Attenuation in optical bus

Assessment of the optical fibre condition involves measuring the attenuation.

A reduction in the power of the light waves during transmission is referred to as attenuation.

Attenuation (A) is given in decibels (dB).

A decibel is not an absolute quantity, but rather represents a ratio of two values.
This also explains why the decibel is not defined for specific physical quantities.
The decibel is also used, for example as a unit for expressing sound pressure or volume.

For attenuation measurement, this quantity is calculated from the logarithm of the ratio of transmission power to reception power.

Formula:

$$\text{Attenuation ratio (A)} = 10 * \lg \frac{\text{Transmission power}}{\text{Reception power}}$$

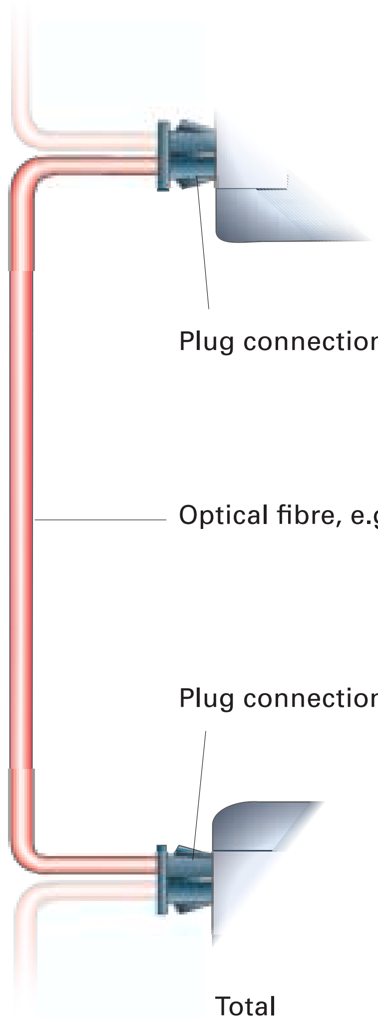
Example:

$$10 * \lg \frac{20\,\text{W}}{10\,\text{W}} = 3\,\text{dB}$$

This means that the light signal is reduced by half for an optical fibre with an attenuation ratio of 3 dB.

In other words, the higher the attenuation ratio, the poorer the signal transmission.

If several components are involved in the transmission of light signals, the attenuation ratios of the components can be added up to form a total attenuation ratio in the same way as the resistances of electrical components connected in series.



SSP286_045

As in the MOST bus each control unit re-transmits the light waves, only the total attenuation ratio between two control units is of significance.

Causes of increased attenuation in the optical data bus

1. Optical fibre bending radius too small
   Bending the optical fibre to a radius of less than 5 mm (kinking) obscures the core (comparable with bent perspex) at the bending point.
   The optical fibre has to be replaced.

2. Damage to optical fibre cladding.

3. End face scratched.

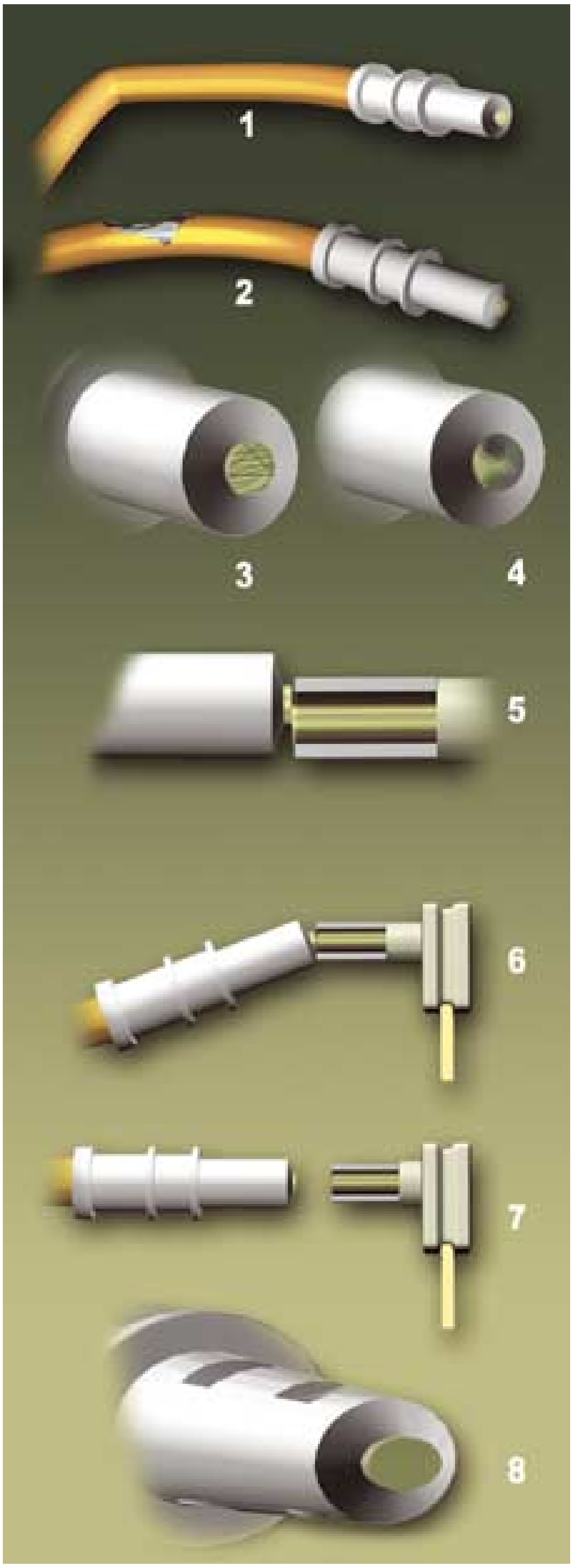
4. End face dirty.

5. End faces offset
   (connector housing broken).

6. End faces not in line
   (angle error).

7. Gap between end face of optical fibre and contact surface of control unit (connector housing broken or not engaged).

8. Ferrule not properly crimped.



SSP286_069

Optical fibre anti-kink sleeve

Fitting an anti-kink sleeve guarantees a minimum optical fibre radius of 25 mm.

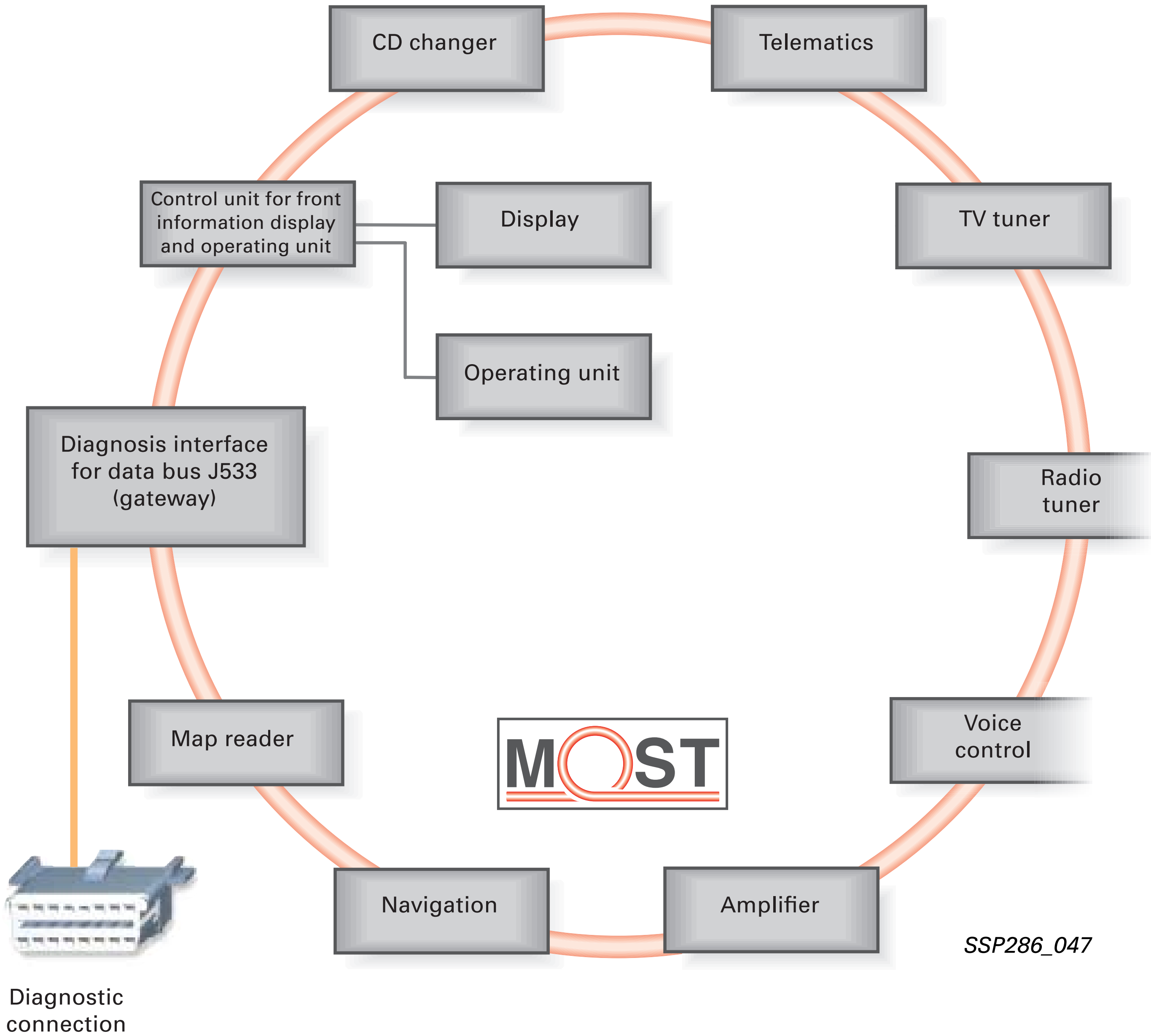
SSP286_087

Rules for handling optical fibres and their components

- Never employ thermal working and repair methods such as soldering, hot bonding or welding
- Never employ chemical and mechanical methods such as bonding and jointing
- Never twist together two optical fibre cables or an optical fibre cable and a copper wire
- Avoid cladding damage such as perforation, cutting or crushing: Do not stand or place objects on cladding, etc. when fitting in vehicle
- Avoid contaminating end face, e.g. with fluids, dust or other media; prescribed protective caps are only to be removed for connection or test purposes employing extreme care
- Avoid loops and knots when laying in vehicle; pay attention to correct length when replacing optical fibre

MOST bus

Ring configuration of MOST bus



SSP286_047

A distinguishing feature of the MOST bus system is its ring configuration.

The control units transmit data in one direction via an optical fibre to the next control unit in the ring.

This process continues until the data return to the control unit which originally transmitted them.

This completes the ring.

MOST bus system diagnosis is implemented by way of the data bus diagnosis interface and the diagnosis CAN.

System manager

Together with the diagnosis manager, the system manager is responsible for system administration in the MOST bus.

The diagnosis interface for data bus J533 (gateway) assumes the diagnosis manager functions in the Audi A8 ´03 (refer to Page 41).

The control unit for front information display and operating unit J523 implements the system manager functions.

Functions of system manager:

– Control of system statuses
– Transmission of MOST bus messages
– Management of transmission capacities

MOST bus system statuses

Sleep mode

There is no data exchange in the MOST bus. The units are switched to standby and can only be activated by an optical start pulse from the system manager.

The closed-circuit current is reduced to a minimum.

Sleep mode activation conditions:

– All control units in MOST bus system indicate readiness to switch to sleep mode.

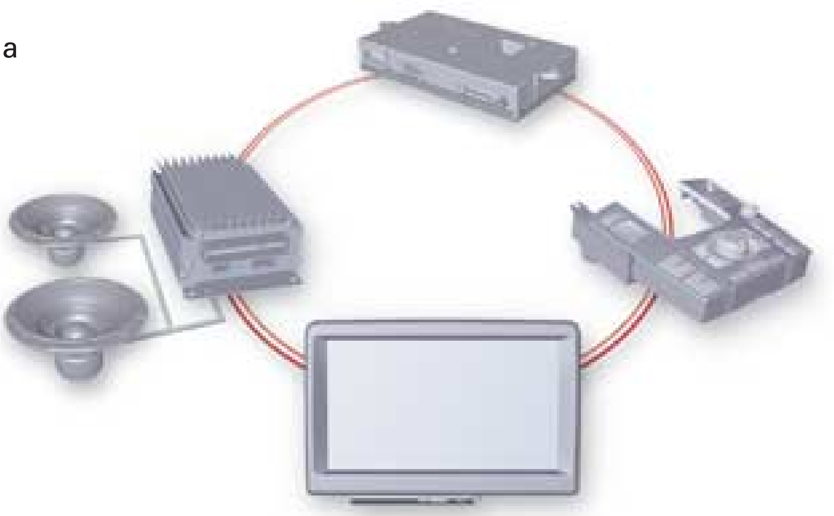
– No requests from other bus systems via the gateway.

– Diagnosis not active.

At a higher ranking level, the MOST bus system can be switched to sleep mode

– by the battery manager via the gateway in the event of starter battery discharge

– by activation of transport mode via the diagnosis tester



SSP286_066

Standby mode

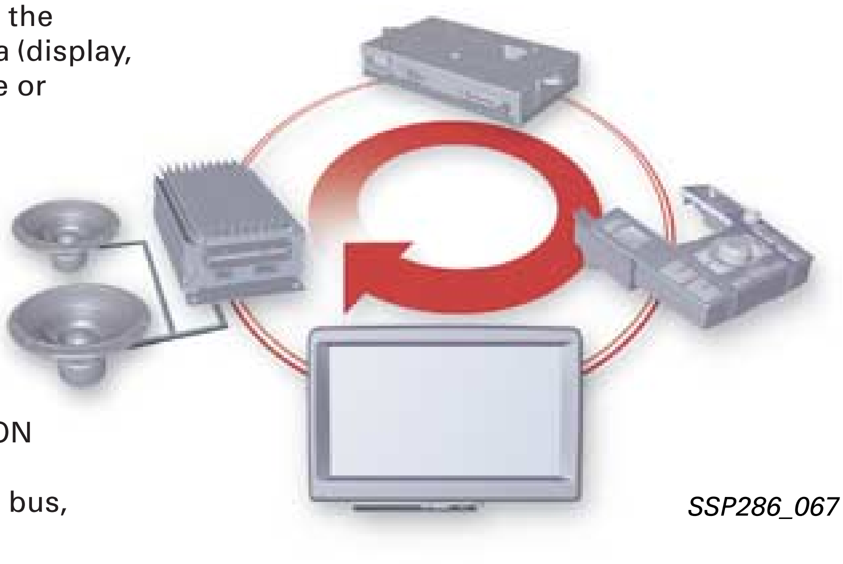
No functions are available to the user, i.e. the system gives the impression of being switched off. The MOST bus system is active in the background, however all output media (display, radio amplifier etc.) are either inactive or muted.

This mode is active on starting and during system run-on.

Activation of standby mode

– Activation by other data buses via gateway, e.g. unlocking/ opening of driver's door, ignition ON

– Activation by control unit in MOST bus, e.g. incoming call (telephone)



SSP286_067

Power ON

The control units are fully activated. Data are exchanged on the MOST bus. All functions are available to the user.

Prerequisites for Power ON mode:

– MOST bus system in standby mode

– Activation by other data buses via gateway e.g. S-contact, display active

– Activation by user function selection, e.g. via multimedia operating unit E380

Further information on system status activation can be found in the Self Study Programmes for the appropriate vehicle models.

SSP286_068

Frames

The system manager transmits the frames to the next control unit in the ring at a clock frequency of 44.1 kHz.

Clock frequency

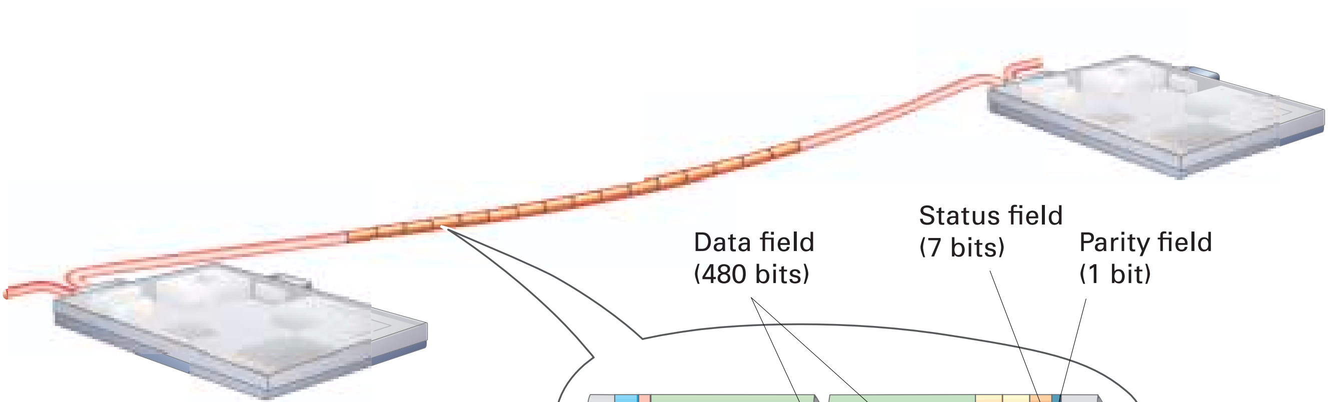
On account of the fixed time slot pattern, the clock frequency permits the transmission of synchronous data.

Synchronous data are used to carry information such as sound and moving images (video) which always has to be transmitted at the same intervals.

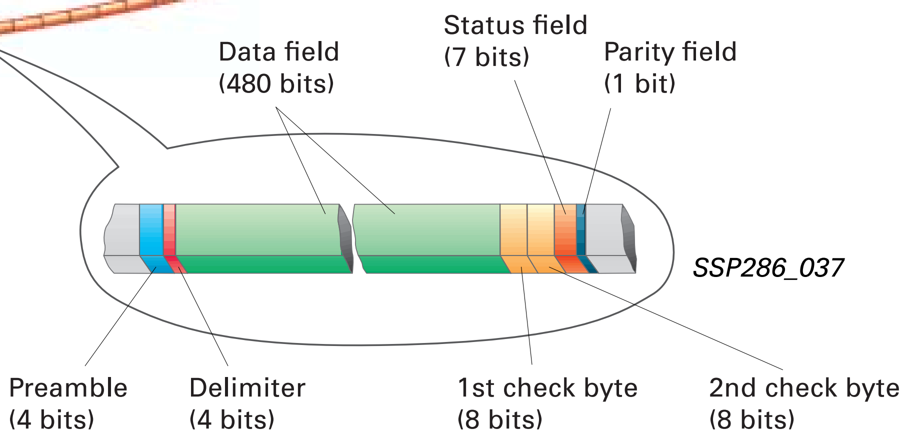
The fixed clock frequency of 44.1 kHz corresponds to the transmission frequency of digital audio units (CD, DVD player, DAB radio) and thus permits the connection of these units to the MOST bus.

The magnitude of a frame is 64 bytes, divided up as indicated below.

Structure of a frame



SSP286_036

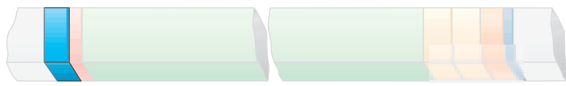


SSP286_037

1 byte corresponds to 8 bits.

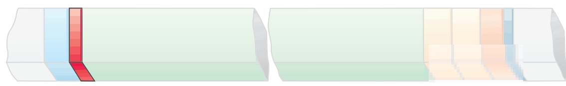
Frame areas

The **preamble** marks the start of a frame. Each frame in a block has a separate preamble.



SSP286_039

A **delimiter** creates a clear distinction between the preamble and the subsequent data fields.



SSP286_040

The **data field** is used by the MOST bus to transmit up to 60 bytes of user data to the control units.

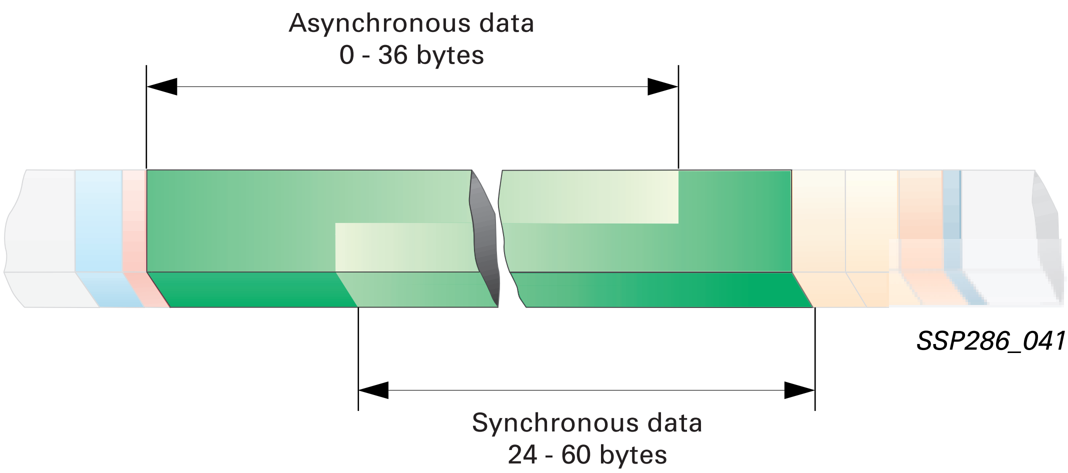
A distinction is made between two types of data:

- Audio and video in the form of synchronous data
- Images, information for calculation purposes and messages in the form of asynchronous data

The data field has a flexible structure. The proportion of synchronous data in the data field is between 24 and 60 bytes. The transmission of synchronous data has priority.

The asynchronous data are entered and thus transmitted to the receiver in packets of 4 bytes (quadlets) on the basis of the transmitter/receiver addresses (identifier) and the available asynchronous volume.

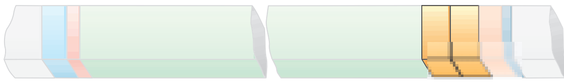
The corresponding data transfer processes are described in more detail on Page 38 onwards.



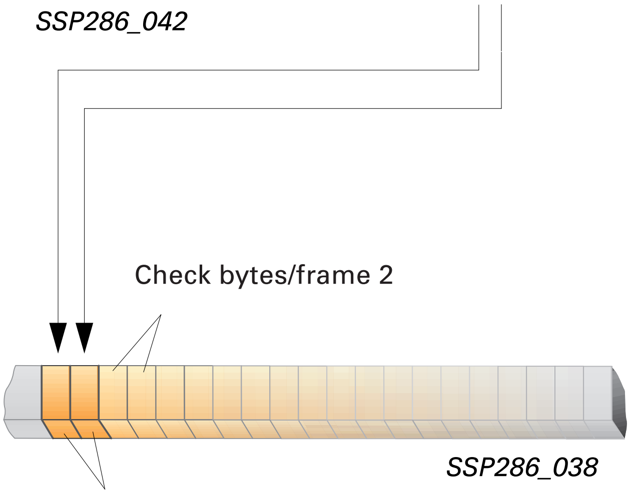
SSP286_041

The two **check bytes** are used to transmit information such as

– Transmitter and receiver address (identifier)
– Control commands to receiver (e.g. amplifier setting up/down)


SSP286_042

The block **check bytes** are assembled in the control units to form a check frame. One block consists of 16 frames. The check frame contains control and diagnosis data to be transferred from a transmitter to a receiver. This is referred to as address-oriented data transfer.



SSP286_038

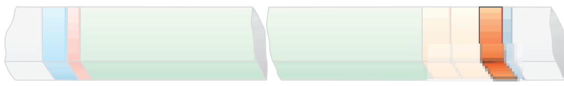
Example:

Transmitter – Control unit for front information display and operating unit

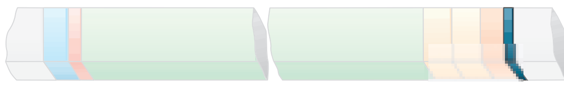
Receiver – Amplifier

Control signal – up/down

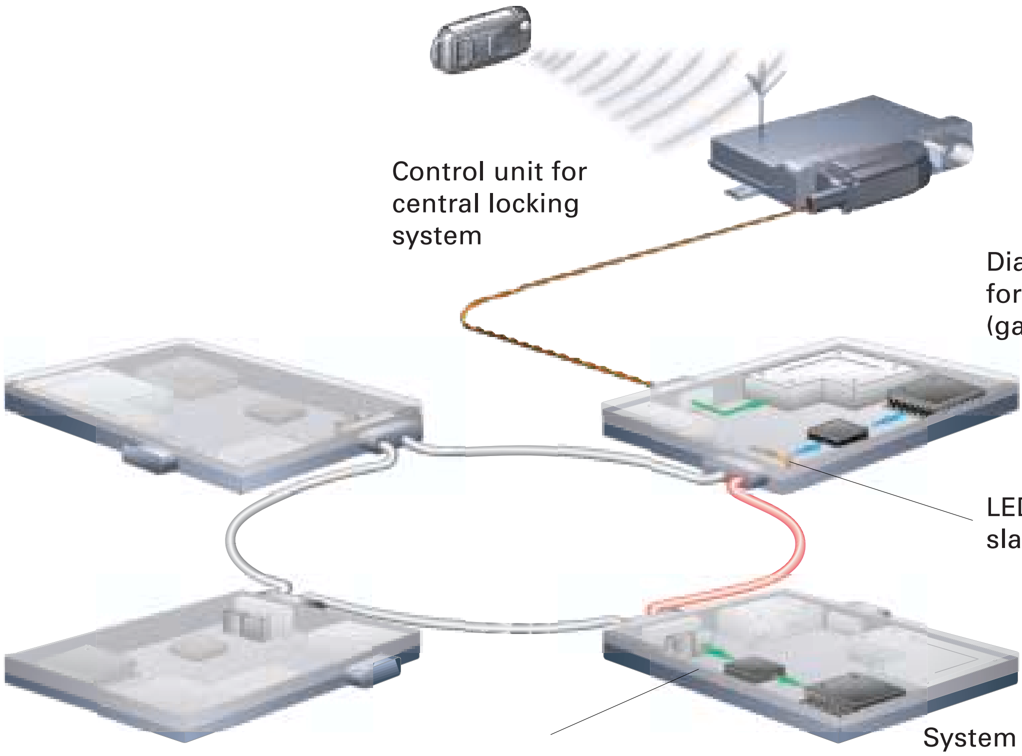
The **status field** of a frame contains frame transmission information for the receiver.


SSP286_043

The **parity field** is used for a final check that the frame is complete. The content of this field governs whether a transmission process is repeated.


SSP286_044

Operating sequences in MOST bus



SSP286_046

System start (wake-up)

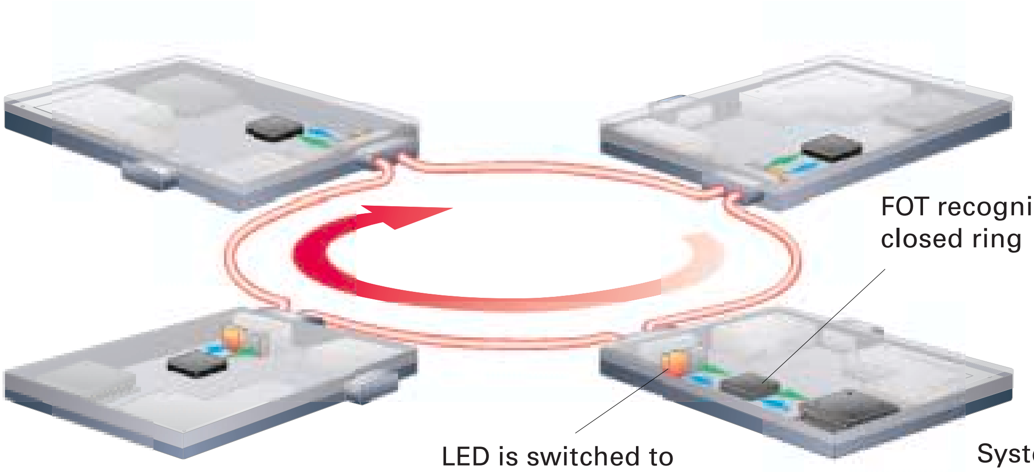
If the MOST bus is in sleep mode, the wake-up process initially switches the system to standby mode.

If one of the control units, with the exception of the system manager, wakes the MOST bus, it transmits specially modulated light – slave light – to the next control unit.

By way of the photodiode which is active in sleep mode, the next control unit in the ring receives the slave light and passes it on.

This process continues right through to the system manager. In the incoming slave light the manager recognises the prompt for system starting.

The system manager then transmits another specially modulated light – master light – to the next control unit. This master light is relayed by all control units. Reception of the master light in its FOT informs the system manager that the ring is complete and frame transmission commences.



SSP286_076

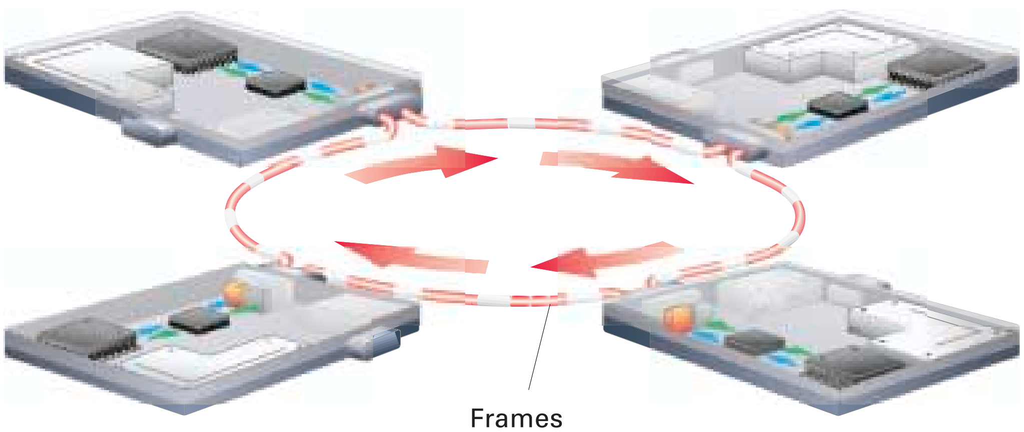
In the first frames the control units in the MOST bus are requested to provide identification.

Based on the identification, the system manager transmits the current sequence (actual configuration) to all control units in the ring. This permits address-oriented data transfer.

The diagnosis manager compares the reported control units (actual configuration) to a stored list of control units fitted (specified configuration).

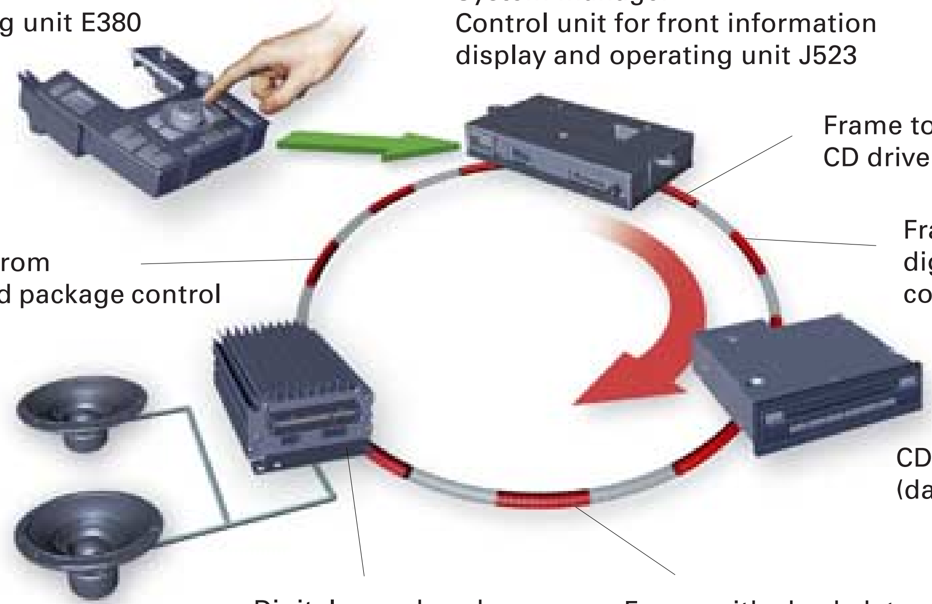
If the actual and specified configurations do not coincide, the diagnosis manager stores corresponding fault memory entries.

This completes the wake-up process and data transfer can commence.



SSP286_086

Audio and video transmission in the form of synchronous data



SSP286_077

By way of explanation, synchronous data transfer is described on the basis of the mode of operation involved in playing a music CD in the Audi A8 '03.

With the aid of the multimedia operating unit E380 and the information display unit J685, the user selects the desired track on the music CD.

By way of a data wire, the operating unit E380 transmits the control signals to the control unit for front information display and operating unit J523 (system manager). Corresponding information can be found in the Self Study Programme 293 – Audi A8 ´03 Infotainment.

The system manager then inserts a message block (= 16 frames) with the check data into the frames constantly transmitted.

– Transmitter address:
  - Control unit for front information display and operating unit J523, position 1 in ring

– Receiver address of data source:
  - CD drive, position in ring (depends on equipment)

– Control commands:
  - Play track 10
  - Assign transmission channels

The CD drive (data source) determines which bytes in the data field are available for transmitting its data.

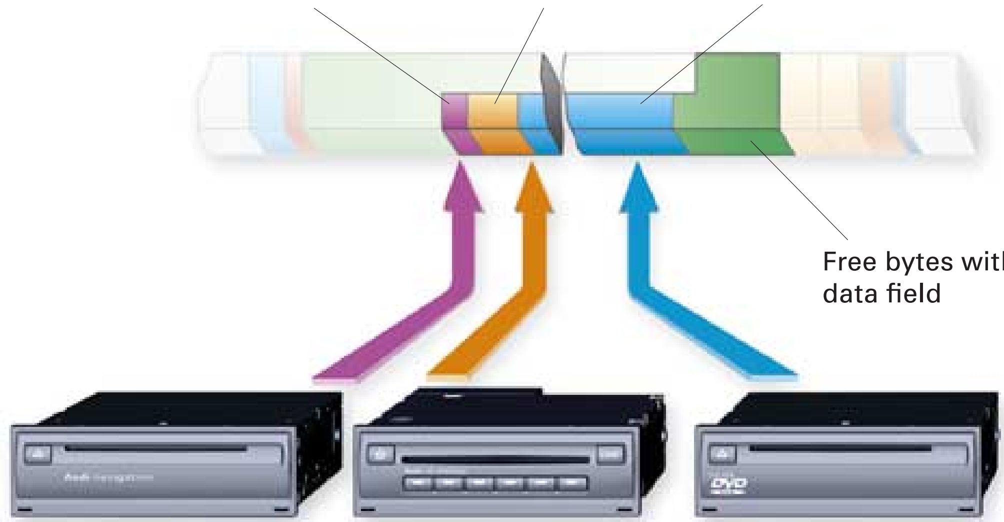
It then inserts a block with the check data.

– Transmitter address of data source:
  - CD drive, position in ring (depends on equipment)

– Receiver address of system manager:
  - Control unit for front information display and operating unit J523, position 1 in ring

– Control command:
  - Data transfer/music CD on channels 01, 02, 03, 04 (stereo))

Data management with synchronous transmission



SSP286_078

The control unit for front information display and operating unit J523 then uses a block with the check data

- Transmitter address:
  - Control unit for front information display and operating unit J523, position 1 in ring
- Receiver address:
  - Digital sound package control unit J525, position in ring (depends on equipment)
- Control commands:
  - Read out data channels 01, 02, 03, 04 and reproduce via speakers
  - Current sound settings such as volume, fader, balance, bass, treble, middle
  - Deactivate muting

to issue the instruction to the digital sound package control unit J525 (data receiver) to reproduce the music.

The music CD data are retained in the data field until the frame reaches the CD drive (i.e. the data source) again via the ring.
The data are then replaced by fresh data and the cycle commences again.

This permits use of the synchronous data by all output units (sound package, headphone connections) in the MOST bus.

The system manager determines which unit is to use the data by transmitting the corresponding check data.

Transmission channels

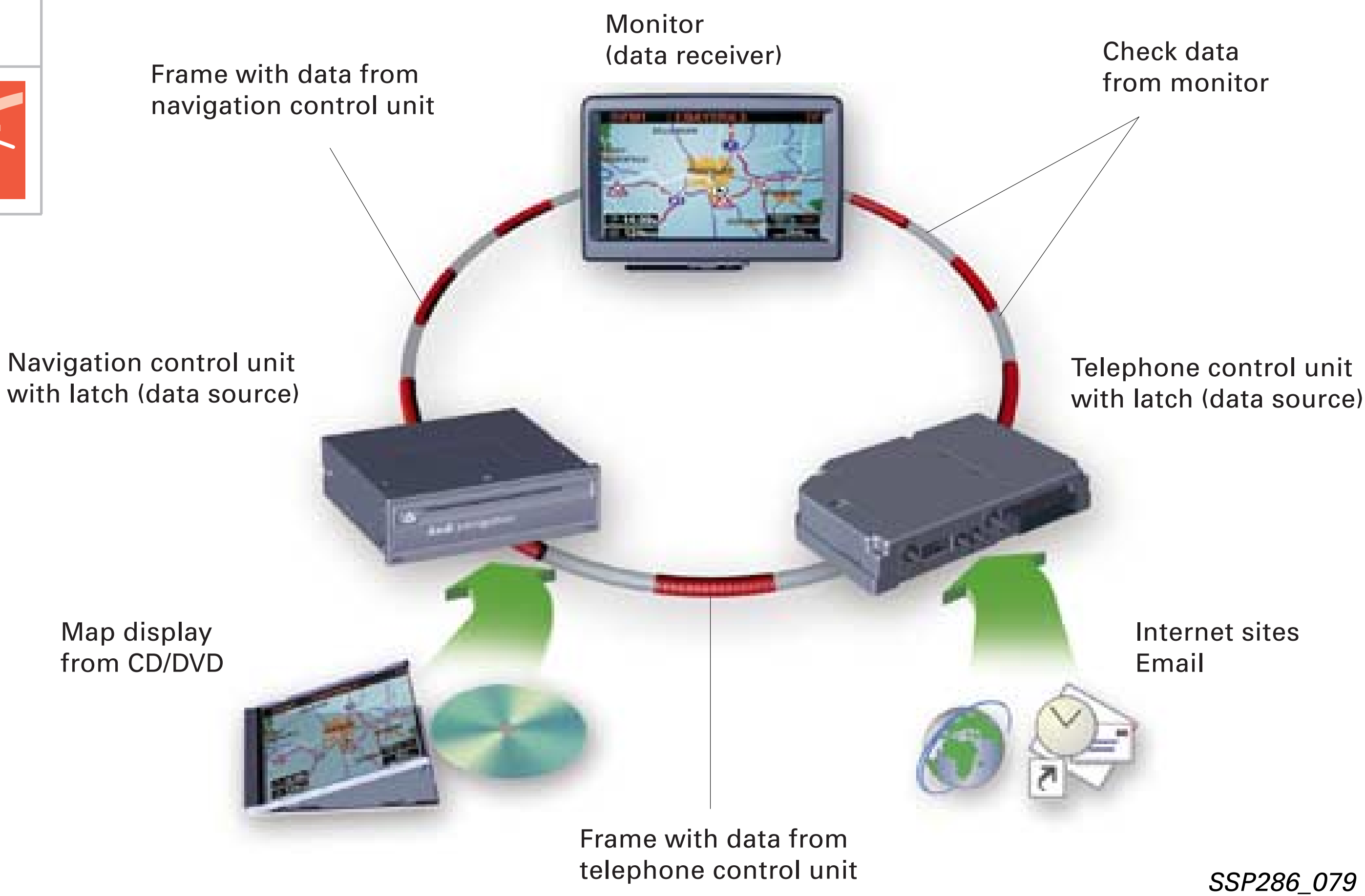
Audio and video transmission requires several bytes in each data field. The data source reserves a number of bytes in line with the type of signal. The bytes reserved are referred to as channels. One channel contains one byte of data.

Number of transmission channels

Signal	Channels/bytes
Mono	2
Stereo	4
Surround	12

This reservation of channels permits the simultaneous transmission of synchronous data from several data sources.

Transmission of data for images, messages and functions in the form of asynchronous data



SSP286_079

The data for

- Navigation system map display
- Navigation calculations
- Internet sites
- Email

are transmitted in the form of asynchronous data.
The asynchronous data sources transmit at irregular intervals.

For this purpose, each source stores its asynchronous data in a latch.

The data source then waits until it receives a message block with the address of the receiver.

The source enters the data into the free bytes in the data fields of this message block.

This takes place in packets (quadlets) of 4 bytes each.

The receiver reads the data packets in the data fields and processes the information.

The asynchronous data are retained in the data fields until the message block returns to the data source.

The data source extracts the data from the data fields and replaces them with fresh data if applicable.

Diagnosis

Diagnosis manager

In addition to the system manager, the MOST bus also has a diagnosis manager.

This is responsible for ring fault diagnosis and transmits the diagnosis data of the control units in the MOST bus to the diagnosis unit.

In the Audi A8 ´03, the diagnosis interface for data bus J533 implements the diagnostic functions.

SSP286_057

System malfunction

On account of the ring configuration, interruption of data transfer at a given MOST bus location is referred to as a ring break.

Possible causes of break in ring:

– Break in optical fibre
– Fault in power supply of transmitter or receiver control unit
– Defective transmitter or receiver control unit

Ring fault diagnosis must be performed to localise a break in the ring.
Ring fault diagnosis is part of the final control diagnosis routine of the diagnosis manager.

Consequences of break in ring:

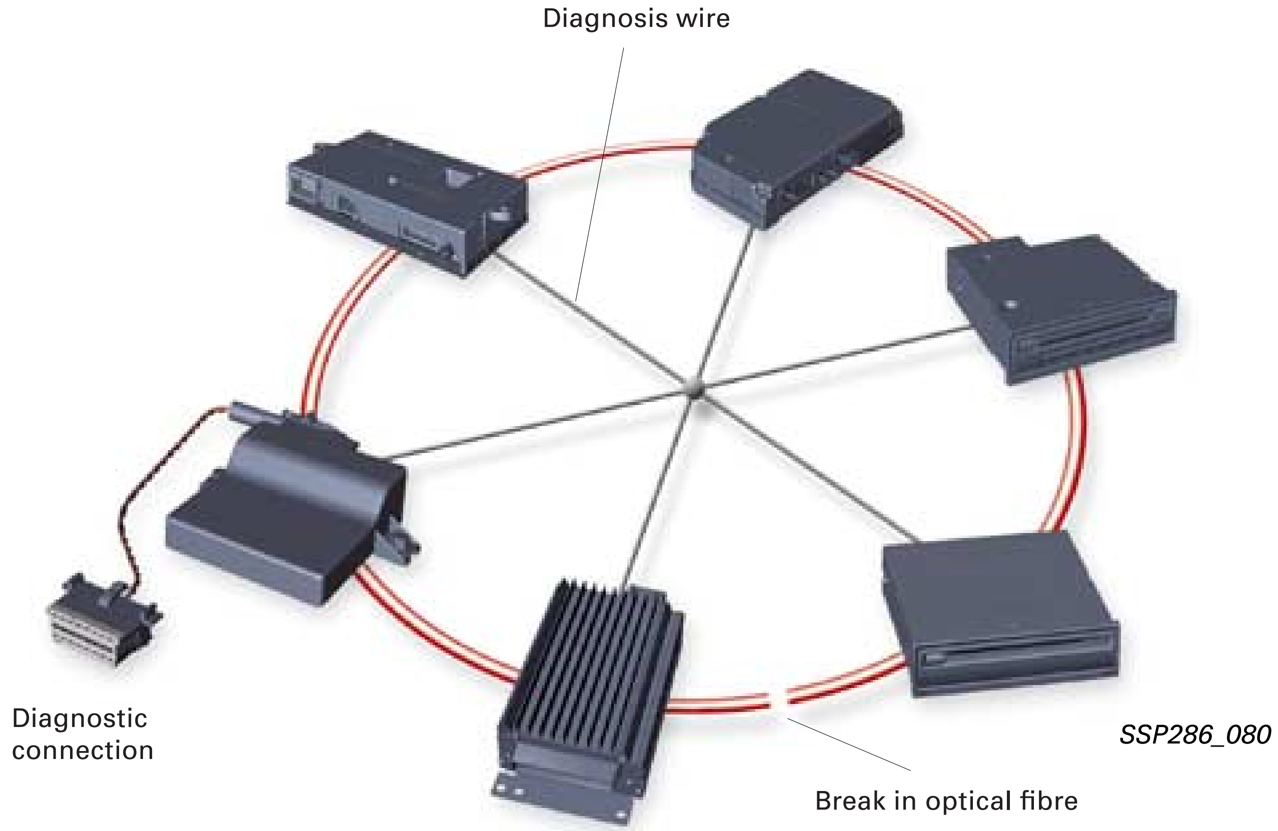
– No audio and video reproduction
– No control and adjustment by way of multimedia operating unit
– Entry in diagnosis manager fault memory ("Break in optical data bus")

Ring fault diagnosis

Ring fault diagnosis wire

As a break in the ring prevents data transfer in the MOST bus, ring fault diagnosis is implemented with the aid of a diagnosis wire.

The diagnosis wire is linked by way of a central wiring connection to each MOST bus control unit.



After starting ring fault diagnosis, the diagnosis manager transmits a pulse via the diagnosis wire to the control units.

This pulse causes all control units to transmit light signals with the aid of their transmission unit in the FOT.

In this process, all control units check

- their power supply and internal electrical functions.
- Reception of light signals from preceding control unit in ring.

Each MOST bus control unit responds following a time period stipulated in its software.

The time period between start of ring fault diagnosis and control unit response enables the diagnosis manager to recognise which control unit has transmitted the response.

Content of response

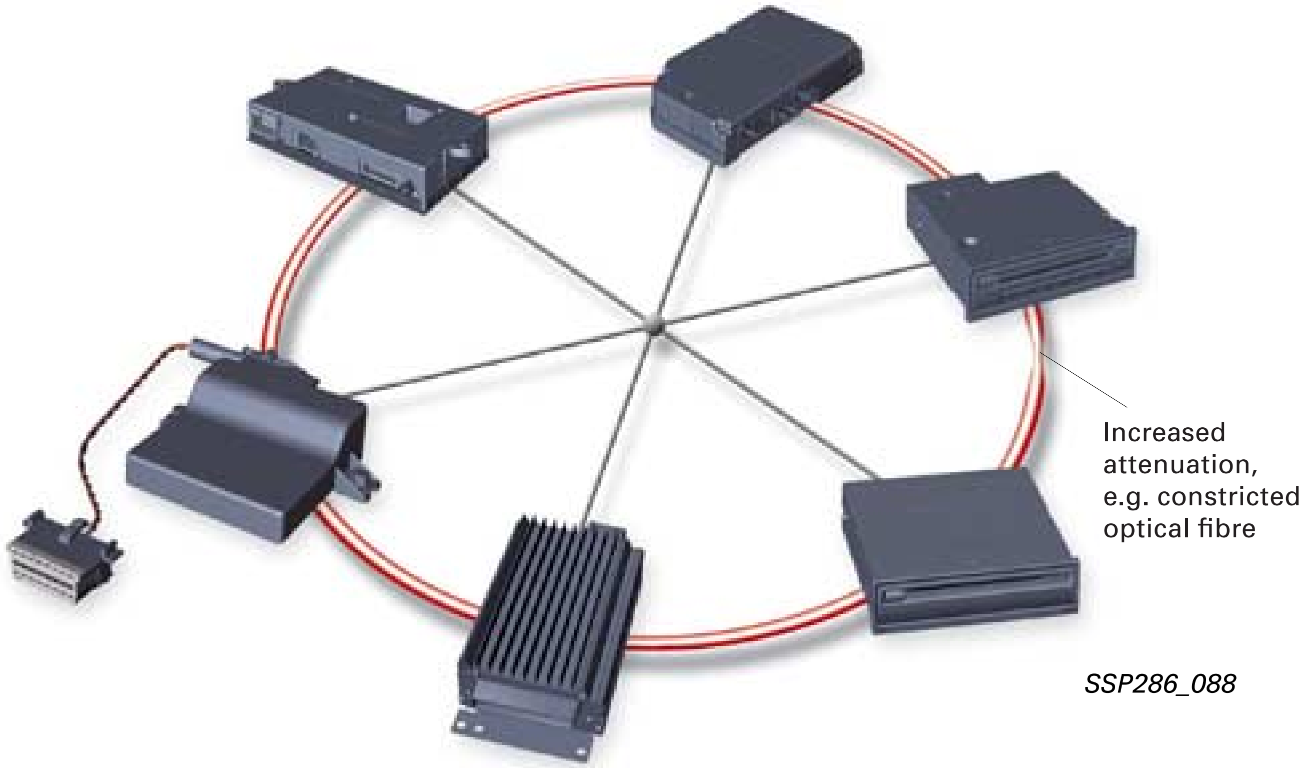
Following start of ring fault diagnosis, the MOST bus control units transmit two items of information:

1. Control unit in proper electrical working order – i.e. electrical functions of control unit (e.g. power supply) are OK
2. Control unit in proper optical working order – its photodiode receives the light signal from the preceding control unit in the ring

These messages inform the diagnosis manager

- of any electrical faults in the system (fault in power supply)
- or of the control units between which there is a break in optical data transfer.

Ring fault diagnosis with increased attenuation



SSP286_088

Ring fault diagnosis only permits detection of a break in data transfer.

The final control diagnosis function of the diagnosis manager additionally contains ring fault diagnosis with reduced light power for detection of increased attenuation.

The ring fault diagnosis process with reduced power corresponds to that described above.

However, the control units switch on their LEDs in the FOT with an attenuation of 3 dB, i.e. with light power reduced by half.

If the optical fibre is subject to increased attenuation, the light signal reaching the receiver is of insufficient strength. The receiver signals "optical problem".

The diagnosis manager thus recognises the fault location and issues a corresponding message in the assisted fault-finding of the diagnosis tester.

Introduction

SSP286_085

Mobile communication and information are gaining in importance in both the modern business world and the private sector.

For example, it is not unusual for one person to use several mobile systems such as mobile phone, Personal Digital Assistant (PDA) or notebook.

In the past, the exchange of information between mobile systems required the use of a hard wire or infrared techniques.

Such non-standardised links greatly restricted mobility or were complicated to use.

Bluetooth™ technology provides the solution by creating a standardised radio link for connecting mobile systems from different manufacturers.

This technique is to be introduced for the first time in the Audi A8 ´03 to provide a wireless link between the telephone handset and the control unit for telephone/telematics.

Additional applications for the vehicle user are planned for the future:

- Installation of second handset at rear of vehicle
- Connection of notebooks, smart phones and notepads to the internet for information transmission and entertainment
- Reception and transmission of emails via user's notebook or PDA
- Transmission of addresses and telephone numbers from user's notebook or PDA to Multimedia Interface (MMI) system
- Hands-free unit for mobile phones with no additional cable adapters
- Use of Bluetooth™ technology in other vehicle systems
  (example: remote control for
  auxiliary heating)

What is Bluetooth™?

The Swedish company Ericsson proposed the development of a standardised short-range wireless system – Bluetooth™ technology.

Several other companies decided to join in with this project and today the Bluetooth Special Interest Group (SIG) includes some 2000 companies from the fields of telecommunications, data processing and equipment and vehicle manufacturing.

The name "Bluetooth" originates from the Viking king Harald Blåtand, who unified Denmark and Norway in the tenth century and was known by the nickname "Blue tooth".

As this system combines a wide range of different information, data processing and mobile phone systems it reflects the philosophy of king Harald and thus came to be known as Bluetooth™.

Operation

Design

Short-range transceivers (transmitters and receivers) are either installed directly in selected mobile units or integrated by way of an adapter (e.g. PC card, USB).

Communication takes place in the 2.45 GHz frequency band which is freely available worldwide.

The extremely short wavelength of this frequency permits integration of

- Aerial
- Control and encoding
- Entire transmission and reception system

into the Bluetooth™ module.

The compact design of the Bluetooth™ module makes it suitable for installation even in miniature electronic devices.

SSP286_082

The data transfer rate is up to 1 Mbit/s. The units can transmit up to three voice channels simultaneously.

Bluetooth™ transmitters have a range of ten metres. Up to 100 metres can be achieved with an additional amplifier for special applications.

Data transfer does not require any complicated settings.

A link is automatically established between any two Bluetooth™ units entering into contact with one another. Before this can occur, once-only matching of the units has to be implemented by entering a PIN. Information on the procedure involved can be found in SSP 293 – Audi A8 Infotainment.

This involves the creation of miniature wireless cells known as "Piconet" for organisational purposes.

One piconet provides space for a maximum of eight active Bluetooth™ units, however each unit may form part of several picocells at the same time. In addition, up to 256 non-active units can be assigned to one piconet.

One unit assumes the master function in each piconet:

- The master establishes the link.
- The other units are synchronised with the master.
- Only the unit receiving a data packet from the master can transmit a response.

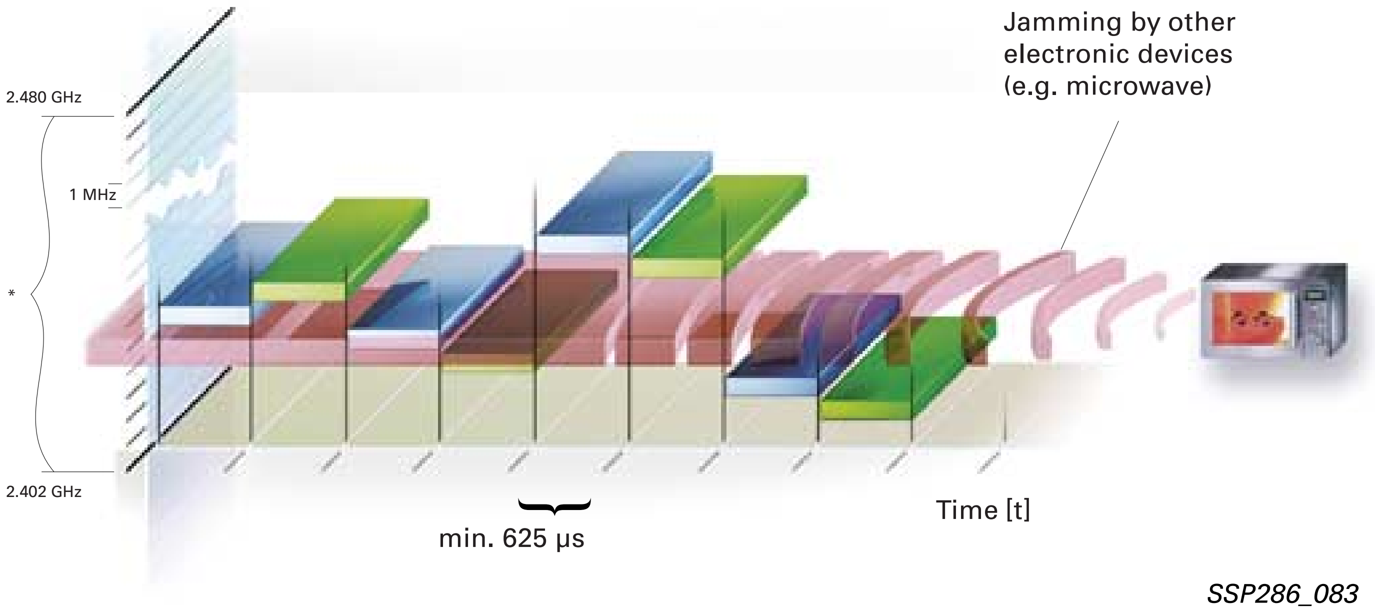
Example:

In the Audi A8 ´03, the telephone/telematics control unit is the Bluetooth™ master.

To avoid chaos when creating a piconet, settings can be made on each unit to determine the unit with which it is allowed to communicate or not.

Each unit has a unique worldwide address with a length of 48 bits, thus permitting unequivocal identification of more than 281 billion units.

Operation



SSP286_083

* Transmission range: 79 1 MHz channels

Master message (request)

Slave message (response)

Data transfer in the Bluetooth™ system involves the use of radio waves in a frequency range between 2.40 and 2.48 GHz.

This frequency range is also used for other applications.

Examples:

– Garage door openers
– Microwave ovens
– Medical appliances

Interference immunity

Through the use of measures designed to enhance interference immunity, Bluetooth™ technology reduces the interference caused by such equipment.

The control module

– Divides the data into short and flexible data packets with a duration of approx. 625 µs.
– Uses a 16-bit checksum to check that the data packets are complete.
– Automatically re-transmits data packets subject to interference.
– Makes use of stable language encoding in which the language is converted into digital signals.

The radio module

changes the transmission and reception frequency 1600 times per second on a random basis after each data packet. This is referred to as frequency hopping.

Data security

During the development of Bluetooth™ technology, the manufacturers placed great emphasis on the protection of the data transmitted against manipulation and unauthorised monitoring.

A 128-bit code is used to encode the data.

The authenticity of the receiver is also checked with a 128-bit code. In this process the units use a secret password for mutual identification of the individual users.

A new code is generated for each link.

As the range is restricted to 10 metres, manipulation can only take place within this area, thus additionally enhancing data security.

The above-mentioned interference immunity measures also increase the level of protection against manipulation of the data stream.

Data security can be further increased by equipment manufacturers through the additional use of complex encoding methods, different security levels and network protocols.

Diagnosis

The diagnostic procedure for the Bluetooth™ link is implemented with the aid of the master control unit address word.

Example:

In the Audi A8 ´03, the telephone/telematics control unit J526 is the Bluetooth™ master.

Address word	Telephone	77
	Emergency call module	75

The Bluetooth™ link between the telephone handset and the telephone/telematics control unit J526 is monitored by checking the Bluetooth™ aerial.

An entry is made in the fault memory if there is a break in the link with the aerial.

Bluetooth™ aerial

- No signal/no communication

The measured value blocks provide a display of

- The number
- The unit number
- The field strength of the radio link

of the portable units communicating with the master control unit.

The Bluetooth™ function can be activated or deactivated in the Bluetooth™ master adaption process.

Examples:

- Transportation of vehicle by air
- Use of vehicle in countries where Bluetooth™ frequencies are not authorised

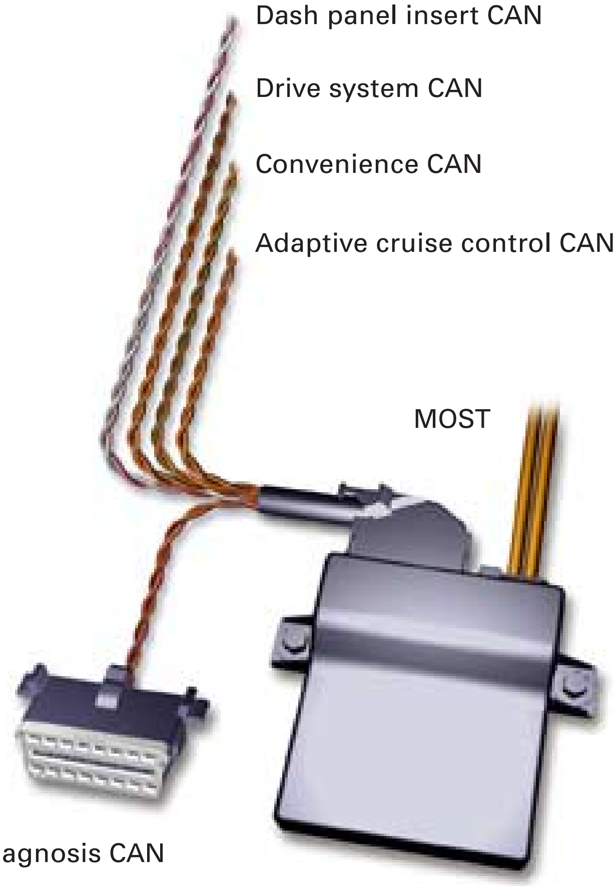
Diagnosis bus

Introduction

The diagnosis CAN is used to exchange data between the diagnosis unit and the control units fitted in the vehicle, thus obviating the need for the K or L-wires previously required (exception: emission-specific control units). Diagnosis is implemented using the vehicle diagnostic, testing and information system VAS 5051 or the vehicle diagnostic and service information system VAS 5052.

The control-unit diagnostic data are transmitted by way of the respective data bus system to the diagnosis interface for data bus J533 (gateway).

Thanks to the rapid data transfer via the CAN and the high performance of the gateway, the diagnosis unit is able to display a list of the components fitted and their fault status immediately after connection to the vehicle.

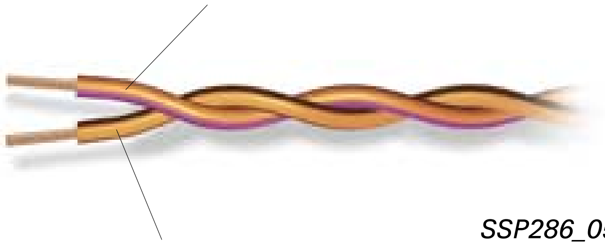


SSP286_012

The diagnosis CAN uses a non-screened twisted pair of wires with a cross-section of 0.35 mm^2 each.

The CAN low wire is orange/brown and the CAN high wire orange/violet.

Data are transferred at a rate of 500 kbit/s in full duplex mode. This means that data can be transmitted in both directions at once.



SSP286_055

Diagnosis can be implemented under the following conditions:

No.	Diagnosis	Condition		Remarks
1	Start	With ignition on	Yes	Wake-up of control unit via diagnosis CAN is not possible
		With ignition off	Yes, but not in sleep mode	
2	Implementation	With ignition on	Yes	
		With ignition off	Yes, but no write functions (e.g. control unit encoding)	
3	End	Termination by switching off ignition	No	

Implementation of diagnosis on the vehicle requires use of the new diagnosis wires VAS 5051/5A (3 m) or VAS 5051/6A (5 m). These new diagnosis wires can also be used with the familiar diagnosis systems employing K or L-wire.

SSP286_056

The current basic software version is also required for diagnosis.

VAS 5051: Basic software 3.0 for diagnosis via CAN

VAS 5052: Basic software

Basic software modification is accompanied by the addition of new functions and alterations to the tester user interface.

SSP286_051

Extension of forms of address

In addition to the direct addressing of individual control units, provision is now also made for group addressing, i.e. the fault memory content of several control units can be interrogated more or less simultaneously.

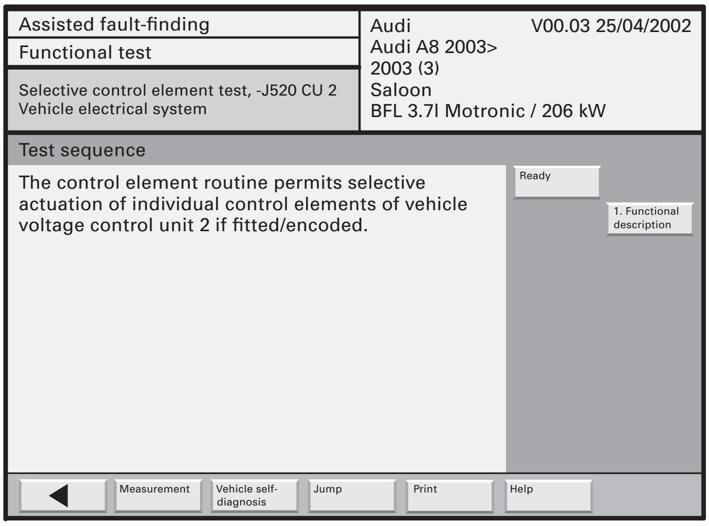
This considerably speeds up readout of the fault memory content.

Selective control element test

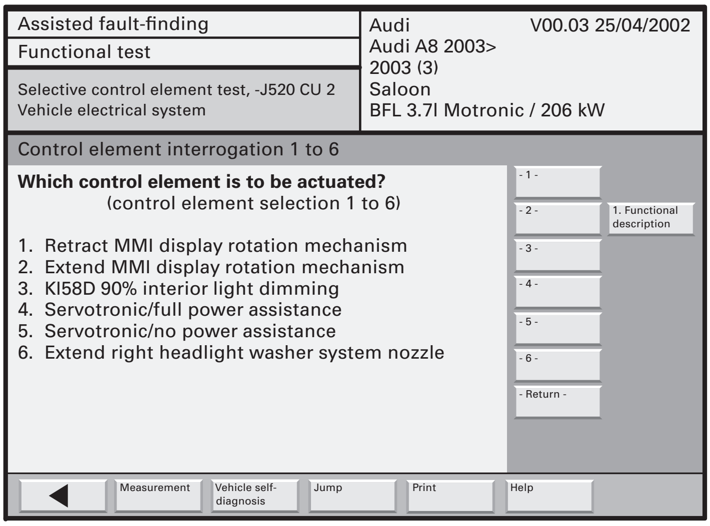
The selective control element test permits direct activation of actuators without having to adhere to a specified sequence.

In addition, it is possible to simultaneously display control-unit measured value blocks for checking switches and sensors.

These new features offer additional options as part of assisted fault-finding.



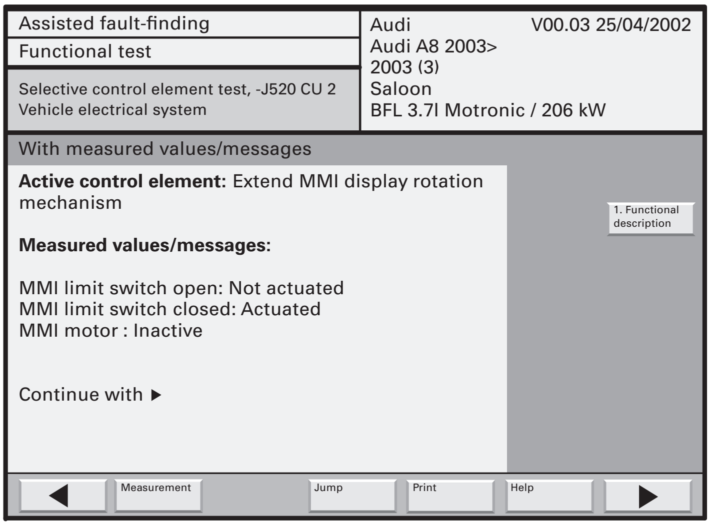
SSP286_089



SSP286_090

Example:

The illustration shows the selective control element test for vehicle voltage control unit 2 J520 in the Audi A8 ´03 for checking the display mechanism.



SSP286_091

Pin assignment at diagnostic connector

Pin	Wire
1	Terminal 15
4	Earth
5	Earth
6	Diagnosis CAN (high)
7	K-wire
14	Diagnosis CAN (low)
15	L-wire
16	Terminal 30

SSP286_052

Pins not listed are not used at present.

Notes

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