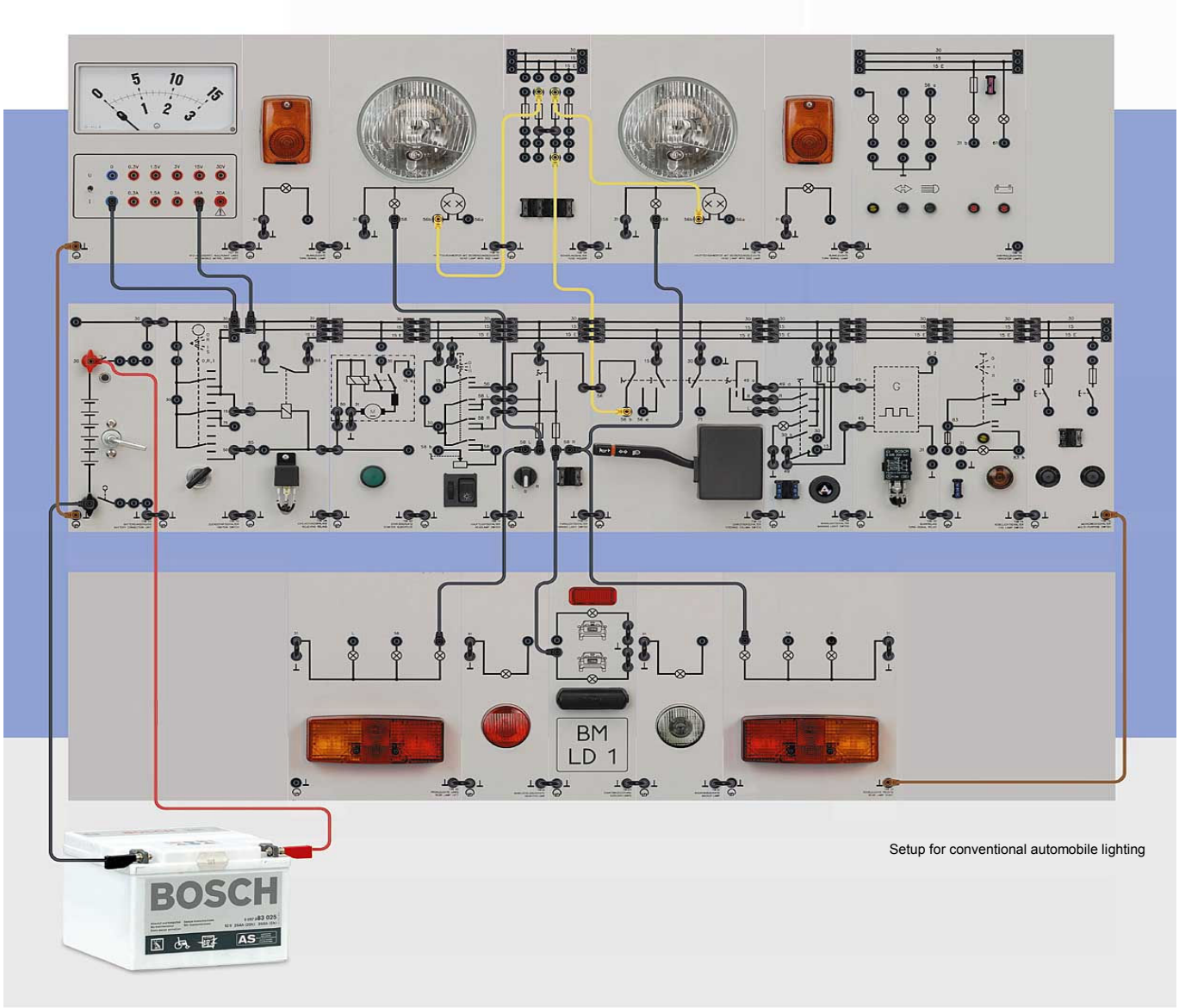
Equipment list, T 3.2.2.2

Intelligent On-board computer (Additional equipment)

QTY.	CATALOG NO.	DESIGNATION
1	738 031	Battery monitoring
1	738 04	Car Battery 12V/50 Ah
1	738 588	LIN BUS PC interface USB
1	738 9803	OBD Adaptor CAN+USB

T 3.2.3 Lighting and Signal Systems
T 3.2.3.1 Main Lighting
T 3.2.3.2 Signal Systems

T 3.2.3.3 Trailer Lights
T 3.2.3.4 Auxiliary Lights



Setup for conventional automobile lighting

Training Objectives

- reading and interpreting circuit diagrams
- protecting circuits
- differentiating between control and power circuits
- setting up simple and complex circuits
- using electronic relays for special applications
- using multifunction switches
- employing optical and acoustic signal devices
- recording measurements and troubleshooting

T 3.2.3 Lighting and Signal Systems

T 3.2.3.1 Main Lighting
T 3.2.3.2 Signal Systems
T 3.2.3.3 Trailer Lights
T 3.2.3.4 Auxiliary Lights

EQUIPMENT LIST, T 3.2.3.1

Main Lighting

QTY.	CATALOG NO.	DESIGNATION
1	738 07	Interior Lamp
1	738 08	Door Contact Switch
1	738 09	Fuse Holder
1	738 11	Head Lamp Switch
1	738 12	Multi-Purpose Switch
1	738 13	Steering Column Switch
2	738 16	Main Headlamp with Side Lamp
(2)	738 1821	Xenon headlight unit
1	738 17	Parking Lamp Switch
1	738 190	Rear lights
2	738 291	Relay 1NO
1	738 31	Time Delay Relay
1	565 672	**Book**: T 3.2.2 On-board power supply and T 3.2.3.1 Lighting systems, part 1
1	566 152	**Book:** Vehicle lighting Part 2

EQUIPMENT LIST, T 3.2.3.2

Signal Systems

QTY.	CATALOG NO.	DESIGNATION
1	738 35	Normal and High Volume Horn
2	738 36	Turn Signal Lamp
2	738 361	Side turn signal light LED
1	738 37	Turn Signal Relay
1	738 38	Warning lamp switch

EQUIPMENT LIST, T 3.2.3.3

Trailer Lights

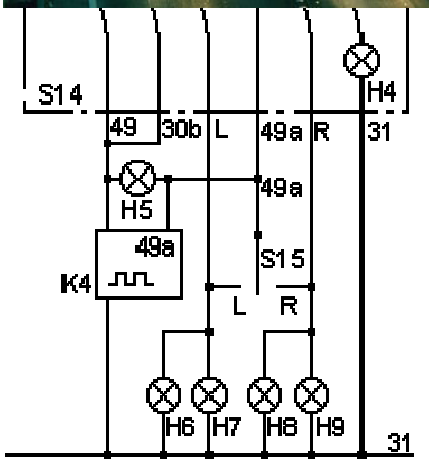
QTY.	CATALOG NO.	DESIGNATION
1	738 251	Trailer Socket 13 pole
1	738 261	Trailer Plug 13 Pole
1	738 27	Trailer Lights
1	738 262	Adapter 13/7 Pole
1	738 190	Rear lights

EQUIPMENT LIST, T 3.2.3.4

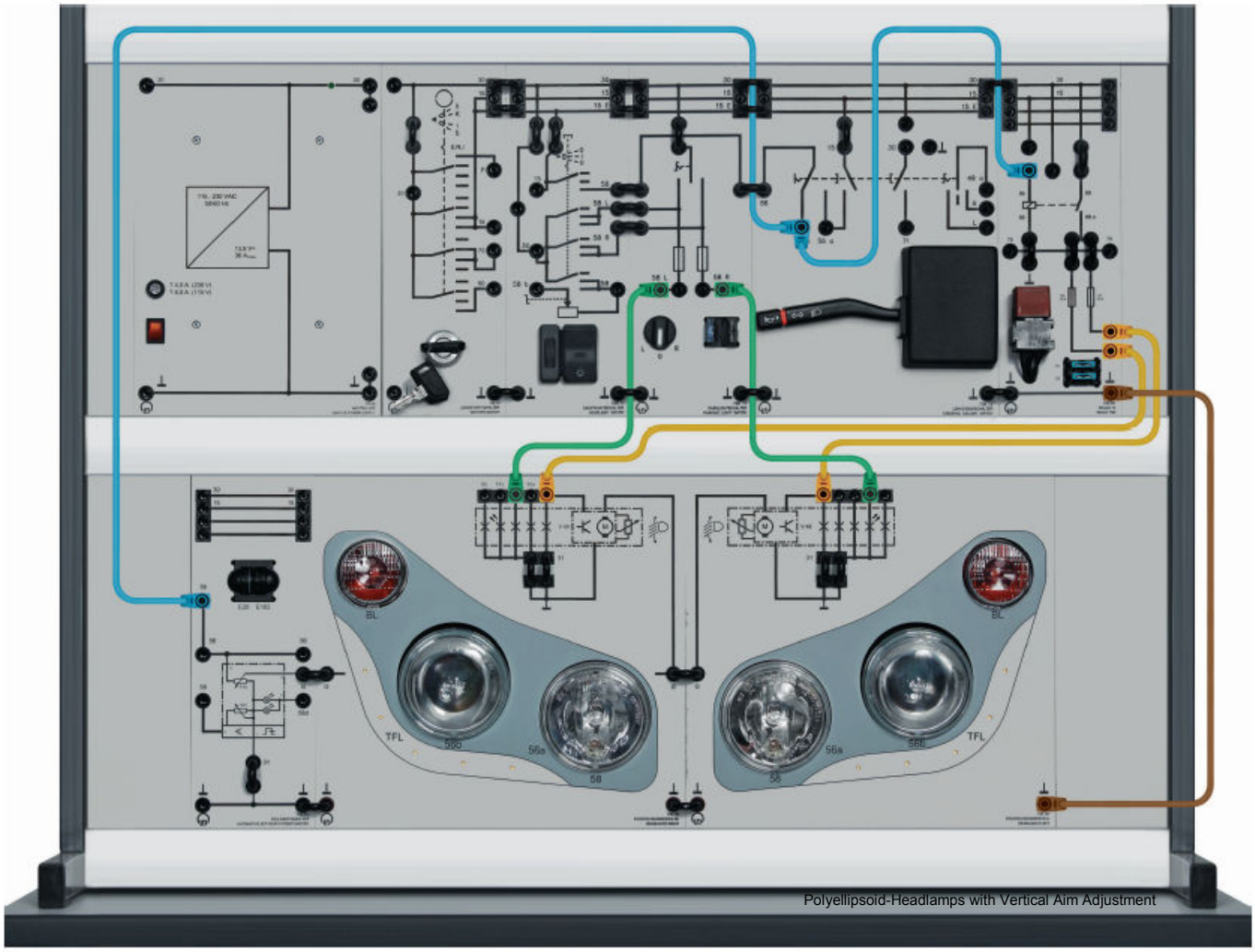
Auxiliary Lights

QTY.	CATALOG NO.	DESIGNATION
1	738 14	Fog Lamp Switch
2	738 18	Auxiliary Headlamp
1	738 30	Relay 1 CO

Picture: PACIFIC NORTHWEST NATIONAL LABORATORY



T 3.2.3 **Lighting and Signal Systems**
T 3.2.3.5 Polyellipsoid-Headlamps with Vertical Aim Adjustment



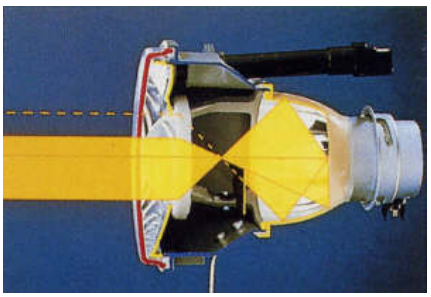
Training Objectives

- ➔ implementing StVZO [german road traffic regulation] requirements
- ➔ differentiating between control and power circuits
- ➔ setting up a manual lighting-distance regulator
- ➔ using multifunction switches
- ➔ control and regulation characteristics
- ➔ recording measurements and troubleshooting

T 3.2.3 Lighting and Signal Systems
T 3.2.3.5 Polyellipsoid-Headlamps with Vertical Aim Adjustment

Polyellipsoid headlamps

The bundling of radiated light to a distant focal point is the peculiar feature of an ellipsoid. If a diaphragm is placed in the vicinity this focal point then a precise light/dark barrier is produced. Somewhat further to the front, residual light can then be evenly dispersed over the driving lane by an appropriate lens. Immediately after passing through the ellipsoid the bundle of light rays is substantially smaller than for a parabolic or free-form reflector. Only after passing through the subsequent lens (with only a small light exit-surface area) does the beam become larger again.



Structure of a polyellipsoid headlamp

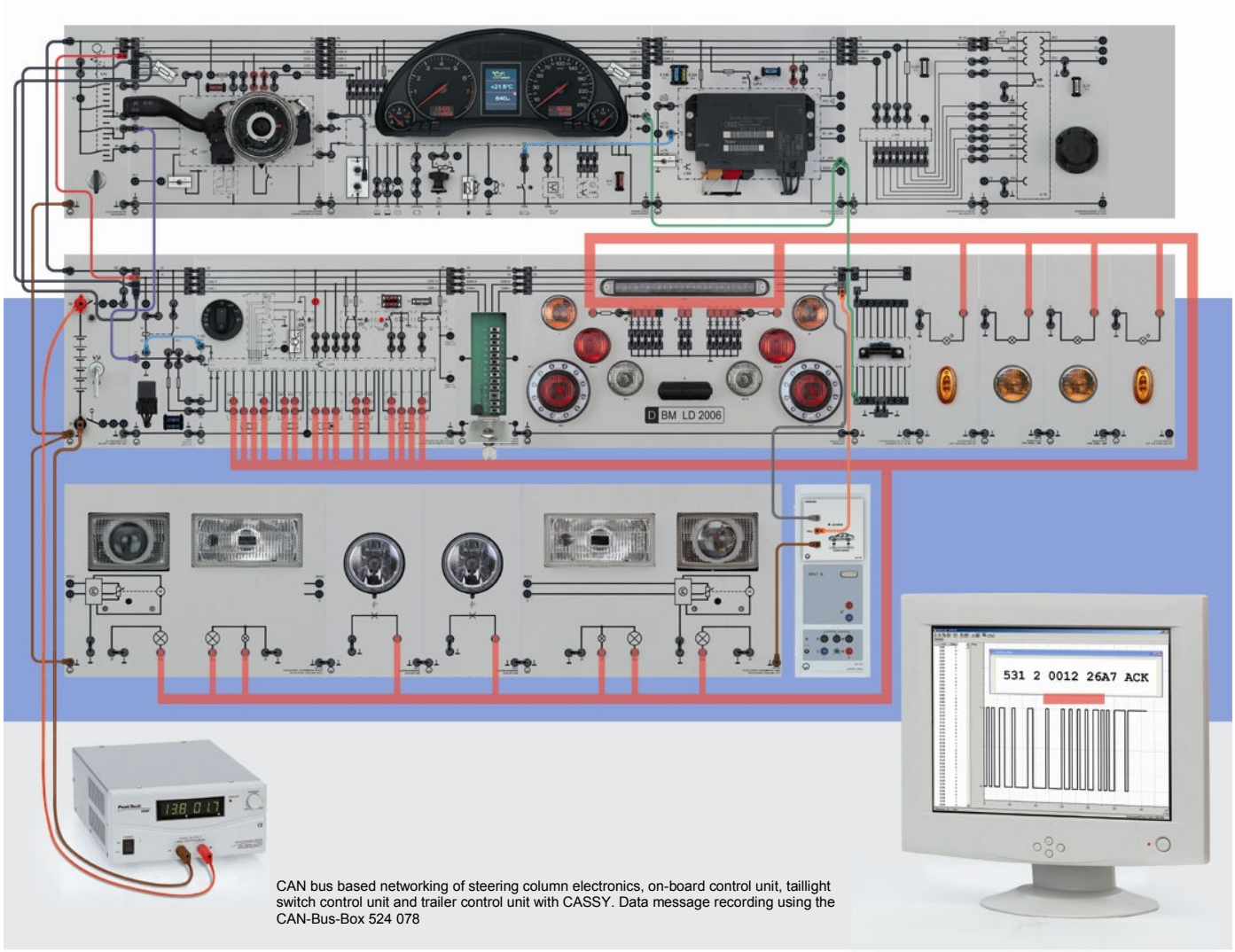
Lighting-distance regulation is intended to prevent the blinding of oncoming drivers despite various loading conditions for the vehicle. The reflectors are mounted such that they can be pivoted vertically by electric motors. For manual regulation, these motors are set by a position encoder that can be operated by the driver. For automatic light-distance regulation, the position of the apparatus is detected by a level-transducer and the control unit sends appropriate signals to the electric motors (➔T 3.2.12.6).

EQUIPMENT LIST, T 3.2.3.5

Polyellipsoid-Headlamps with Vertical Aim Adjustment

QTY.	CATALOG NO.	DESIGNATION
1	738 166	Polyellipsoid Headlamp Right
1	738 167	Polyellipsoid Headlamp Left
1	739 573	Automotive Set Point Potentiometer

T 3.2.3 **Lighting and Signal Systems**
T 3.2.3.7 Light Control with CAN Bus



CAN bus based networking of steering column electronics, on-board control unit, taillight switch control unit and trailer control unit with CASSY. Data message recording using the CAN-Bus-Box 524 078

Training Objectives

- modern on-board systems technology
- automatic lamp monitoring
- comfort elements for lighting control
- CAN databus topology
- examining CAN bus signals with an oscilloscope
- interpretation of CAN bus protocols
- functionality of a controller unit for trailer detection
- troubleshooting

T 3.2.3 Lighting and Signal Systems
T 3.2.3.7 Light Control with CAN Bus

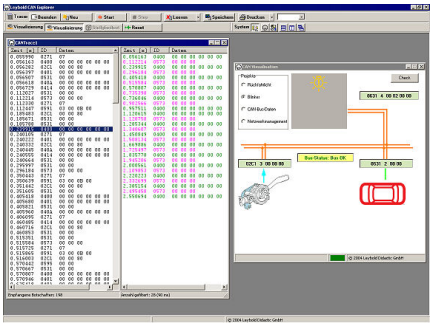
As data transmission and networking are increasingly implemented in vehicles, the lighting and on-board network management functions are also being taken over by controller units in modern automobiles. This training system consists of a steering column switch with control unit and the on-board network control unit. Experiments can be carried out to investigate modern control unit functions such as: ▪ cold lamp monitoring ▪ warm lamp monitoring ▪ lane-change blinking ▪ daylight driving light ▪ automatic driving light ▪ automatic vehicle position lights or ▪ PWM controlled taillights. Furthermore, all workshop-relevant measurements can be carried out on the CAN data bus. The fault simulator (➔ 738 585), which can be locked up, is particularly well suited for student troubleshooting exercises. This simulator is capable of producing all ISO standard faults as well as others that are particularly realistic to practical workshop experience.

Automobile headlights in the past and today

Tip: This system is suitable as an enhancement to lamps and lights already available.

The CASSY system from LD Didactic is used for data telegram measurement data acquisition and evaluation. CASSY's oscilloscope facility permits these data telegrams to be recorded and interpreted. With the help of the CAN-Bus-Box (➔ 524 078), a complete CAN bus protocol analysis can be performed. With the help of CAN bus software (➔ 739 581USB), the system can be visualized on the PC using LDCANExplorer software ➔ 739 587. The system is fully capable of self diagnosis function using the OBD/PC adaptor ➔ 737 9802. Descriptions of additional equipment for the CAN data bus are provided in sections ➔ T 3.2.7.5 and ➔ T 3.2.12.

Supplementary: Instrument cluster, 739 6021



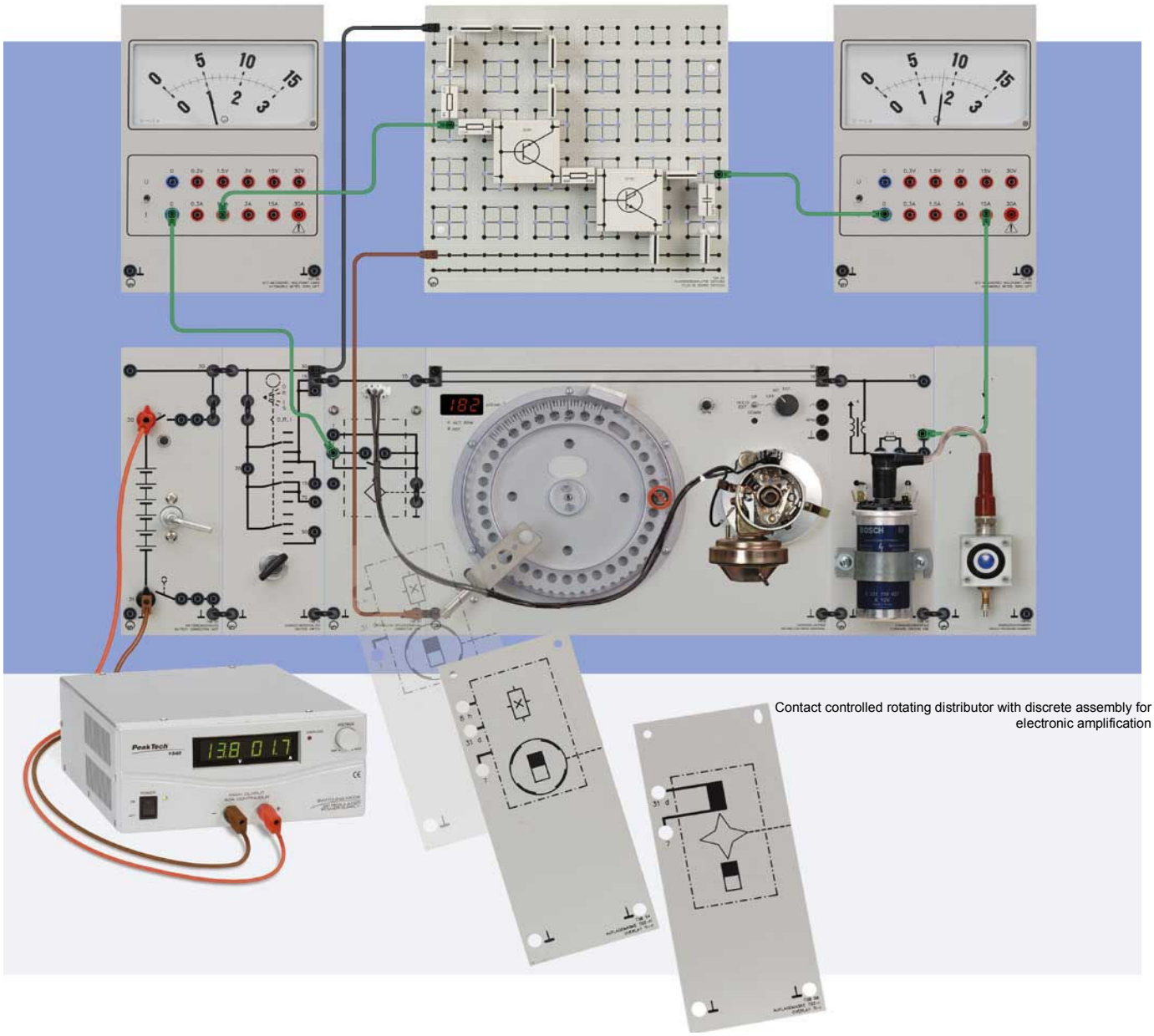
Screenshot: 739 587, LD CANExplorer Software

EQUIPMENT LIST, T 3.2.3.7

Light Control with CAN Bus

QTY.	CATALOG NO.	DESIGNATION
1	738 111	Equipment set "Intelligence automotive lighting management system"
1	738 1121	OBD adaptor
	Alternatively to 738 1121; but without self diagnostics function:	
(1)	738 112	CAN backup light switch
(1)	739 6021	Instrument cluster unit
(1)	739 654	Steering angle sensor
1	738 975	Diagnostic Plug 16 Pin
1	737 9803	OBD Adapter CAN+USB
(1)	739 585	Fault simulator CAN Bus
(1)	738 491S	Automotive fault simulator; Starter
1	739 581USB	CAN bus software USB
1	739 587	Software: CAN bus visualization
(1)	739 5835	Model: Vehicle door DS
(1)	739 5836	Model: Vehicle door PS
1	524 013S	Sensor-CASSY 2 - Starter
1	566150en	**Book:** Vehicle lighting w. CAN Bus

T 3.2.4 Ignition Systems
T 3.2.4.2 Breaker-triggered Coil Ignition System
T 3.2.4.3 Transistorized Coil Ignition System



Contact controlled rotating distributor with discrete assembly for electronic amplification

Training Objectives

- ➔ recording primary and secondary waveforms
- ➔ purpose of the rotating distributor
- ➔ breakerless contact function
- ➔ speed detection and dwell angle determination
- ➔ Hall effect sensor principle
- ➔ centrifugal and vacuum spark advance

T 3.2.4 Ignition Systems

T 3.2.4.2 Breaker-triggered Coil Ignition System
T 3.2.4.3 Transistorized Coil Ignition System

Ignition systems with ...

... a rotating distributor – almost a rarity nowadays but indispensable for an understanding of ignition systems! Arranged in the classic study panel style, ignition experiments can be carried out in a completely harmless manner. This allows observation of the influence of, for example, contact separation, compression pressure or interference suppression components. Measurement values for primary and secondary signals as well as measurement quantities derived from these can be recorded with an original motor tester or with the Sensor-CASSY 2 in conjunction with boxes Auto-Box i (➔ 524 076) and Auto-Box z (➔ 524 077).

Ignition contact set for conventional coil ignition and contact controlled transistor ignition systems
Picture: Beru AG

EQUIPMENT LIST, T 3.2.4.2

Breaker-triggered Coil Ignition System

QTY.	CATALOG NO.	DESIGNATION
1	738 40	Standard Ignition Coil
1	738 42	Distributor Breaker-Triggered
1	738 461	Distributor Cap, Transparent

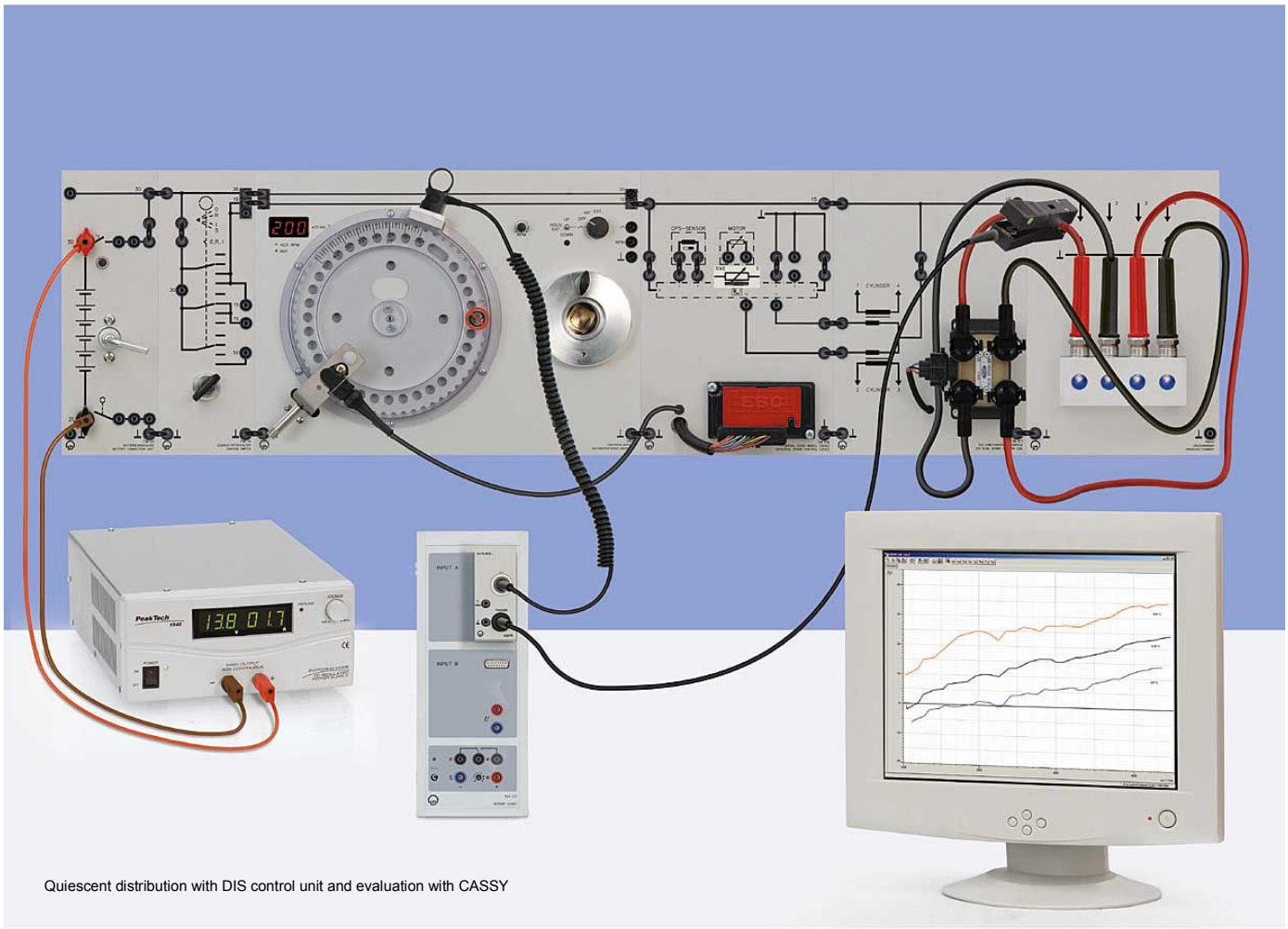
Automotive Fault Simulator, 738 49

EQUIPMENT LIST, T 3.2.4.3

Transistorized Coil Ignition System

QTY.	CATALOG NO.	DESIGNATION
1	738 50	Control Unit TI-H
1	738 51	Ignition Coil TI-H/I
1	738 531	Distributor TI-H
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

T 3.2.4 Ignition Systems
T 3.2.4.5 Distributorless Coil Ignition System (DIS)
T 3.2.4.6 Distributorless Coil Ignition System (SSI)



Quiescent distribution with DIS control unit and evaluation with CASSY

Training Objectives

- TDC pick-up with "GM" divisions
- double ignition operating principle
- recording primary and secondary waveforms
- the influence of motor temperature
- the influence of ambient air pressure
- recording characteristics
- fault code output
- troubleshooting and problem remedies

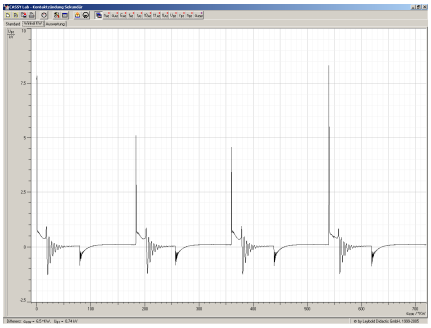
T 3.2.4 Ignition Systems

T 3.2.4.5 Distributorless Coil Ignition System (DIS)
T 3.2.4.6 Distributorless Coil Ignition System (SSI)

Advances in the field of ignition from conventional distributor ignition (DI) and transistorized ignition (TI) to electronic ignition (EI) and fully electronic ignition (FI) has taken place since 1982. Whereas high-voltage distribution is still done mechanically with EI, this too is implemented electronically with FI. This latter solution eliminates wearing parts entirely. Spark timing is accomplished electronically under consideration for: ▪ motor speed ▪ motor load ▪ knock combustion (739 021 only) ▪ crankshaft position (738 516 only) and ▪ throttle flap position (full-gas/idle, 739 021 only).
Measurement values for primary and secondary signals as well as measurement quantities derived from these can be recorded with an original motor tester or with the Sensor-CASSY 2 in conjunction with boxes Auto-Box i (➔ 524 076) and Auto-Box z (➔ 524 077).

Spark plugs
Picture: Beru AG

By the single spark ignition system, an ignition coil and spark plug form a compact unit. One side of the secondary winding is grounded, the other side is connected directly to the spark plug. This means that a capacitive voltage probe can no longer be attached to the spark plug's wire. The "Single spark ignition system" study plate is therefore equipped with two test points so that the secondary's waveform can be recorded.

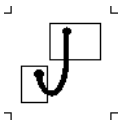


Secondary waveform recorded with a capacitive probe clip attached to CASSY

EQUIPMENT LIST, T 3.2.4.5

Distributorless Coil Ignition System (DIS)

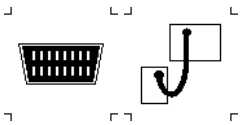
QTY.	CATALOG NO.	DESIGNATION
1	738 515	Crankshaft position sensor (CPS)
1	738 516	Universal ignition module (UESC)
1	738 517	DIS two-spark ignition coil
1	738 518	DIS ignition cable set



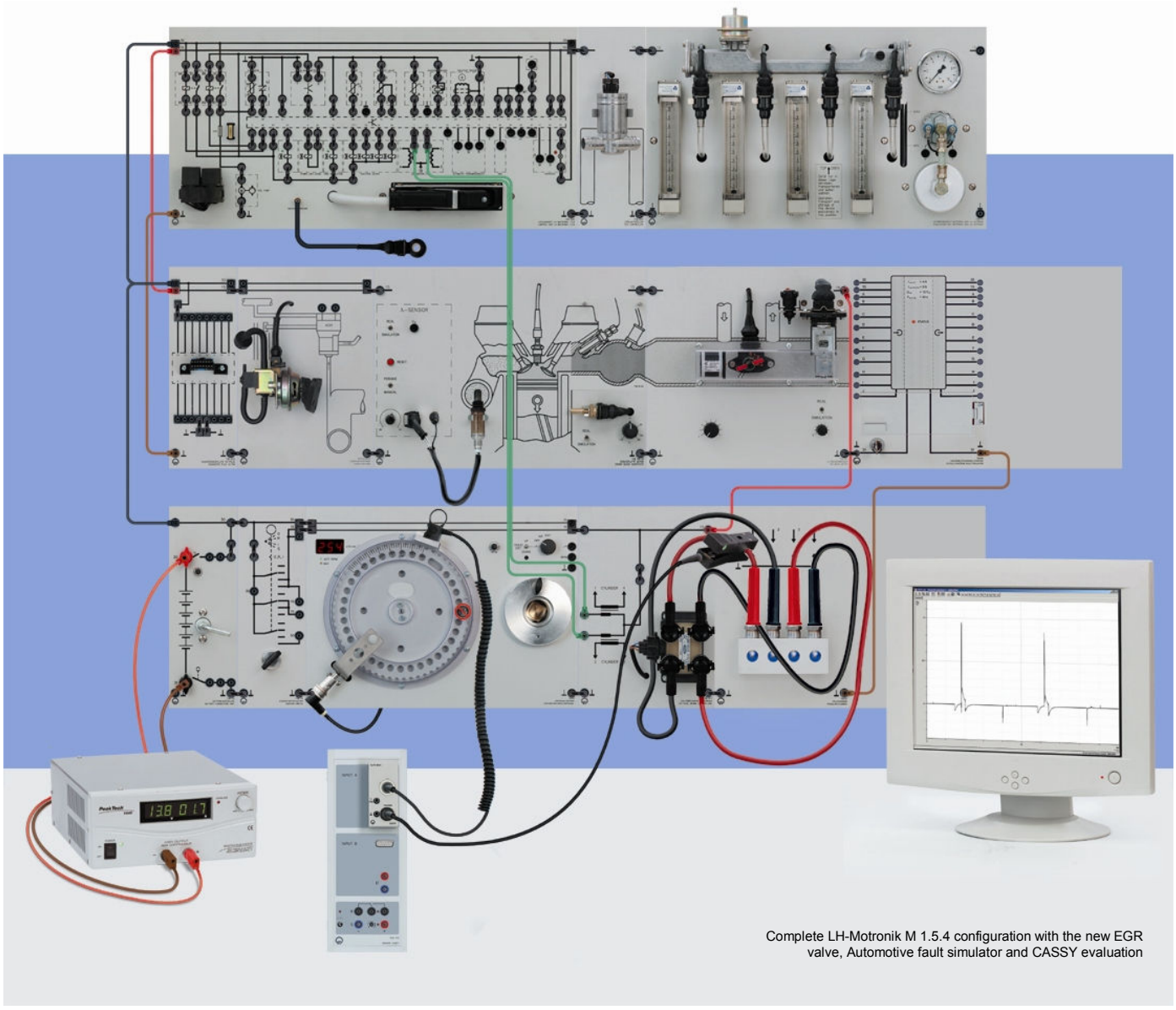
EQUIPMENT LIST, T 3.2.4.6

Distributorless Coil Ignition System (SSI)

QTY.	CATALOG NO.	DESIGNATION
1	738 481	Single Spark Ignition System (SSI)



T 3.2.5 **Air/Fuel Management Systems**
T 3.2.5.10 LH-Motronik M 1.5.4



Complete LH-Motronik M 1.5.4 configuration with the new EGR valve, Automotive fault simulator and CASSY evaluation

Training Objectives

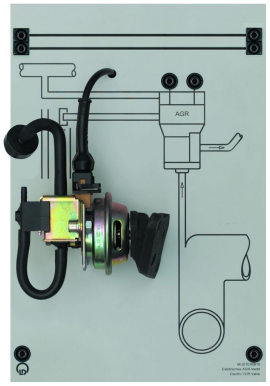
- principles of individual injection systems
- speed sensor on sensor wheel
- operational data acquisition and evaluation
- principle of quiescent distribution with DIS ignition
- exhaust gas re-circulation
- idle speed stabilization
- diagnostic options

T 3.2.5 Air/Fuel Management Systems
T 3.2.5.10 LH-Motronik M 1.5.4

LH-Motronik

... the flagship of LD Didactic motor management systems. Arranged in the classic experiment panel style with backside signal cabling, this arrangement permits the investigation of all components of a modern ignition and fuel injection controller having quiescent distribution and individual injection. From a sensor standpoint this includes: ▪ the mass airflow sensor ▪ the throttle potentiometer ▪ the Lambda sensor ▪ the motor/air temperature sensors ▪ the knocking sensor ▪ the engine speed sensor – as well as actuators for ▪ the rotary idle actuator ▪ the exhaust re-circulation valve ▪ the DIS coil firing unit ▪ the injection valves.
Fault diagnosis is possible via suitable testers attached to the on-board diagnostic socket or via blink-code output. A 3-channel ABS (➔ T 3.2.6.1) unit as well as an automatic transmission (➔ T 3.2.13.1) are available as optional enhancements.
The CASSY system from LD Didactic, combined with Auto-Box i (524 076) and Auto-Box Z (524 077), are used for LH-Motronik measurement acquisition and the evaluation of operational data. This instrumentation arrangement permits assessment of: ▪ voltages and currents ▪ primary and secondary waveform recording ▪ contact interval ▪ ignition timing ▪ injection period ▪ speed ▪ pulse duty factors ▪ frequencies.
The control unit can optionally be connected to additional student test stations (➔ 740 050 and ➔ 740 052). Students can record and evaluate all of the system's measurement values from their own work stations.

Mass airflow sensor



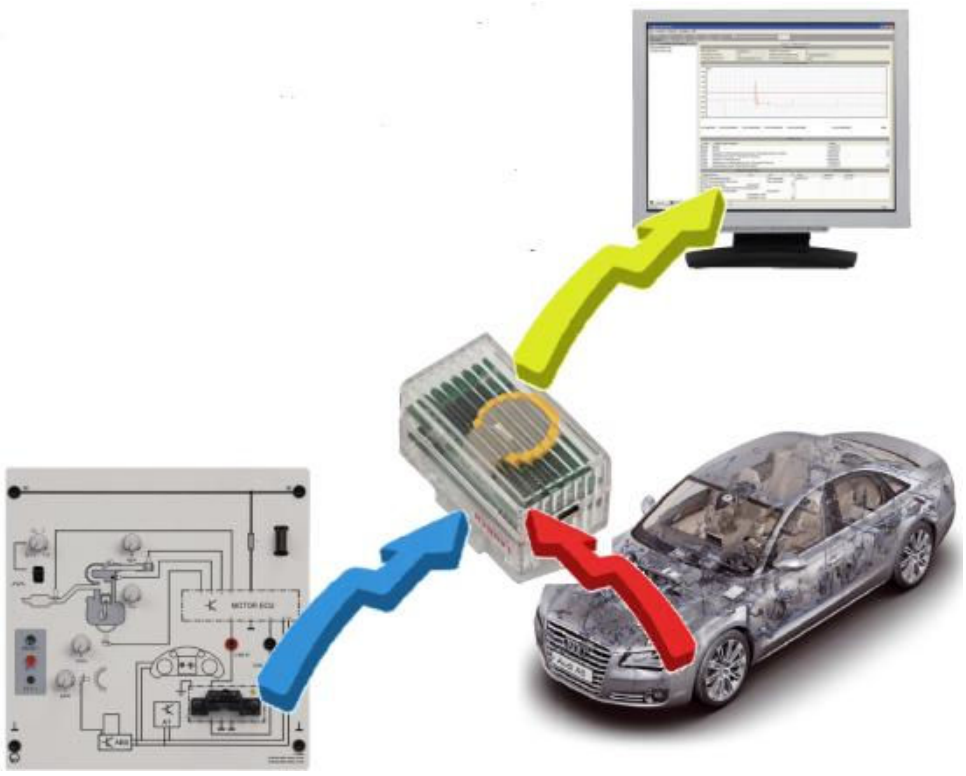
The new actuator EGR valve 739 255 for the exhaust gas recirculation.

EQUIPMENT LIST, T 3.2.5.10

LH-Motronik M 1.5.4

QTY.	CATALOG NO.	DESIGNATION
1	739 402	Control Unit, LH Motronik (M 1.5.4)
1	739 411	Air Mass Meter, LH Motronik
1	739 03	Knocking Sensor
1	739 253	Rotary Idle Actuator
1	739 42	Crank Angle Sensor
1	738 431	Flywheel with Sensor Holder
1	739 37	Evaluation Unit Motronic and LU-Jetronic
1	739 255	Electric EGR valve
1	738 517	DIS-Two Spark Ignition Coil
1	739 191	Substitute Engine Panel
1	739 271	Lambda Sensor, heated
1	738 981	Silicone Oil M3, 1 Liter
1	738 441	Spark plug holder
1	569 792	**Book**: LH Motronik M 1.5.4, T 3.2.5.10

T 3.2.5 Air/Fuel Management Systems
T 3.2.5.23 Vehicule Diagnose OBD2/EOBD

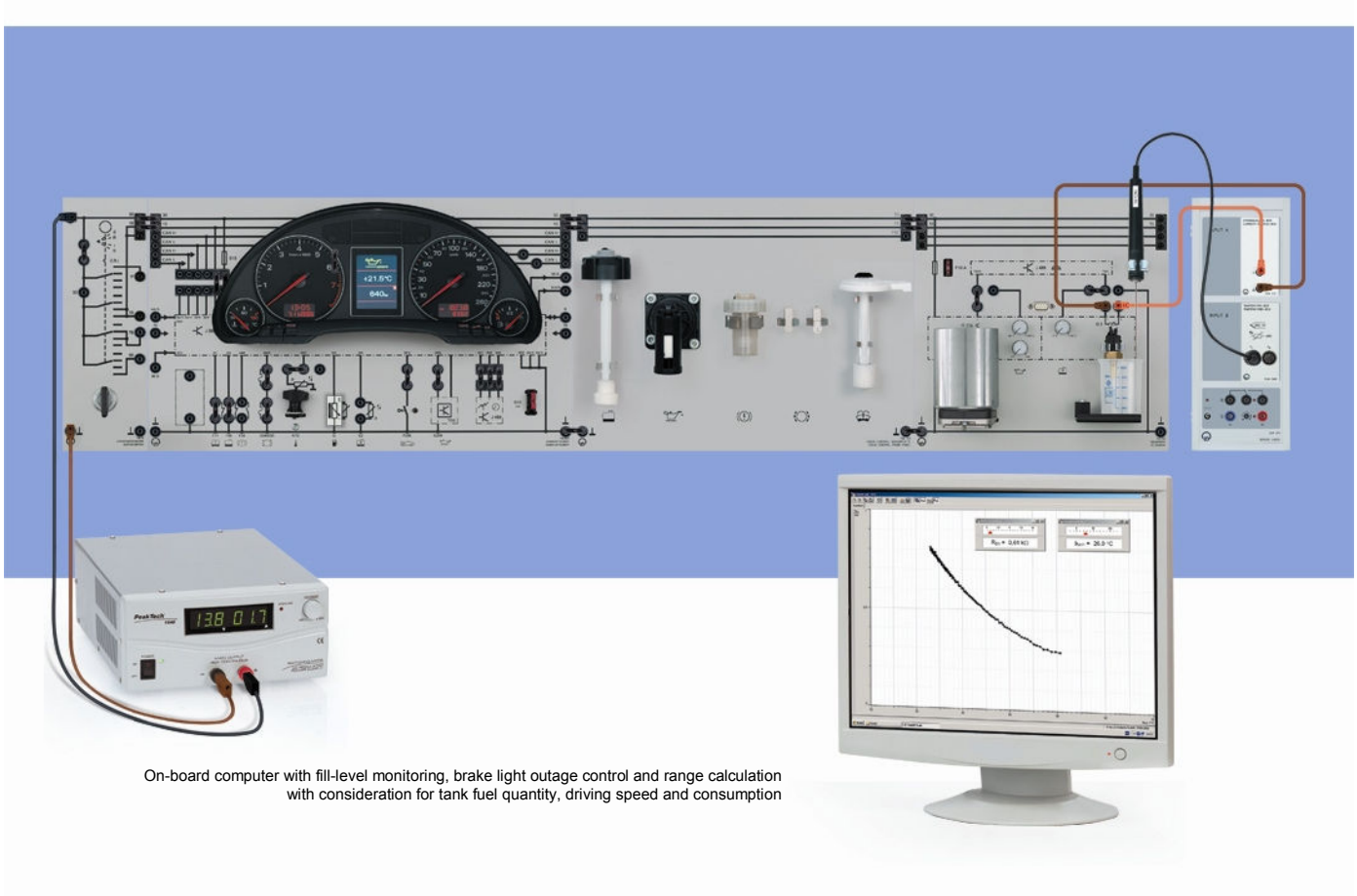


EQUIPMENT LIST T 3.2.5.23

Vehicule Diagnose OBD2/EOBD

QTY.	CATALOG NO.	DESIGNATION
1	739 660	EOBD/OBD2 Simulator
1	737 9803	OBD Adaptor CAN+USB
1	737 9804	OBD data logger CAN+USB

T 3.2.6 **Operation and Safety Electronics**
T 3.2.6.3 On-board computer



On-board computer with fill-level monitoring, brake light outage control and range calculation with consideration for tank fuel quantity, driving speed and consumption

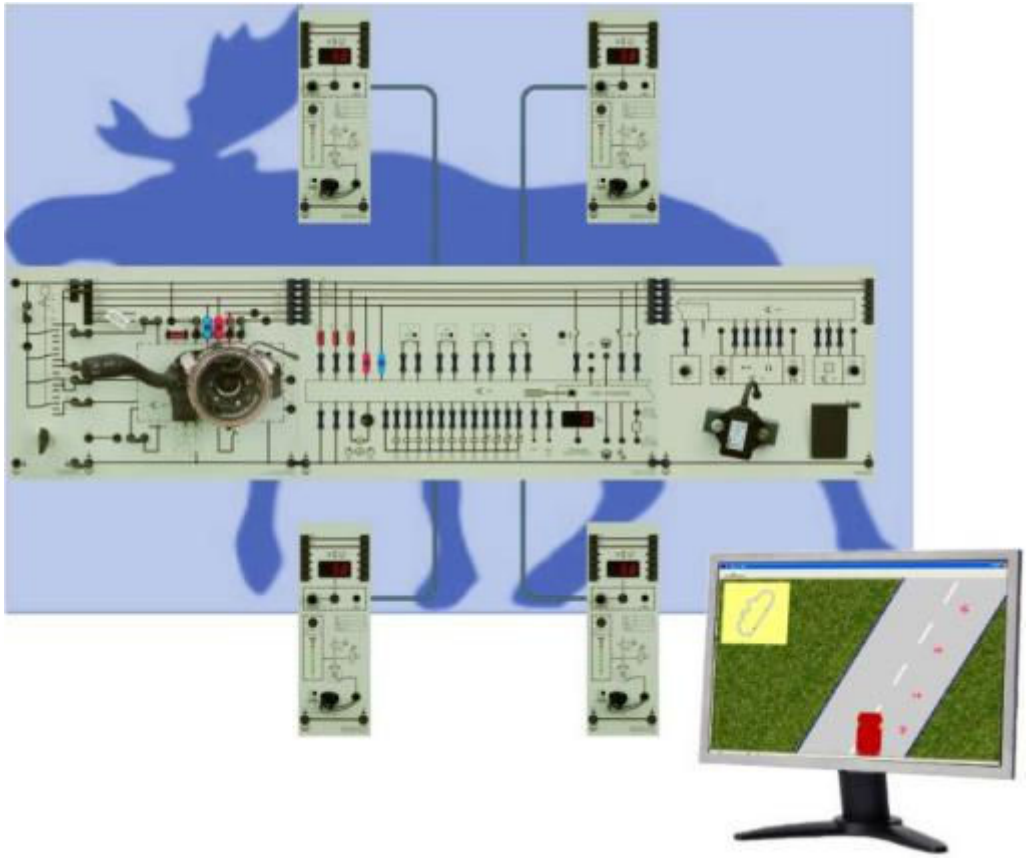
Training Objectives

- structure and operating principles of vehicle sensors
- structure of a oil level and temperature sensor
- signal encoding of oil sensors
- Recording of sensor characteristics (i. e. NTC)
- sensor signal check and priority
- liquid level check
- self-diagnosis

T 3.2.6 Operation and Safety Electronics
T 3.2.6.3 On-board computer

Conventional monitoring of fill levels, wear and temperatures will be implemented in a modern control unit. For example, current measurements in conductor loops provide an indication of worn brake shoes.
Moreover, various fill level sensors provide data that can be optically or acoustically presented to the driver. This "on-board computer" training system monitors fill levels for ▪ windshield washer water ▪ brake fluid ▪ motor oil and ▪ radiator water as well as ▪ brake shoe wear and the temperatures of ▪ motor oil and ▪ radiator water.
The oil sensor is a thermal oil level sensor which continuously measures oil level and oil temperature and can itself be filled with oil. Optionally, its signals can be simulated with potentiometers. The encoded signal which it produces contains the oil information in a combination PWM (pulse width modulated) / PFM (pulse frequency modulated) signal that, for example, can be recorded with Sensor-CASSY 2.
The signal from the radiator coolant temperature sensor can either be simulated by submerging it in a beaker of warm water or by setting a potentiometer. An appropriate bracket is available for simultaneous temperature measurements with a temperature sensor (➔ 666 212). In a decoupled state, both real temperature and the resistance can be measured then evaluated as an NTC characteristic (for example, with Sensor-CASSY 2 - Starter).
All values are available via the combi-instrument's diagnose conductor so they can also be displayed in self-diagnose mode. The linear values for oil level, oil temperature and coolant temperature are available at a 9-pole socket on the oil sensor. These signals can be measured directly or incorporated into a CAN-bus system.

T 3.2.6 Operation and Safety Electronics
T 3.2.6.6 Electronic Stability ABS/ESP

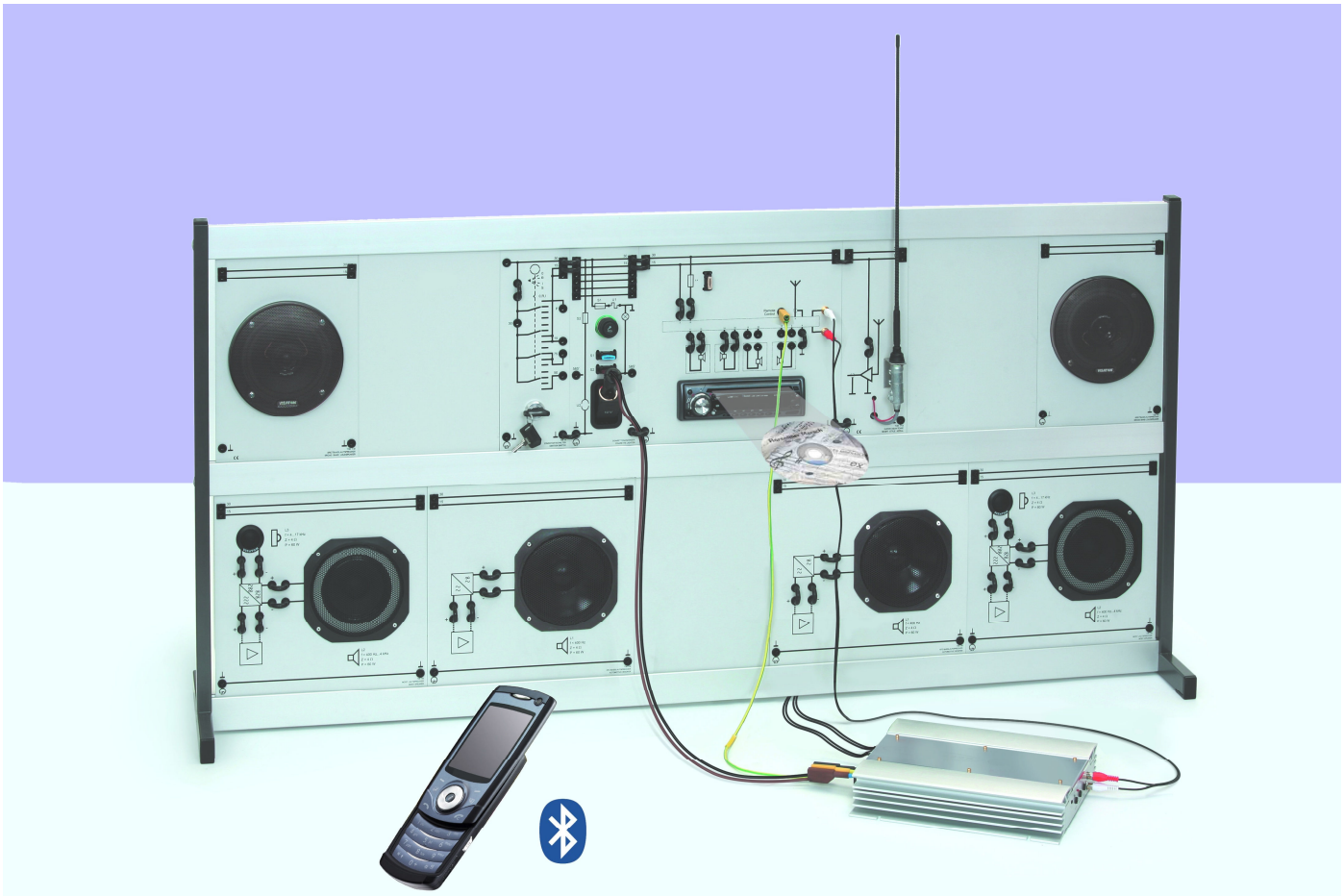


EQUIPMENT LIST, T 3.2.6.6

Electronic Stability ABS/ESP

QTY.	CATALOG NO.	DESIGNATION
1	739 650	LampABS/ESP control unit
1	739 651	ABS/ESP sensors
1	739 652	Wheel replacement plate, inductive

T 3.2.7 Communication and Comfort Electronics
T 3.2.7.1 Car Radio



Car radio with external amplifier and mobile phone connected via Bluetooth

Training Objectives

- ➔ schematic and connections
- ➔ motor antenna connection
- ➔ connection of an external amplifier
- ➔ antenna signal detection
- ➔ the Bluetooth telephone link data bus protocol
- ➔ coupling with an external MP3 player
- ➔ Bluetooth profile A2DP
- ➔ impedance measurement of a loudspeaker

T 3.2.7 Communication and Comfort Electronics
T 3.2.7.1 Car Radio

Car radio developments have been every bit as interesting as those for engine relevant components. Though built with vacuum tube technology, there was already an car radio model with an FM band and station-search function as early as 1953. The transistor replaced vacuum tube technology at the end of the 50s. This led to significant reductions in weight and required space. In 1969 stereo reception became available, the compact cassette player/radio followed, and in 1974 the first ARI [automobile radio information] traffic reporting system was established. Digital technology made inroads at the beginning of the 90s, digital display, CD player, the path from RDS [radio data system] to DAB (digital audio broadcast) paved the way for an integrated multimedia center.

This training system consists of a CD radio and supports ▪ four loudspeakers (connected on the back side) ▪ motor antenna ▪ Bluetooth® mobile[1] connection ▪ telephone mute function and ▪ Bluetooth® audio transmission. More systems covering the topic automotive data bus can be found at ➔ T 3.2.12.
The car radio is equipped with two front panel RCA type sockets to be connect to an external amplifier. For the skills of communication technology the antenna signal as well as the impedance of the loudspeakers can be determined.

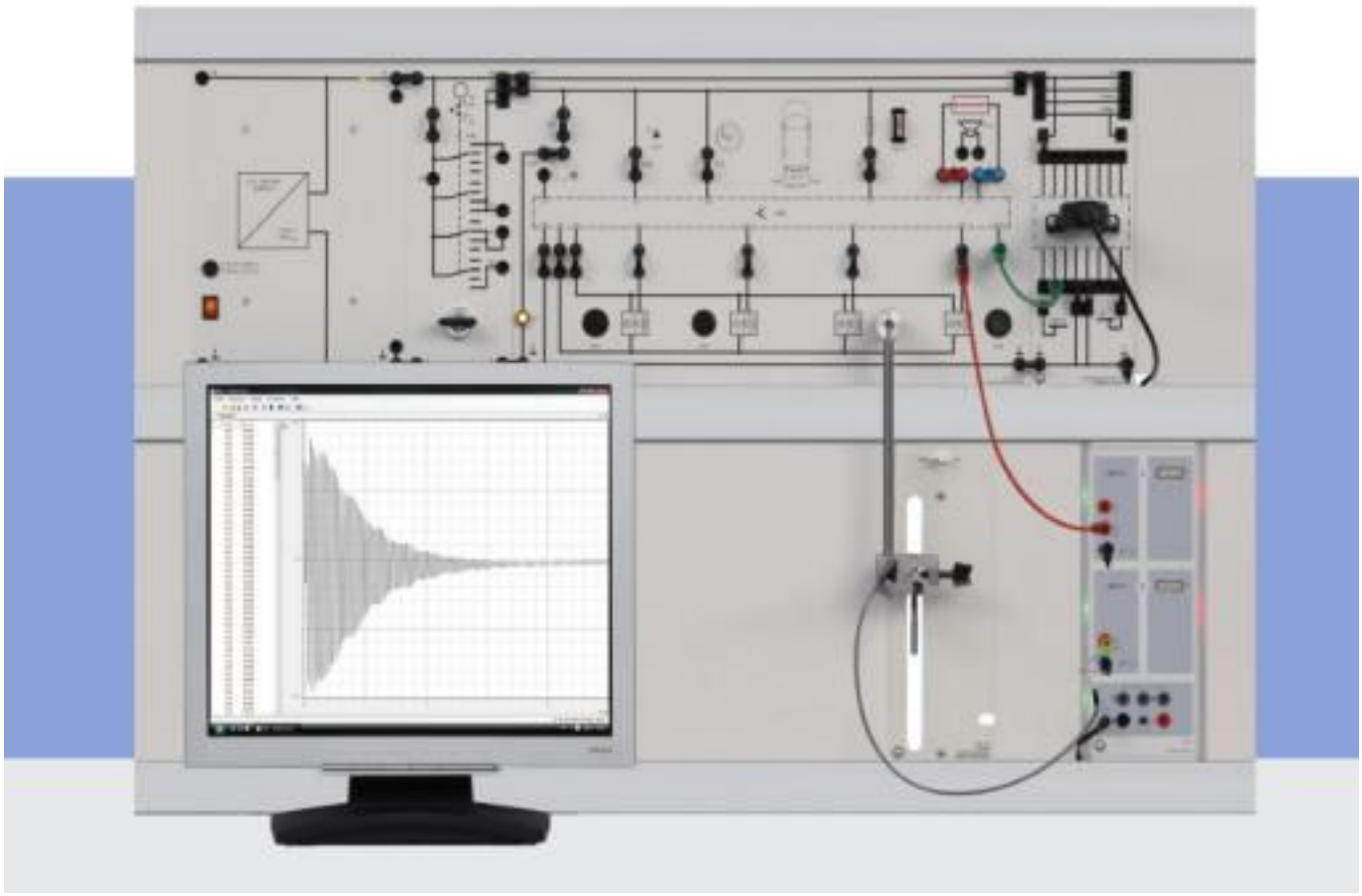
[1] mobile phone is not included in the scope of delivery!

EQUIPMENT LIST, T 3.2.7.1

Car Radio

QTY.	CATALOG NO.	DESIGNATION
1	739 718	BT car radio
2	739 731	Broad Band Loudspeaker
1	739 741	Electrical Antenna
(2)	739 735	MOST Loudspeaker
(2)	739 736	Automotive Bass Loudspeaker

T 3.2.7 Communication and Comfort Electronics
T 3.2.7.2 Park Distance Control

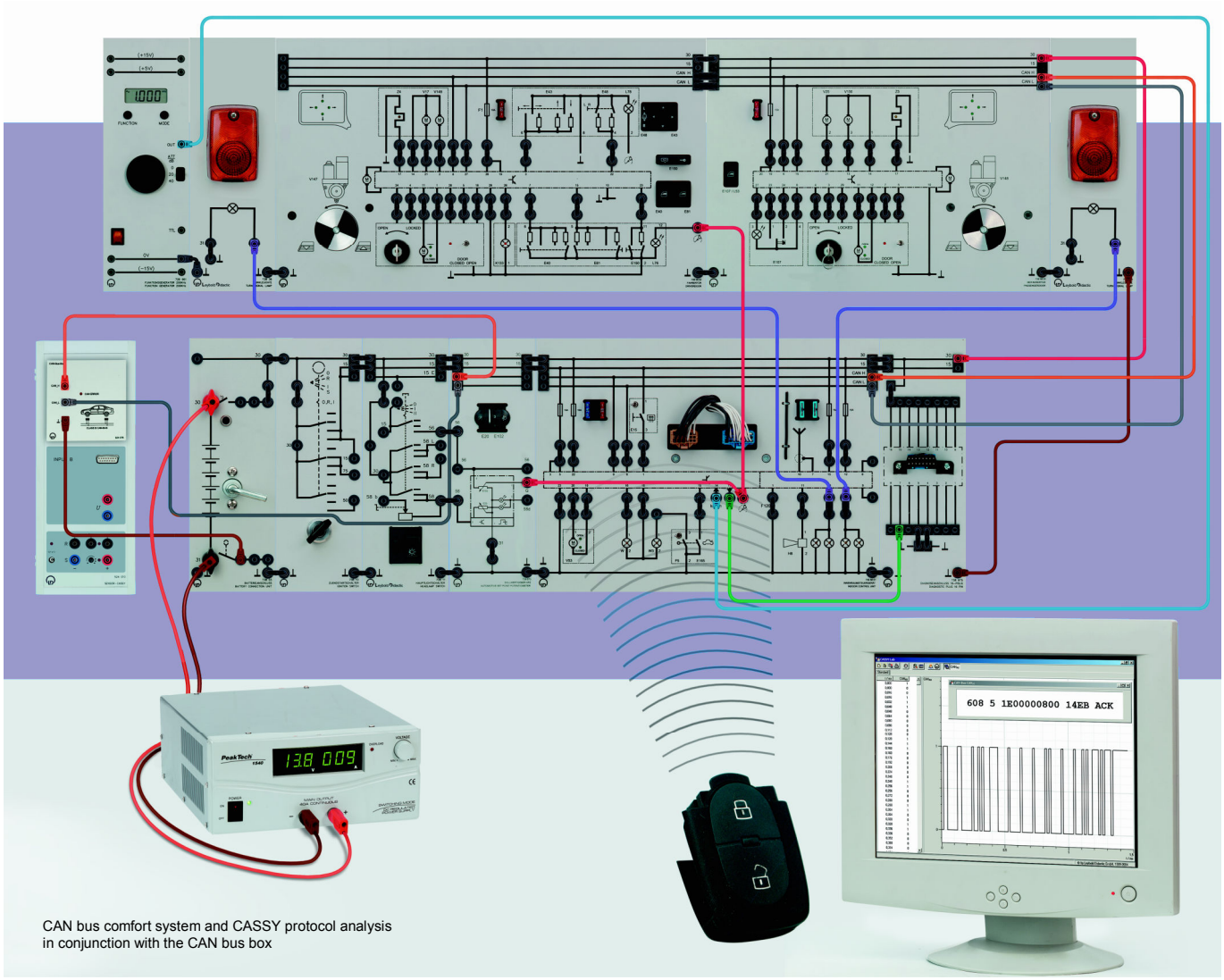


EQUIPMENT LIST, T 3.2.7.2

Park Distance Control

QTY.	CATALOG NO.	DESIGNATION
1	739 750	Park distance control
2	737 60601	Ultrasonic converter 40 kHz

T 3.2.7 **Communications and Comfort Electronics**
T 3.2.7.5 Comfort System with CAN-Databus



CAN bus comfort system and CASSY protocol analysis
in conjunction with the CAN bus box

Training Objectives

- ➔ voltage-coded signal transmission
- ➔ low-speed CAN bus functionality
- ➔ signal analysis on CAN H and CAN L
- ➔ data protocol contents
- ➔ realization of comfort functions
- ➔ operating data acquisition and evaluation
- ➔ training new function transponders
- ➔ diagnostic options

T 3.2.7 Communications and Comfort Electronics
T 3.2.7.5 Comfort System with CAN-Databus

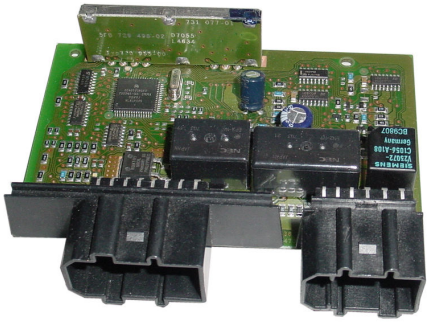
The CAN bus comfort training system ...

... the classic approach! The coupling of individual "islands" with as few conductors as possible while still retaining full functionality – that was the fundamental purpose of the CAN data bus with respect to comfort features. The "islands" are vehicle doors, each of which has its own control unit. These door-panel controls operate: ▪ window opening ▪ the central locking system ▪ the outside mirror positioning motors ▪ the outside mirror heater ▪ and the SAFE LED in conjunction with sensor states ▪ door lock ▪ window control buttons ▪ mirror positioning buttons ▪ central lock button ▪ door contact switches.

The control units are interconnected via the low-speed CAN data bus and therefore only requires a two-wire connection between each door and the vehicle's interior. The CAN bus features high data transfer rates, great security through single-wire capability and common mode rejection as well as excellent EMC behavior. Potential additional functions are: ▪ remote control operation ▪ blinker control ▪ interior and trunk space lights ▪ alarm system ▪ brightness control for instrument panel illumination ▪ speed-dependent central locking.

Since the training system has no defects in its normal state, an appropriate tester is best suited for self-diagnosis. Support is provided for: ▪ fault memory recall and deletion ▪ measured value display ▪ recoding ▪ adaptation as well as ▪ actuator testing.

The recording and evaluation of CAN bus signals is done with Sensor-CASSY 2 used as an oscilloscope or also analytically with the help of the CAN bus box. Further equipment sets related to the subject of CAN data busses can be found in the topic areas ➔ T 3.2.12 and ➔ T 3.2.3.7.



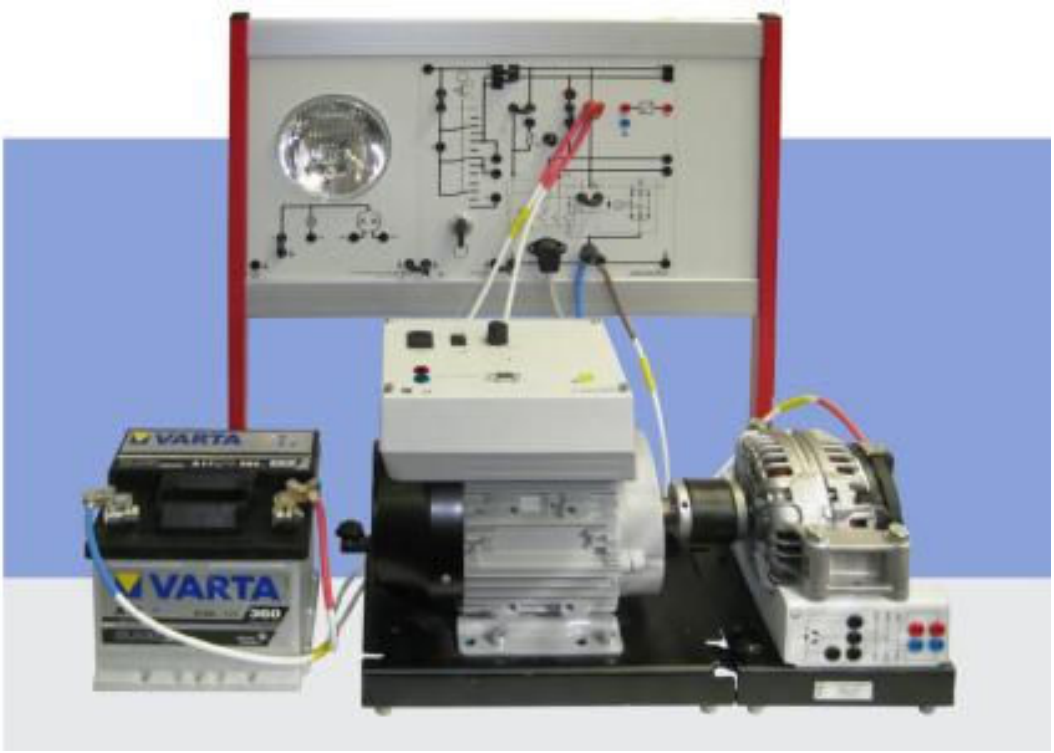
CAN bus fault simulator, 739 585

EQUIPMENT LIST, T 3.2.7.5

Comfort System with CAN-Databus

QTY.	CATALOG NO.	DESIGNATION
1	739 58	Comfortsystem with CAN - Bus
		Demonstration set supplement
4	738 36	Turn Signal Lamp
2	738 07	Interior Lamp
		Additional functions supplement
1	726 961	Function Generator 200 kHz, 230 V
1	738 11	Head Lamp Switch
1	739 573	Automotive Set Point Potentiometer
		Self-diagnosis supplement
1	738 975	Diagnostic Connector 16 pin
1	739 585	Fault simulator CAN Bus
1	739 581USB	CAN - Bus Software
1	737 9803	Diagnostic Adapter CAN+USB
1	566 1482	**Book:** T 3.2.7.5 Comfort system with CAN-Bus

T 3.2.8 **Generators and Electrical Motors**
T 3.2.8.2 Three-phase Alternator



Complete setup of alternator with standard regulator, driven by an electric motor

Training Objectives

- three-phase systems
- generator structure and function
- voltage generation and rectification
- circuit diagrams, cross-section areas for connections and wires
- function of a voltage regulator
- over-voltage protection
- differentiating between various types of generators
- troubleshooting

T 3.2.8 Generators and Electrical Motors
T 3.2.8.2 Three-phase Alternator

The alternator ...

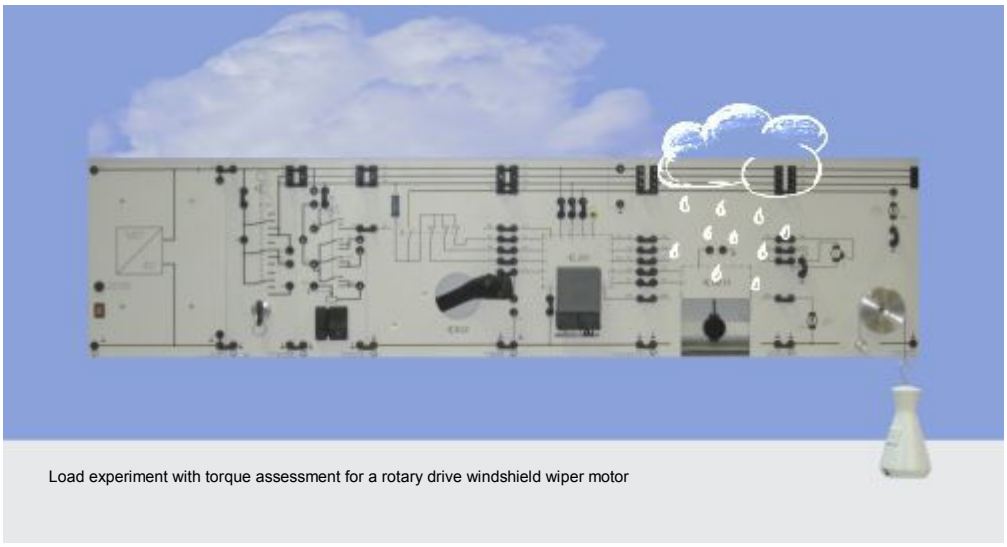
..., when driven by a mechanical source of power, is a three-phase generator of alternating current having a electrically-excited field poles. Since vehicle electrical power is conceptually a direct current grid, this three-phase voltage must be rectified. Furthermore, regulating elements come into play to maintain a constant voltage level despite varying motor speed.
This training system uses a three-phase electric motor to drive the generator. The power rectifier is mounted externally on a study panel, as is the regulator. Plug-in type electronic elements allow discrete configurations to be implemented for fundamental investigations. In combination with light components and a battery, a complete vehicle power supply grid can be set up!
In the context of further development from a pure generator to a belt-driven starter/generator, its behavior as a synchronous motor can also be investigated if a suitable voltage supply is available.
Respective measurements can be recorded with Sensor-CASSY 2 (➔ 524 013) or volt/ohm meters.

EQUIPMENT LIST, T 3.2.8.2

Three-phase Alternator

QTY.	CATALOG NO.	DESIGNATION
1	738 711	Compact alternator
1	738 76	Field Regulator, Generator
1	738 631	Motor f. Generator Experiments, 1.0 kW
1	738 632	Belt drive for vehicle 1:3
1	738 18	Auxiliary Headlamp
1	566 102	**Book**: Generators and Electrical Motors T 3.2.8

T 3.2.8 **Generators and Electrical Motors**
T 3.2.8.4 Windshield Wiper Motor



Load experiment with torque assessment for a rotary drive windshield wiper motor

Training Objectives

- fundamentals of direct current electric machines
- circuit diagrams, cross-section areas for connections and wires
- schematic diagrams
- wiper switch and wiper interval relay functions
- implementing two-speed operation
- producing torque
- current draw and power consumption

T 3.2.8 Generators and Electrical Motors
T 3.2.8.4 Windshield Wiper Motor

The windshield wipers ...

... provide a clear view that would otherwise not be possible for rain and snow conditions when on the road! In a classic windshield wiper application, a rotary drive is located in front a wiper motor in a networked system. The complete T 3.2.8.4 system, windshield wiper motor, consists of: ▪ a Wiper Switch ▪ a Wipe-Wash Interval Relay ▪ Rain sensor and ▪ the Windshield Wiper Unit.

Picture: Deutscher Verkehrssicherheitsrat e.V. [German traffic safety board, registered organization], Bonn, Germany

Respective measurements can be recorded with Sensor-CASSY 2 (➔ 524 013) or volt/ohm meters.

Additional windshield wiper systems in networked systems can be found in:

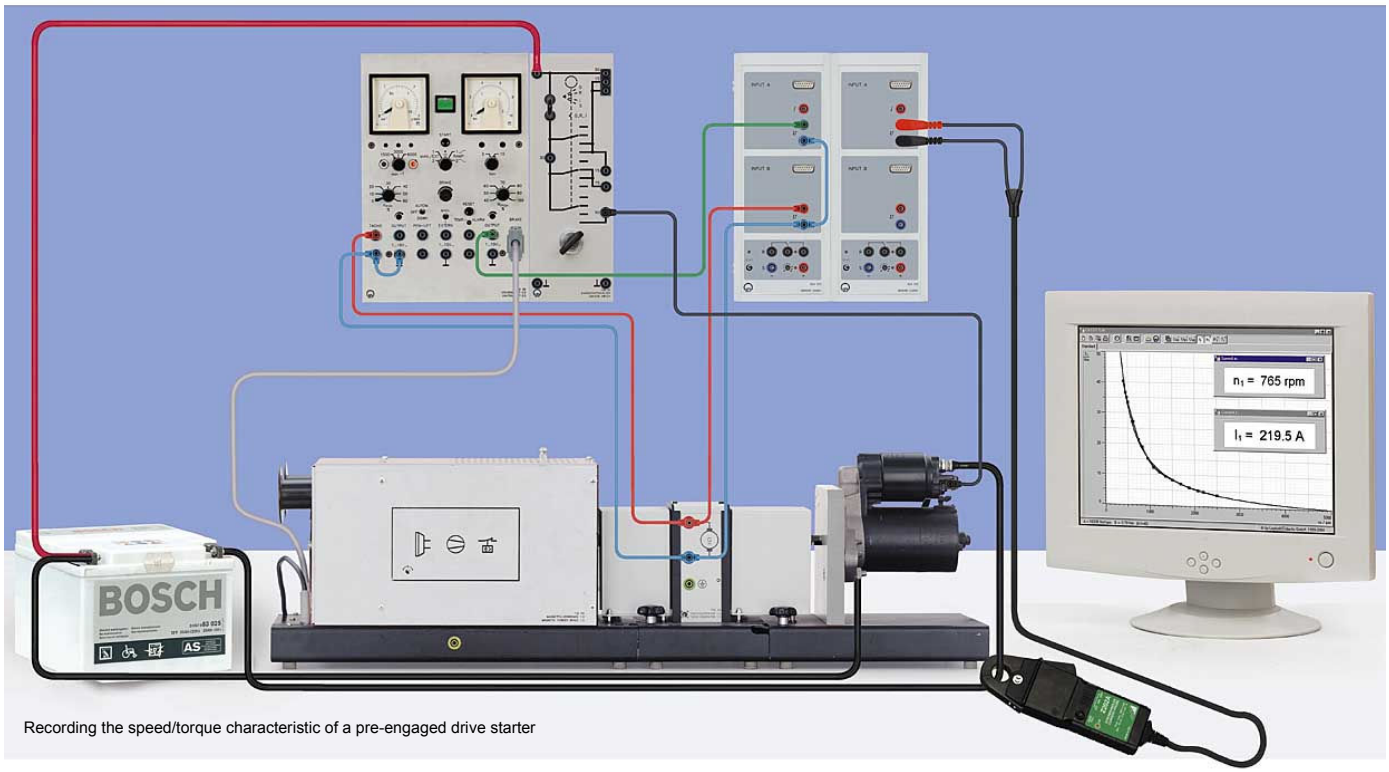
- ➔ T 3.2.12.3, Networking Automotive Systems 1 (Lighting)
- ➔ T 3.2.12.7, Networking Automotive Systems 4 (LIN bus)

EQUIPMENT LIST, T 3.2.8.4

Windshield Wiper Motor

QTY.	CATALOG NO.	DESIGNATION
1	738 830	Wiper Switch
1	738 831	Wipe-Wash Interval Relay
1	738 832	Rain sensor
1	738 833	Windshield Wiper Unit
1	566 102	**Book**: Generators and Electrical Motors T 3.2.8

T 3.2.8 **Generators and Electrical Motors**
T 3.2.8.5 Pre-engaged Drive Starter



Recording the speed/torque characteristic of a pre-engaged drive starter

Training Objectives

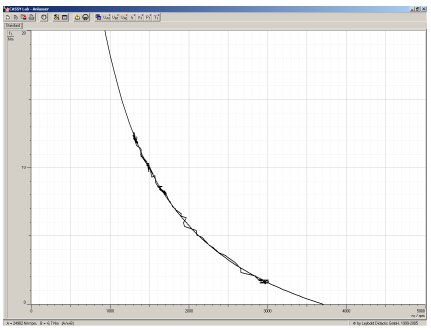
- starting requirements
- fundamentals of direct current electric machines
- starter requirements, starter structure and types
- schematic diagrams
- circuit diagrams, cross-section areas for connections and wires
- speed/torque characteristic
- current draw and power consumption
- the starting process sequence

T 3.2.8 Generators and Electrical Motors
T 3.2.8.5 Pre-engaged Drive Starter

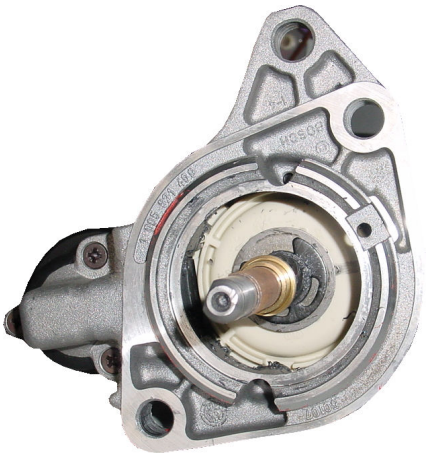
The electric machine ...

... the second rotary force in the car! It is a proven principle: a flow of current produces a magnetic field that, together with a second magnetic field, produces a force. This process can be used to produce linear motion (e.g. for valves, injectors, relays) as well as rotary motion.
The starter is a direct-current, series-wound machine that can produce sufficient torque at relatively low speeds to start an internal combustion motor. Because the on-board voltage is quite low, relatively high current is drawn in order to develop the necessary mechanical power. This high current draw also means that the starter's supply leads must have appropriately large cross-sectional areas.
This training system aims at the recording of the speed/torque characteristic. This is done by loading the starter mechanically with a magnetic powder brake, allowing the: ▪ braking torque ▪ voltage ▪ speed and ▪ current drawn (via a clamp-on probe) to be recorded, displayed and evaluated with Sensor-CASSY 2 - Starter.

A starter battery is necessary to carry out the experiments!



Speed/torque characteristic recorded with CASSY



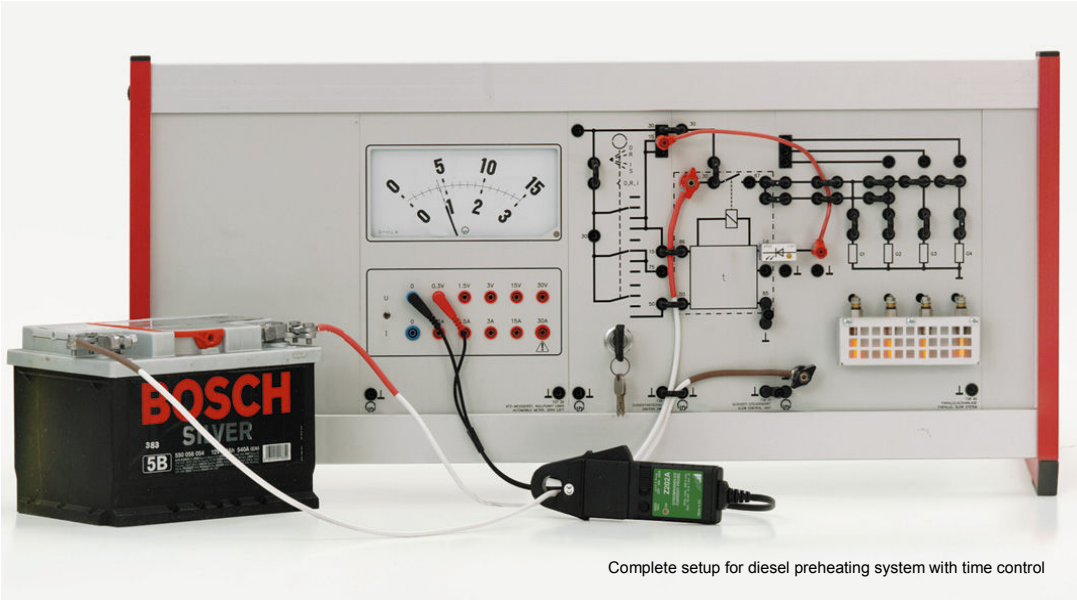
A view into an opened starter

EQUIPMENT LIST, T 3.2.8.5

Pre-engaged Drive Starter

QTY.	CATALOG NO.	DESIGNATION
1	738 851	Pre-Engaged Drive Starter, Perman.-Excited
1	738 88	Set of Connecting Leads II
1	732 59	Tacho Generator 1.0
1	500 597	Automobile protection measuring adaptor
1	732 54	Magnetic Powder Brake 1.0
1	732 55	Control unit 1.0
2	732 56	Coupling 1.0
2	732 58	Coupling guard 1.0
1	566 102	**Book:** Generators and Electrical Motors T 3.2.8

T 3.2.9 **Starting Aids for Diesel Engines**
T 3.2.9.1 Parallel Pre-Glow System



Complete setup for diesel preheating system with time control

Training Objectives

- glow plug function
- investigation of the heating process
- operational data acquisition and evaluation
- operating principle of temperature dependent control
- operating principle of current dependent control
- pre and post glow function

T 3.2.9 Starting Aids for Diesel Engines
T 3.2.9.1 Parallel Pre-Glow System

Diesel motors are self-igniting – at least most of the time. But in the winter and on other cold days the diesel just doesn't want to spring into life. It does not have sufficient heat in the combustion chambers to produce the self-ignition. This necessary heat is provided by the glow plug – particularly the rod glow plug. It extends its heating rod into the pre-chamber or the whirl chamber so that the injected fuel vaporizes on the glow plug's hot surface and self-ignites. The released heat initiates combustion.
The heating rod of a modern rod glow plug reaches a temperature of over 850 °C within a few seconds. A lot of energy is needed to ignite diesel fuel at low temperatures – particularly if the motor is to start quickly. This requires a great deal more than just a glowing point at the tip of the glow plug – especially since a plug can be blow-cooled by the intake of cold air during the starting process. In such surroundings, the plug will only function properly if it has enough reserves, i.e. when enough glowing volume is present so that heat can immediately be re-supplied to the cold-blown zone.
This training system "Parallel preheating system" investigates the glow process whereby the glow plugs can be selectively regulated by either a temperature controlled or a current controlled glow-time relay. Investigations will be made of the: ▪ duration of the preheating period ▪ control of the indicator lamp ▪ duration of post-heating ▪ the current during the preheating phase ▪ the current during the post-heating phase as well as ▪ the glow plug's PTC effect.
Respective measurements can be recorded with Sensor-CASSY 2 (➔ 524 013SKFZ) or volt/ohm meters.

Heated to 1,100 °C in only 2 seconds – for a diesel motor start as quick as a gas motor

EQUIPMENT LIST, T 3.2.9.1

Parallel Pre-Glow System

QTY.	CATALOG NO.	DESIGNATION
1	738 90	Parallel Glow System
1	738 91	Glow Time Control Unit Temperature
1	500 597	Automobile protection measuring adaptor
1	524 013SKFZ	CASSY 2 – Starter , Automotive
1	566 112	**Book**: Starting Aids for Diesel Engines T 3.2.9

T 3.2.10 Electronic Diesel Control

T 3.2.10.2 Common Rail Diesel Direct Injection

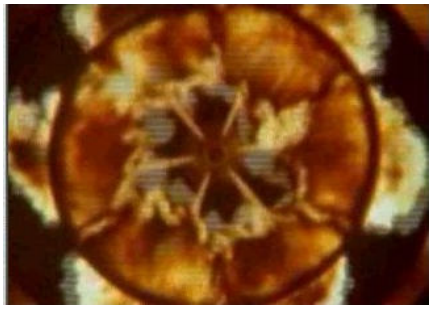
Complete common rail experiment stand with hydraulic components and fuel circuit

Training Objectives

- ➔ the structure and function of injectors
- ➔ rotary speed acquisition on the sensor wheel
- ➔ camshaft position encoding on the sensor wheel
- ➔ operating principle of the electronic gas pedal
- ➔ the function of exhaust gas re-circulation
- ➔ operational principle of rail pressure regulation
- ➔ diagnostic options

T 3.2.10 Electronic Diesel Control
T 3.2.10.2 Common Rail Diesel Direct Injection

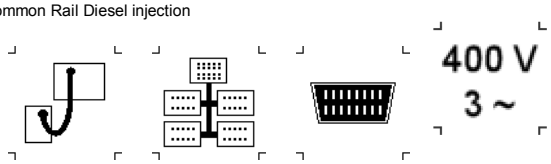
Common rail has become synonymous with the world's most advanced diesel technology, the direct injection of fuel. This system, as implemented with DaimlerChrysler technology, the build-up of pressure and the fuel's injection occur independently of one another. The CDI engine's fuel line, common to all cylinders (common rail), stores pressure and distributes fuel to the injectors at a constant pressure. Magnetic valves in the injectors determine the time when injection starts and the volume of fuel injected. This is done individually for each combustion cylinder – as regulated by the electronic motor controller according to the prevailing conditions.
This system accommodates the recording of measurements with Sensor-CASSY 2 as well as analog signal fault simulation. Diagnostic units can be connected via the OBD interface. In combination with suitable software (➔ 739 582), the observation of CAN bus signals is also possible. Signal wires are routed on the rear side of the panel to preserve an uncluttered overview of components on the panel's front side.
The control unit can optionally be connected to additional student test stations (➔ 740 050 and ➔ 740 0531). Students can record and evaluate all of the system's measurement values from their own work stations.

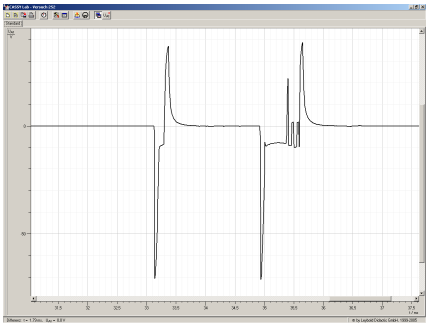


EQUIPMENT LIST, T 3.2.10.2

Common Rail Diesel Direct Injection (**Hydraulic Stand**)

QTY.	CATALOG NO.	DESIGNATION
1	740 105	Common Rail
1	738 10	Ignition Switch
1	738 026	Digital Power Supply 3-15 V/40 A
1	569 760EN	**Book**: Common Rail Diesel injection





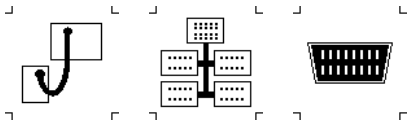
CASSY recording of an injector signal, left the pre-injection pulse and right the main injection

Or alternatively:

EQUIPMENT LIST, T 3.2.10.2

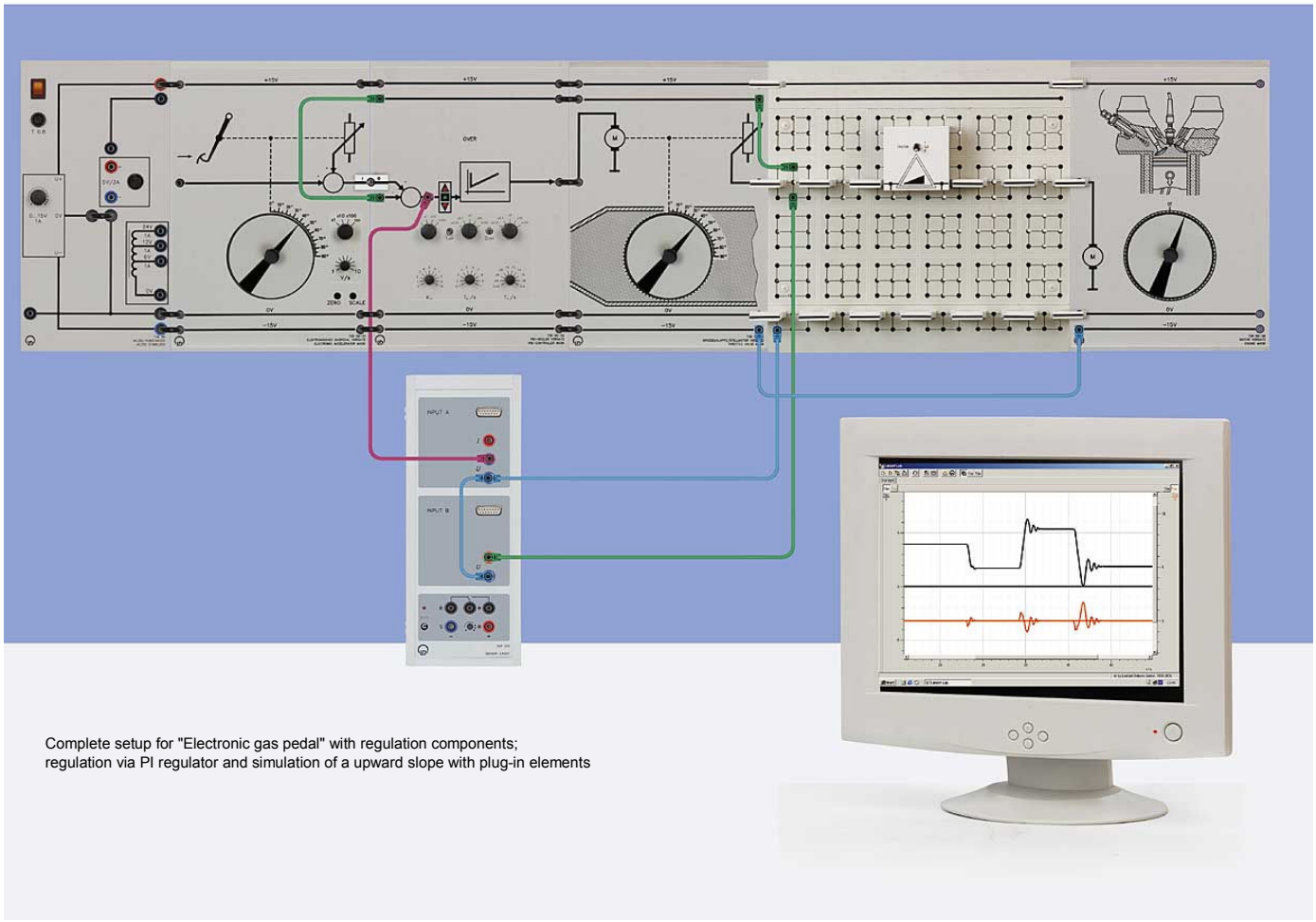
Common Rail Diesel Direct Injection (**Hydraulic simulation**)

QTY.	CATALOG NO.	DESIGNATION
1	740 106	Common Rail with Hydr. Simulation
1	738 10	Ignition Switch
1	738 026	Digital Power Supply 3-15 V/40 A
1	569 760EN	**Book**: Common Rail Diesel injection



T 3.2.11 Open and Closed Loop Control in the Vehicle

T 3.2.11.1 Fundamentals of Open and Closed Loop Control
T 3.2.11.2 Electronic Gas Pedal



Complete setup for "Electronic gas pedal" with regulation components;
regulation via PI regulator and simulation of a upward slope with plug-in elements

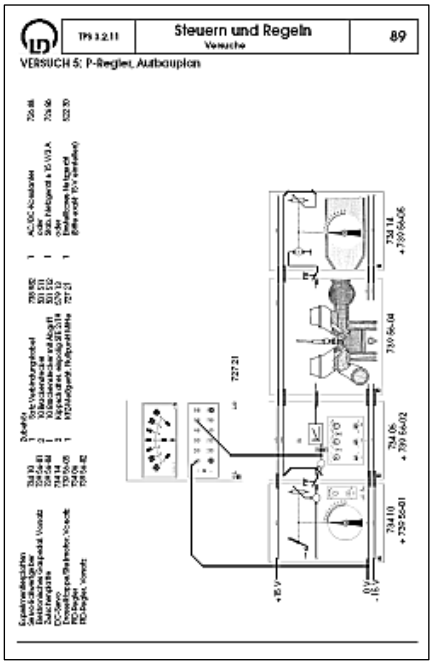
Training Objectives

- ➔ the function of regulating systems in vehicles
- ➔ **IPO principle:** signal input, processing and output
- ➔ regulating techniques
- ➔ reference and set-point values
- ➔ open and closed regulating circuits
- ➔ operating principle of the electronic gas pedal
- ➔ interference quantity investigation

T 3.2.11 Open and Closed Loop Control in the Vehicle

T 3.2.11.1 Fundamentals of Open and Closed Loop Control

T 3.2.11.2 Electronic Gas Pedal



Controls and regulators have always had their place in vehicles. What was once mechanical, e.g. vacuum adjustment of ignition, is today substantially implemented electrically or with electronics. In the training course synopsis for training field 7, this is expressed as follows:
"[...] they (the students) will differentiate between control and regulation. They will be able to correlate typical vehicle assemblies and components to hydraulic, pneumatic or electric/electronic systems. They will analyze functional relationships and apply fundamental test and measurement procedures for the investigation of signal, material and energy flows."
This LD Didactic training system illustrates fundamental theoretic relationships of process control systems on the basis of typical vehicle applications. Respective measurements can be recorded with either Sensor-CASSY 2 or volt/ohm meters.

EQUIPMENT LIST, T 3.2.11.1

Fundamentals of Open and Closed Loop Control

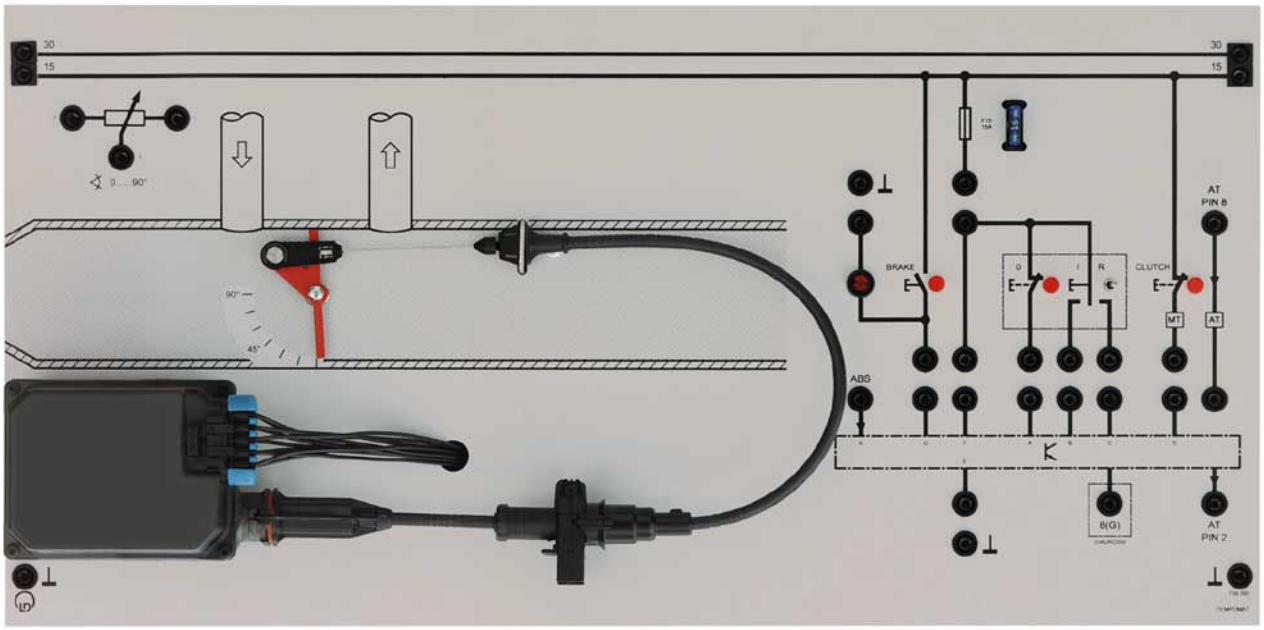
QTY.	CATALOG NO.	DESIGNATION
1	734 064	PID Digital Controller
1	734 10	Servo Setpoint Generator
1	734 13	Power Amplifier
1	734 14	DC-Servo
1	726 50	Plug-In Board 297 x 300 mm
1	577 32	Resistor 100 Ohm, 2 W
1	577 35	Resistor 200 Ohm, 2 W
1	577 40	Resistor 470 Ohm, 2 W
2	578 51	Si Diode 1N 4007
2	579 13	Toggle switch, single-pole
2	501 48	Set of 10 Bridging Plugs
1	726 88	AC/DC Stabilizer
1	313 17	Stopclock II
1	579 161	Simulation "Incline"
1	568 052	**Book**: Open and Closed Loop Control in the Vehicle T 3.2.11

EQUIPMENT LIST, T 3.2.11.2

Electronic Gas Pedal

QTY.	CATALOG NO.	DESIGNATION
1	739 56	Electronic Gaspedal Accessory
1	734 064	PID Digital Controller
1	734 10	Servo Setpoint Generator
1	734 13	Power Amplifier
1	734 14	DC-Servo
1	726 50	Plug-In Board 297 x 300 mm
1	577 32	Resistor 100 Ohm, 2 W
1	577 35	Resistor 200 Ohm, 2 W
1	577 40	Resistor 470 Ohm, 2 W
2	578 51	Si Diode 1N 4007
2	579 13	Toggle switch, single-pole
2	501 48	Set of 10 Bridging Plugs
1	726 88	AC/DC Stabilizer
1	313 17	Stopclock II
1	579 161	Simulation "Incline"
1	738 042	Battery pole-clamp set
1	568 052	**Book**: Open and Closed Loop Control in the Vehicle T 3.2.11

T 3.2.11 **Open and Closed Loop Control in the Vehicle**
T 3.2.11.3 Speed Control

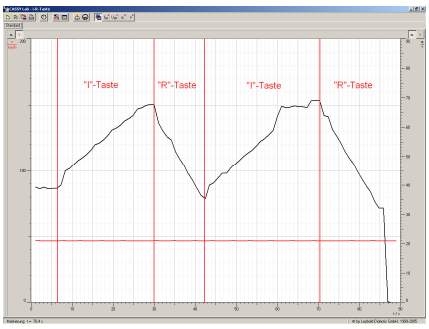


Training Objectives

- ➔ the function of regulating systems in vehicles
- ➔ **IPO principle: signal input, processing and output**
- ➔ regulating techniques
- ➔ reference and set-point values
- ➔ interference quantity investigation
- ➔ the influence of brake and coupling signals
- ➔ operating functions
- ➔ self-diagnosis

T 3.2.11 Open and Closed Loop Control in the Vehicle
T 3.2.11.3 Speed Control

One of the most interesting forms of regulation found in vehicles is also one that is quite advantageous for the driver – "cruise control" for maintaining a constant speed. This feature is really appreciated on long stretches that have a speed limit The desired speed is entered into the control unit as a reference value and subsequently compared with the vehicle's actual speed. If the difference is negative, the control unit will cause the throttle flap to open further in an attempt to increase speed; if the difference is positive the throttle flap will be ordered to close a bit in an attempt to reduce speed.
This training system from LD Didactic illustrates the system's regulating processes, data entry procedures as well as the control unit's self-diagnostic capabilities. Measurements can be recorded with a workshop oscilloscope or with Sensor-CASSY 2.
Examples of other types of regulation in our program include: ▪ lighting-distance regulation (➔ T 3.2.12.6) ▪ windshield wiper regulation (➔ T 3.2.12.7) ▪ the regulation of various physical motor variables (➔ T 3.2.10.2) ▪ voltage regulation (➔ T 3.2.8.2) or ▪ Lambda regulation (➔ T 3.2.5.10).



Speed change recorded with CASSY after pressing the I and R buttons

EQUIPMENT LIST, T 3.2.11.3

Speed Control

QTY.	CATALOG NO.	DESIGNATION
1	739 350	Cruise Control
1	739 602	Tachometer/Speedometer
1	569 782	**Book**: Electronic Cruise Control (Tempomat) T 3.2.11.3

T 3.2.12 **Bus-Systems and Diagnostic**
T 3.2.12.3 Networking Automotive Systems 1 (Lighting)

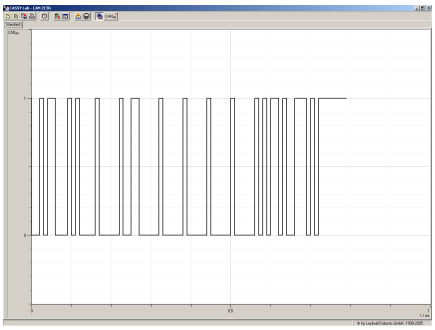
Training Objectives

- ➔ the function of networked systems in vehicles
- ➔ the principle of CAN bus data transfer
- ➔ the function of networked sensors
- ➔ controlling networked actuators
- ➔ implementing comfort functions
- ➔ modern control unit functions
- ➔ electronic lamp monitoring
- ➔ self-diagnosis

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.3 Networking Automotive Systems 1 (Lighting)

The "Lighting" training system

This training panel includes a modern vehicle instrument panel with electronic vehicle immobilizer, complete steering column electronics, a central module comfort system and electronic central electric controls. The light system and a windshield wiper motor complement the system. The fundamentals of vehicle electronics and modern data bus systems are presented in a clear, comprehensive manner. This concept strongly emphasizes the use of original vehicle components. Fault detection, analysis and repair are always kept as the central point.
The following components are included with this training panel: ▪ the light system ▪ the combi instrument ▪ electronic vehicle immobilizer ▪ steering wheel electronics ▪ a control unit for automatic trailer detection ▪ a 13-pole trailer socket ▪ the comfort system's central module (CAN-Bus) ▪ the electronic central electric controls ▪ the windshield wiper motor ▪ the relay board ▪ an OBD II diagnostic connector ▪ a CAN bus interface and ▪ a fault-switch box.
The CASSY system from LD Didactic is used for data telegram measurement data acquisition and evaluation. CASSY's oscilloscope facility permits these data telegrams to be recorded and interpreted. With the help of the CAN-Bus-Box (➔ 524 078), a complete CAN bus protocol analysis can be performed. With the help of CAN bus software (➔ 739 581), the system can be visualized on the PC. The system has self-diagnostic capabilities. All diagnostic options can be performed with an appropriate diagnostic tester (➔ 737 980).
Additional equipment sets on the subject of CAN busses can be found in topic areas ➔ T 3.2.7.5 and ➔ T 3.2.3.7. The fundamentals of windshield wiper motors is located under ➔ T 3.2.8.4 and board computers under ➔ T 3.2.6.3!



Recording a single CAN bus message with the help of CASSY box 524 078

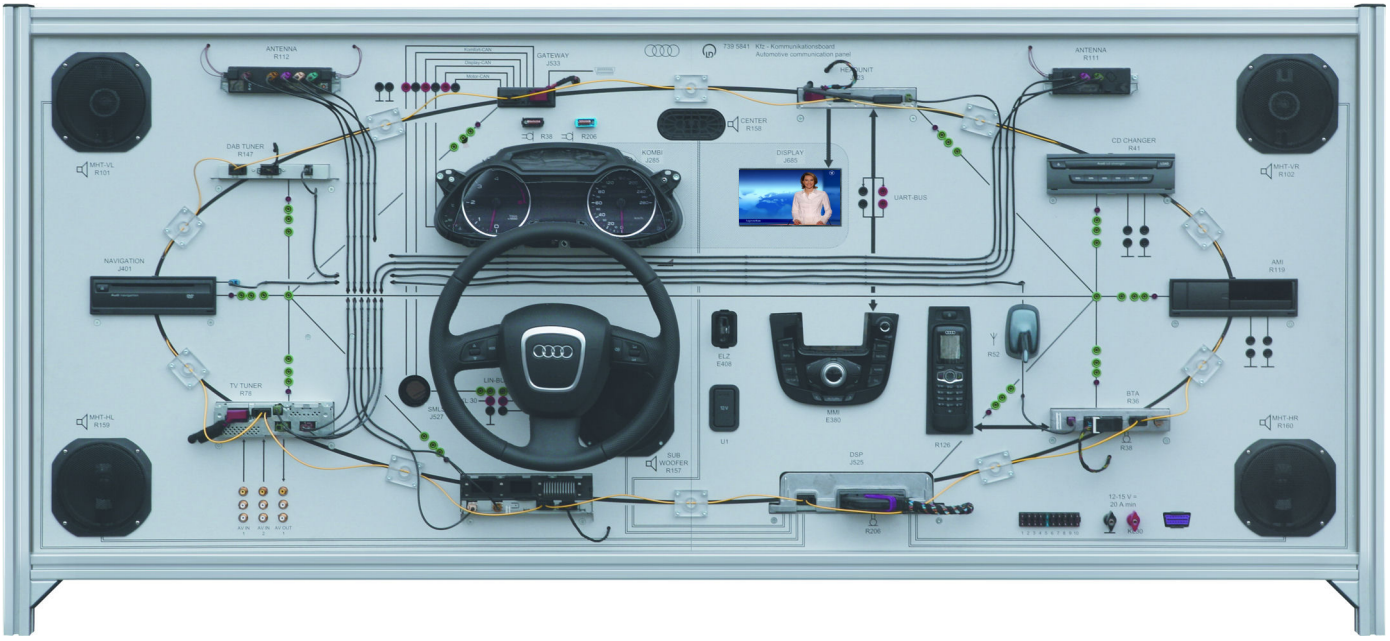
Supplementary Vehicle Door DS (739 5835) or PS (739 5836)

EQUIPMENT LIST, T 3.2.12.3

Networking Automotive Systems 1 (Lighting)

QTY.	CATALOG NO.	DESIGNATION
1	739 5821	Automotive Training Panel Lighting
1	739 581USB	CAN bus software USB
1	739 587	Software: CAN-Databus visualization (with 739 581USB only!)
1	738 026	Digital Power Supply 3-15 V/40 A
(1)	739 5836	Model: Vehicle door PS
(1)	737 9803	OBD Adaptor CAN+USB
(1)	524 078	CAN Bus Box (only with CASSY 524 013!)
(1)	739 5835	Model: Vehicle door DS

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.5 Networking Automotive Systems 3 (Infotainment)



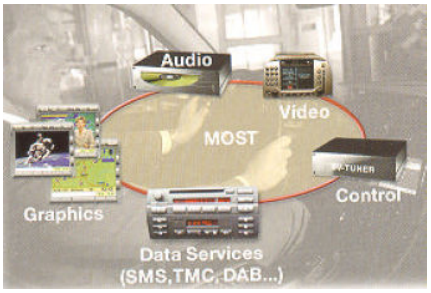
Training Objectives

- principles of CAN and LIN databus and MOST data transmission
- practical exercises: making up MOST OWGs
- self-diagnosis via the CAN diagnostic bus
- MOST ring-break diagnosis
- supplementing systems (MOST control units)
- determination of loudspeaker impedances
- field strength measurement for mobile telephones
- characteristics of vehicle send/receive antennas
- antenna diversity principle
- HF and AF signal transmission
- investigation of electrical (AF and HF) as well as optical faults

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.5 Networking Automotive Systems 3 (Infotainment)

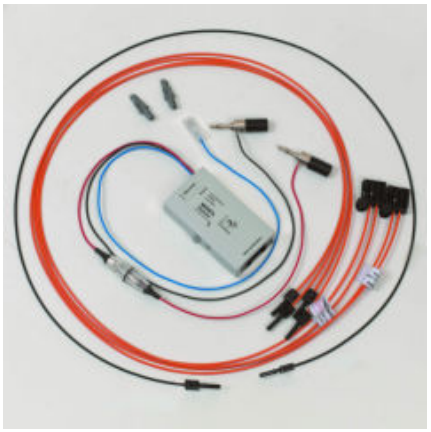
The infotainment training system

The training board includes a complete infotainment package networked by MOST (=**M**edia **O**riented **S**ystems **T**ransport) bus with new Audi technology.
Included are ▪ a instrument cluster and gateway ▪ an antenna amplifier system ▪ a true color display with control unit for information ▪ an operator unit for multimedia ▪ a hybrid TV tuner ▪ an MP3-capable CD changer ▪ a navigation system ▪ an analog and a digital radio receiver ▪ an OBD socket ▪ a cell phone connection ▪ a steering wheel operator panel 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 impedances, assessing transmission power-level of cell phone antennas, performing AF and HF signal investigations and detecting reception signal levels.

The optical characteristics of the MOST bus' optical wave guide can be investigated in more detail with the optical bench (➔ 736 415). With equipment set ➔ T 3.2.12.8, 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), the system has self-diagnostic capabilities over the CAN diagnose bus or an original workshop tester .



MOST repeater for fault analysis and ring extension (Plug&Play)

Additional equipment sets on the subject of CAN data busses can be found in topic areas ➔ T 3.2.7.5 and ➔ T 3.2.3.7.

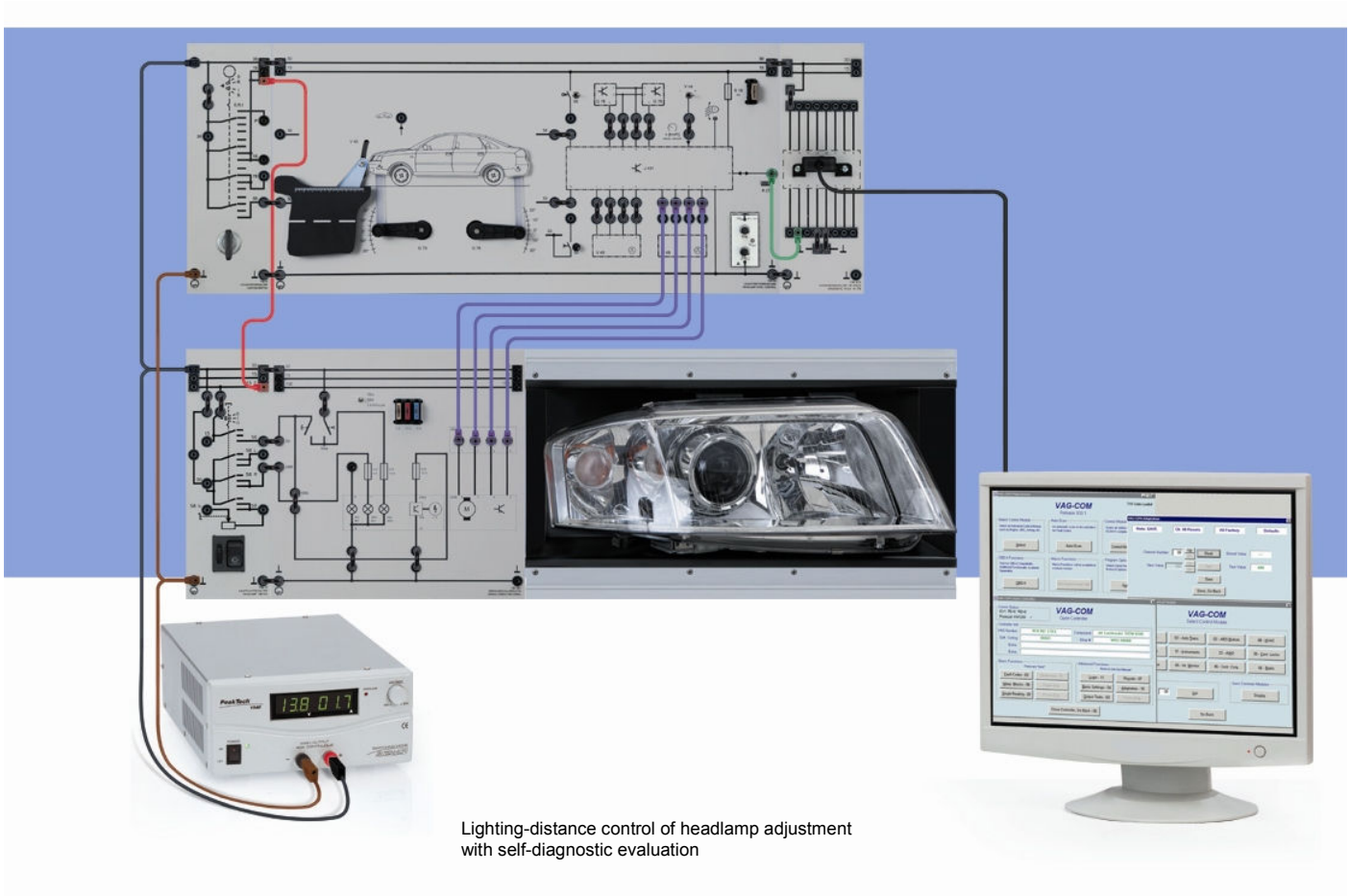
Reading out fault memory via the CAN diagnose bus

EQUIPMENT LIST, T 3.2.12.5

Networking Automotive Systems 3 (Infotainment)

QTY.	CATALOG NO.	DESIGNATION
1	739 5841	Training panel, vehicle communications
1	738 026	Digital Power Supply 3-15 V/40 A
(1)	739 588	LIN-Bus PC interface USB
(1)	737 9803	OBD Adaptor CAN+USB
(1)	524 078	CAN-Bus Box (*with CASSY 524 013 only !*)
(1)	524 081	LIN-Bus Box (*with CASSY 524 013 only!*)
(1)	740 20711	MOST repeater TPS
(1)	740 2013	MOST PC interface USB
(1)	739 581USB	CAN Bus Software
(1)	524 013S	Sensor-CASSY 2 - Starter

T 3.2.12 **Bus-Systems and Diagnostic**
T 3.2.12.6 Vehicle Onboard Diagnosis



Lighting-distance control of headlamp adjustment
with self-diagnostic evaluation

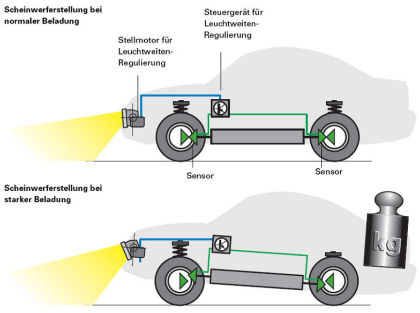
Training Objectives

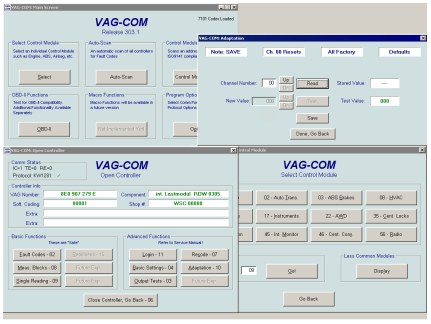
- the function of regulating systems in vehicles
- **IPO principle:** signal input, processing and output
- diagnostic function via the K line
- connecting and setting up a diagnostic tester
- reading out the fault memory
- displaying measurement value blocks
- recoding a control unit
- performing an actuator test

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.6 Vehicle Onboard Diagnosis

Diagnosis of lighting-distance regulation

Traffic safety authorities require automatic lighting-distance regulation for Xenon lamps. The LD Didactic training system includes an a u t o m a t i c / d y n a m i c lighting-distance regulation system for compensating changes in lighting distance that would otherwise occur when the chassis' front-to-rear level is altered. This system also includes integrated acceleration/braking simulation (switchable). The system acquires sensor input data from: ▪ level signals on the front and rear axles as well as from ▪ the speed signal. These input signals are used to generate ▪ actuator output control signals for headlamp positioning motors as well as ▪ for the fault function indicator. The system has self-diagnostic capability via the K-line. By attaching a diagnose adapter (➔ 737 980) or an original workshop tester, all available measurement value blocks can be displayed and the functions: ▪ coding ▪ reset ▪ diagnose actuator and ▪ fault evaluation can be executed. The training panel is prepared for connection to an external Xenon headlight (➔ 738 1821).
Additional equipment sets on the subject of vehicle lighting with lighting-distance regulation can be found in topic area ➔ T 3.2.3.5 and on the subject of vehicle regulation technology in ➔ T 3.2.11.





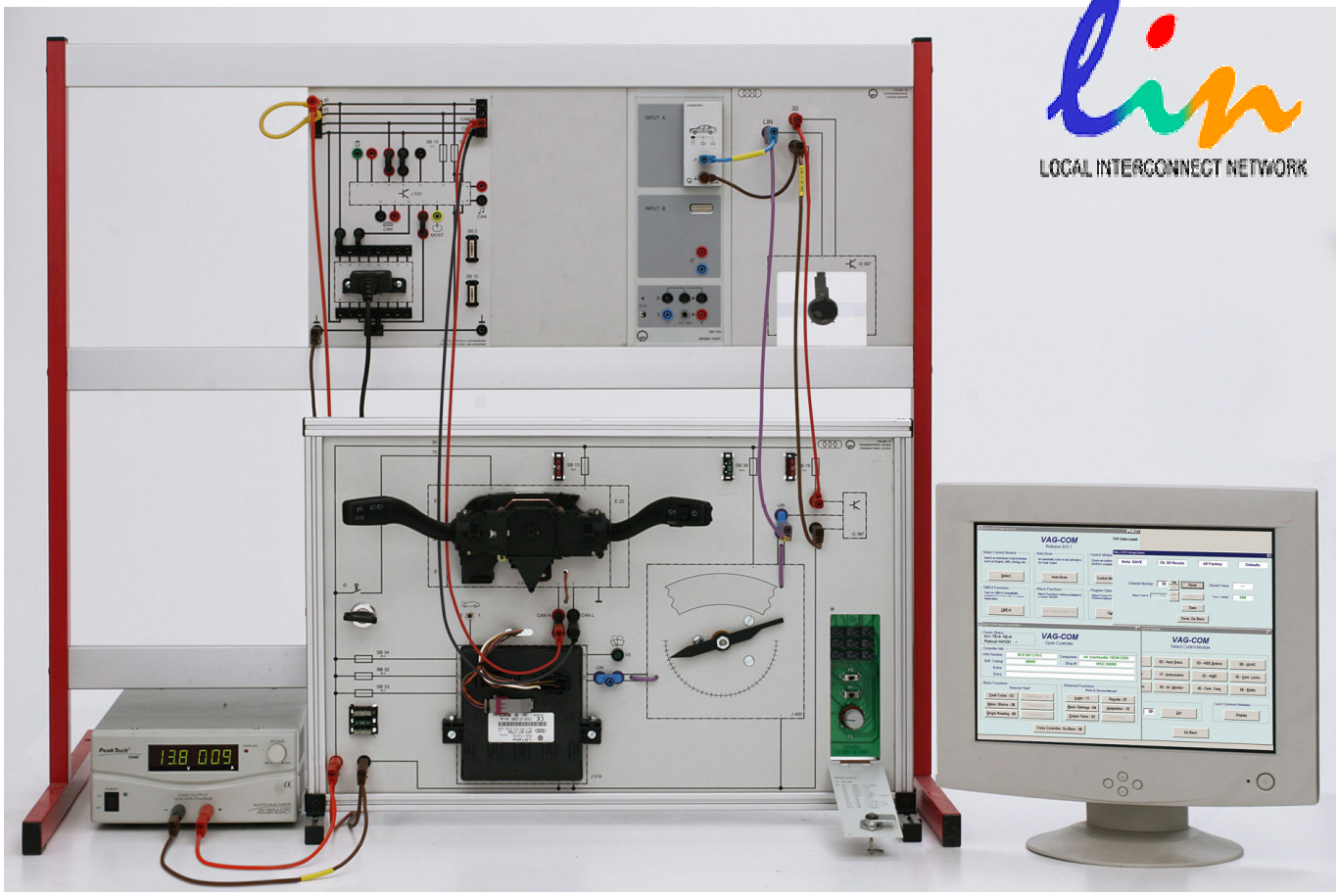
Self-diagnose with: fault memory read-out, actuator test, reset execution and display of measurement value blocks

EQUIPMENT LIST, T 3.2.12.6

Vehicle Onboard Diagnosis

QTY.	CATALOG NO.	DESIGNATION
1	738 165	Headlamp level control
1	738 975	Diagnostic Plug, 16 pin
1	737 9803	OBD Adaptor CAN+USB
(1)	738 11	Head Lamp Switch
(1)	738 1821	Xenon Headlight
1	566881EN	**Book**: Self diagnosis in vehicles

T 3.2.12 **Bus-Systems and Diagnostic**
T 3.2.12.7 Networking Automotive Systems 4 (LIN bus)



Training Objectives

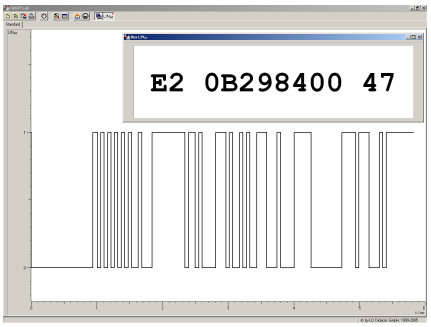
- the function of networked systems in vehicles
- the principle of CAN bus data transfer
- the principle of LIN bus data transfer
- the function of networked sensors
- controlling networked actuators
- realizing comfort functions
- automated wiper functions

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.7 Networking Automotive Systems 4 (LIN bus)

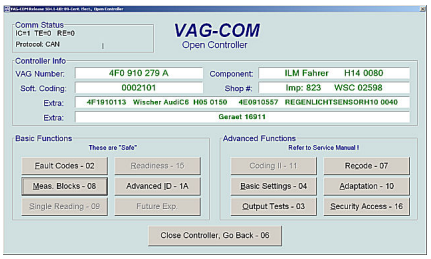
The LIN bus training system ...

... his master's voice! 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.
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 and ▪ a fault-switch box (CAN and LIN faults).
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. Using the CASSY CAN bus box (➔ 524 078) or the LIN bus box (➔ 524 081) the data protocols can be analyzed and displayed in it's hexadecimal values.
Furthermore, adding the CAN Gateway (➔ 739 5861) all self diagnosis functions of the system's control units are available. Simply link an original workshop tester or LD's Vehicle diagnostic adapter CAN+USB (➔ 737 9803) to the OBD socket to access the ECUs.
The lockable fault-switch box can be used to introduce CAN and LIN faults.
Additional equipment sets on the subject of CAN data busses can be found in the topic areas ➔ T 3.2.7.5 and ➔ T 3.2.3.7 and the fundamentals of windshield wipers in ➔ T 3.2.8.4.

Picture: Deutscher Verkehrssicherheitsrat e.V., Bonn



Data protocol of LIN databus



Self diagnosis of the Central Electrics ECU

EQUIPMENT LIST, T 3.2.12.7 / T 3.2.12.7**D**

Networking Automotive Systems 4 (LIN bus)

QTY.	CATALOG NO.	DESIGNATION
1	739 586	Training panel LIN-Bus
1	301 339	Pair of stand bases
1	739 581USB	CAN bus software USB
1	739 588	LIN databus PC interface USB
1	524 013SKFZ	CASSY 2 – Starter, Automotive
1	524 081	LIN Databus box (only with CASSY 524 01SKFZ)
1	738 026	Digital Power Supply 3-15 V/40 A
		Components in () are additionally necessary to complete the set T3.2.12.7D
(1)	737 9803	Vehicle diagnostic adapter CAN+USB
(1)	739 5861	CAN Gateway
1	566882EN	**Book**: LIN databus in vehicles

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.8 Networking Automotive Systems 5 (MOST Bus)

Optical data busses

most (mōst) *adj.* **1.** Consisting of the greatest number: superlative of *many*. **2.** Consisting of the greatest amount or degree: superlative of much. ... [OE mæst, māst]

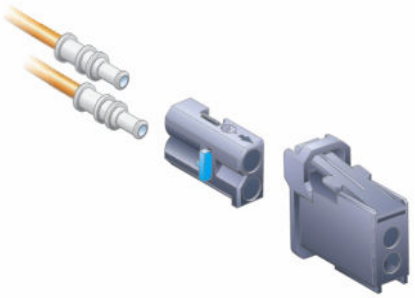
... really? No, not this time. Here MOST (=**M** edia **O** riented **S** ystems **T** ransport) designates a serial bus networking standard intended for interconnecting multimedia components in automobiles and other vehicles over an optical fiber guide.

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.8 Networking Automotive Systems 5 (MOST Bus)

NEU

Professional practical exercises

The devices and subcomponents listed here permit the student to assemble typical optical fiber guides that can be evaluated by the instructor. In contrast to the fiber-optic repair kits used in service workshop environments, this equipment set includes large quantities of all "user components" (such as fiber-optic guides, crimp sleeves and polishing mechanisms) so that these exercises can be performed by many students.



Practice-oriented exercises in making up optical wave guides

740 2081

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. Delivered in a plastic case.

740 2082

MOST Montagesatz

Accessories set for carrying out practical exercises in "Making up MOST optical wave guides"

Set consisting of:
-100 pieces POF metal inserts ①,
-50 pieces fiber optic carrier housing ②,
-50 pieces fiber optic housing ③,
-5 pieces fiber optic inline housing 2fold ④,
-6 pieces fiber optic inline housing 1fold ⑤,
-2 pieces fiber optic coupling 2fold ⑥,
-50 m POF orange,
-1 polishing aid ⑦ and
-0.2 m polishing linen (grain 600) ⑧

740 2088

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. Used in the make-up optical fibers.

740 20821

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 20711

MOST repeater TPS

MOST dual hub for displaying transmission activity, decoupling of optical signals and facility for connection/expansion of additional components in a MOST ring with option to attenuate optical performance by 3 dB. The unit is held by a bracket that can be released so it is easily relocated for experimental setups or in a real vehicle.
Connections for +12 V, ground and a status output are available. For error diagnosis, this controller can be used in place of any other control unit in a MOST ring.
Includes 4 optical wave guide couplers and 2 optical wave guides pre-assembled with connector housings.

T 3.2.12 **Bus-Systems and Diagnostic**
T 3.2.12.8 Networking Automotive Systems 5 (MOST Bus)

Training Objectives

- ➔ the function of networked systems in vehicles
- ➔ the principle of MOST bus ring data transfer
- ➔ making up optical wave guides
- ➔ incorporating system enhancements
- ➔ implementing multimedia functions
- ➔ use of self-diagnosis
- ➔ upgrading wireless signal transmission systems
- ➔ CAN data bus measurement techniques
- ➔ working with CAN bus error images

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.8 Networking Automotive Systems 5 (MOST Bus)

The MOST-bus training system **LOW**

The starter system from LD Didactic takes advantage of the MOST-bus to communicate audio and diagnostic signals at a rate of 21.2 MBit/s. The setup is comprised of ▪ monochrome display ▪ central control unit for information ▪ radio ▪ amplifier ▪ CD player ▪ operator unit ▪ gateway with driving privilege system ▪ antenna and ▪ loudspeakers.
The control unit for information is connected to the gateway over optical wave guides, optionally the MOST signal can be communicated by way of the MOST transceiver (➔ 578 486) plug-in component to allow examination of the electrically equivalent bus signal with an oscilloscope. The optical wave guides are connected with Plexiglas couplers so that faulty plug-in connections can be simulated easily. Incoming and outgoing light can also be observed during ring priming (wake-up), data transfer and ring-break diagnosis. The ring-break diagnostic signal is accessible at all connected MOST devices. Self-diagnosis with an appropriate diagnostic unit (e.g. ➔ 737 980 2/3) can be carried out over the gateway.
The quality of the optical ring can be investigated with 3 dB of attenuation introduced by the MOST repeater (➔ 740 2071). Furthermore, the incorporation of supplementary sets can be practiced with the available optional devices MOST DAB tuner or MOST Bluetooth™ telephone setup. Practical exercises (➔ 740 208 1/2) in making up optical wave guides and MOST plug-in contacts round out the system.

MOST PC interface USB, 740 2013, for connecting the MOST ring to a PC and on an oscilloscope (with MOST address display)

Set of 6 CAN bus fault plugs 739 5858

Digital antenna 739 743 for DAB radio

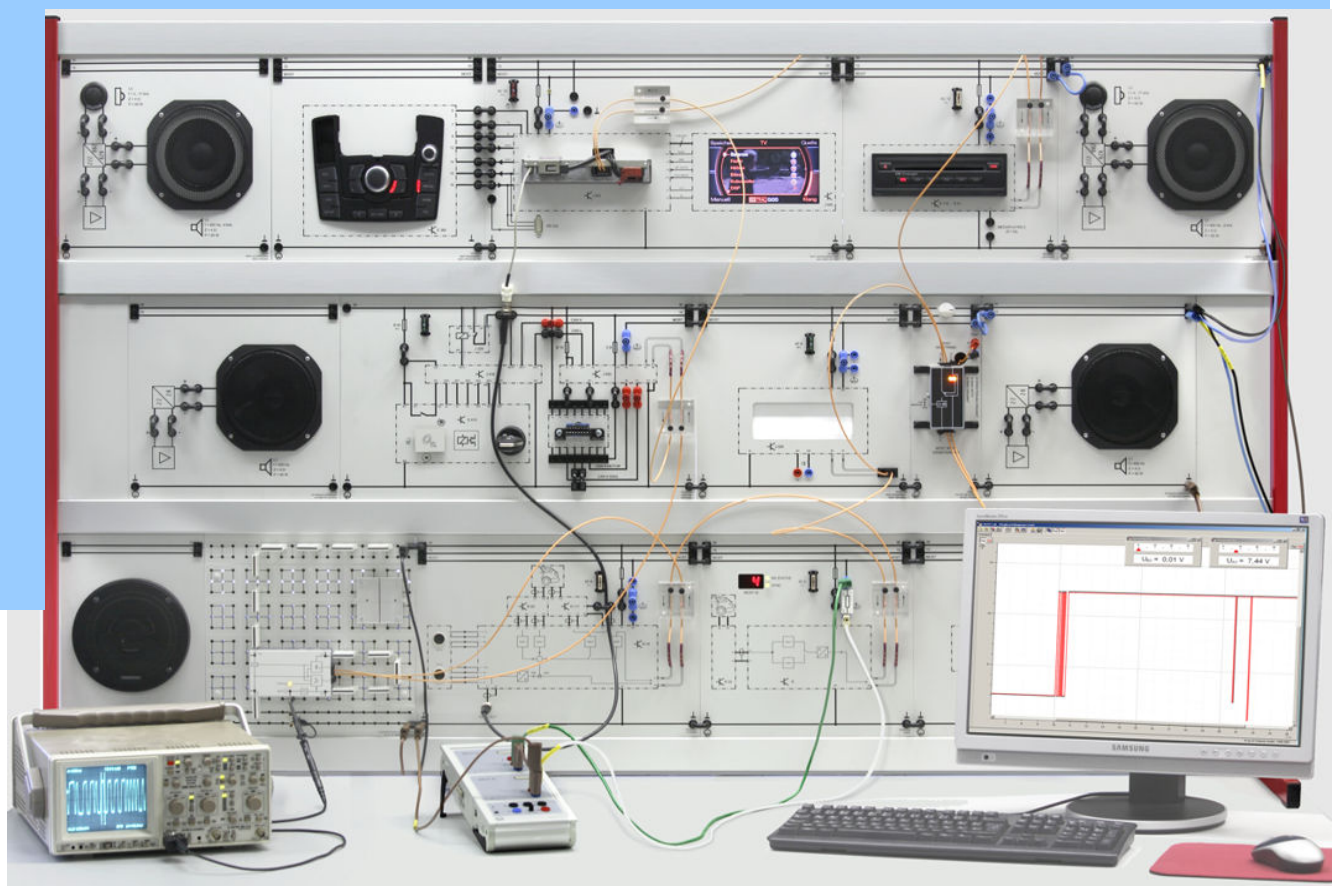
EQUIPMENT LIST, T 3.2.12.8L

Networking Automotive Systems 5 (MOST Bus) “Basic-Line”

QTY.	CATALOG NO.	DESIGNATION	
1	740 2010	MOST System Low	
1	524 013SKFZ	CASSY 2 – Starter, Automotive	
1	738 02	Automotive power supply 13.8 V/36 A	1
2	739 731	Broad Band Loudspeaker	
(1)	740 20711	MOST repeater TPS	
1	737 9803	OBD Adaptor CAN+USB	
	Optional system extensions:		
(1)	740 2012-08	MOST BT Phone preparation	
(1)	740 2014	MOST DAB* radio	
(1)	739 743	Digital antenna	
	Investigations on the CAN databus:		
1	524 078	CAN-Bus-Box *(CASSY 524 013 required!)*	
(1)	739 581USB	CAN-Bus software USB	
(1)	739 587	Software: CAN bus visualisation *(739 581USB required!)*	
(1)	739 5858	Set of 6 CAN Bus Fault Plugs	
(1)	740 2084	MOST POF 0.75 m with connector	
(1)	740 2085	MOST POF 1.5 m with connector	

* Only available regionally, more information in the Internet at www.worlddab.org

T 3.2.12 **Bus-Systems and Diagnostic**
T 3.2.12.8 Networking Automotive Systems 5 (MOST Bus)



Training Objectives

- ➔ the function of networked systems in vehicles
- ➔ the principle of MOST bus ring data transfer
- ➔ MOST communication with address assignment
- ➔ MOST protocol analysis
- ➔ use of self-diagnosis
- ➔ performing ring-break diagnosis
- ➔ upgrading wireless signal transmission systems
- ➔ antenna diversity and reception characteristics
- ➔ CAN data bus measurement techniques
- ➔ working with CAN bus error images

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.8 Networking Automotive Systems 5 (MOST Bus)

The MOST-bus training system HIGH ...

... the highlight in optical data communications for networked vehicle systems!
This equipment set consists of ▪ color display ▪ central control unit for information ▪ radio ▪ audio amplifier ▪ 6-fold CD changer ▪ operator unit ▪ gateway with FBS ▪ hybrid TV tuner (analog and digital*) ▪ Bluetooth™ cell phone setup and ▪ two broadband loudspeakers.
All devices are interconnected with optical wave guides; ring expansions – with or without the MOST repeater (➔ 740 2071) – and this can be accomplished with great flexibility. The radio comes equipped with a digital MOST address display as well as a ring-status display.
The 6-channel audio amplifier (sound package) and the cell phone setup are equipped with original optical wave guide sockets in the front plate for use in practical exercises. In conjunction with a Bluetooth™-capable cell phone, calls can be made and taken by way of the integrated hands-free car kit.

Audio/Video data transfer in MOST ring

Telephone connection via Bluetooth™

TV reception in vehicle multimedia systems

Other features:

- investigations of RS232 data transfer between operating unit and head unit
- connection of external TV or radio antennae for reception improvement inside buildings
- connections are available for external audio/video devices (e. g. DVD player, rearview camera)
- rear socket for simulation of CAN errors
- can be enhanced with additional components (e.g. DAB* tuner)
- errors on the optical wave guide can be simulated at any point with optical couplers
- the ring-break diagnostic signal can be recorded with differentiation between request (by the gateway) and response (by individual control devices)

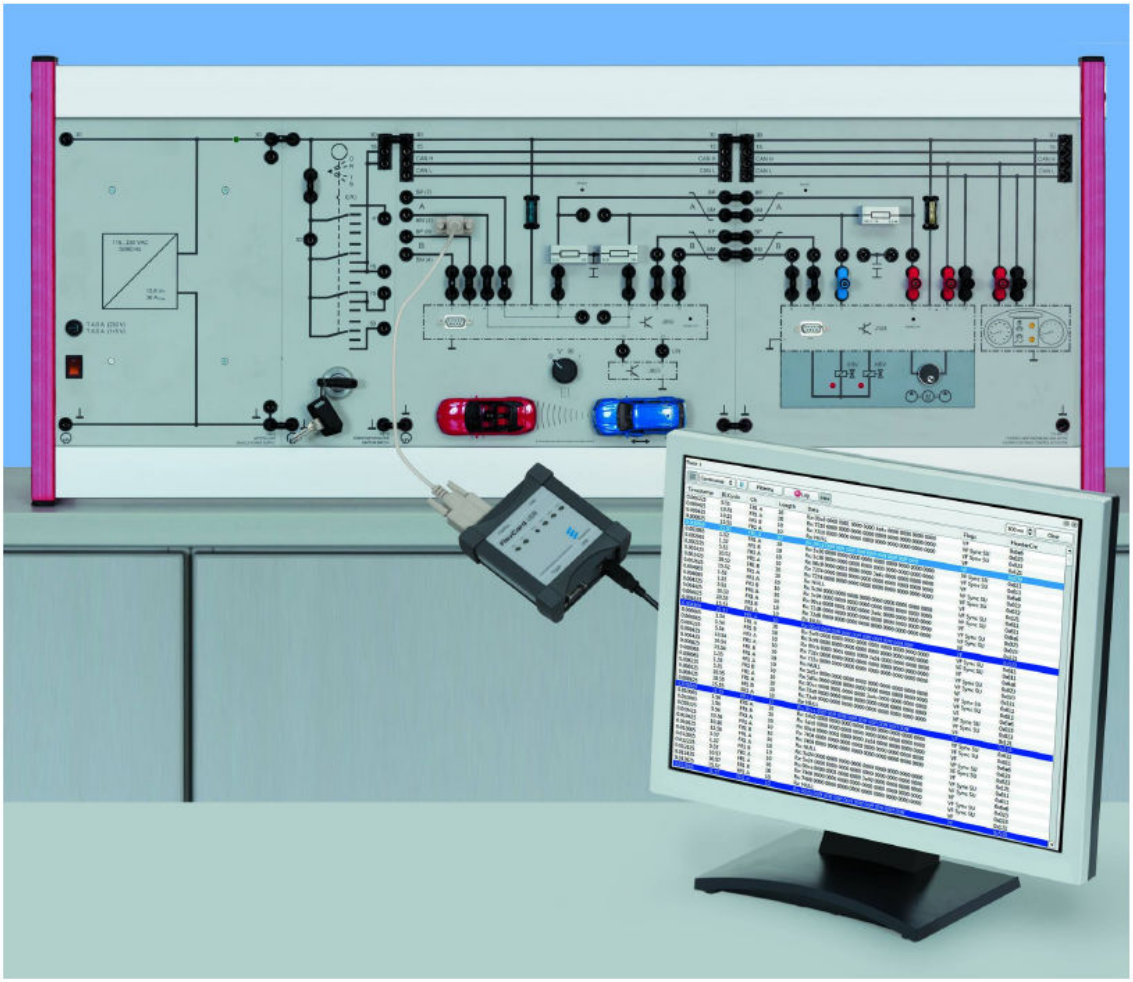
EQUIPMENT LIST, T 3.2.12.8

Networking Automotive Systems 5 (MOST Bus)

QTY.	CATALOG NO.	DESIGNATION
1	740 2012	MOST System High
1	737 9803	OBD Adaptor CAN+USB
1	524 013SKFZ	CASSY 2 – Starter, Automotive
1	738 02	Automotive power supply 13.8 V/36 A
1	739 7421	Short rod antenna
	Optional system extensions:	
(1)	740 2014	MOST DAB* radio
(1)	739 743	Digital antenna
(2)	739 735	MOST loudspeaker
(2)	739 736	Automotive Bass Loudspeaker
	Investigations on the CAN databus:	
1	524 078	CAN-Bus-Box *(CASSY 524 013 required!)*
1	739 581USB	CAN-Bus software USB
1	739 587	Software: CAN bus visualisation *(739 581USB required!)*
(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 connector

* Only available regionally, more information in the Internet at www.dvb.org and www.worlddab.org

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.9 Networking Automotive Systems 6 (Flexray)



Training Objectives

- ➔ the function of networked systems in vehicles
- ➔ the principle of FlexRay bus data transfer
- ➔ the function of sensors (CAN bus and LIN bus)
- ➔ controlling of networked actuators
- ➔ safety functions and driving assistance systems
- ➔ modern control units functions
- ➔ Data analysis of CAN, LIN and FlexRay signals
- ➔ Structure and safety systems of the topology

T 3.2.12 Bus-Systems and Diagnostic
T 3.2.12.9 Networking Automotive Systems 6 (Flexray)

The training system FlexRay

The training system FlexRay includes a brake assist functionality equipped with ▪ radar sensor ECU ▪ street condition sensor ▪ ABS/ESP ECU and ▪ instrument cluster.

Using two model cars the distance between two real vehicles is simulated. If the cars are too close to each other this condition is transmitted via FlexRay databus to the ABS/ESP ECU which triggers an immediate brake maneuver to increase the distance to a safe value again.
This value depends on the street's condition: dry, wet or icy which is transmitted via LIN databus to the radar sensor ECU.
The brake function is visualized via the high pressure pump and the high pressure valves and is forwarded to the instrument cluster using the Highspeed CAN databus to control the appropriate lights.

The system can be extended using the active star component (➔ 773 959). Additionally, there is a connector for the FlexRay/USB Adaptor (➔ 773 960) for protocol analysis using the computer.

The FlexRay wires can be connected to external plug-in resistors and they are prepared for oscilloscope data recording.

960

EQUIPMENT LIST, T 3.2.12.9

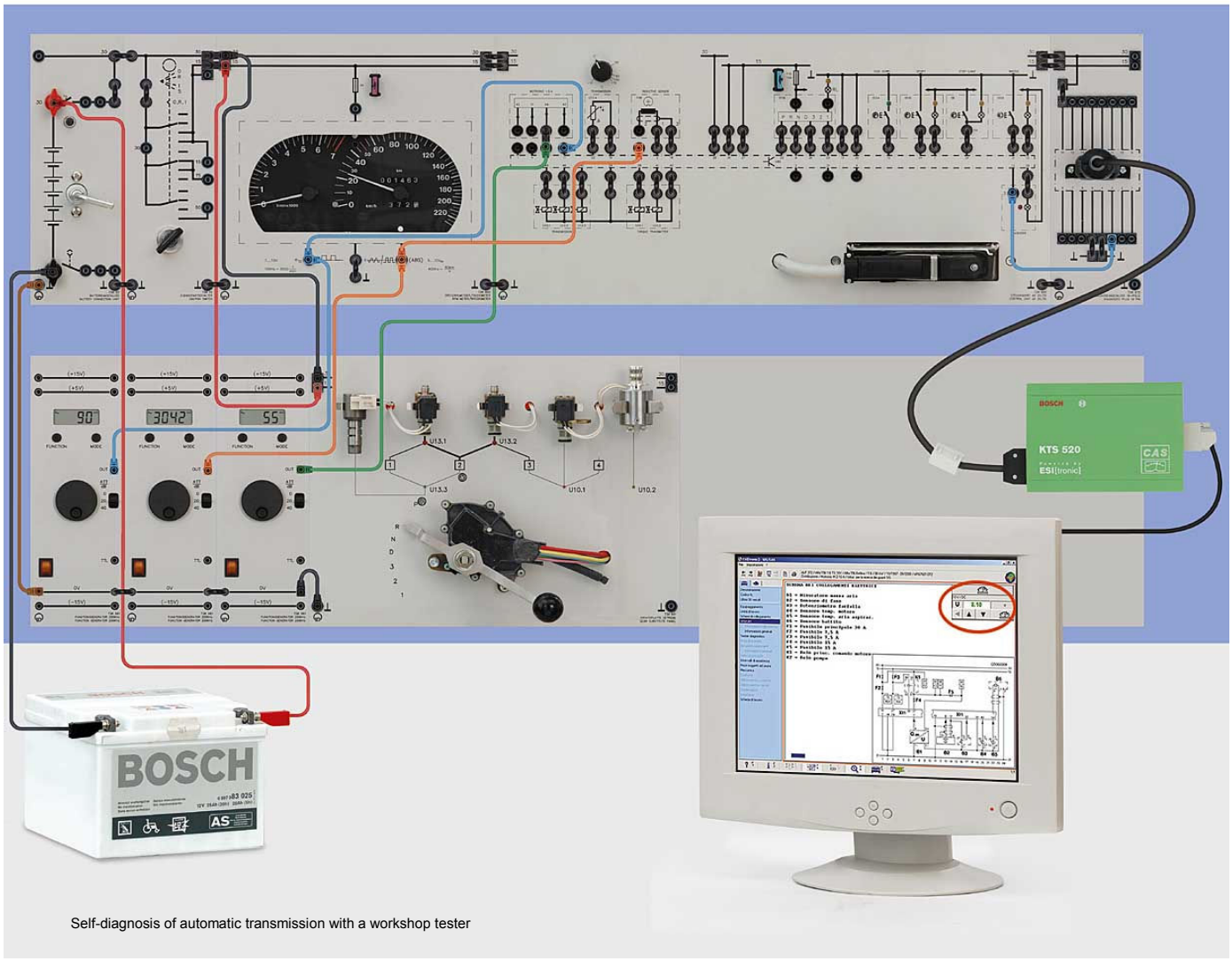
Networking Automotive Systems 6 (FlexRay)

QTY.	CATALOG NO.	DESIGNATION
1	773 958	FlexRay distance control
(1)	773 959	FlexRay active star
1	773 960	FlexRay interface USB
1	738 02	Automotive power supply 13.8 V/36 A
1	738 10	Ignition Switch
3	500 59	Set of 10 safety bridging plugs, black
1	500 592	Set of 10 Safety Bridging Plugs with Tap, black
(1)	739 581USB	CAN bus software USB
(1)	739 588	LIN BUS PC interface USB
(1)	739 587	Software: CAN bus visualisation (in combination with 739 581USB!)
2	577 321	STE Resistor 120 Ohm, 0.5 W
4	577 30	STE Resistor 62 Ohm
1	575 298	Digital Storage Oscilloscope 150 MHz
2	575 231	Probe 100 MHz, 1:1 / 10:1

T 3.2.13 Electronically Controlled Power Train and Running Gear Systems

T 3.2.13.1 Automatic Transmission Systems

T 3.2.13.2 Steering Booster



Self-diagnosis of automatic transmission with a workshop tester

Training Objectives

- function of an automatic transmission
- drive-gear selection
- the "kick-start" principle
- the gear-shift lever's function
- purpose and control of valves
- dynamic adaptation of power steering
- using the self-diagnose function

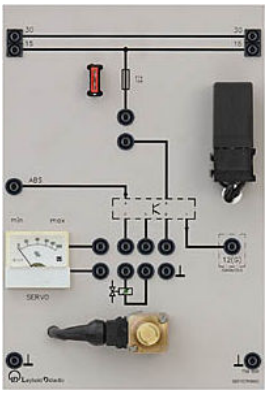
T 3.2.13 Electronically Controlled Power Train and Running Gear Systems

T 3.2.13.1 Automatic Transmission Systems

T 3.2.13.2 Steering Booster

Convenience in the car

In the USA it has been a virtual standard for many years, in Germany it is just now becoming popular – the automatic transmission. This training system is equipped with a 4-speed automatic control that consists of a control unit and a gear substitute panel. Connections for sensors and activators are located on the panel's rear side. The control unit is capable of operational modes: ▪ economy ▪ sport ▪ winter and ▪ kick-down. The gear substitute panel has a drive-select lever as well as magnetic valves for: ▪ 1-2/3-4 switching ▪ 2-3 switching ▪ converter coupling ▪ pressure regulator and ▪ brake band.
Measurement values are recorded with Sensor-CASSY 2, the control unit can optionally be connected to additional student test stations (➔ 740 050 and ➔ 740 059).



Servotronic, 739 500

The control unit for speed-dependent power steering operates a magnetic valve as a function of speed. The slower the vehicle is moving, the greater power steering assistance will be.

➔ Both control units are capable of self-diagnosis: the self-diagnose function can be activated with an appropriate diagnostic tester via the diagnose interface.
➔ Both systems can be used individually, i.e. as free-standing complete systems, or as an expansions to the "LH-Motronik" (➔ T 3.2.5.10) equipment set.

EQUIPMENT LIST, T 3.2.13.1

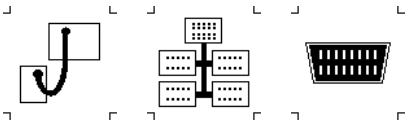
Automatic Transmission Systems

QTY.	CATALOG NO.	DESIGNATION
1	739 600	Control Unit AR 25/35
1	739 601	Gear Substitute Panel
1	739 602	Tachometer/Speedometer
1	524 013SKFZ	CASSY 2 – Starter, Automotive
1	726 961	Function Generator 200 kHz, 230 V
(1)	738 975	Diagnostic plug 16 pin
1	569 752	**Book**: Automatic Transmission T 3.2.13.1

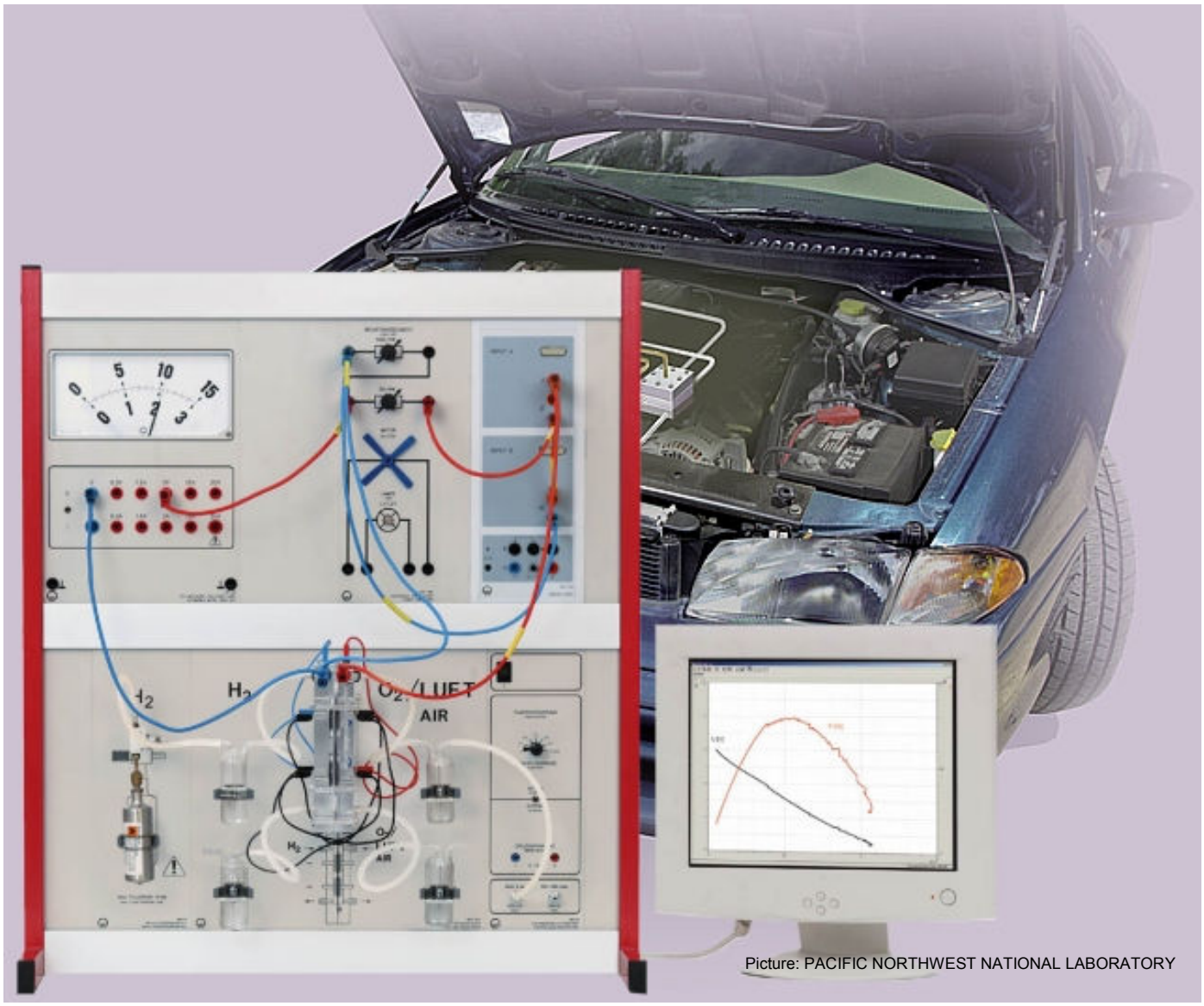
EQUIPMENT LIST, T 3.2.13.2

Steering Booster

QTY.	CATALOG NO.	DESIGNATION
1	739 500	Servotronic
1	739 602	Tachometer/Speedometer
1	738 02	Automotive power supply 13.8 V/36 A
1	524 013S	Sensor CASSY 2 – Starter
(1)	738 975	Diagnostic plug 16 pin
1	569 772	**Book**: Power-Assisted Steering (Servotronic) T 3.2.13.2



T 3.2.14 Alternative Driving Systems
T 3.2.14.1 Fuel Cell



Picture: PACIFIC NORTHWEST NATIONAL LABORATORY

Training Objectives

- ➔ fuel cell operational principle
- ➔ application potential for vehicles
- ➔ electric power generation principle
- ➔ recording fuel cell characteristic curves
- ➔ operational principle of fuel cell stacks
- ➔ the purpose of energy storage
- ➔ assessment of efficiency

T 3.2.14 Alternative Driving Systems
T 3.2.14.1 Fuel Cell

A power concept for the future?

Hydrogen and oxygen can be stored as gasses then converted into easily-used electrical energy on an as-needed basis. In vehicles, fuel cells can be used in combination with electric motors to replace the classic internal combustion engine. This process allows a direct conversion of the chemical energy into electrical energy, i.e. without any intermediate conversions.

Our experimental devices on this subject employs the new PEM fuel cell (PEM = Proton Exchange Membrane) which has already been tested in vehicles. The hydrogen (H_2) is first split into hydrogen atoms by a catalytic active electrode. After relinquishing an electron (- pole) the H^+ proton wanders through the polymer membrane to the oxygen side where it picks up an electron (+ pole) and forms water as a product:

$$O_2 + 4\ H^+ + 4\ e^-\ \ 2\ H_2O.$$

Electric drive motors require higher voltages than that produced by a single fuel cell. This is why many of these fuel cell elements must be packed together tightly into stacks and interconnected in series, similar to a battery. Each of the fuel cell elements produces about 1 V so these stacks are arranged to connect about 200 such elements. Because the resulting energy cannot be directly used immediately, a battery is necessary as an intermediate buffer. However, this buffer battery can be much smaller than in a purely battery-powered electric system.

This training system consist of: ▪ a hydrogen storage tank (metal hydride storage, content: 1 mole) ▪ a fuel cell stack with 4 individual cells ▪ an electric aeration pump for oxygen intake and ▪ an electric load unit; all packaged in the classic study panel style.

The hydrogen is taken from a refillable metal hydride container. Further details about this can be found in our catalogs for Physics, Biology and Chemistry!

Measurement value recording is performed with Sensor-CASSY 2 or with digital multi-meters. The fuel cell workstation (➔ 667 404 and ➔ 667 4041) is available for student exercises.

Additional fuel tank in the trunk of a fuel cell test car

Stack voltage and power as a function of current, recorded with CASSY

EQUIPMENT LIST, T 3.2.14.1

Fuel Cell

QTY.	CATALOG NO.	DESIGNATION
1	666 483	Electric load (CPS)
1	666 479	CPS-metal hydride reservoir (H_2)
1	666 4792	Regulating valve for metal hydride reservoir
1	666 482	CPS aeration pump, controllable
1	675 3400	Water, pure, 1 l
1	604 134	Hose bottle with dangers marking, distilled water 500 ml

T 3.2.14 Alternative Driving Systems
T 3.2.14.2 Fundamentals of hybriddrives

T 3.2.14.3 Demonstration equipment of "Parallelhybrid"
T 3.2.14.3 Workstation vehicle hybride drive

EQUIPMENT LIST, T 3.2.14.2

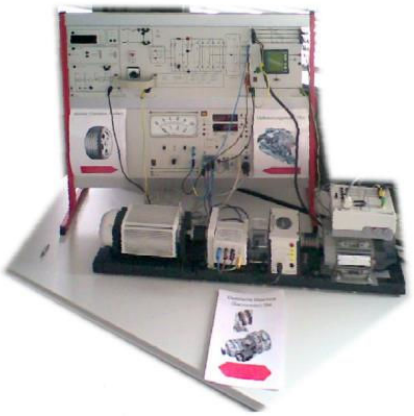
Fundamentals of hybriddrives

QTY.	CATALOG NO.	DESIGNATION
1	563 04	Storage tray for ELM apparatus
3	563 11	ELM Coil with 250 turns
1	563 16	Allen wrench
1	563 17	ELM Centering disc
1	563 18	ELM Brush holder
1	563 19	ELM Magnet rotor
1	563 28	ELM Magnetic needle rotor
1	727 81	Basic machine unit
1	727 88	Driving unit
1	563 101	ELM Wide pole piece
3	563 13	ELM Brush
3	563 22	ELM Two-pole rotor

EQUIPMENT LIST, T 3.2.14.3

Demonstration equipment of "Parallelhybrid"

QTY.	CATALOG NO.	DESIGNATION
1	731 096	Commutation Pick-Up 0.1/0.3
1	731 994	AC Servo Motor 0.3
1	735 292	Contr. Unit Block Commutation
1	735 297	Universal Converter 3X230V
1	727 230USB	Multifunctional measuring instrument
1	732 46	Motor with FCC 0.3
1	731 989USB	Electrical machine test system 300 W

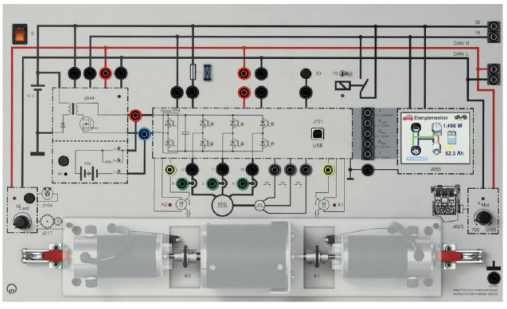


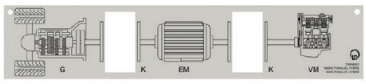
"Parallelhybrid" workstation for student experiments

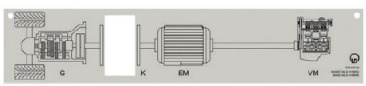
EQUIPMENT LIST, T 3.2.14.4

Workstation vehicle hybride drive

QTY.	CATALOG NO.	DESIGNATION
1	739 940	Workstation vehicle hybride drive
(1)	524 013SKFZ	CASSY 2 – Starter, Automotive

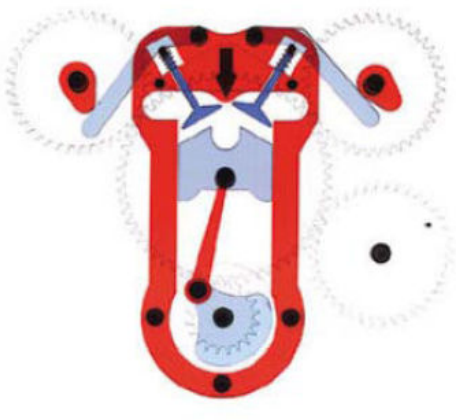




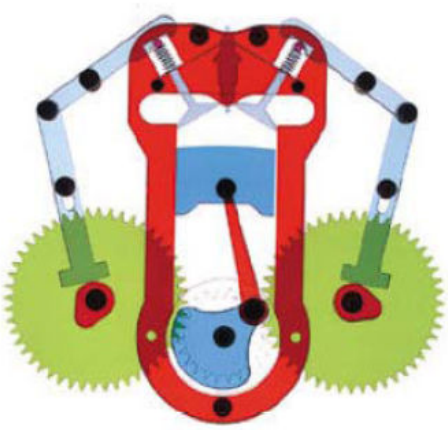


T 3.2.17 Models

T 3.2.17.1 Overhead Models
T 3.2.17.4 Function Models



Diesel engine



Four-stroke engine

Additional to the Overhead Models, we offer cutaway models of different components of Audi engine.

Roost

Sport differential

EQUIPMENT LIST, T 3.2.17.4

Function Models

QTY.	CATALOG NO.	DESIGNATION
1	773 806	Cutaway Intake Manifold module
1	773 807	Cutaway sport differential
1	773 808	Cutaway transfer case
1	773 809	Cutaway oil pump
1	773 810	Cutaway camshaft

T 3.2.17 Models
T 3.2.17.2 Cutaway Models
T 3.2.17.3 Ignition Model

Function models are available to supplement instruction with classroom demonstrations.

Two-stroke engine

Four-stroke engine

Diesel engine

➔ Other overhead, cutaway, and function models on request!

EQUIPMENT LIST, T 3.2.17.1

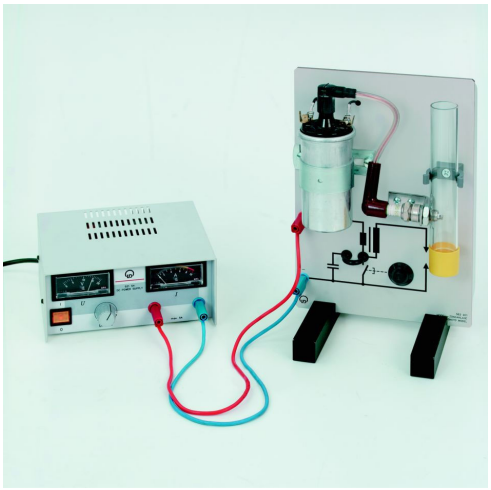
Overhead Models

CATALOG NO.	DESIGNATION
388 512	Four-stroke engine, transparent
388 552	Diesel engine, transparent
388 562	Rotary piston engine,transparent
388 542	Two-stroke engine, transparent

EQUIPMENT LIST, T 3.2.17.2

Cutaway Models

CATALOG NO.	DESIGNATION
388 51	Model of a four-stroke engine
388 55	Model of a four-stroke diesel engine
388 54	Model of a two-stroke engine



EQUIPMENT LIST, T 3.2.17.3

Ignition Model

CATALOG NO.	DESIGNATION
562 901	Model Ignition System

T 3.2.90 Upgrading vehicle systems
T 3.2.90.1 Electrical systems

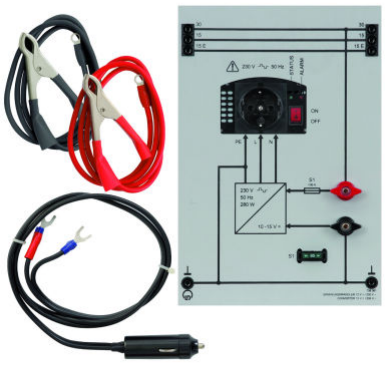
The 230 V outlet

Scenario: A motor vehicle is simply part of everyday life for today's licensed driver. Numerous vehicle drivers have a natural desire to use conventional mobile devices and entertainment units, even when they are underway. Because of this, many car manufacturers already offer an option for a 230 V outlet in their car and truck models. Alternatively, there are many solutions offered on the aftermarket that provide 230 V power by way of connection to the 12 V cigarette lighter socket.

This situation presents the vehicle mechatronic with a whole new set of tasks and challenges.
Should the vehicle mechatronic be allowed to make changes to such equipment? Can they make repairs to this equipment? Are there safety regulations to be observed?

These questions, as well as the technology, are treated in detail in this training field.
▪ What is an inverter ▪ and how does it operate? ▪ What human safety factors are involved? ▪ What kind of faults can occur and how are they diagnosed and eliminated?

738 06 cigarette lighter and 12 V on-board outlet



738 061 converter 12 V=/230 V ~

EQUIPMENT LIST, T 3.2.90.1

Electrical systems

QTY.	CATALOG NO.	DESIGNATION
1	738 06	12 V on-board socket
1	738 061	Inverter 12/230 V
1	502 05	Measuring junction box
1	505 27	Lamp 220 V / 40 W
1	729 13	Lamp Socket E27
(1)	524 013SKFZ	CASSY 2 – Starter, Automotive

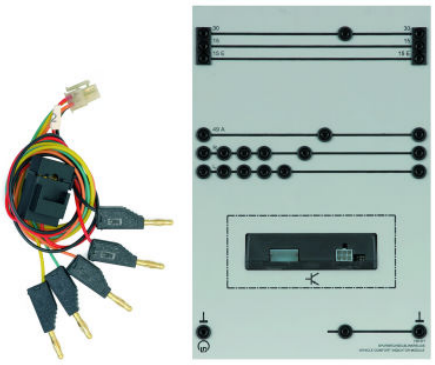
T 3.2.90 Upgrading vehicle systems
T 3.2.90.2 Comfort systems

Comfort turn-signals – just a touch is enough

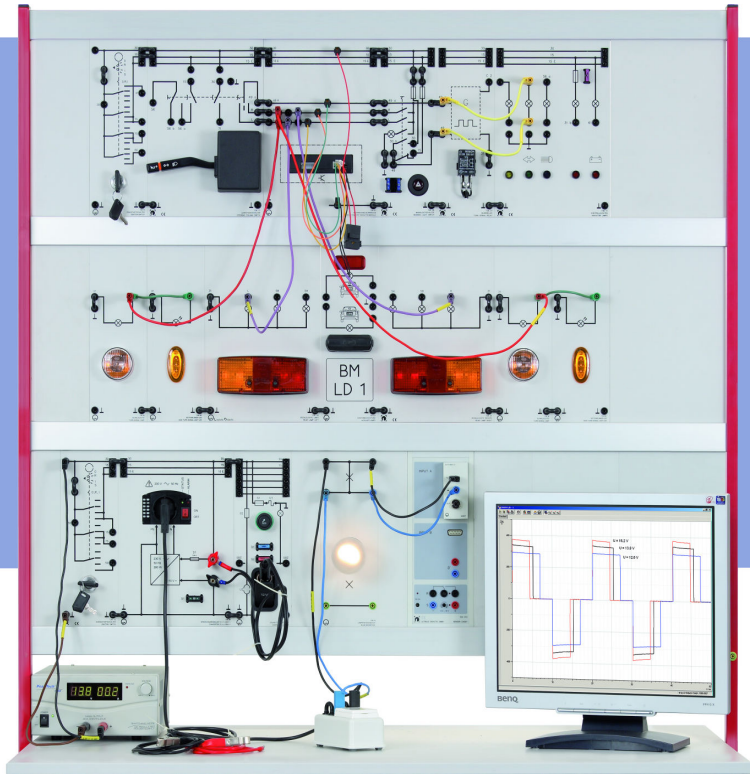
This is really a convenience during passing maneuvers. Pulling out to the left and returning to the right should be clearly indicated with multiple blinks as required by road traffic regulations. This warns the vehicles following sufficiently and the passing driver can concentrate fully on traffic conditions. This "multi-blink function" is a comfort detail that many, especially older, standard vehicles do not have and can only become through an upgrade.
The upgrade is examined closely in a practice-oriented manner by this subject material.

- How are the existing direction indicators connected?
- How should the schematic diagram in the operating instructions be read?
- How does this apply to the vehicle?
- Where should the upgrade module be connected?
- The module doesn't work – why?

A relationship to real-world practice is maintained by working with the original operating instructions and an original cable harness. This system is ideally suited as a supplement to existing lighting systems in section ➔ T 3.2.3.2.



Comfort turn-signal blinker as upgrade



Automatic comfort-blink relay and
inverter in experimental setup (measurement with CASSY)

EQUIPMENT LIST, T 3.2.90.2

Comfort systems

QTY.	CATALOG NO.	DESIGNATION
1	738 371	Automotive 1 tip/3 flash relay
(1)	524 013SKFZ	CASSY 2 – Starter, Automotive

T 3.2.91 Workshop praxis

EQUIPMENT LIST, T 3.2.90.2

Workshop praxis

QTY.	CATALOG NO.	DESIGNATION
1	747 800	Tool set spark plug
1	738 441	Spark plug holder

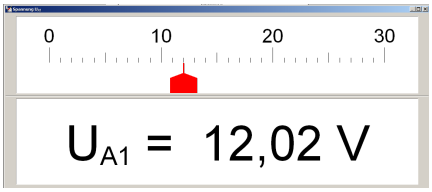
VEHICLE TECHNOLOGY SYSTEM

Computer aided Measurements and Evaluations in Vehicles

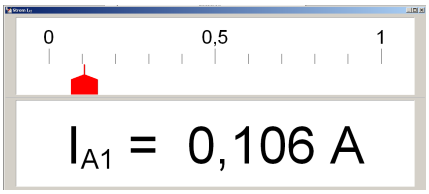
CASSY®, the didactic vehicle tester for classroom training

Sensor-CASSY 2 - Starter **524 013S** offers two galvanic isolated voltage and sensor-box inputs as well as an alternative current input with selectable measurement ranges. The adjustable voltage source eliminates the need for a separate power supply in many applications. The powerful relay is handy for many other experiments.

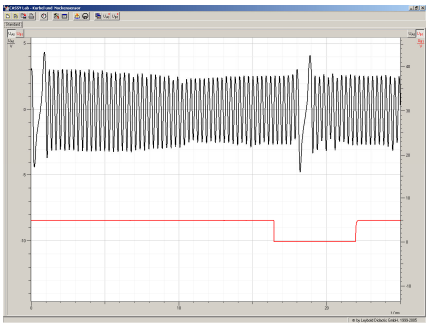
CASSY® as voltmeter:



CASSY® as ammeter:



CASSY® as dual-channel oscilloscope:



plug and play
...automatic detection and configuration by CASSY® and sensor-boxes

compatible
...all CASSY® sensor boxes and sensors are fully compatible with Sensor-CASSY

flexible
...can be operated on all experimenter panel setups, function motors and original vehicles!

Computer-aided Measurements and Evaluations in Vehicles

Measurements on databusses

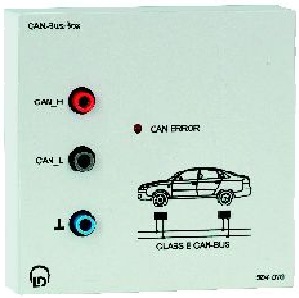
CASSY®, the didactic vehicle tester for classroom training

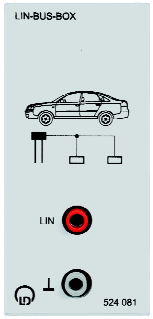
According to your needs Sensor-CASSY 2 can be extended using so called measurement boxes for measurements on non-electrical values.

EQUIPMENT LIST CASSY

Computer-aided Measurements and Evaluations in Vehicles

CATALOG NO.	DESIGNATION
524 013S	Sensor-CASSY 2 - Starter
CASSY sensor boxes	
524 031	Current Source Box
524 043	30 A box
524 044	Temperature sensor S (NTC)
524 0511	Lux Adapter S
Additonally required:	
524 0512	Optical power sensor S
524 064	Pressure sensor S, ± 2000 hPa
524 076	AUTO-BOX i
Additonally required:	
738 986	Inductive-Type Pulse Pick-Up
738 989	Standard Workshop TDC Pick-Up
524 077	AUTO-BOX Z
Additonally required:	
738 987	Capacitive-Type Pick-Up
524 078	CAN bus box
524 081	LIN bus box



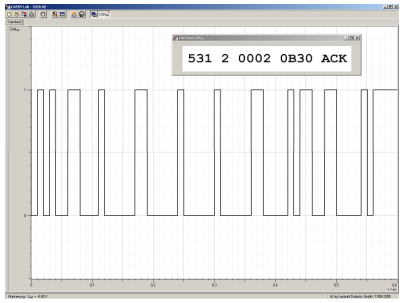


524 078

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).

Connection: 4 mm safety sockets



524 081

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.

Connection: 4 mm safety sockets

Computer-aided Measurements and Evaluations in Vehicles

524 076

AUTO-BOX i

Sensor box for connecting a vehicle trigger clip (→ 738 986) and a workshop TDC pickup (→ 738 989) to a Sensor-CASSY. The additional PWM input can be used to evaluate the pulse width and frequency of a square-wave signal or an injection signal.

Measurement ranges
- Speed: 0 ... 2000/7000 1/min
- Advance angle: -90 ... +90°KW
- Duty factor: 0 ... 100 %
- Switching time: 0 ... 100 ms
- Frequency: 0 ... 1000 Hz
- Injection time: 0 ... 20 ms

Connections
- TDC pickup: 3-pole DIN connector with bayonet lock
- Trigger clip: 3-pole DIN connector with screw-on connection
- PWM: two 4 mm banana-plug sockets

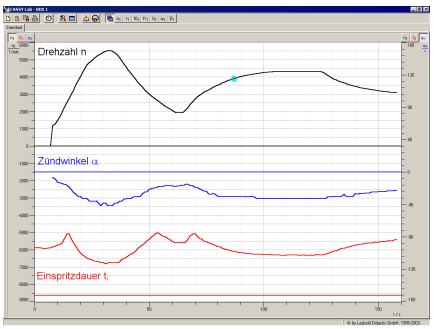
524 077

AUTO-BOX Z

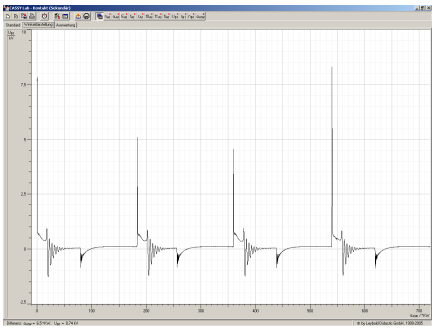
Permits the measurement of primary and secondary ignition coil voltages in vehicle ignition systems. The primary voltage is fed directly into the box via the two 4 mm banana-plug sockets, the secondary voltage is connected via a capacitive clip (→ 738 987).

Measurement ranges
- Primary voltage: -200 ... +600 V
- Secondary voltage: -2 ... +10 kV
- Contact interval: 0 ... 100 %
- Speed: 0 ... 7000 1/min

Connections
- Capacitive clip via 3-pole DIN socket with bayonet lock
- Primary voltage via two 4 mm banana-plug sockets



Speed dependency on advance angle and injection period



Secondary waveform

738 989

Workshop TDC pickup

for speed and ignition timing measurements in conjunction with an original motor tester or CASSY Auto-Box i (→ 524 076).

Connection: 5-pole plug with screw-on connector

738 987

Capacitive test probe

for connection to CASSY Auto-Box Z when measuring ignition coil secondary voltage (4 terminal).

Connection: 4-pole plug with bayonet lock

738 986

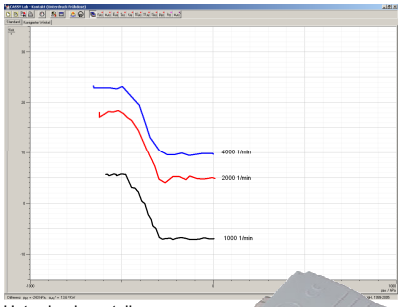
Inductive pulse pickup

for connection to CASSY Auto-Box i (→ 524 076) to trigger on cylinder 1.

Connection: 5-pole plug with bayonet lock

Computer-aided Measurements and Evaluations in Vehicles

Measuring electrical and physical values



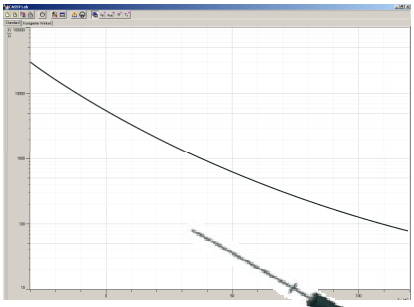
Unterdruckverstellung

524 064

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



NTC-Kennlinie eines Kühlmittelsensors

524 044

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

524 0511

Lux Adapter S

Enables the illuminance to be measured with CASSY. Depending on the sensor, the illuminance can be measured in lux or the irradiance in W/m² in various spectral ranges (UV-A, UV-B, UV-C, Vis, IR, IR-CO_2).

Measuring ranges:
100 lx, 1 klx, 10 klx, 100 klx
10 W/m², 100 W/m², 1000 W/m²
Connection: DIN socket

666 243

Lux sensor

The Lux Sensor is used for measuring illuminance. The photometer probe consists of a Si-photo element equipped with VCO-filter to match the photo element to the spectral sensitivity of the human eye. Using a dispersion lens an evaluation of cosine angles of incidence is carried out on the light incidenting on a photo-sensitive surface. The sensor is also made watertight so that it is also suitable for immersion in water samples (e.g. for measuring turbidity).

Cable length: 2 m (with 5-pole diode plug)
Dimensions: 100 mm length, 12 mm Ø
Diameter of the light-collecting surface: 10.5 mm
Measurement range: 0 ... 200 klx

524 031

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

524 043

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

524 0512

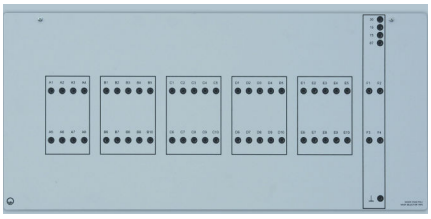
Optical power sensor S

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 CASSYLab the measuring data can be transferred comfortably in the PC, explained and evaluate.

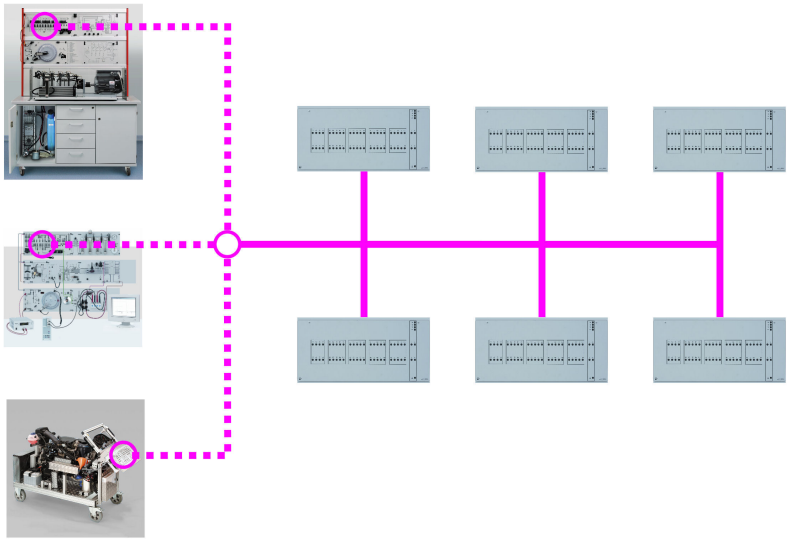
Connections: FSMA, unmanufactured fibers PMMA (2.2 mms) about provided adaptor
Wavelengths: 665, 820 nm
Measuring area absolutely:-5 ...-55 dBm
Measuring area relatively: 50...-50 dB
Resolution: 0.1 dB
Absolute exactness: 1 dB

Student measurement adaptors

Student test stations consist of a student workstation with measurement connection and an overlay mask appropriate to the experiment setup. These test stations are interconnected with one another and with the central control unit by **two** 48-pole flat ribbon cables which permit both star and series type topologies. Students can perform online recording and evaluation all of system measurement values from their own work stations. Additionally, the instructor can simulate motor-specific faults that are for subsequent analysis at the student work stations. Student test stations are reverse-decoupled from the central control unit so that students cannot create system faults. Control units in the vehicle study panel program can be optionally upgraded with interfaces. **Just ask us!**



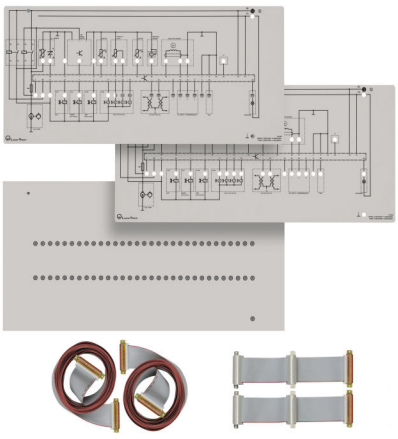
Universal adaptor



EQUIPMENTLIST STUDENT TEST STATIONS

Student measuring adaptors and masks

CATALOG NO.	DESIGNATION	FOR CAT.-NO.
740 050	Student Measuring Adaptor	
Overlay masks for panel-type control units		
740 051	Mask LU-Jetronic	739 31 + 32
740 052	Mask LH-Motronik	739 402
740 053	Mask EDC	738 961
740 0531	Mask Common Rail	740 105 / 106
740 054	Mask ABS 3-Kanal	739 622
740 057	Mask Motronik	739 40
740 058	Mask ABS 4-Kanal	739 621
740 059	Mask Automatic Gear	739 600
Universal signal distributon mask		
	Mask Universal connectos	

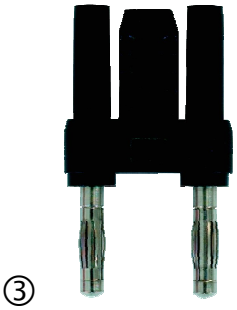


The interfaces of older model study panel control units can be upgraded!

Accessories

Accessories set

Here useful accessories can be found, which are partly already included in basic equipment sets but not mentioned separately.



LIST

ACCESSORIES

CATALOG NO	DESIGNATION	FIGURE
738 042	Battery pole-clamp set	1
738 9821	Set 51 safety experiment cables	
738 9831	Set 102 safety experiment cables	
500 990	Set of 2 adapter sockets	6
500 594	Set of 10 4 mm branching bridging plugs, blue	4
500 595	Set of 10 4 mm branching bridging plugs, red	5
500 596	Set of 10 STE safety bridging plugs, black	3
500 597	Automotive fuse measuring adaptor	7
738 021	Battery Charger, Automatic	2

Vehicle Test and Measurement Equipment

A practical education requires familiarity with the use of original vehicle test and measurement instruments. LD Didactic offers a diverse array of instruments. More detailed descriptions are provided on the following pages!

EQUIPMENT LIST, INSTRUMENTATION

Vehicle Test and Measurement Equipment

	CATALOG NO.	DESIGNATION	
	738 992	Ignition Timing Light	
	375 58	Manual vacuum and pressure pump	
	738 998	Pressure Pump, Foot-Operated	
	738 991	Automotive Voltage Tester	
	738 990	Test Lamp	
	738 9841	Automotive oscilloscope	
	739 588	LIN BUS PC interface USB	
	739 581USB	CAN - Bus Software USB	
	737 9803	OBD Adaptor CAN+USB	
	738 985	Automotive meter	
	738 999	DC/AC CLAMP ON CURRENT PROBE	x
	685 45	Battery 9 V (block)	x
	Alternatively:		
(1)	522 84	NiMH rechargeable 9.0 V battery block	

Classic analog (magnetic needle) instruments are also still in our product line for demonstration purposes.

EQUIPMENT LIST, INSTRUMENTATION

Demonstration Multi-Meter

	CATALOG NO.	DESIGNATION
	727 20	Automobile Meter Zero-Left
	727 21	Automobile Meter Zero-Center

Vehicle Test and Measurement Equipment
Motor Mechanics/Electrics

738 991

Automotive voltage tester

with cable test device; test tip and needlepoint lance mechanism on one end, alligator clip on the other end.

Features:
- Voltage range: 3 ... 48 V DC
- Indicator: 2 red LEDs for voltage and polarity
- Current draw: 1.5 mA
- Includes plastic tube
- Cable length: about 130 cm

375 58

Vacuum & pressure hand pump

mechanical air-pump with built-in release valve and dial gauge.

Features:
- Suction capacity: 36 ml/stroke
- Pressure limit: 120 mbar
- Vacuum limit: + 270 mbar
- includes plastic tube

738 998

Pressure pump, foot-operated

with dial gauge, 0 ... 6/10 bar

Vehicle Test and Measurement Equipment
Motor Mechanics/Electrics

738 992

Ignition timing light

for ignition timing testing on all gasoline motors. Bright Xenon light and alligator clips for connecting to ignition cable

727 20

Auto test instrument, zero-point left

Moving coil meter for demonstration purposes with 10 measurement ranges for DC voltage and current. Measurement range selection via marked sockets. Measurement type selection via toggle switch.

Measurement ranges:
- DC voltage: 0.3/1.5/3/15/30 V
- DC current: 0.3/1.5/3/15/30 A
- Scale length: 119 mm
- Scale divisions: 0 ... 15 and 0 ... 3
- Class 1.5
- Display field: 192 x 96 mm (W x H)
- Movement is overvoltage protected

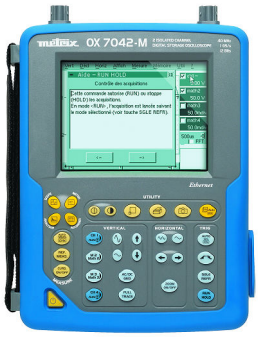
727 21

Auto test instrument, mid-point zero

Moving coil meter for demonstration purposes with 10 measurement ranges for DC voltage and current. Measurement range selection via marked sockets. Measurement type selection via toggle switch.

Measurement ranges:
- DC voltage: ± 0.3/1.5/3/15/30 V
- DC current: ± 0.3/1.5/3/15/30 A
- Scale length: 119 mm
- Scale divisions: 15 ... 0 ... 15 and 3 ... 0 ... 3
- Class 1.5
- Display field: 192 x 96 mm (W x H)
- Movement is overvoltage protected

Vehicle Test and Measurement Equipment
Vehicle Electrics



738 985

Auto workshop multimeter

Digital auto workshop multimeter with 3½ digit display, automatic ranging and enhancements for special vehicle measurements:
- speed
- temperature
- advance angle
- injection period
- Lambda regulation
- generator
- blink code

738 9841

Auto workshop multimeter

Portable 2 channel 40 MHz of workshop oscilloscope with color LCD display and touch screen 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.

Measurement ranges:
- Sampling 25 GS/s
- Input sensitivity: 2.5 mV ... 200 V/DIV
- Time base range: 1 ns ... 200 s/DIV

Features:
- Up to 7 hours of battery operation
- Safety certified per CAT III, 600 V
- Compact, robust housing

738 999

AC/DC current probe

Inductive current probe with ON/OFF switch; particularly well suited for starter experiments

Measurement ranges:
- AC/DC current: 0.3/1 kA
- AC current: 0.2/1 kA
- Lead conductor cross-section area: 31 mm^2
- Conversion ratio: 1 mV/A
- Accuracy: 1 % + 0.5 A

Vehicle Test and Measurement Equipment
Databus Signals

739 588

LIN BUS PC interface USB

Galvanically isolated adaptor to the connection with a LIN databus system (e.g., 739 586) 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 739 587 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.

739 581USB

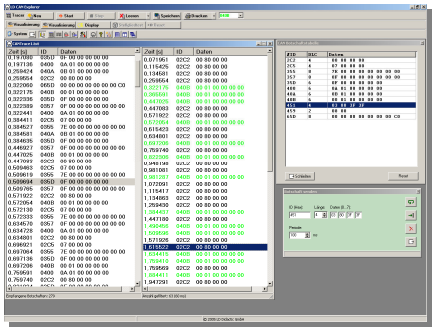
CAN bus software USB

consists of:
Software CANView (German and English)
The CANVIEW program in this package is a Windows CAN bus viewer for both high and low speed signals. It can send and receive CAN messages. CANView permits quick examination of existing networks and rapid configuration of networks.
Hardware PCAN Dongle
For connection to the PC's USB port.
The connecting cable included (9 pole Sub-D plug and 4 mm banana plugs) connect to the CAN bus system.

739 587

Software: CAN-Bus Visualisierung

Software visualization of the instrument cluster unit for the intelligent lighting management 738 111 in conjunction with CAN databus software 739581USB.
The software displays the defective lamp symbols ant the appropriate messages which normally appears on the original car's display. Furthermore, the self-diagnosis features actuator test, ECU adaptation and recoding are integrated and the control of "Coming-" and "Leaving-home" function is possible.
The CAN-Databus traffic can be recorded into a timetable (Tracing) or continuously into a table. Additionally, individual messages can be sent by the user.
Additionally the LIN databus topology of the system 739588 can be visualized and the LIN data can be displayed.



Vehicle Test and Measurement Equipment
Self-diagnosis

737 9802

Vehicle diagnosis adaptor CAN+USB

Vehicle diagnosis adaptor 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. Software license is already integrated!

Measurement technology using automotive equipment
System diagnosis

NEU

738 997

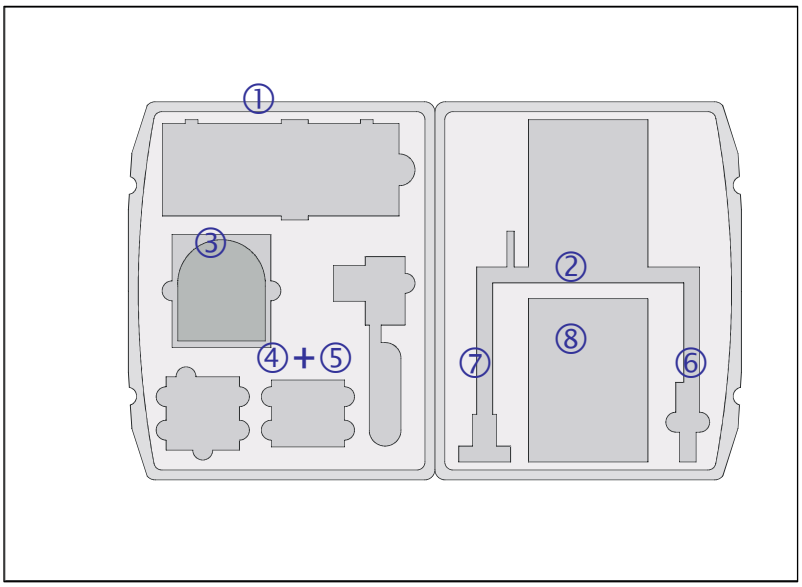
CASSY automotive measuring set

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.

Set consisting of:

1	524010USB	Sensor CASSY USB	①
1	738 062	Automotive connecting cable	②
1	524200	Software CASSYLab	③
1	524076	Auto-Box i	④
1	524077	Auto-Box Z	⑤
1	738986	Inductive pick-up	⑥
1	738987	Capacitive pick-up	⑦
1	738989	Workshop TDC pick up	⑧
1	50135	Cable red, 2 m	
1	50138	Cable black, 2 m	
2	50183	Crocodile clip	

The inlay is prepared for an additional CAN-Bus-Box, 524 078.



Inlay of the opened suitcase

Measurement technology using automotive equipment
Workshop tester

737 9806
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,Łrechargable 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.

Vehicle diagnosis
Fault simulation

LD Didactic offers a selection of study panels that can simulate errors for realistic troubleshooting. Special fault simulators are available for the fields of ignition and CAN bus. The universal vehicle fault simulator can be used for any signal line and, as a highlight, it can be activated or changed from the instructor's PC by means of a wireless remote connection. Individual addressing also allows multiple fault simulators to be remotely controlled in the classroom!

738 49

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 T 3.2.4.2, 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.

739 585

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.

738 491S

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.

500 593

Fault simulation bridging plugs

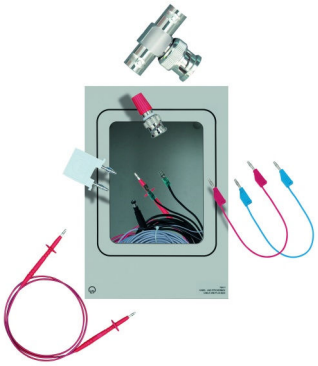
ten each 4-mm safety bridging plugs with 19 mm spacing, colour black, with 2 4-mm taps nonconducting

738 491

Automotive fault simulator

Like 738 491S but without CD-ROM and USB wireless-remote adapter (student workplace version)

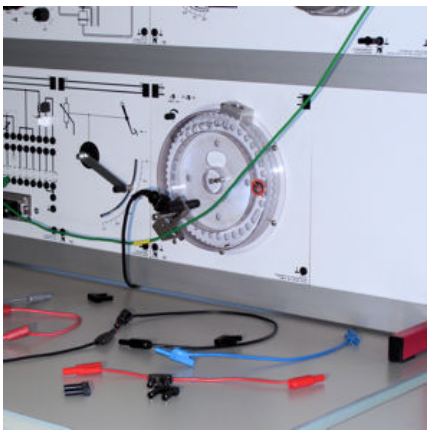
Order



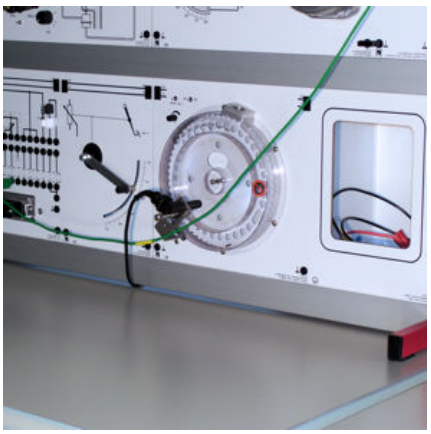
Prüll un Gedöns om Desch ? – Fott domet!

That is **Koelsch** the German dialect spoken in **Cologne** - *a Rhineland variation closely tied to Lower Rhineland and Mosel/Frankish dialects* – it roughly means: "Is there stuff laying about on the table? Get rid of it – keeping an orderly workplace is half the jo

Vorher...



... und nachher



738 01

Cable and plug box

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

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