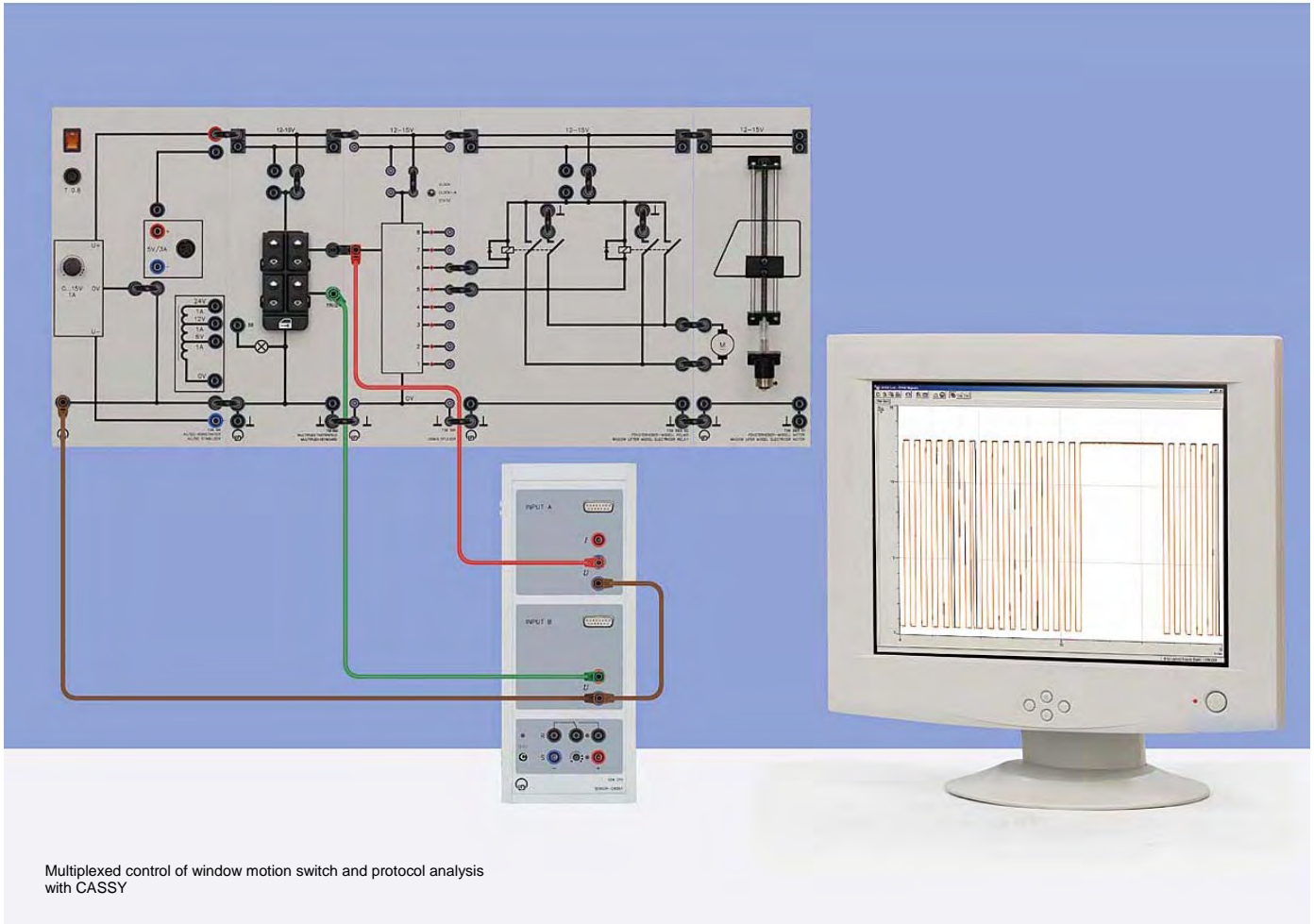


- T 3.2.12 Bus-Systems and Diagnostic**
- T 3.2.12.1 Multiplex Systems
- T 3.2.12.2 Wave Propagation on Signal Lines



Training Objectives

- ➔ digital data transfer principles
- ➔ multiplexer/demultiplexer
- ➔ signal coding
- ➔ data telegrams
- ➔ optical data transfer
- ➔ conductor terminations
- ➔ signal reflections

T 3.2.12 Bus-Systems and Diagnostic

T 3.2.12.1 Multiplex Systems

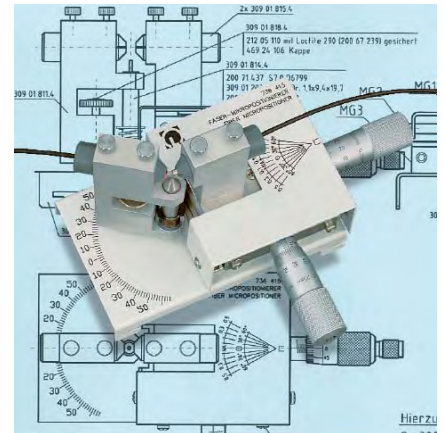
T 3.2.12.2 Wave Propagation on Signal Lines

Data transfer

Multiplexing technology, the first digital, protocol-oriented data transfer for vehicular use. Increased demands for comfort and safety led to a continuously increasing number of sensors, actuators and cables. A means had to be found to reduce the number of cables so that cost increases could be slowed down. Analog, voltage coded signaling (→ T 3.2.7.1), single-wire digital data transfer (LIN bus → T 3.2.12.7 or MOST bus → T 3.2.12.5), or two-wire transmission schemes (I²C bus → T 3.2.7.1 or CAN bus → T 3.2.7.5 and T 3.2.3.7) were the projected solutions. The LD Didactic multiplexing system offers an introduction to digital, serial data transfer. This system permits fundamental functions to be investigated and then employed into a window motion system as a practical application. The optical components included allow data transfer over fiber optic cables, thus bringing the system up to date for today's applications with high data transfer rates.

High transfer speeds can lead to signal reflections that, in worse case, could cause the true signal to be falsified; thus these must be eliminated. The "Signal distribution on conductors" training system allows these reflected signals to be made visible so that they can be investigated.

The CASSY system from LD Didactic is used to perform measurement data acquisition and evaluation of these multiplexed signals. CASSY's oscilloscope facility permits data telegrams to be recorded and interpreted.



Optical bench for investigating a fiber optic cable coupling while transmitting an optical signal

EQUIPMENT LIST, T 3.2.12.1

Multiplex Systems

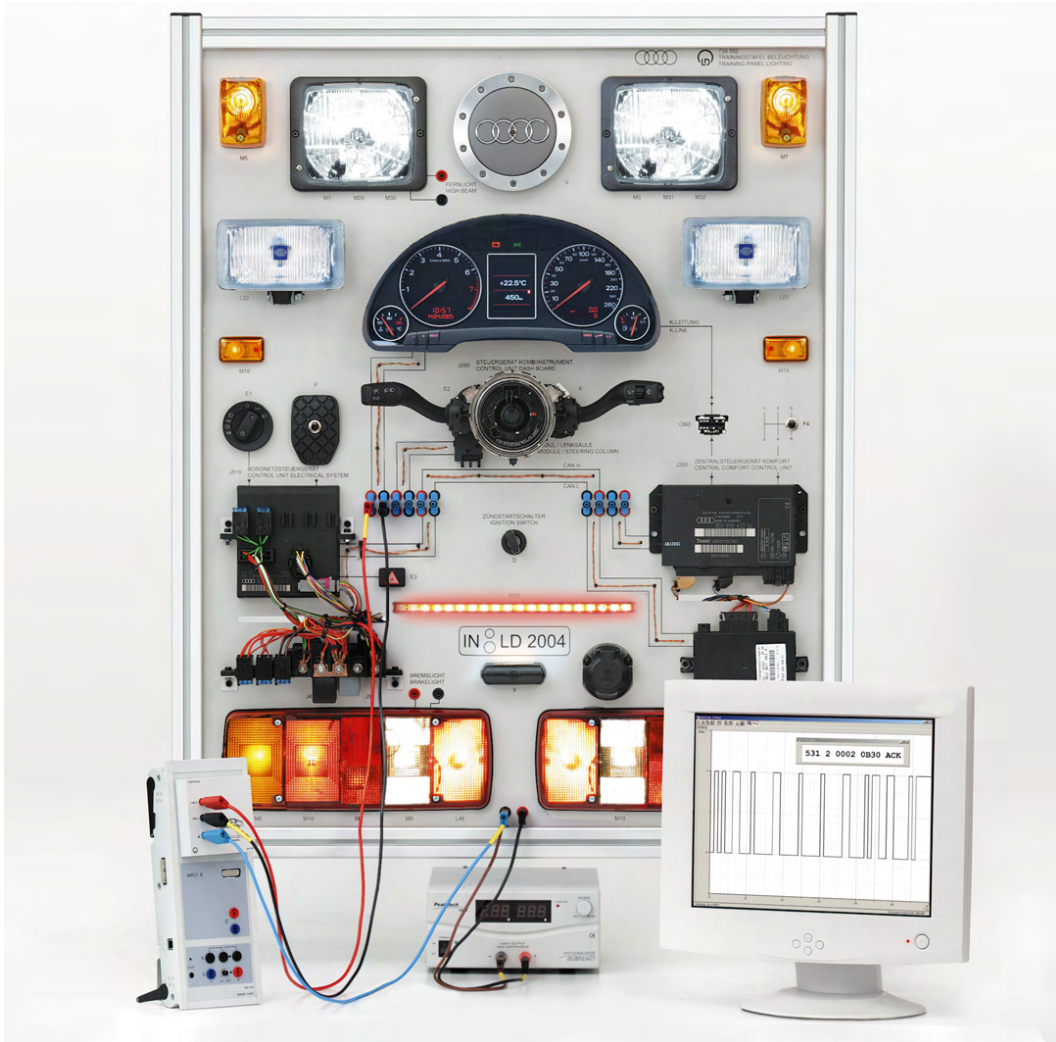
QTY.	CATALOG NO.	DESIGNATION
1	739 590	Multiplexer for Vehicles
1	739 591	Demultiplexer for Vehicles
1	739 592	Multiplex Keypad
1	739 593	Model Window Lifter
1	726 50	Plug-In Board 297 x 300 mm
1	578 73	Transistor BD 137, emitter top, NPN
1	578 612	Phototransistor for light waveguide SFH 350
1	578 615	Photodiode for light waveguide SFH 250
2	577 44	Resistor 1 kOhm, 2 W
1	577 48	Resistor 2.2 kOhm, 2 W
2	579 44	Light waveguide, 2 each
(1)	736 401	Fiber Optic Adapter
(1)	736 415	Fiber Micropositionier

EQUIPMENT LIST, T 3.2.12.2

Wave Propagation on Signal Lines

QTY.	CATALOG NO.	DESIGNATION
1	736 471	Pulse Generator
1	736 463	Coaxial Adapter
1	501 024	BNC Cable, l = 10 m
1	501 01	BNC Cable, l = 0.25 m
2	501 02	BNC Cable, l = 1 m

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 via the K line

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.

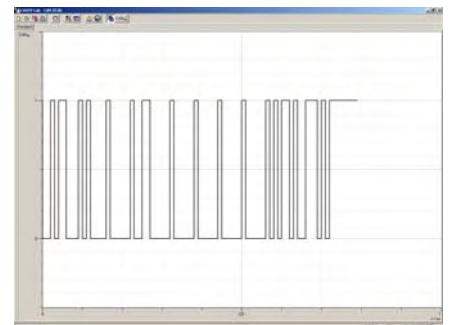
The following components are included with this training panel: ■ the light system ■ the combi instrument ■ electronic vehicle immobilizer ■ steering wheel electronics ■ a control unit for automatic trailer detection ■ a 13-pole trailer socket ■ the comfort system's central module (CAN-Bus) ■ the electronic 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 3.2.6.2!



Displaying CAN bus processes on the PC with CAN bus software

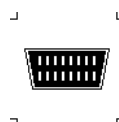


Recording a single CAN bus message with the help of CASSY box 524 078

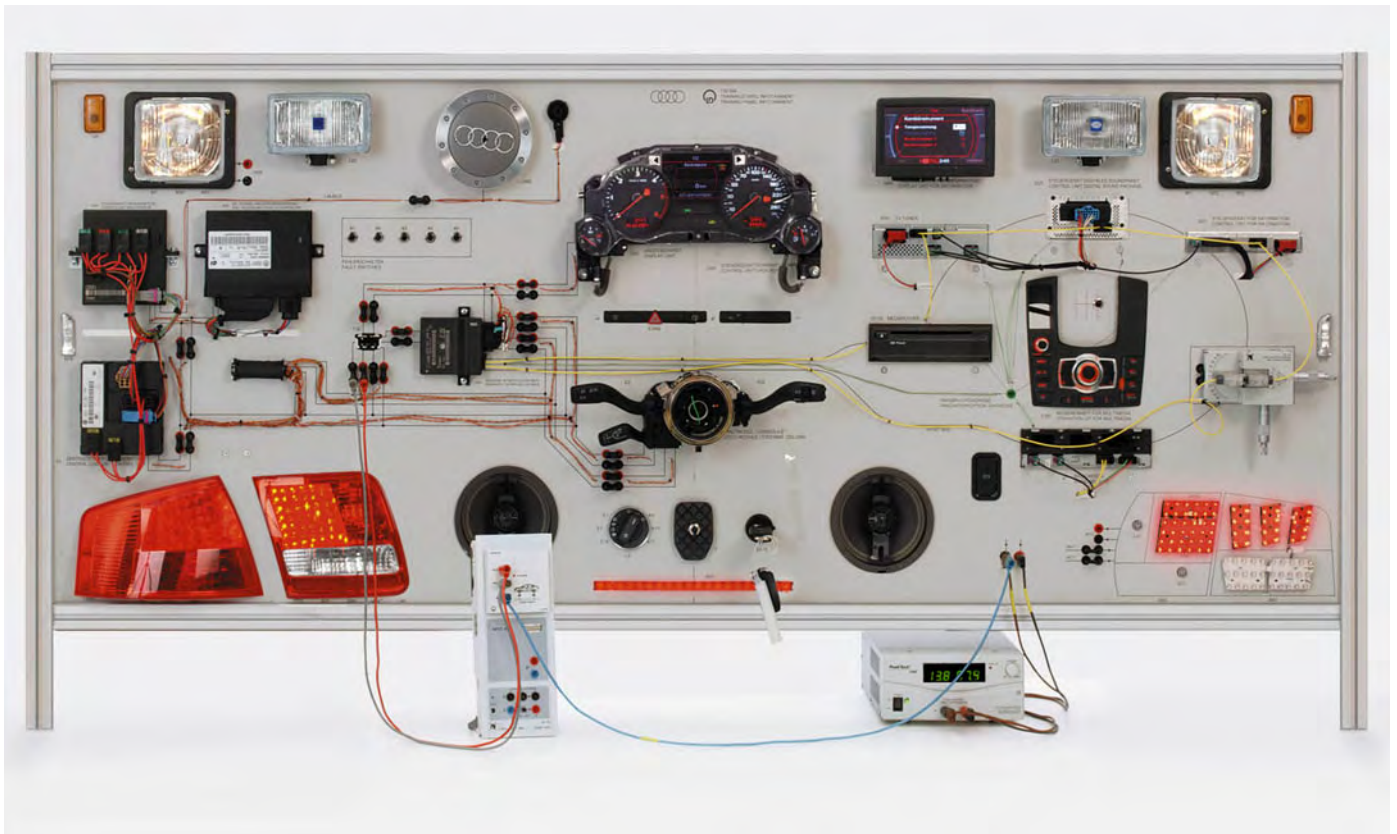
EQUIPMENT LIST, T 3.2.12.3

Networking Automotive Systems 1 (Lighting)

QTY.	CATALOG NO.	DESIGNATION
1	739 582	Automotive Training Panel Lighting
(1)	739 581USB	CAN bus software USB
(1)	737 9802	OBD Adaptor CAN+USB



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



Training Objectives

- ➔ the function of networked systems in vehicles
- ➔ the characteristics of low-speed CAN bus data transfer
- ➔ the characteristics of high-speed CAN bus data transfer
- ➔ the principle of LIN bus data transfer
- ➔ the principle of MOST bus data transfer
- ➔ ring-break diagnosis
- ➔ the function of networked sensors
- ➔ controlling networked actuators
- ➔ implementing comfort functions
- ➔ self-diagnosis via the CAN diagnostic bus

T 3.2.12 Bus-Systems and Diagnostic

T 3.2.12.5 Networking Automotive Systems 3 (Infotainment)

The infotainment training system

This training panel includes networked systems for: light management via CAN bus, windshield wiper management via LIN bus (Local Interconnect Network) as well as the infotainment packet which is networked via the MOST bus (Media Oriented Systems Transport). Aside from evaluating modern controller functions, these three bus systems can be experimentally investigated and self-diagnostics can be performed with appropriate testers. Practical skills can be gained in the handling of fiber-optic conductors with the MOST bus.

This training system includes:

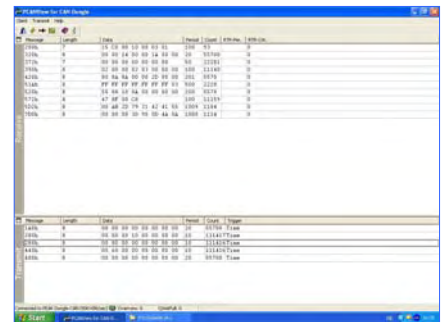
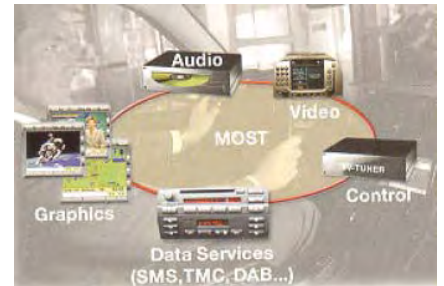
- a combi instrument and gateway
- a complete light system
- a display with control unit for information
- a multimedia operating unit
- an analog TV/radio tuner with antenna module
- a media-player, loudspeakers and display
- a windshield wiper motor with rain sensor
- LED taillights
- an OBD diagnostic socket with diagnostic bus
- a CAN bus interface
- a MOST bus interface
- a LIN bus interface and
- a fault-switch field.

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 for low-speed signals can be performed. The optical characteristics of the MOST bus' fiber optic cable can be investigated in more detail with the optical bench (→ 736 415).

The system has self-diagnostic capability via the CAN diagnose bus. By attaching a diagnose adapter or an original workshop tester, all available measurement value blocks can be displayed and the functions:

- coding
- reset
- diagnose actuator and
- fault evaluation for all incorporated control units can be executed.

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.



Recording all CAN bus messages from the comfort, motor, display and diagnose busses



Reading out the fault memory via the diagnose bus

EQUIPMENT LIST, T 3.2.12.5

Networking Automotive Systems 3 (Infotainment)

QTY.	CATALOG NO.	DESIGNATION
1	739 584	Training panel infotainment
(1)	736 415	Fiber Micropositioner
(1)	739 581USB	CAN bus software USB
(1)	737 9802	OBD Adaptor CAN+USB



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



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 automatic / dynamic 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

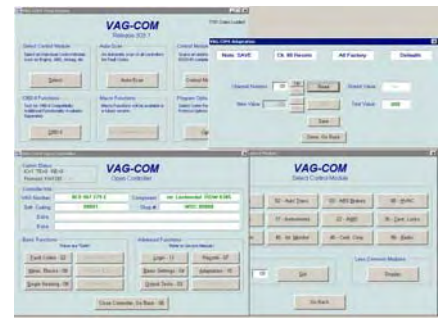
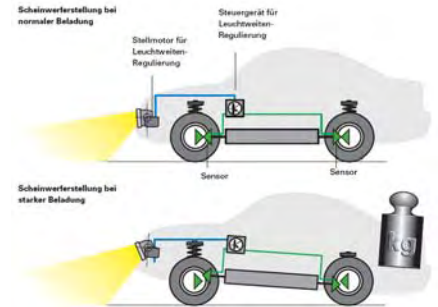
- actuator output control signals for headlamp positioning motors as well as
- for the fault function indicator.

 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 OEM Xenon headlamp.

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.

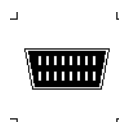


Self-diagnose with: fault memory read-out, actuator test, reset execution and display of measurement value blocks

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 9802	OBD Adaptor CAN+USB
1	738 11	Head Lamp Switch



T 3.2.12 Bus-Systems and Diagnostic

T 3.2.12.7 Networking Automotive Systems 4 (LIN bus)



Activating windshield wipers by spraying the rain sensor with water

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)

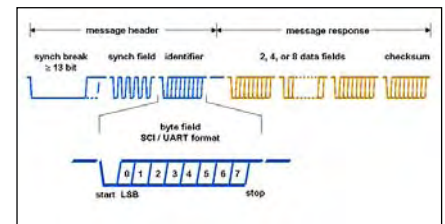
The LIN bus training system ...

... 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. 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



LIN bus data protocol

EQUIPMENT LIST, T 3.2.12.7

Networking Automotive Systems 4 (LIN bus)

QTY.	CATALOG NO.	DESIGNATION
1	739 586	Training panel LIN-Bus
1	604 2403	Photographic tray , red, 24 x 30 cm
1	604 120	Spray bottle, 500 ml, LDPE
1	301 339	Pair of stand bases
(1)	739 581USB	CAN bus software USB