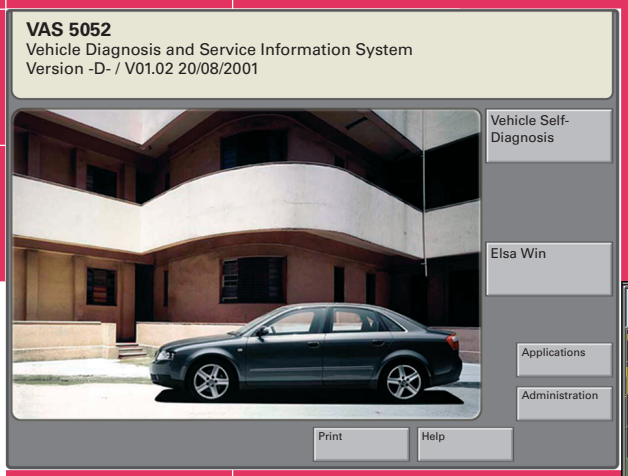
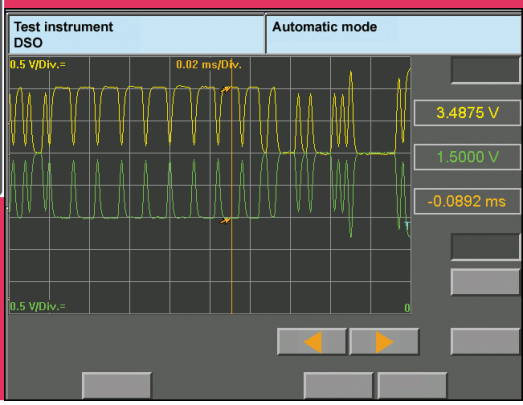
Service Training





Audi Data Bus Technologies

Course Number 971603

Audi of America, Inc.
Service Training
Printed in U.S.A.
Printed 12/2005
Course Number 971603

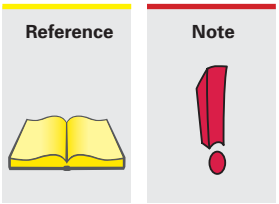
Always check Technical Bulletins and the latest electronic repair information for information that may supersede any information included in this booklet.

Table of Contents

The Self-Study Program provides introductory information regarding the design and function of new models, automotive components or technologies.

The Self-Study Program is not a Repair Manual!
All values given are intended as a guideline only and refer to the software version valid at the time of publication of the SSP.

For maintenance and repair work, always refer to the current technical literature.



Notes

Data Bus Technology

The demand for more luxury features and increased comfort in vehicles creates an ever-increasing need for more capable and more complicated vehicle electronic systems. Data bus technology makes it possible to form a complex network of electronic control modules and sensors that can communicate with each other and share data across the entire network without the size, complexity, expense and other limitations of a conventional wiring harness.

Audi's introduction of Controller Area Network or CAN data bus technology in the mid-'90s was a first, important step toward the exchange of increasing amounts of data between control modules.

The first portion of this Self-Study Program describes basic functions of CAN-bus systems in general, and goes on to cover specific functions, diagnosis and testing for Drivetrain, Convenience and Infotainment CAN bus systems.

The latter portion of this Self-Study Program describes the single wire Local Interconnect Network (LIN) data bus, Media Oriented Systems Transport (MOST) fiber-optic data bus, and wireless data transmission technology used in the latest Audi vehicles.

Purpose of a CAN-bus System

The CAN-bus system provides the following advantages as an overall system:

- Data exchange between control modules takes place on a uniform platform or *protocol,* with the CAN-bus acting as a *data highway*
- Systems involving several control modules, ESP for example, can be implemented efficiently
- System expansions and additions of optional extras are easier to implement
- CAN is an open system that permits adaptation to various data transfer media, such as copper wires or fiber-optic cables
- CAN is used for control module diagnosis, replacing the actual K-wire with a so-called *virtual* K-wire
- System-oriented diagnosis is possible across systems employing several control modules

CAN-bus Networking in Audi Vehicles

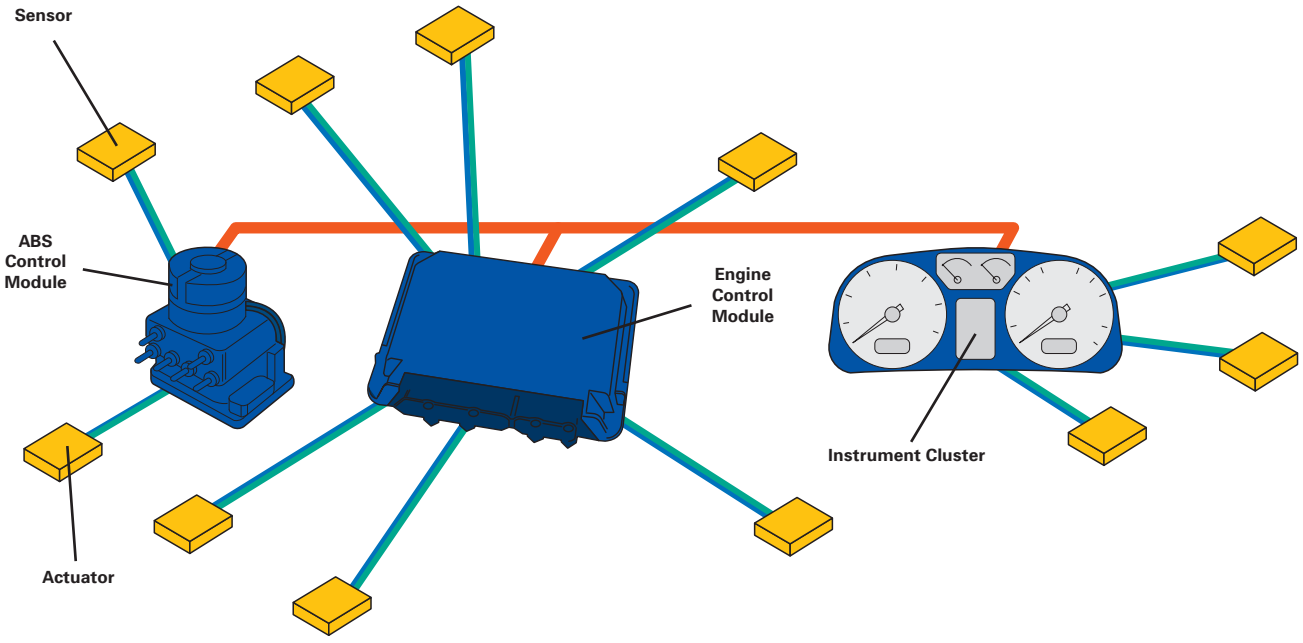
Depending on the model year, different CAN-bus systems are used in Audi vehicles.

The first, introduced in the mid-'90s, was a Convenience CAN with a data transfer rate of 62.5 kbits/s (kilobits per second). Next came a Drivetrain CAN using a data transfer rate of 500 kbits/s.

As of model year 2000, more advanced Convenience and Infotainment CAN systems have been introduced, each with a data transfer rate of 100 kbits/s. Additional types of data bus systems, introduced in model year 2004, are covered in this Self-Study Program.

The Convenience and Infotainment CAN systems exchange data with the Drivetrain CAN through the Gateway, which allows for communication between bus systems operating at different data transfer rates.

Drivetrain CAN Network with Three Control Modules



Design and Main Features

Individual electronic control modules are connected in parallel through the CAN-bus system. This results in the following requirements for the design of the overall system:

- High level of error protection: transmission interference caused by internal or external sources must be detected with a high degree of certainty
- High availability: if a control module fails, the rest of the system must continue to function as well as possible in order to continue the exchange of information
- High data density: all control modules have the same information status at all times. This means there is no difference in data between the control modules. In case of faults anywhere in the system, all the connected users can be informed with equal certainty.
- High data transmission rate: data exchange between networked users must be very fast in order to meet real-time requirements

Signals are sent over the CAN system digitally. Secure transmission is possible at rates of 1000 kbits/s (kilobits per second) or more, as seen in the latest Infotainment network. Some CAN systems are fixed at lower data transmission rates to ensure signal quality.

Practical Layout

Due to different demands with respect to the required repeat rate of the signals, the volume of data and its availability (readiness), the three CAN systems used since model year 2000 are configured as follows:

Drivetrain CAN (high speed) at 500 kbits/s networks the control modules in the drivetrain systems.

Convenience CAN (low speed) at 100 kbits/s networks the control modules in the convenience system.

Infotainment CAN (low speed) at 100 kbits/s networks the information and entertainment systems — radio, telephone and navigation, for example.

Note

Transmission rates of 1,000 kbits/s and higher are used in the latest Infotainment CAN networks, which are covered later in this Self-Study Program.

CAN-bus Overview

Common to All CAN-bus Systems:

- Systems are all subject to the same regulations for data exchange, such as the defined transfer protocol
- To assure a high degree of protection from electro-magnetic interference and prevent radiation emission, each CAN-bus is made up of entwined two-conductor wiring referred to as a *twisted pair*
- Signals to be sent are stored in the transceiver of a sending control module with different signal levels before being sent to both CAN lines. Not until the differential amplifier of the receiving control module calculates the difference of both signal levels is a single, cleaned signal sent to the CAN receiver of the control module
- First examples of the Infotainment CAN have the same properties as the Convenience CAN. In some models, they are operated through one common pair of wires (bus). In newer vehicles, we will see optical bus systems for the Infotainment network

Main Differences Between CAN-bus Systems:

- Drivetrain CAN is switched OFF by terminal 15 following an after-run period
- Convenience CAN is supplied with power through terminal 30, and must remain on standby. To prevent excessive electrical load, the system switches to *sleep mode* by switching terminal 15 OFF when it is not required
- Convenience/Infotainment CAN remains operational, thanks to the second wire, if there is a short circuit in the data bus or an open circuit in a CAN wire. In such an instance, the system will switch automatically to single wire operation
- Electrical signals from the Drivetrain CAN and Convenience/Infotainment CAN are different

Warning!

The Drivetrain CAN should never be electrically connected to the Convenience/ Infotainment CAN! The various data bus systems for Drivetrain and Convenience/ Infotainment networks should only be connected in the vehicle through the Gateway. The Gateway may be integrated with an existing control module or installed as a separate Gateway control module.

CAN-bus Components

The CAN-bus is made up of a controller, a transceiver and two data bus lines.

Apart from the data bus lines, the components are located in the electronic control modules. The main functions of the control modules are the same as before, with the following additional tasks:

CAN Controller

The CAN controller receives transfer data from a micro-computer integrated into the control module.

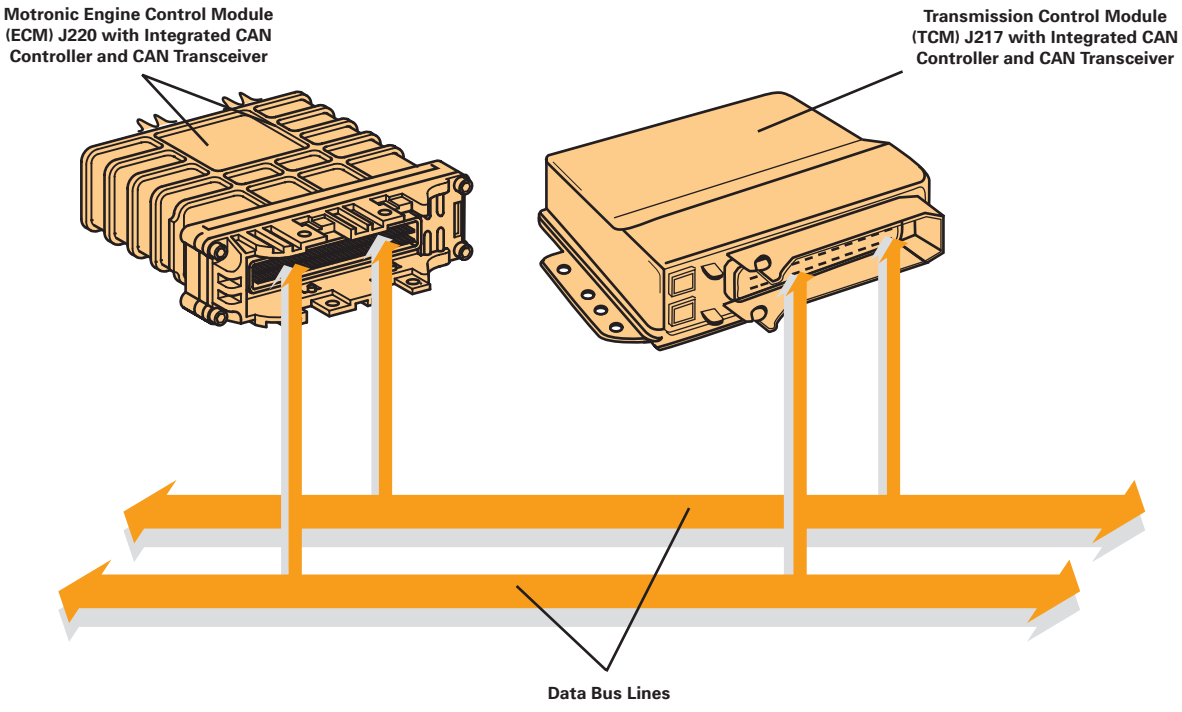
The CAN controller processes this data and relays it to the CAN transceiver. Likewise, the CAN controller receives data from the CAN transceiver, processes it, and relays it to the elctronic control module micro-computer.

CAN Transceiver

The CAN transceiver is a combined transmitter and receiver. It converts the data that the CAN controller supplies into electrical signals, sending this data over the data bus lines. Likewise, it receives data and converts this data for the CAN controller.

Data Bus Lines

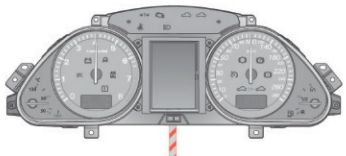
The data bus lines are bi-directional and transfer data. They are referred to as *CAN-high* and *CAN-low*.



CAN-bus Topology

A special feature of Audi's CAN-bus design is the tree-like connecting structure for the control modules. This structure allows optimal connection of the control module wiring.

The actual layout of the CAN wiring in a vehicle is referred to as CAN topology and is vehicle-specific.



Instrument Cluster Control Module J285

Distance Regulation Control Module J428

16-Pin Connector T16

Data Bus On Board Diagnostic Interface J533

NOX Sensor Control Module J583

Engine Control Module (ECM) J623

Rotation Rate Sensor G202

ABS Control Module J104

Seat Occupied Recognition Control Module J706

Airbag Control Module J234

Transmission Control Module (TCM) J217

Left Headlamp Power Output Stage J667

Right Headlamp Power Output Stage J668

Electrical Drive Main Relay J437

Electro-Mechanical Parking Brake Control Module J540

Level Control System Control Module J197

Steering Angle Sensor G85

Steering Column Electronic Systems Control Module J527

Multi-Function Steering Wheel Control Module J453

Driver's Door Control Module J386

Front Passenger's Door Control Module J387

Left Rear Door Control Module J388

Right Rear Door Control Module J389

Memory Seat/ Steering Column Adjustment Control Module J136

Passenger Memory Seat Control Module J521

Towing Recognition Control Module J345

Energy Management Control Module J644

Auxiliary Heater Control Module J364

Parking Aid Control Module J446

Vehicle Electrical System Control Module J520

Access/Start Control Module J518

Vehicle Electrical System Control Module J519

Comfort System Central Control Module J393

Climatronic Control Module J255

Tire Pressure Monitoring Control Module J502