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# Introduction to Advanced Body Electronics

**Model: E65, E66, E60, E63, and E64**

**Production: All**

## OBJECTIVES

After completion of this module you will be able to:

- Understand changes to Body Electronic Systems on the E6X models
- Understand advanced bus systems
- Understand Principles of Fiber Optics
- Diagnose MOST Bus concerns

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## Introduction to Advanced Body Electronics

Beginning with the 2002 model year, a new era in on-board electronics began with the new BMW flagship - The E65. Although there were significant cosmetic changes between the last generation 7-series and the new 7, the major advances were “under the skin”.



Some of the most obvious changes were in the cockpit area. The E65 no longer used a conventional key to start the vehicle, instead a remote key fob is used in conjunction with a start/stop button. Entertainment and communications are now accessed via a single controller, which is a part of the new iDrive System.



Some of the design objectives on the E65/E66 included an overall reduction in control knobs and switches. This is the objective of the iDrive system, to simplify the control of the various vehicle functions.

To make these changes possible, new bus networks were created. For the first time, fiber optic networks were used on BMW vehicles. The 2 new bus networks are the MOST bus and the new **byteflight** bus. In addition to the DISplus and GT-1, there are some new tools for diagnosing system using fiber optic technology.

As with previous 7 series introductions, the E65 platform initiated a new wave of technological advances which were subsequently carried over to the rest of the model line.

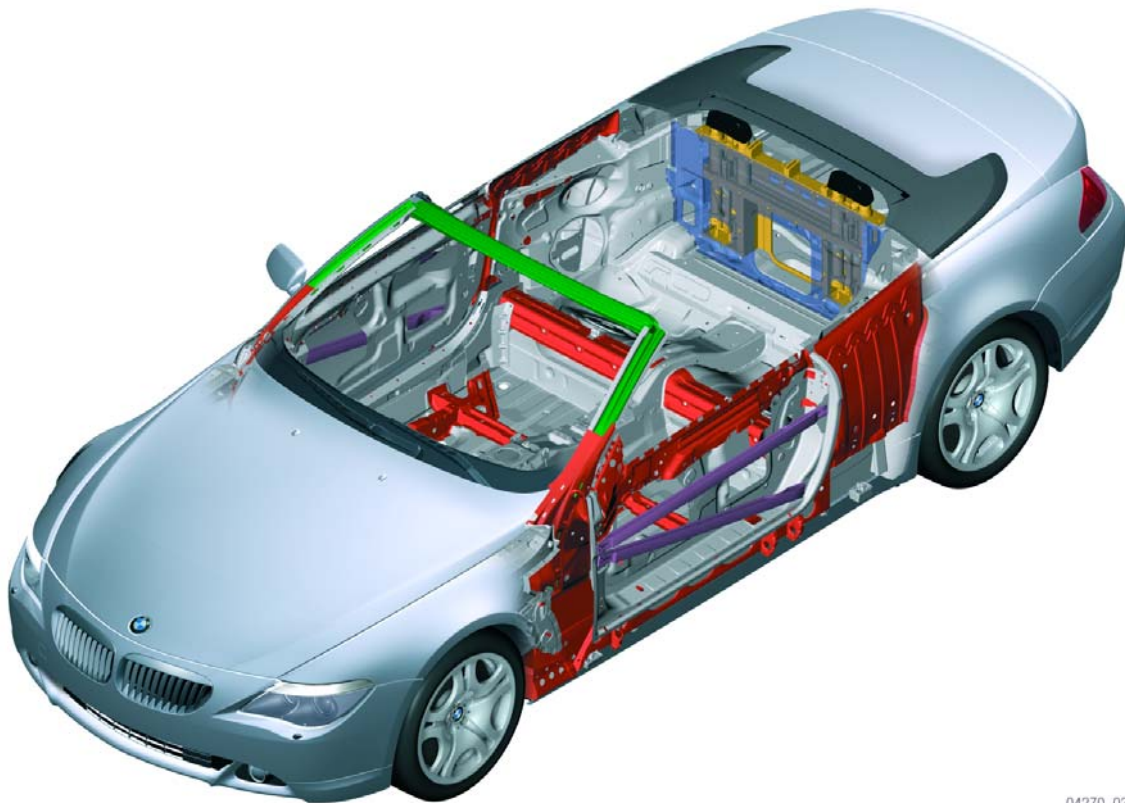
From the 2004 model year, the E60 also integrates many of the new innovations from the E65.



The MOST and **byteflight** networks are still used, but modified slightly. The iDrive controller is also carried over, with less overall features and an added menu button to simplify operation.



To continue with the advances in technology, the new E63 and E64 were introduced with some new features such as Car Computer Control (CCC) and the new Head-up Display (HUD). These 2 new features will be seen on other models as well in the near future.



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In this training course, the latest in BMW electronics technology will be covered. This course will focus on the new 5, 6 and 7 series models. This includes the following vehicle systems:

- Power (energy) management
- Driver information systems (Instrument cluster, iDrive etc.)
- Vehicle lighting systems (including LWR, AHL etc.)
- Body Electronics (Power locks, windows, wipers etc.)
- Vehicle warning systems (PDC, DWA and ACC)
- Entertainment and Communication Systems
- Seat, mirror and steering wheel functions
- Head-up Display
- Bus Systems
- Fiber Optic technology

Systems such as Passive Safety and Climate Control will be covered in their respective courses.

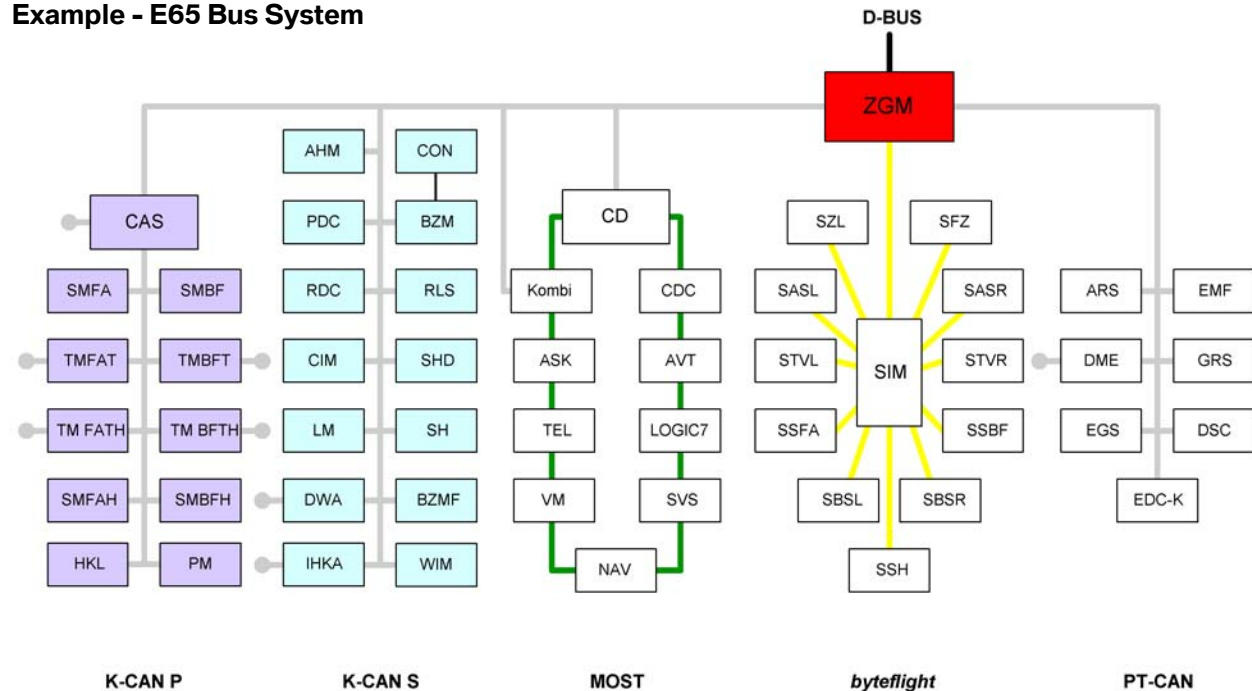
## Advanced Bus Systems

The launch of the E65 brought about new technological innovations which required some advancements in bus technology. Fiber Optics, newly introduced to BMW group vehicles, allow for a larger amount of data transfer at a faster rate.

There are 2 new Fiber Optic Networks used on the E65. These new networks are MOST (Media Orientated System Transport) and byteflight. MOST is used for information and communication systems such as navigation, audio and telephone. The new byteflight system is used exclusively for the safety system (ISIS).

In addition to fiber optics, copper wire bus networks were also modified to meet the needs of the new technology. New networks such as PT-CAN and K-CAN enhanced the existing CAN bus and K-bus already in use on earlier models.

### Example - E65 Bus System



The K-CAN (Body Controller Area Network) replaces the single wire K-bus used on earlier models. K-CAN is subdivided into two sections: K-CAN System and K-CAN Periphery. K-CAN S and K-CAN P use the two wire twisted pair configuration. The communication speed has also been increased to 100Kbps.

The PT-CAN system replaces the existing CAN system. PT-CAN differs from the existing CAN system by using an additional KL-15 “wake-up” wire. Communication speed remains the same at 500Kbps.

New Sub-Bus systems have also been added to provide “local” communication to the larger networks. There are several Sub Bus systems on the E65, these include the Driver’s door P-Bus, the Engine LoCAN, Telecommander CAN, M-Bus DWA K-Bus and the BSD interface. These systems will be discussed later in this course.



## Fiber Optic Bus Networks

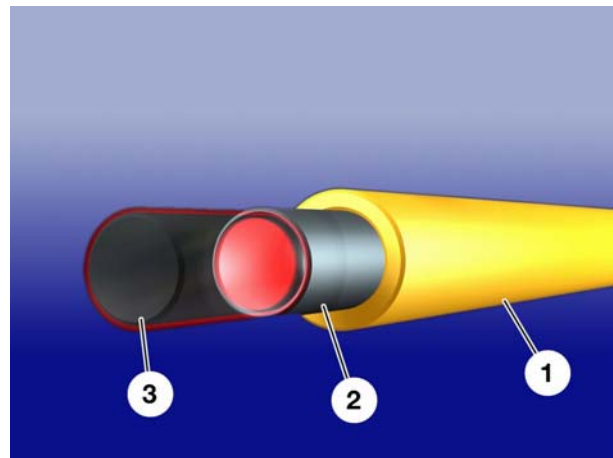
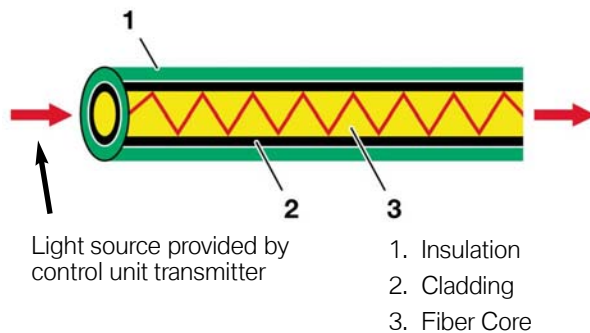
The ever-increasing level of features available in today's automobiles require a corresponding increase in vehicle electronic systems. The transmission of data, voice and images require an efficient method to move data.

Copper wire bus networks offer many advantages. However high data transmission rates in copper wires can cause electro-magnetic interference with other vehicle systems. Compared with copper wires, fiber optic lines require less space and are lighter in weight for the same transmission band width. In contrast with copper wires, which carry digital or analog voltage signals as the means of transmitting data, fiber optic busses transmit light pulses.

Fiber Optic technology has been in use in the telecommunications industry for many years. However, this type of fiber-optic cable is not practical for automotive use. These cable utilize glass based fibers which are not practical for automotive use. They are subject to fracture from vibration and do not hold up to "tight radius" installations.

POF (polymer optical fibers) were developed for the automotive industry. These fibers were developed and manufactured by Dow-Corning.

### Construction of Fiber Optic Cable

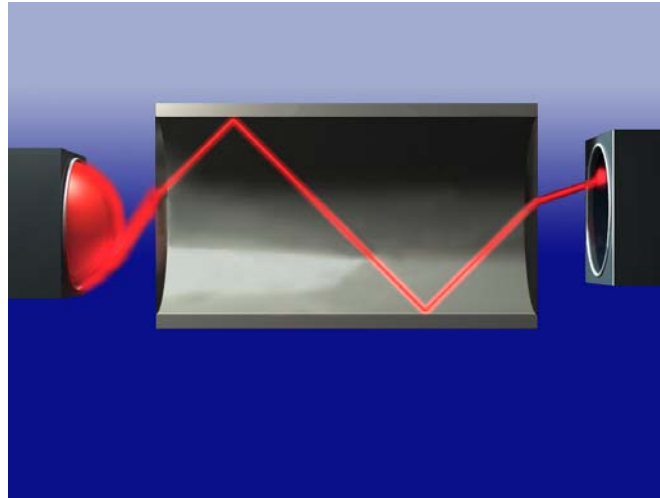


There are significant advantage to using POF fiber optic cables:

- There is a low sensitivity to dust. Small amounts of contamination do not adversely affect communication.
- They are easy to work with. These fibers can be bent to a radius of approximately 50mm. This allows for practical installation within the vehicle.
- Processing is practical, these fibers can be cut and modified which makes the production of wiring looms easy. Service repairs are also made simple.
- These fibers are inexpensive to manufacture and do not require expensive connections or housings.

## Principle of Light Transmission

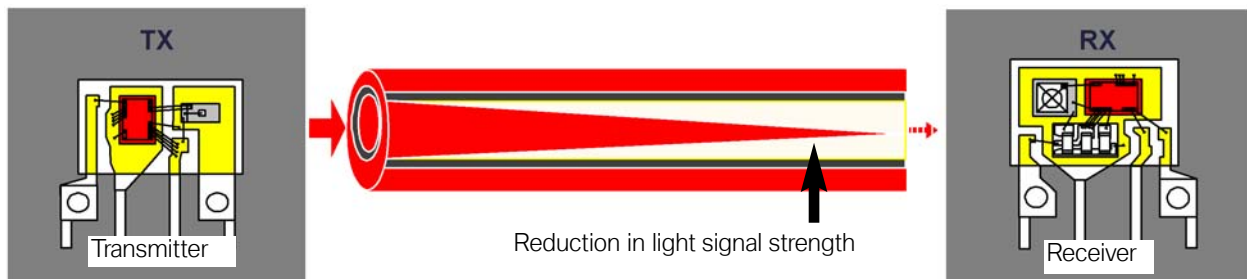
The electrical signal generated by the control unit is converted to an optical signal by an internal transmitter module and sent along the fiber optic bus. The fiber core carries the light beam to a receiver module which converts the light signal back to a useable electrical signal.



In order to prevent the light from escaping, the fiber core is enclosed by a cladding layer. The cladding is reflective and reflects light back into the core, thus making it possible to transmit light along the fiber.

## Light Attenuation

Attenuation refers to the reduction in strength of a signal. Light transmitted along the optical fiber becomes weaker the further it has to travel. Attenuation is usually measured in decibel units (dB). In fiber optic cables, attenuation is measured in terms of the number of decibels per unit of length (foot/meter etc). The less attenuation per unit distance, the more efficient the cable.



In comparison with an electrical circuit, think of attenuation as “light resistance”. The more attenuation in the fiber optic cable, the less light output to the receiver module.

The average attenuation for fiber optic bus lines is .5 decibels (dB) for each connector and .3 dB for each meter of cable.

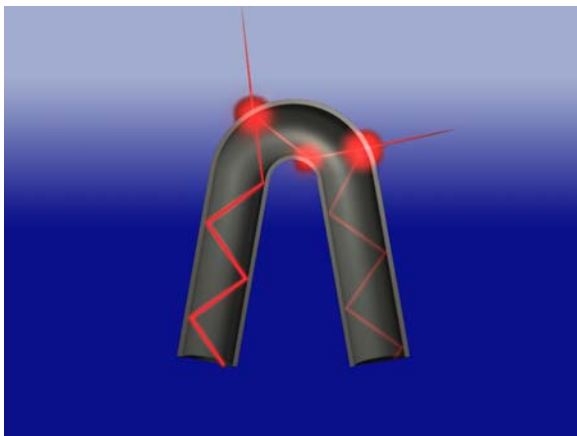
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## Causes of Excessive Attenuation

Excessive attenuation can be caused by the following reasons:

- Bends in the fiber optic cable with a radius of less than 50mm.
- Kinks in the fiber optic cable
- Squashed or compressed fiber optic cable
- Damaged insulation on fiber optic cable
- Stretched fiber optic cable
- Dirt or grease on the exposed cable ends
- Scratches on the exposed cable ends
- Overheated fiber optic cable

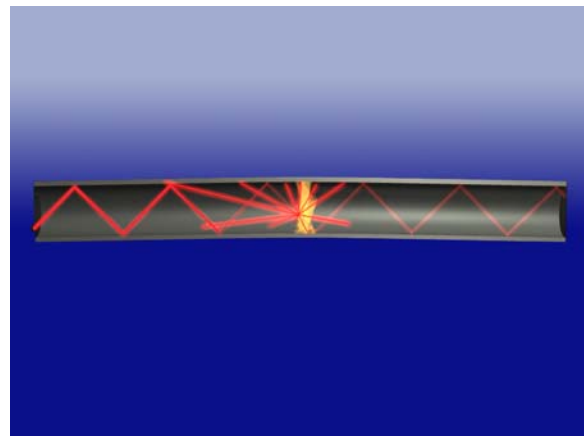
Here are some examples of various fiber optic cable failures:



### Bending Radius

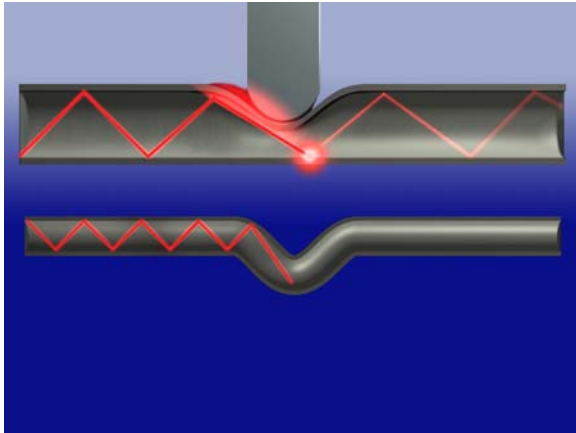
The plastic fiber optic cable should not be bent to a radius of less than 50mm. That is roughly equivalent to the diameter of a soft-drink can. Bending the cable any tighter can impair its function or irreparably damage the cable.

Light can escape at points where the cable is bent too tightly. This is caused by the fact that the light beam strikes the interface between the core and cladding at too steep an angle and is not reflected.



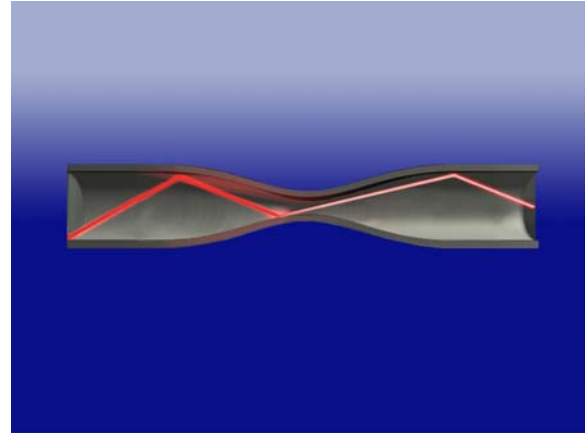
### Kinking

Fiber optic cables must not under any circumstances be kinked when fitted because this damages the cladding and the fiber core. The light is partially dispersed at the point where the fiber is kinked and transmission loss results. Even just kinking the cable once very briefly is enough to cause permanent damage.



### Compression Points

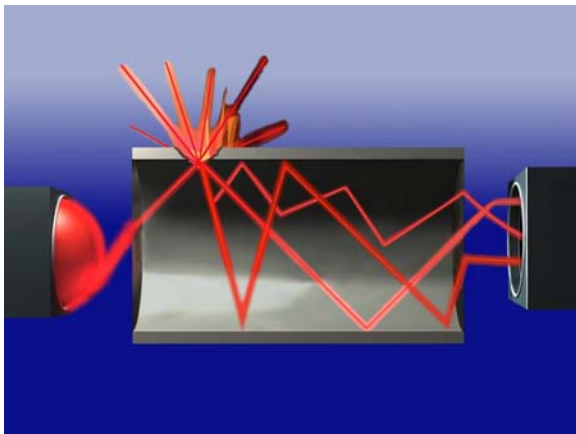
Compression points must also be avoided because they can permanently deform the light conducting cross section of the optical fiber. This would cause a loss of light.



### Stretching

Overstretching of the fiber optic cables, caused by pulling for example, can destroy them.

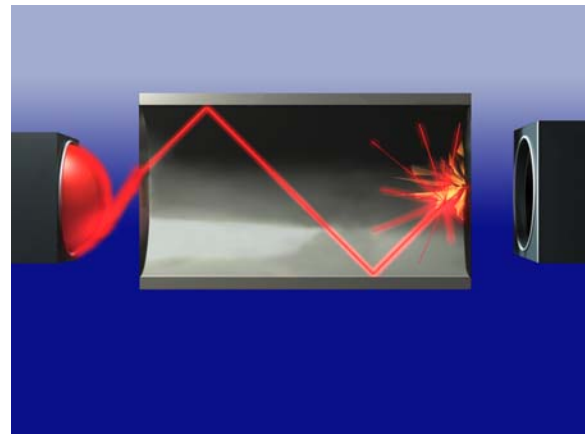
Stretching reduces the cross-sectional area of the fiber core. Restricted passage of light is the end result.



### Abrasion Points

In comparison with copper wires, abrasion of fiber optic cables does not cause a short circuit.

Instead, loss of external light occurs. The system then suffers interference or fails completely.



### Dirty or scratched Fiber Optic Cable Ends

Another potential source of problems is dirty or scratched cable ends. Although the ends of the cables are protected against accidental contact, damage can still occur by incorrect handling.

Dirt on the end of an optical fiber will prevent light from exiting/entering. The dirt absorbs the light and increases attenuation.

# Fiber Optic System Service and Diagnosis

## Service Considerations

During repair work, there are some things that need to be taken into account when working with fiber optic cables. Any paintwork which requires the use of drying by heat, the temperature should not exceed 85°C. This could cause deformation of the fiber optic cable resulting in excessive attenuation.

Extreme care should be taken around fiber optic cables. Any wiring harness that contain fiber optic cables should not be subjected to stretching, pulling or any undue stress.

## Cable Repair

Repair cable are available for the fiber optics. The MOST bus which is normally green in the vehicle is repair using a black or orange cable. The MOST bus allows for up to one splice between control units.

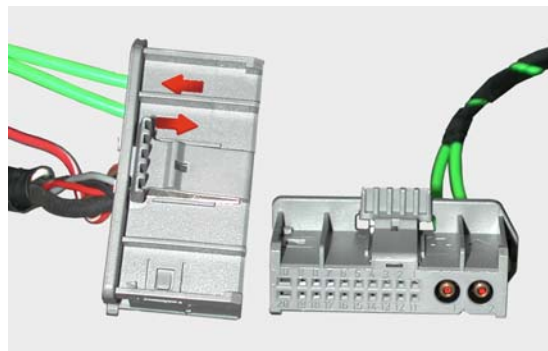
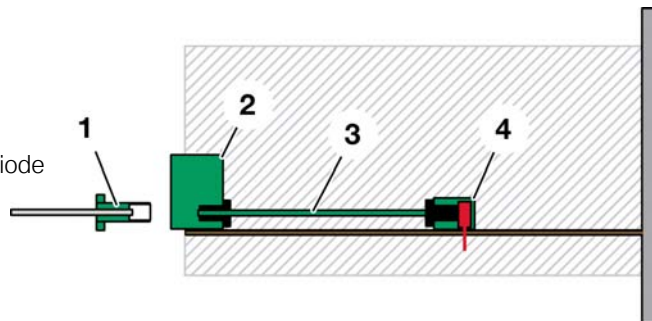
There are special tool for servicing and splicing the optical cables.

The **bytfelight** which is a safety critical network does not allow for any splices or repairs between control units. The entire defective optical cable must be replaced. Replacement cables are orange or black.

## Fiber Optic Connectors

There are slight differences between the connectors on the MOST and bytfelight bus. The transmitter/receiver module on the MOST bus are set back into the control unit housing. This setup allows for the protection of the delicate fiber ends of the cable. Also, MOST cable connectors are marked 1 and 2. 1 is assigned to the incoming optical fiber and 2 is assigned to the outgoing optical fiber.

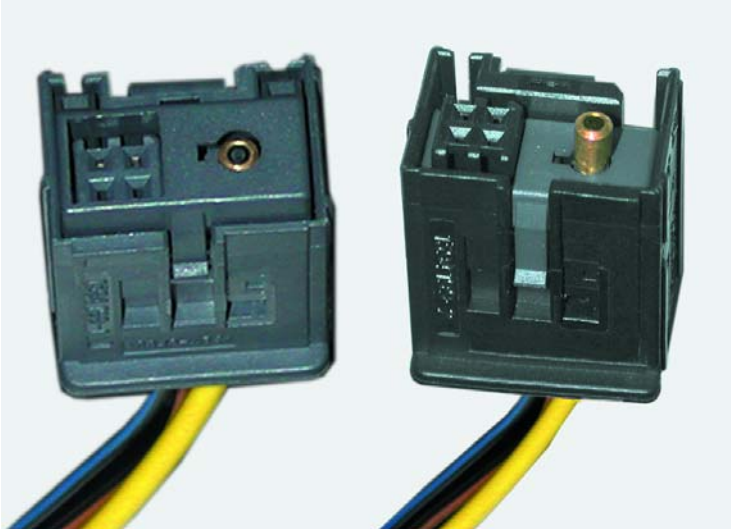
- 1. Fiber optic connector
- 2. Socket on control unit
- 3. Fiber optic jumper
- 4. Receiver module with diode



**Typical connector used on the MOST bus components**

The **byteflight** bus uses a different connector configuration than MOST. Since the byteflight is connected directly to the diode, the protruding fiber end is protected by a flap.

The flap is retracted when the connectors are plugged together.



Typical connector used on **byteflight**

**Fiber Optic Diagnosis**

When checking attenuation, the OPPS or OPS tester should be used in conjunction with the DISplus/GT-1.

The Optical Testing and Programming System (OPPS) can be used as a substitute diagnostic head for diagnosis, or to expedite programming procedures. The OPPS can also be used to check attenuation on both the MOST or **byteflight** bus.

The OPS is an abbreviated version of OPPS. The OPS does not have the capability to check attenuation on the **byteflight** bus. OPPS and OPS appear similar, but are different in color. OPPS is gray and yellow, while OPS is gray and orange.



OPPS Tester (OPS not shown)



## Workshop Exercise - Fiber Optic Cable Repair

*Using the instructor designated fiber optic cable/connector, perform a connector /cable repair.*

What special tool is used to remove the sheathing from the fiber optic cable?

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What special tool is used to crimp the fiber optic terminal to the fiber optic cable?

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What is the part number of the blades used for cutting the fiber optic cable? And how many cuts are allowed per blade?

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What precautions should be observed when handling fiber optic cable?

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How many splices are allowed between two MOST bus components?

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How many splices are allowed between two **byteflight** bus components?

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What is the part number of the AMP butt connector?

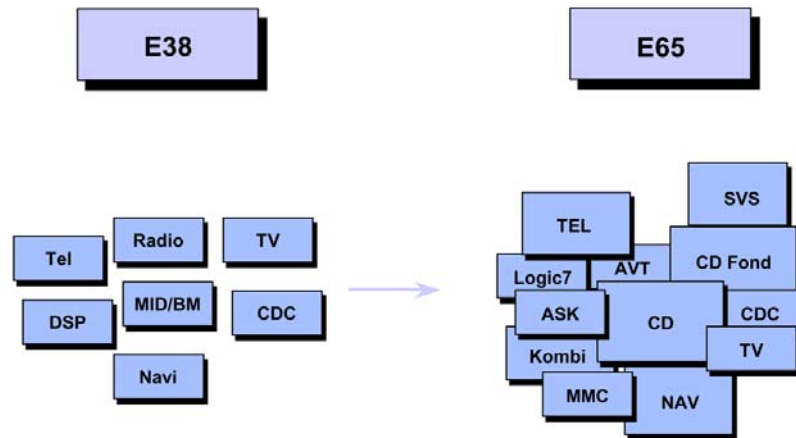
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## MOST Bus

Of the 2 fiber optic networks introduced on the E65, the MOST bus is used for audio, entertainment and communication systems. MOST stands for Media Orientated Systems Transport.

Starting in 1998, OEM manufacturers such as Audi, Becker, BMW and Daimler/Chrysler came together to develop a common multi-media network. As of 2001, MOSTCo (Cooperation) has approximately 65 members including all of the American and European auto manufacturers. Toyota and Nissan represent the Japanese auto industry. MOSTCo now unites about 90 percent of global automotive production and is now on track to becoming the standard for automotive multi-media services.

Since the introduction of the E65, MOST has been added to the E60, E63 and E64 vehicles. MOST will also be a part of future BMW models as well.



In comparison with the E38, which had only a few entertainment -related control units on the network, the E65 has a significant increase in multi-media systems. This requires a bus network with a substantial amount of bandwidth (communication speed). The MOST bus was introduced with a data rate of 22.5 Mbps and will be increased as system needs demand.

### MOST Multimedia Network

MOST technology meets 2 essential requirements:

- The MOST bus transports control data as well as data from audio, video navigation and other services.
- MOST Technology provides a logical framework model for control of the variety and complexity of data. The MOST application framework organizes the functions of the overall system. MOST is able to control and dynamically manage functions that are distributed in the vehicle.

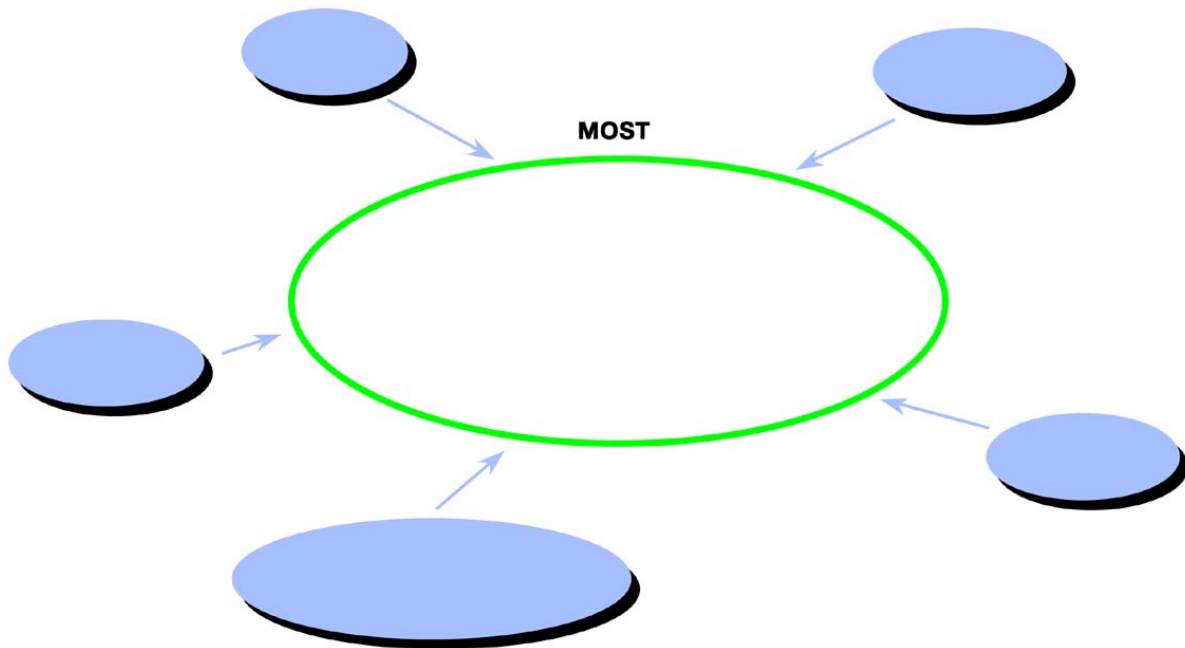


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## Principle of a Multimedia Network

An important feature of a multimedia network is that it transports not only control data and sensor data. A multimedia network can also carry digital audio and video signals and graphics as well as other data services.

### Information transmitted on MOST network



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## Advantages of a Multimedia Network

All data can be transported across a shared network. This offers the following benefits:

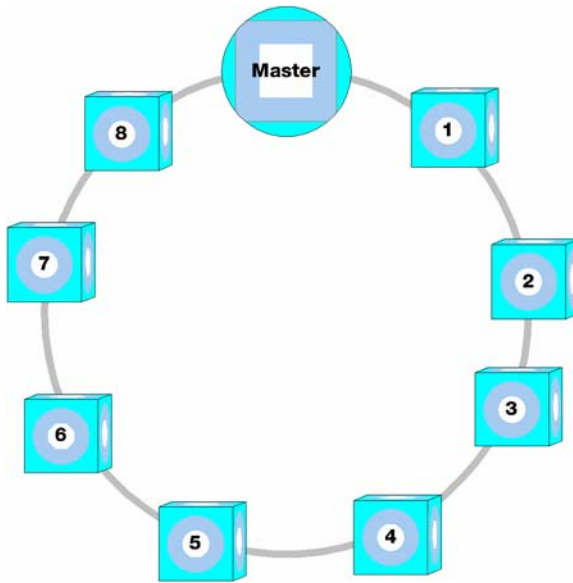
- Additional signal wiring harnesses are eliminated.
- The only addition many control units need is a power supply.
- As each participant (control unit) has access to the data, cost intensive components for signal distribution are eliminated.

Different data formats also have different requirements for transmission regarding both mechanisms (synchronous or asynchronous data) and the required bandwidth. The MOST format is able to meet these requirements to satisfactory extent.

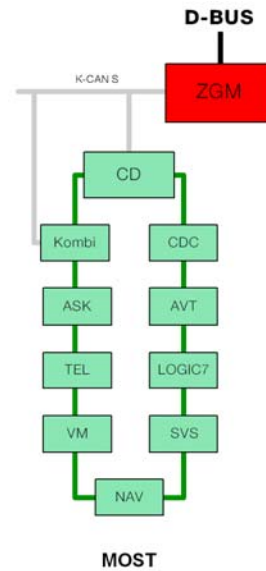
## MOST Structure

The MOST bus is configured in a “ring” structure. Data transmission on the ring takes place in one direction only. Messages can be transmitted provided the bus ring is complete and fully functional.

A failure, such as an interruption in the ring, will cause a complete failure of the MOST ring. All modules on the MOST bus will cease to function when there is an open in the MOST bus.



**Graphic example of “ring structure” used on MOST bus**



**Example of MOST bus on the E65**

### Data Quantities

The aim is that in the near future all vehicle occupants can call up different services at one time, e.g.:

- The driver calls up navigation information.
- The passenger talks on the telephone.
- A rear seat passenger listens to a CD.
- The other rear seat passenger watches a DVD video.

The data quantities this requires produce the following example:

Application	Band-width (data rate)	Data	Data Format
AM/FM Check Control Audio/CD Telephone SVS	1.4 Mbits/s	1 Channel Stereo	Synchronous
TV CD Video	1.4 Mbits/s	Audio MPEG 1 Video	Synchronous
DVD	2.8-11 Mbits/s	MPEG 2 Video	Synchronous and Asynchronous
Navigation	250 Kbits/s 1.4 Mbits/s 1.4 Mbits/s	Vector data (arrows) MPEG 1 Video (maps) Voice commands	Asynchronous Synchronous Synchronous
Telematic services	A few bytes		Asynchronous

Using MOST, there is already the capability today to transport these large data quantities.

## Functional Description

### Data Transport

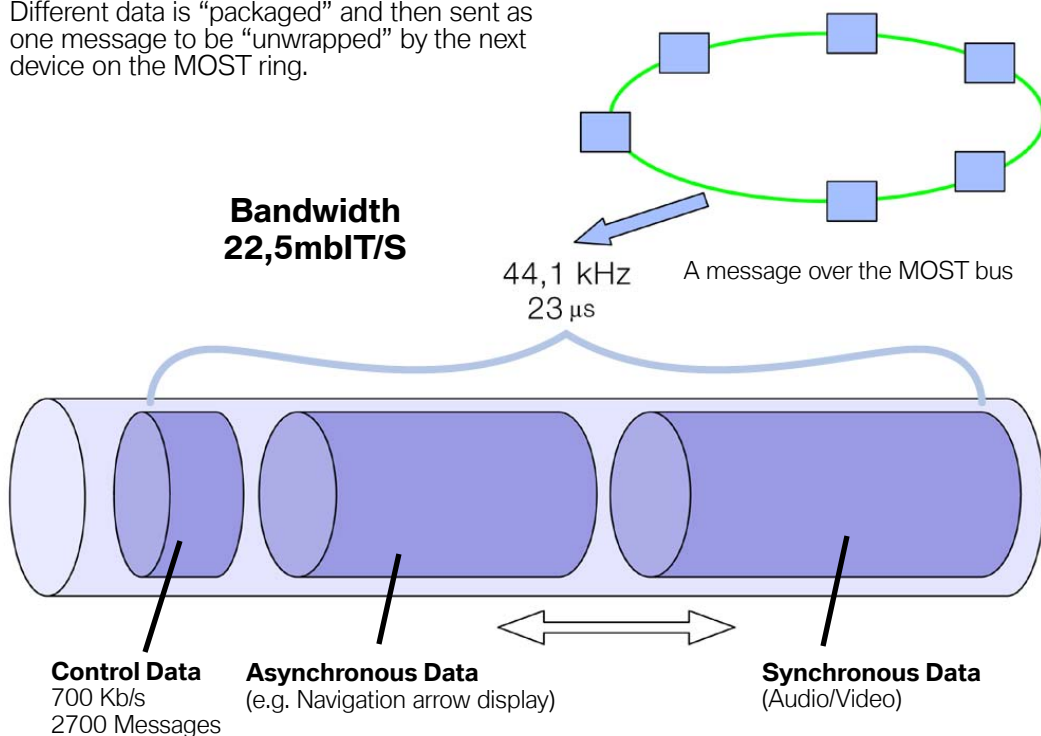
MOST currently offers a band-width of 22.5 Mbits/s . In the next generation, the band-width will be increased to 50 and then later to 150 Mbits/s (as of approx. 2002).

In order to meet the different requirements of the applications regarding data transport, each MOST message is divided into three parts:

- Control data
- Asynchronous data: e.g. navigation system, arrow representation
- Synchronous data: e.g. audio, video signals

#### Data transport on the MOST bus.

Different data is “packaged” and then sent as one message to be “unwrapped” by the next device on the MOST ring.



The control data controls the functions and devices in the network. The information can be compared to CAN bus data.

The control data has a band-width of 700 Kbit/s. That corresponds to around 2700 messages per second.

For the data transmission of synchronous and/or asynchronous data, there is a total of 60 bytes. The limit is variable: e.g. 20 bytes of synchronous data and 40 bytes of asynchronous data.

## Optical Bus

The MOST bus is a plastic optical waveguide. The MOST bus is coded in green in the E65.

The light wavelength is 650 nm (red light). The MOST bus requires the following converter components:

- Optical transmitter
- Optical receiver

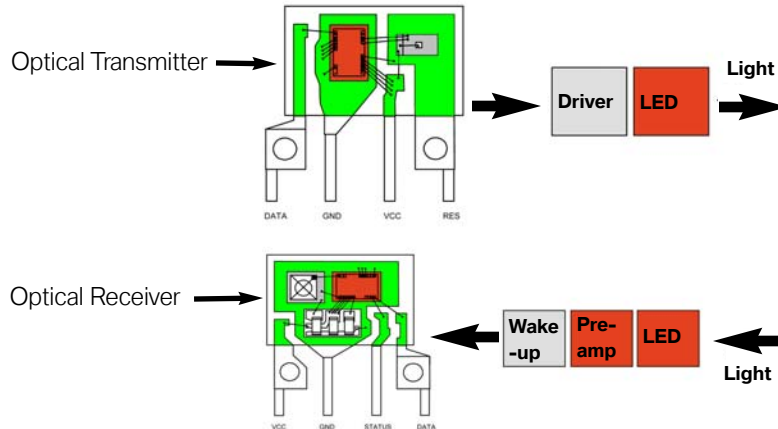
Each control unit of the MOST framework contains a transmitter and a receiver. The transmitter and receiver have been developed by BMW. The low closed circuit (rest) current properties of the transmitter and receiver enable optical wake-up by the MOST bus.

### Optical Transmitter

A driver is fitted in the transmitter. The driver energizes an LED (light-emitting diode).

The LED transmits light signals on the MOST bus (650 nm light, i.e. red visible light). The repeat frequency is 44.1 MHz.

The sensing frequency on a CD player and for audio is 44.1 MHz; this means that no additional buffer is required, yet another reason why this bus system is so efficient for multi-media.



### Optical Receiver

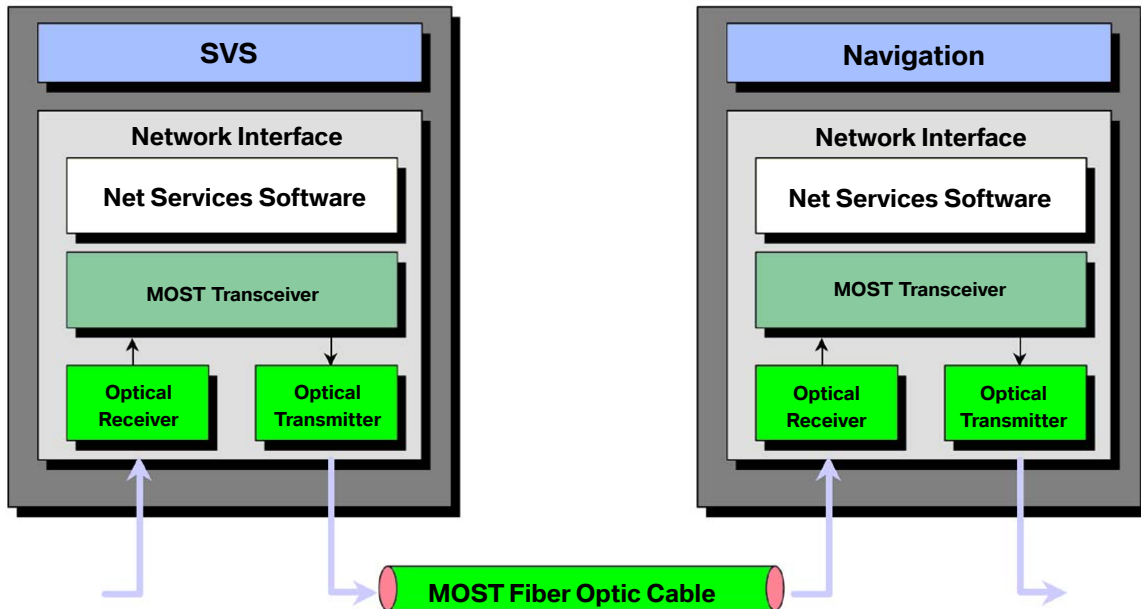
The receiver receives the data from the MOST bus. The receiver consists of:

- An LED
- A pre-amplifier
- A wake-up circuit
- An interface that converts the optical signal into an electrical signal

The receiver contains a diode that converts the optical signal into an electrical signal. This signal is amplified and further processed at the MOST network interface.

## Control Unit/Control Unit Connection

The MOST ring is composed of optical point-to-point connections between 2 control units. Each control unit has a network interface. The network interface consists of:



- An opto-electrical converter (optical waveguide receiver, already mentioned).
- An opto-electrical converter (optical waveguide transmitter, already mentioned).
- A MOST transceiver (interface between the optical waveguide receiver/transmitter and the electronic network driver).
- A network driver, the so-called NetServices.

The NetServices run on a microcontroller (main computer in the control unit)

On the application level, a control unit in the MOST framework contains stand-alone function units, so-called function blocks. Examples of function blocks include:

- Tuners
- Amplifiers
- CD players

A control unit can contain several function blocks at one time, e.g. the AVT contains the functions:

- Antenna
- Amplifier
- Tuner

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## E65 Interfaces

The following contains a brief summary of the tasks of the connected control units in the MOST framework:

### Control Display

The Control Display is the system master of all MOST bus functions and serves as the power master. It wakes up the bus and is responsible for switching it off (power down).

The DIS Plus and GT1 will show a Control Display and a Control Display (Gateway).

### Audio System Controller (ASK)

The audio system controller has the following controller functions:

### Network Master (Main Controller)

The ASK performs the role of network master for the MOST bus. The functions of the network master are the following:

- **Wake-up, initialization, power-down** - The network master wakes up the bus and has the task of achieving an orderly initialization of the network. The ASK can operate with KLR off. To turn it on, push in the volume/ON/OFF knob. Adjustments and control is carried out by using the Controller and Control Display. Another task of the network master is to control the power-down process. Each power-down is initiated and started by the ASK.
- **Configuration control** - The network master detects the exact system configuration each time that the network is started and compares it to the stored coded configuration.
- **Control of the network operation** - The network master controls the MOST transceiver of the slave equipment for correct operation. The equipment which is not operating properly will be released by a reset or switched to low power mode so that they do not affect bus communication.
- **Fault code memory** - The network master includes the fault code memory of the MOST network. It stores all the faults occurring during the network operation as well as deviations from the nominal configuration.

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## Audio Master

As audio master, the ASK has the task to collect and process all the audio signals of the vehicle and to distribute them to their destinations.

The ASK controls all the acoustic requests from the Control Display. The changes in the level of a signal is not sudden, but smooth, e.g. during suppression, insertion and fading out or temporary suppression of the signal at the destination: Because of this, a high-quality acoustic sound is obtained.

The ASK also assumes the generation and preparation of different acoustic signals, e.g. PDC signals and warnings. In the event of a request for a warning or caution signal from a control unit, the ASK provides a clean acoustic change of the signals.

- Audio data - All audio data from any control unit are converted by the ASK into digital audio AF format at a sampling rate of 44.1 MHz.
- Categorization of audio sources - All possible audio sources are divided into different groups according to priority. Warning signals have priority over any other audio source. Mixing of lower priority audio signals (e.g. navigation, radio) is possible.
- Generation of acoustic gongs - These are acoustic alarm signals which help the driver perceive sounds according to a system. The different sounds, requested by the different control units, (e.g. gongs, PDC, etc.), must be generated only in association with a visual indication. These come from the instrument cluster and the Control Display.

The following sounds can be generated in the ASK.

- Beeping for the PDC.
- Various Check Control and warning gongs.

**Note: A maximum of three sounds can be produced at once. Sounds are produced in order of importance. Any sound requests of greater than three will be lost.**

## Connection Master

As connection master, the ASK must provide channels to the equipment connected to the bus and distribute the audio signals on the outputs (loudspeakers).

The connection master also controls the basic Hi-Fi or the LOGIC 7 Hi-Fi amplifiers.

---

### **CD Changer Audio (CDC)**

The CD changer is a slave control unit in the MOST framework.

### **Navigation System (NAV 01)**

The control unit of the navigation system has controller tasks and slave functions in the MOST framework.

### **Slave (Subordinate) Control Units**

The following control units are slave control units:

- Kombi (control unit of the instrument cluster)
- AVT
- LOGIC7
- SVS Speech processing system
- Telephone
- MMC (if equipped - not currently used on US models)

### **Component Locations**

Located in the dashboard assembly are the Control Display, Kombi, ASK, CD changer and OPPS connector.



Located in the luggage compartment, rear left, are the Logic 7 Amp, SVS, NAV and TCU.



Located in the C pillar left side, the AVT (Antenna Tuner)



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## MOST Bus Diagnosis

Due to the differences in the configuration of the MOST bus, diagnosis methods will differ slightly between the E65/E66 and the E60, E63, E64. However, there are many similarities and there are some basic rules which apply to all MOST equipped vehicles.

The following diagnosis applies to the E65/E66 configuration and the differences will be pointed out as necessary.

It is important to remember that on the MOST network, messages can only be transmitted provided the bus ring is complete and fully functional. If there is a ring fault in the MOST network, the diagnostic system only communicates with the instrument cluster and the Control Display because both of these modules are directly connected to the K-CAN System Bus.

The fiber optic signals on the MOST network always travel in one direction and only in one direction. Signals always originate at the Control Display and travel to the CD changer, AVT, Logic 7 (if equipped), SVS, NAV, Multi-Media Changer (if equipped), Telephone, ASK, Kombi and back to the Control Display.

The MOST bus allows intersystem fault memory entries in the individual control modules. A feature of the system faults is that faults may be entered in a control module although the control module is OK. Conclusions may be drawn about the cause of the fault, using the fault information stored in all the control modules.

The possible system faults are:

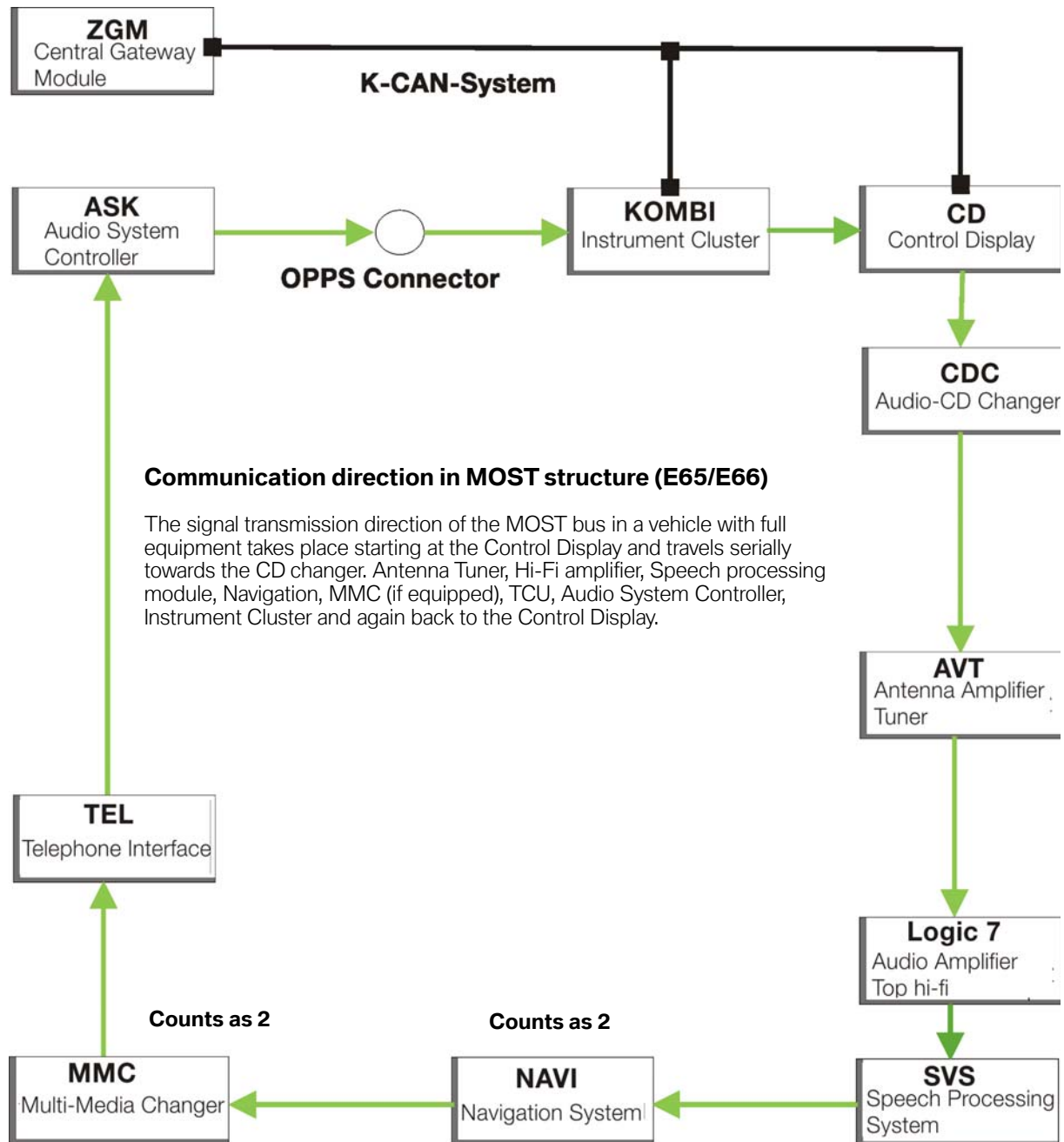
- Optical wave guide communication fault (All MOST Control Module) FC 111
- A Control Module does not switch a light off (All MOST Control Modules)
- Network wake-up unsuccessful (Control Display (Gateway), ASK, Telephone Only) FC E18D
- Ring fault diagnosis run (Control Display (Gateway) and Kombi Only) FC E190

The Control Display functions are split between acting as a Gateway and Displaying information. The Gateway function serves as the interface between the MOST and the K-CAN System buses. Although the Control Display is one control module, two control module names are displayed in the DIS Plus:

- CD Control Display (MOST CAN Gateway or MCGW)
- CD Control Display

The faults stored in the Control Display are distributed between the Control Display Gateway and Control Display according to the function of the fault.

## MOST Control Unit Sequence (E65)



**Note: Important! The component sequence of the MOST controllers in the ETM is incorrect when it comes to signal transmission direction. The correct sequence is indicated above!**

---

## Optical Wave Guide Communication Fault

This fault (FC 111) indicates a problem with optical transmission. Insufficient light is being received by one of the modules in the ring. The loss of light may be caused by:

- Defective optical wave guide, Harness twisted too tightly (Min. bend radius 50mm.)
- Light output or reception sensitivity of a diode is too low
- Connector not installed correctly
- Voltage fluctuation while powering up a control module

If the fault is stored, the system triggers a reset and starts up again. The music is switched off briefly and the display screen of the Control Display continues to operate.

To find the module responsible for the fault, the fault memory of the modules must be read in MOST ring order.

Fault lies between the module with the fault code (B) and the preceding module (A).

If the voltage has dipped below 9v, the fault may be incorrectly stored. If the voltage is low perform the following test after connecting a battery charger.

1. Clear the fault memory in control module B.
2. Lower the light output in control module A.
3. Read out the fault memory in the MOST ring in order.
4. If control module B is again the first to store the fault, it can be assumed the fault lies between control modules A and B.

Then, check control modules A and B for loose connections and check the optical wave guide for kinks. If the visual inspection is OK, the fault can be located using the OPSS tester or optionally performing the following tests.

- Remove the input optical wave guide from control module B and confirm the presence of light. If light is present, install by-pass optical wave guide in place of control module A, clear fault codes in module B and perform ring break test. If MOST network operates properly, then control module A is at fault and must be replaced. If MOST network still has a fault, put module A back in the network and by-pass module B. Clear faults and again perform ring break test. If MOST network operates now problem is with control module B and it must be replaced.
- If light is not present at input of module B, perform by-pass of module A as above.

The possible fault scenarios are:

- Transmit diode in module A defective
- Receive diode in module B defective
- Optical wave guide fault between modules A and B
- Software error or fault in module A or B

**Note: AMP butt connector p/n - 1355734-1**

---

## **Control Module Does Not Switch Off Light**

When the MOST network is requested to sleep, the Control Display switches off the light in the MOST ring. The lack of light input is a signal to the individual control modules to switch off their light output and enter sleep mode.

If a control module does not switch off its light, all down stream control modules register the fault “A Control Module is not switching light off.”

### **Important!**

Failure of a control module to turn its light off, will cause the MOST network NOT to enter sleep mode. If the MOST network fails to sleep, the rest of the car will not be able to enter sleep mode. This will lead to battery discharge.

To diagnose, read out fault memory in MOST ring order.

The fault lies in the control module that precedes the module where the fault is first stored.

Always confirm the problem by first clearing the fault and performing the diagnosis a second time. If the same results occur, replace the defective control module.

## **Network Wakeup Unsuccessful**

This fault indicates a problem with the optical transmission. An insufficient volume of light is coming through one position of the ring and may be caused by:

- Control Module is receiving no voltage
- Optical Wave Guide harness defective
- Optical Element in a control module defective (transmit or receive)
- Connector not installed correctly

A distinction must be made as to whether the fault is currently present or sporadic.

For faults currently present, run the Ring Break Diagnosis Test Plan.

For sporadic faults perform the Luminous Power Reduction Test Plan.

---

## Ring Break Diagnosis Carried Out (FC E190)

Reading out the fault memory of the Control Display (Gateway) after performing the Ring Fault Diagnostic, results in a fault of Ring Fault Diagnosis Carried Out being stored.

This fault memory is not a true fault memory entry, but only an output of additional information for relative node position.

## Testing

### Light Output Reduction

Reducing the light output of individual control modules is a convenient method of determining the area of a defect.

- Switch on the radio.
- In Control Module functions, begin to activate luminous power reduction in the individual control module. (In this test the light output of the selected control module is reduced for 5 seconds and then automatically reset to normal output)
- If the optical transmission for control module A to the next control module in the ring (control module B) is OK, a slight noise may occur when the light output is reduced, however the radio will continue to play.
- If the radio goes off and comes back on again (radio volume may be reduced) in 5 to 10 seconds, the optical transmission between control modules A and B is defective.

If the visual inspection is OK, the fault can be located using the OPPS tester or optionally performing the following tests.

- Remove the input optical wave guide from control module B and confirm the presence of light.
- If light is present, install by-pass optical wave guide in place of control module A, clear fault codes in module B. If MOST network operates properly, then control module A is at fault and must be replaced.
- If MOST network still has a fault, put module A back in the network and by-pass module B. Clear faults.
- If MOST network operates now problem is with control module B and it must be replaced.
- If light is not present at input of module B, perform ring break diagnostics.

---

## Ring Break Test

If there is a break in the ring (a defect between two control modules) the following fault patterns may occur:

- Transmit diode of the transmitting control module defective
- Power supply of the transmitting control module defective
- Internal control module fault of the transmitting control module
- Receiver diode of the receiving control module defective
- Power supply of the receiving control module defective
- Internal control module fault of the receiving control module
- Optical wave guide between transmitting and receiving control module defective

These faults may occur alone or in combination. To diagnose a ring break, the first step is to locate the two control modules between which the transmission failure has occurred.

This is accomplished with the ring break diagnostic function. Once the two control modules have been identified and the diagnostics have been performed, remember to check the power supply and ground circuit of both modules before condemning a module.

Testing of the transmit/receive diodes will be possible using the OPPS tester.

## Perform Ring Break Test

The ring break test mode is entered automatically when the power to all the modules in the MOST network is switched off and then switched back on. The most effective method of switching the power off and on is to disconnect the battery negative terminal for 45 seconds. This time will allow the capacitors of all the control modules to dissipate.

When the battery is reconnected the control modules wake up and in MOST network order transmit a light signal to the next module. Each module checks to see if it has received a light signal from the previous module. If the control module does NOT receive a light input signal it still transmits a signal to the next module. A relative node number of 0 is stored in the control module that did not receive a signal but that transmitted one.

The Control Display receives the light signal back and identifies which modules responded.

Go to “Control Unit Functions” Control Display Gateway and read fault memory.

---

The Control Display will display a relative node number. This number will indicate how many modules communicated after the module which set the relative node number of 0.

To find the control module with the relative node number of 0, count from the input side of the Control Display (counting the Control Display as 0) towards the control modules. When arriving at the control module with the number as displayed as the relative node number in the DISplus, the last known communicating module has been found.

**Example:**

*While performing the ring break diagnostics the Control Display has set a relative node number of 2. Count the Control Display a 0, the Kombi will be 1 and the ASK will be 2.*

*The ring break occurs between the ASK and the module which precedes it, the telephone module.*

**Important!**

When counting control modules, the multimedia changer (if equipped) and the Nav system must be counted as two control modules.

In order to perform the count correctly the equipment on the vehicle must first be identified.

When using the MOST network diagram in the DISplus, connector number 1 of the optical waves are inputs and connector number 2 are outputs.

---

## Status Wakeup

MOST control modules require high current during standby operation and must be disconnected or put in sleep mode to prevent the vehicle battery from being discharged. In case of a fault on the the MOST network that continuously wakes up, the entire MOST bus will be woken up. The Control Display will wake up the CAN Bus and all the vehicle busses will be woken up. This will lead to battery discharge.

It is of great benefit to know which module initiated the wake up call. In order to find out which MOST node woke up the MOST bus, the following procedure is performed - In Control Unit Functions, press "STATUS WAKEUP"

Three different response are possible:

- Control Module woke up
- Control Module woken up
- Control Module not initialized

The Control Module with the status "Control Module woke up" is the module that woke up the rest of the MOST bus.

This diagnosis only informs which control module woke, not the reason for the wake up, diagnostic testing should be performed on the control module and related equipment.

Hints for Vehicle Equipment Identification

- CDC - Look on passenger side of dashboard above glovebox.
- Logic 7 - Look for speaker grills on rear doors  
Look on left side of trunk for large amp.
- MMC - Look on left side of trunk.



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## E65 MOST Bus Diagnostic Tips

### Fault Symptoms E65

Particularly when carrying out troubleshooting in the MOST system network it is important to know the precise significance of visible and audible symptoms. With this information it is possible to locate and correct faults much faster.

The starting point for locating faults should always be to pose detailed questions relating to the fault to the customer. This information can then be used to formulate initial consideration before the BMW diagnosis system is connected.

The following information should be available to the technician:

- When does the fault occur? E.g. already during engine start or while driving?
- Since when does the fault occur?
- Does the fault depend on temperature? When cold, hot or after longer period of vehicle operation?
- Do several functions fail simultaneously? If so, which?
- Is the fault still present after shutting down and restarting the vehicle?
- Was something switched on or off immediately before the fault occurred?
- Is it necessary to enter the telephone PIN after restarting the system?
- Does the radio/CD need to be switched on separately after restarting the system?
- How often does the system fail?
- How long does audio failure last?
- Can a loud clicking noise be heard in connection with the fault?
- Is the system OK again after switching terminal 15 off and on?
- What was shown on the main screen and in the assistance window?
- Does the control display fail?
- Is the display white or black or does it flicker in connection with the fault?
- Can a status line still be seen?
- What is shown after resetting the MOST bus (last menu, basic menu/start menu, BMW logo)?
- Does the CD changer make a noise after audio failure?

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In addition, various factors that could also cause malfunctions in the system should be clarified:

- What control units have already been replaced?
- Did the fault symptom change after replacing control units?
- Was the light intensity reduced for the control units?
- Were the plug connections at the MOST control units checked?
- Was another or new road DVD inserted?
- What road DVD was used?
- Was something retrofitted on the vehicle or a repair carried out?
- To what CIP status (integration stage) does the vehicle correspond?
- Were aftermarket parts retrofitted into any vehicle electrical systems?

Based on the information provided by the customer and after examining any changes in the system it may be possible to determine faults already at this stage.

Why are these statements important? Examples from visual applications:

### **Creating Images**

The control display (CD) contains two control units, i.e. the CD gateway that establishes the connection to the other bus systems and the CD graphics stage that builds up the graphics in the control display. Not all images in the CD are created by the CD graphics stage. All basic menus, sub-menus and the status line are created by the graphics stage (blue). The map is presented by the navigation computer via RGB lines (red).

Consequently:

If only the map is not displayed but the rest, e.g. the on-board computer, is still visible and if other menus can still be selected via the controller, in all probability the fault will be in the area of the navigation system.

Important: The navigation map can also be displayed on the left-hand side.

### **Non-Digitized Area**

A road map DVD, on which an area is not completely digitized can cause the navigation screen to turn green.

### **Self-Burnt DVDs**

A self-burnt or faulty road map DVD can cause the navigation computer to crash. Also a defective computer can trigger a reset of the navigation system, indicating "Initialization running" in the control display.

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## Telephone E65

The telephone AF is routed via the MOST bus in the form of light signals to the ASK. The light is converted in the ASK and the AF is output from the speakers by means of a hard-wired electrical signal.

The microphone is connected via copper cables directly to the telephone control unit. Even if an SVS is installed, it does not have anything directly to do with hands-free telephone operation.

SVS is activated when voice commands are executed. The cause of a fault in hands-free operation should be sought in the area of the microphone, telephone and ASK.

If the telephone PIN is necessary after failure of the MOST bus, this indicates that the telephone control unit triggered a reset and in all probability the fault can be rectified by replacing the telephone control unit.

If the MOST bus is blocked, a telephone conversation via the cordless keypad handset should still be possible provided the telephone itself is not defective.

## Audio

The two models E60 and E65 differ considerably in the area of the audio systems. These design differences necessitate different assessment methods for the purpose of locating faults.

The ASK is responsible for audio output on the E65. If the vehicle is equipped with a Top HiFi amplifier, the audio signal is sent in the form of a light signal from the audio source to the Top HiFi amplifier and forwarded to the speakers as an electrical signal.

Some of the speakers are activated directly by the ASK and some by the Top HiFi amplifier (LOGIC 7).

If the E65 is equipped with a HiFi amplifier, the sound information is transferred via a hard wire circuit to the amplifier.

In connection with the Top HiFi system on the E60, all sound signals are routed from the multi-audio system controller/car communication computer in the form of light signals to the Top HiFi amplifier.

No sound signals are transmitted along fibre-optic cables in connection with the stereo and HiFi systems. The multi-audio system controller/car communication computer itself is responsible for the control of the speakers.

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## E60 MOST Bus Diagnosis

The MOST network uses a ring bus for data communication between the various modules. Signal transmission is by means of a fiber-optic cable. Data transmission on the ring bus takes place in one direction only. On the the MOST ring, messages can only be transmitted provided the bus ring complete and fully functional.

If for example the power supply or the diode of a control module is defective, the MOST bus is non-operational and no communication is able to take place. Exceptions are the gateway control module (CCC or MASK) and the HUD control module.

### CCC/MASK

E60 series vehicles are fitted with either the CCC or the MASK. Either of these control modules are the interface between the MOST bus and the K-CAN.

To diagnose the CCC or MASK:

- CCC (Car Communication Computer) all the control modules with the abbreviation CCC must be selected (e.g. CCC-GW).
- MASK (Multi Audio System Controller) all the control modules the the abbreviation MASK must be selected (e.g. MASK-GW).

### Diagnosis Excessive Temperature

If a control module becomes too hot, this control module switches off for up to 10 minutes. This switches the ENTIRE MOST bus down for 10 minutes. After the control module cools down it (and the MOST bus) is functional again.

If this fault, “Deactivation excess temperature”, is stored in the CCC (or MASK) and any of the other MOST control modules there are two possibilities:

- If the fault is ONLY in the CCC (MASK), then this module is responsible for the MOST bus shut down.
- If the fault is stored in the CCC (MASK) and one or more other control modules on the MOST bus, the most likely cause of MOST bus failure is the other control module. However, this does not rule out the possibility that the CCC (MASK) is also defective.

### Control Module Resets

Using the DISplus or GT1 a Test Plan may be run to check number of control module resets for each control module on the MOST bus.

A control module with 0 (zero) resets has performed no reset, is not installed in the vehicle, or can not be found with the diagnostic equipment.

The control module with the highest number of resets is the most probable cause of a fault with the MOST bus.

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Below is an example of a readout from the DISplus or GT1:

Head-Up Display	15
CD Changer	0
Headset Interface	0
Amplifier	0
Video Module	0
Telephone	0
Satellite Radio	0
Nav System Japan	0
MASK (or CCC)	15

**Note: Resets at a rate of less than 10 may be normal for a control module. When the number of resets is less than 10, this is only an indication on the possible cause of a fault. The control module should generally NOT be replaced with less than 10 resets.**

### **MOST Configuration**

On the E60, certain control units are always arranged in the same order.

Other control units, on the other hand, can be connected in a different sequence.

### **Same Sequence**

Depending on the equipment configuration, the multi-audio system controller/car communication computer is always followed by the CDC, HUD and then the MOST bus terminal.

### **Different Sequence**

The sequence can change as from the MOST bus terminal. Possible control units include:

- Top HiFi amplifier
- Telephone
- Video module

From the MOST bus terminal, the fibre-optic cable is routed back via the flash plug to the multi-audio system controller/car communication computer.

## Store Configuration

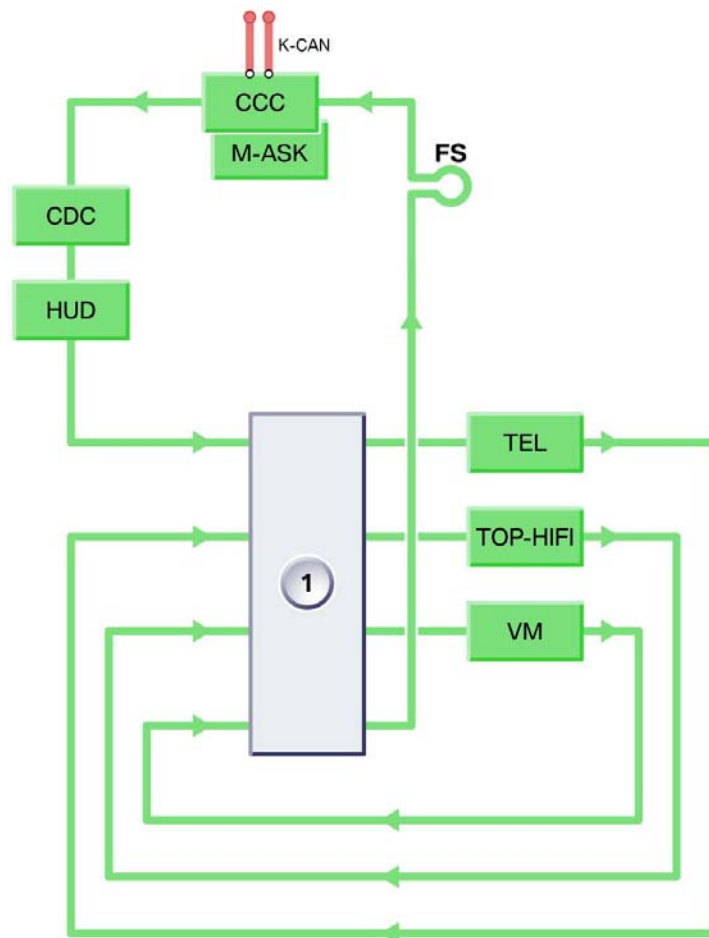
On the E60, the sequence of control units in the MOST system network is identical in the front area of the vehicle. All control units located in the luggage compartment can be connected to the MOST bus terminal in any arbitrary order so that the sequence of the control units can change.

Diagnosis on the MOST bus is only possible over a known sequence of control units in the MOST. When storing the MOST ring configuration, the control units are written in their installed sequence to a registration file. It is first necessary to check whether communication on the MOST bus is possible (stability check).

The configuration is automatically restored after replacing or retrofitting a control unit in the MOST system network. This takes place after programming/encoding with CIP so that the control unit sequence is up-to-date.

The "Store configuration" function is not activated automatically when the control units sequence is changed manually in the area of the luggage compartment (e.g. accident damage repair).

### E60 MOST control unit sequence



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## **Ring Break Diagnosis**

Ring break diagnosis is already known from the E65. During ring break diagnosis on the E65, the voltage supply is interrupted directly at the battery.

Contrary to the E65, restart of the MOST users on the E60 is realized via "Transport mode." The following relays are switched off:

- Relay 1 MPM
- Terminal 30g

These relays supply voltage to all control units in the MOST system network. On activating transport mode, the relays are switched off and the voltage supply interrupted.

After the relays have been switched on again and the control units started up, the multi-audio system controller/car communication computer can detect the control units that still have communication capabilities and evaluate the results. Consequently, the BMW diagnosis system specifies a nodal point that provides an indication of the interruption on the MOST bus.

The functional description in the BMW diagnosis system provides detailed information on determining the nodal position on the MOST bus.

## **Stability Check**

On the E60, the antenna tuner and the audio system controller are located in one unit. The radio is still operable in the stereo and in the HiFi system in the event of a communication fault in the MOST system network. The stability check module was introduced for the purpose of checking the MOST bus in such cases.

Effective operation of the MOST bus on the E60 can be checked with the stability check function.

## **MOST Control Unit Supply**

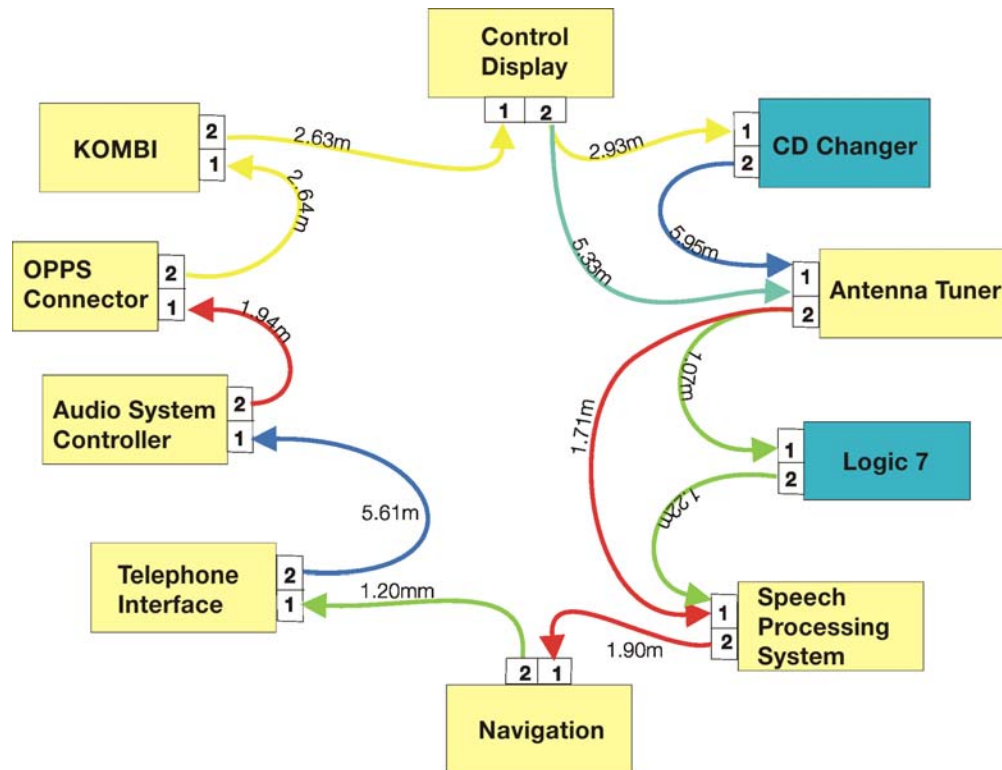
The "MOST control unit supply" module makes available schematic circuit diagrams and information on the power supply of the MOST control units so that specific information is quickly available as required.

## Repair of the MOST Fiber-Optic Cables

The MOST bus may only be repaired (spliced) once between 2 control units, otherwise the attenuation may become too much and disrupt communication.

Attenuation in the Fiber-optic line increases as the distance between controllers increases.

This diagram describes the approximate length of the fiber optic cable from one controller to the next.



Color	Length	Max. Attenuation
Green	1-1.5	-1.4dB
Red	1.5-2	-1.7dB
Yellow	2.5-3	-2.4dB
Blue	5-5.5	-4.5dB

The chart above provides the maximum attenuation values based on the cable length.

The MOST bus may only be repaired using the prescribed special tool (crimping pliers) and special connectors.





## Workshop Exercise - E65 MOST (Ring Break Diagnosis)

*Using an E65/E66 disconnect an instructor designated MOST bus component and perform complete quick test.*

What is observed from the quick test results?

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*Access the “Ring Break” test plan in the diagnosis program. (Note: There are 2 paths to access the ring break diagnostics). Follow the on-screen prompts.*

How can it be determined whether or not there is an existing ring break?

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What are the results of the ring break test? (What nodal position is indicated?)

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What does this nodal position indicate?

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What are some possible causes of a “ring break” fault?

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*Restore MOST bus connection and clear all faults.*



## Workshop Exercise - E65 MOST (Luminous Power Reduction)

*Using the instructor supplied “attenuation tool”, dial in the appropriate amount of attenuation as to cause “crackling” in the audio system.*

*Go to “luminous power reduction” test (a.k.a “test- drop in light output”). Perform test and follow on-screen instructions.*

What is the “luminous power reduction” test used for? (And when should it be used?)

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Which component (if any) exhibited a problem during the test?

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What does this indicate?

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*Using the “control unit functions” menu and access the affected module. Perform the luminous power reduction test via the component activation menu.*

What occurs during the test?

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What does this indicate?

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## Workshop Exercise - E65 MOST (Attenuation Testing)

*Using the OPPS/OPS tester, perform an attenuation test on an instructor designated component/system. Follow on-screen prompts.*

What is tool# 663124 used for?

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During the 1st calibration step (using 663124), what is the observed attenuation reading?

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What is the allowable attenuation for this step?

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**Note: Observe extreme caution when installing or removing tool # 663125. Permanent damage can result to the test cables, which would invalidate attenuation readings.**

What is the observed attenuation reading of the MOST control module being tested?

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What is the specification for the attenuation test for the MOST control module?

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Why is it necessary to reset the OPPS/OPS tester?

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*Perform attenuation test on the “optical wave guide”. Follow on-screen prompts.*

What is the observed attenuation reading of the “optical wave guide” being tested?

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What is the specification for the attenuation test for the “optical wave guide”?

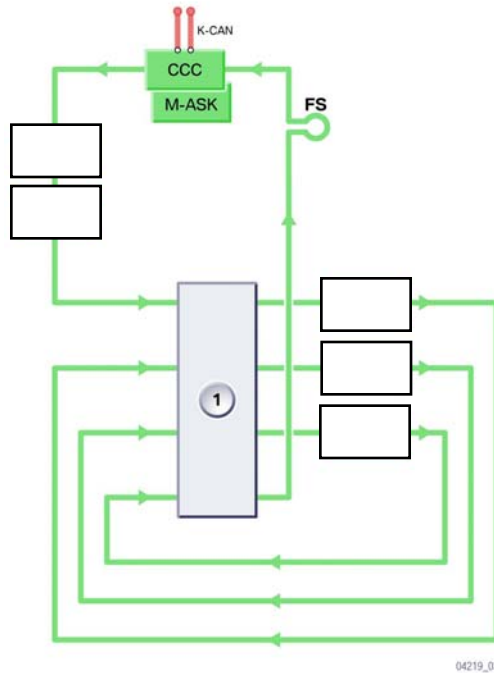
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## Workshop Exercise - MOST Bus (E60,E63 and E64)

Using an instructor designated vehicle, locate the MOST splice point in the rear of the vehicle.

Determine the order of the MOST ring manually and record below:



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List the diagnosis path to access MOST configuration:

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As per the instructors directions, manually re-configure the MOST bus by re-ordering selected components using the MOST bus splice point.

Check the re-configured MOST bus by access the MOST configuration test module in diagnosis.

Why is this test module important and when would it be used?

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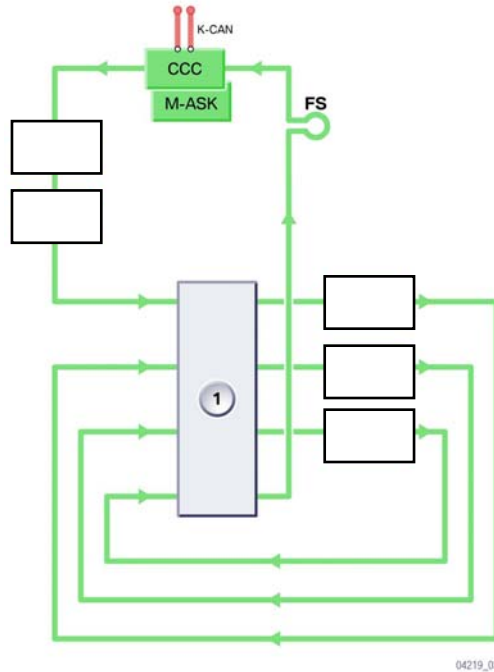
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## Workshop Exercise - MOST Bus (E60,E63 and E64)

After completing the MOST configuration test module, record the new (re-ordered) MOST bus configuration below:



Restore MOST bus to original configuration and re-check system.

Locate the fiber optic jumper harness.

Where is the fiber optic jumper located?

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## **byteflight**

### **Introduction**

The permanently increasing complexity of in-car electronics and the rapidly growing amount of sensors, actuators and electronic control units, places higher demands on high-speed data communication protocols.

Safety critical systems need quick “thinking” protocols with fault tolerant behavior. The need for on-board diagnostics calls for flexible use of bandwidth and an ever-increasing number of functions.

None of the communication solutions available on the market until now have been able to fulfill all these demands.

To solve these problems, BMW together with several semiconductor companies have developed byteflight a new protocol for safety-critical applications in automotive vehicles.

The byteflight is the bus system used exclusively for the ISIS system.

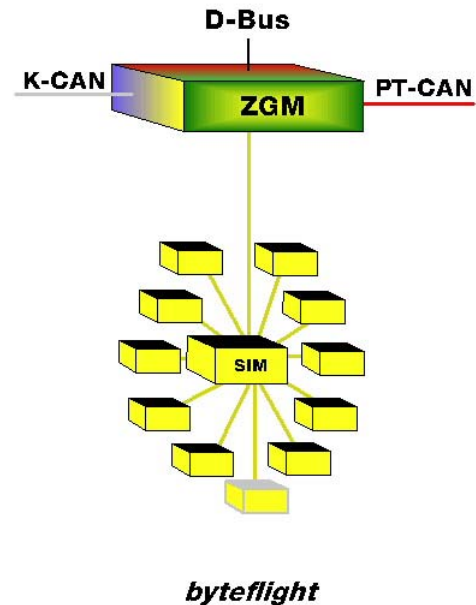
### **Design**

The Intelligent Safety Integration System (ISIS) consists, depending on equipment level, of up to 11 satellites (control units), the Safety Information Module (SIM) and the Central Gateway module (ZGM). Seven of the eleven satellites contain crash detection sensors.

In the event of an accident, the necessary restraint systems have to be activated within a fraction of a second in order to provide the maximum amount of protection for the vehicle's occupants.

The system also has to ensure that the restraint systems are not deployed accidentally. In order to ensure that the ISIS meets the requirements placed upon it, large volumes of data have to be exchanged between the control units. This is achieved by means of an extremely high data transmission rate.

The data is exchanged via a bus system. In order to protect the signals traveling along the bus system from interference caused by electrical or magnetic fields, the ISIS system does not use copper bus wires but optical fibers.



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The layout of the ISIS takes the form of a star pattern. The Safety Information Module (SIM) is at the center of the system. Arranged radially around it are the satellite modules.

Each of the eleven satellites is connected to the SIM by a fibre-optic cable. Each of the satellites contains a transmitter/receiver module.

The SIM contains twelve transmitter and receiver modules. All information from each of the satellites is made available to every other satellite by the SIM. Each individual fibre-optic cable in the byteflight bus system is used for bi-directional data transmission.

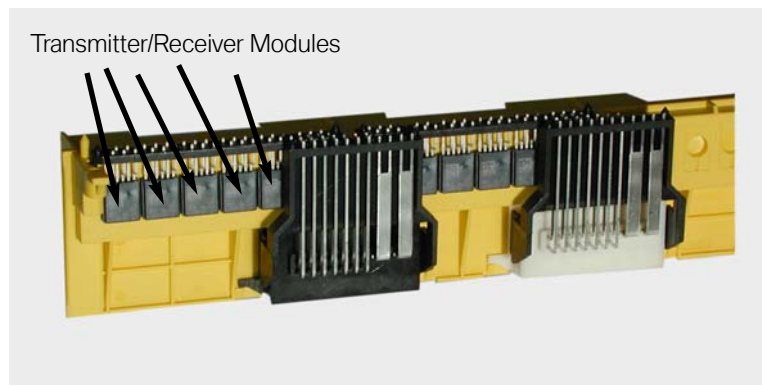
## Function

### Transmitter/Receiver Module (SE)

The transmitter/receiver module is a module that can convert electrical signals into optical signals and transmit them via optical fibers. Every satellite has an electrical-optical transmitter/ receiver module.



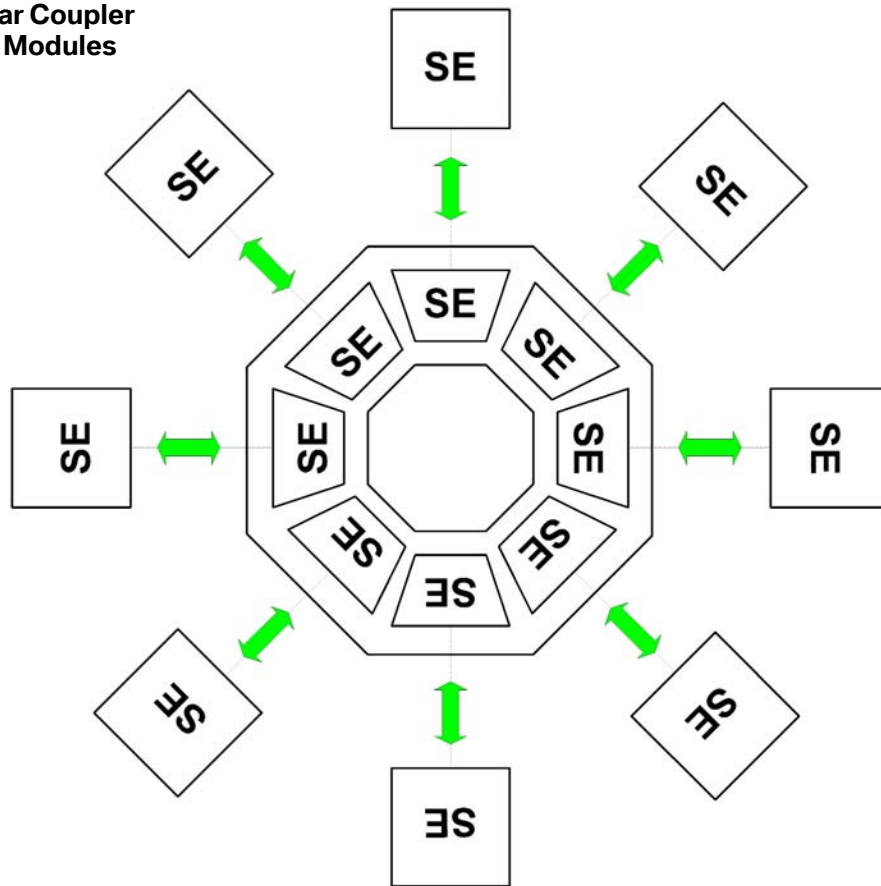
The transmitter/receiver modules are connected individually via the byteflight to the Intelligent Star Coupler in the SIM. The SIM also contains a transmitter/receiver module for each satellite.



All information transmitted across the byteflight is in the form of data telegrams sent by means of light pulses. The transmitter/ receiver modules in the SIM receive the light pulses from the various satellites. The Intelligent Star Coupler sends the data telegrams to all satellites. Data transmission is possible in both directions.

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**Intelligent Star Coupler  
Showing S/E Modules**



The transmitter/receiver (SE) module contains the LED for the driver circuit and the receiver amplifier for converting the optical signals into digital signals. It also has an integral transmission quality monitoring circuit.

**If one of the following faults occurs on one of the fiber-optic cables, the satellite concerned is shut down:**

- No optical signal received over a pre-defined period.
- Transmitter diode sends a continuous light signal.
- Attenuation on the fiber-optic cable too great.

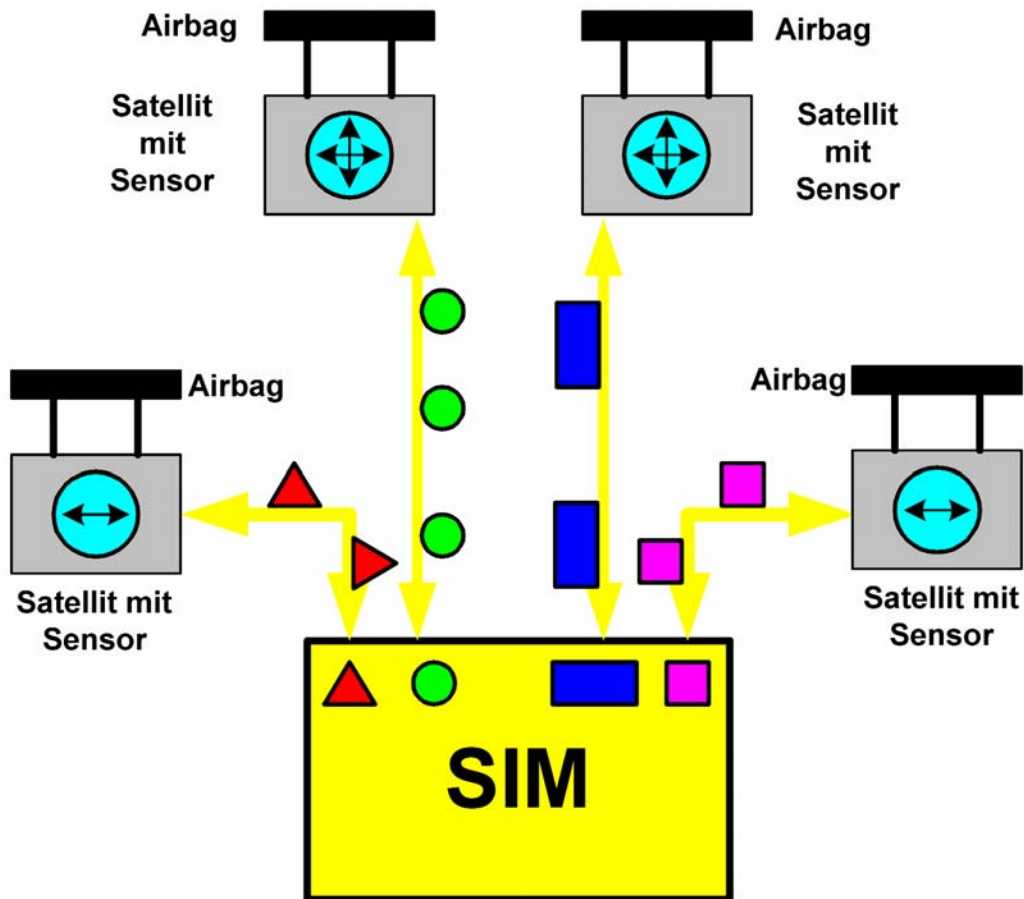
The permissible degree of attenuation is stored within the system. If the attenuation exceeds the specified maximum level, one of the following faults may be the cause:

- Kinking in the fiber-optic cable.
- Compression of the fiber-optic cable.
- Stretching of the fiber-optic cable.
- Broken fiber-optic cable.
- Damaged fiber-optic cable.



## Data Transmission

The ISIS has a number of sensors positioned at strategic points throughout the vehicle. They are located in the satellites that are connected to the SIM via the bytflight. All sensors are scanned continuously and the data distributed to all satellites.



### Information flow on *bytflight*

## Diagnosis

Diagnosis of the bytflight is carried out using the Diagnosis Program. Since the bytflight is a star structure and not a continuous ring like the MOST there is a test module "Data transmission to the satellites" that can check communication between each satellite and the SIM module.

Any satellite that does not respond must then be checked individually using a separate Test Module.

Repairs to the bytflight fiber-optic cable are not permitted. However, complete cables between the SIM and the affected satellites may be replaced.

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## **Controller Area Network (CAN Bus)**

### **Introduction**

The CAN bus is a serial communications bus in which all connected control units can send as well as receive information. Data exchanges over a CAN operate at a rate of 100 to 500Kbps.

The CAN protocol was originally developed by Robert Bosch GmbH and the Intel corporation in 1988 for use in the automotive electronics industry to provide a standardized, reliable and cost-effective communications bus.

The CAN bus was originally introduced on BMW automobiles in 1992 740i/iL as a data link between the DME and AGS control units.

### **E65 K-CAN**

#### **Introduction**

For the E65, the functions that were incorporated within the main bodyshell electrical system on the E38 have been distributed among a number of separate control units. Those control units and various new control units are connected to the K-CAN.

The K-CAN is a new development and is subdivided into two sections, the K-CAN System and the K-CAN Peripherals.

Examples of new control units and functions on the K-CAN are the Car Access System (CAS), the Centre Console Control Center module (BZM), the Rear Centre Console Control Center module (BZMF) and the Power Module (PM).

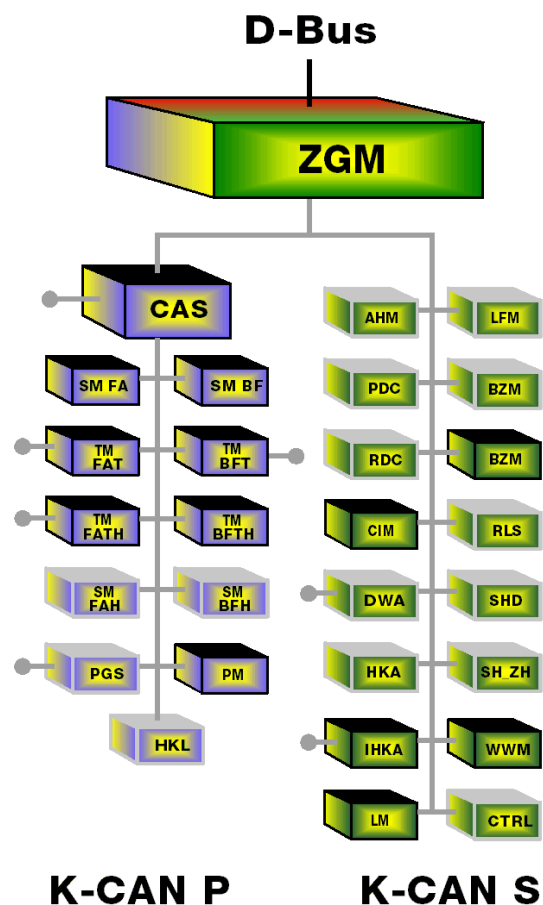
#### **K-CAN System/Peripherals**

The subdivision of the K-CAN into the sections "SYSTEM" and "PERIPHERALS" relieves the load on the bus because the number of vehicle components (control units/modules) is divided between two "independent" bus systems.

## Advantages of two K-CAN Busses

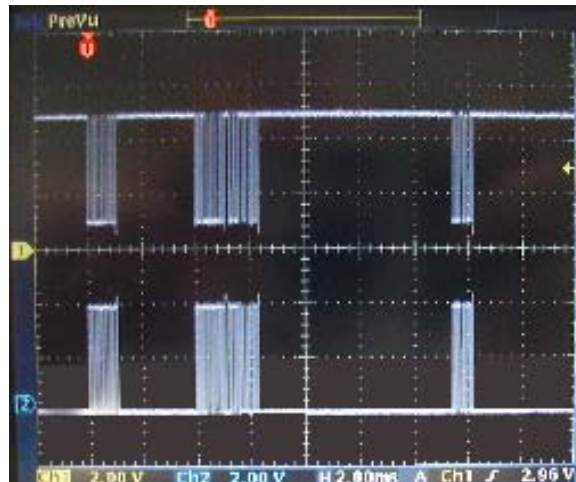
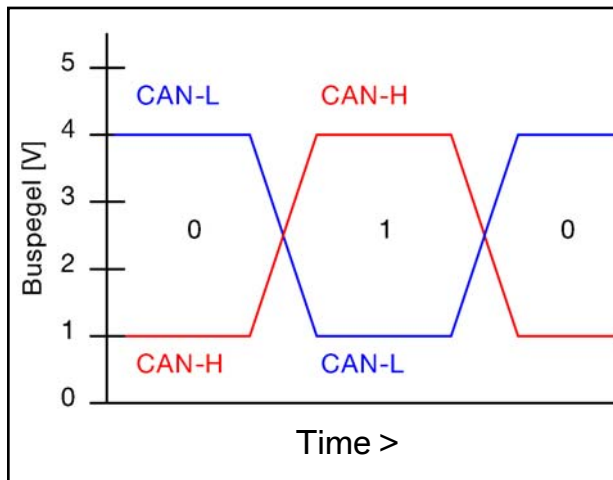
The advantages of two K-CAN busses are as follows:

- In a crash, it is possible that components could fail as a result of a short circuit on the K-CAN. The K-CAN Peripherals covers such at-risk areas. If the K-CAN Peripherals were to fail, the K-CAN System would still remain functional.
- Addition of new vehicle components to either bus is possible at any time. (Maximum 40 control units per bus)
- Low data load on the bus system from bus users due to division into two sections.
- Greater reliability.



## Voltage Level on the K-CAN.

If the CAN High voltage level changes from low to high, this represents a logical 1. If the voltage level changes back to low, this represents a logical 0. The voltage level on the CAN is in the range of 1V to 5V.



**Note: The voltage can alter as a result of a defective terminal resistor, for example. This has an effect on the CAN system. Communication between bus nodes no longer functions properly.**

## Terminal Resistor

An electrical conductor through which current passes always has an ohmic, an inductive and a capacitive impedance. When data is transmitted from point "A" to point "B" over a CAN line, the total sum of that impedance has an effect on the transmission of that data.

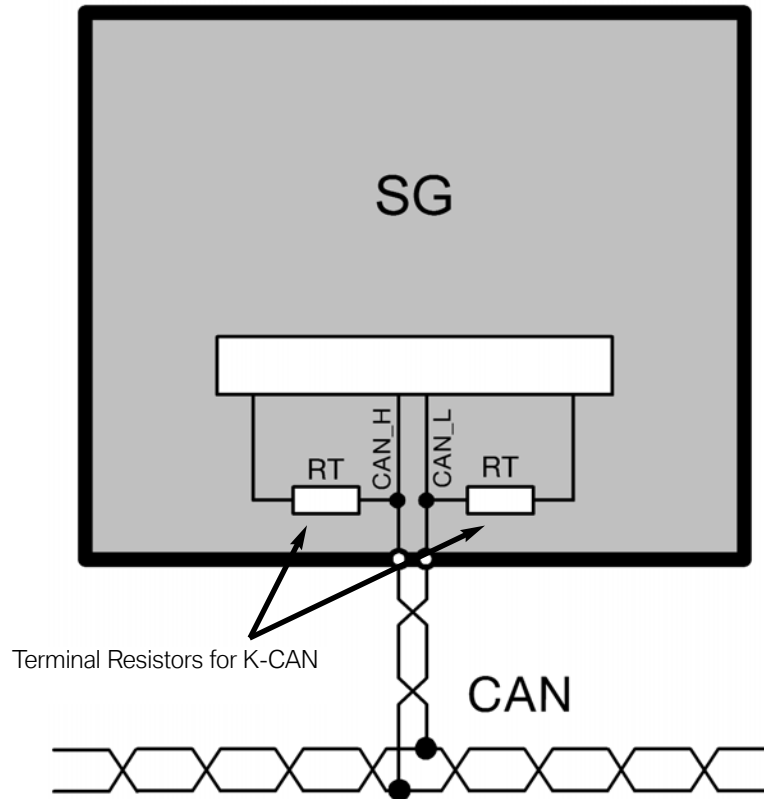
The higher the transmission frequency, the greater the effect of the inductive and capacitive impedance. The result of this can be that when the signal reaches the end of the data transmission line, it is unidentifiable. For that reason, the data line is "modified" by terminal resistors so as to preserve the original signal.

The inductive impedance is produced by phenomena such as the coil effect of the wire. The capacitive impedance for example is produced by the effect of routing the wire parallel to the vehicle body. The terminal resistors on a bus system vary. They are generally dependent on the following parameters:

- Frequency of data transmission on the bus system.
- Inductive/capacitive load on the transmission channel.
- Length of the data transmission cable (The longer the cable is, the greater is the inductive component).

The control units are categorized either as basic control units or other control units. Categorization is performed on the basis of the impedance level. Basic control units are those which always have to be fitted in the car regardless of equipment level or market. Other control units are those that are dependent on the options fitted.

The terminal resistor values for the K-CAN system are 820 Ohm for "Basic" controllers and 12K Ohms for all other control units.



For the E65 the Basic controllers are:

K-CAN S: LM, IHKA, CAS, CD, ZGM, KOMBI.

K-CAN P: CAS, TMFAT, TMBFT, HKL

The resistors are located inside of the control units.

Wake-Up on the K-CAN

The control units on the K-CAN network are "awakened" via the bus. For that reason, it has been possible to dispense with the previous function of terminal 15 as wake-up line. The wake-up message is passed directly to the control unit output stage by the CAS module receiver. The output stage switches terminal 30 on and the unit is woken up.

# PT (Powertrain) CAN

## Introduction

The PT CAN is the fastest CAN bus in the E65. It is an existing bus system. PT CAN stands for powertrain CAN. It links all control units/modules associated with the powertrain. All the bus nodes are connected in parallel with one another. In contrast with the previous bus, (two-core twisted pair) it now has three wires. The third wire of the bus cable is used as the wake-up line and has nothing to do with the actual CAN bus function.

## Voltage Level on the PT CAN

When the bus is inactive, the bus high and low levels are at 2.5 V.

When the bus becomes active, the CAN Low voltage level changes to low (1.5 V) and the CAN High level changes to high (4 V), thus representing logical 1.

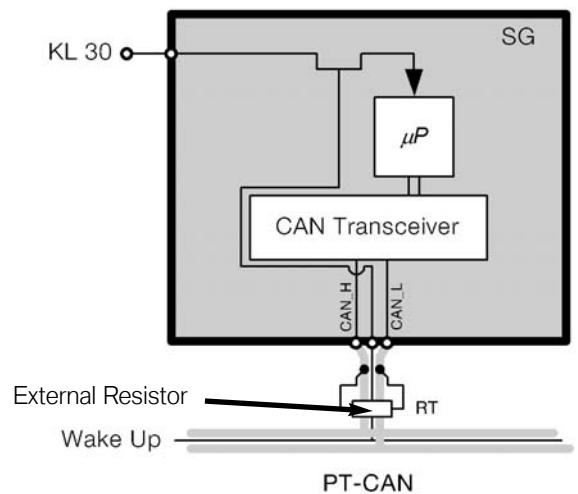
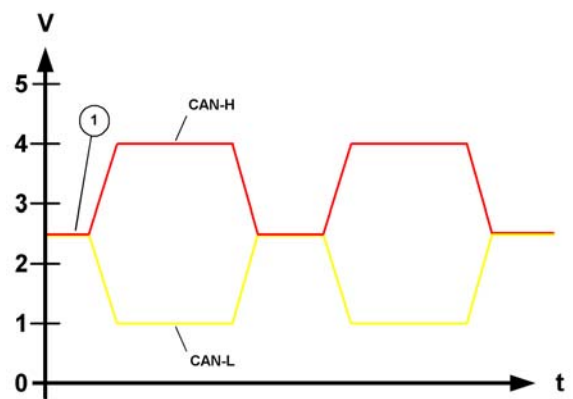
## PT CAN Terminal Resistors

The PT CAN uses two terminal resistors to establish the correct inductive and capacitive impedance in the communication lines. Two 120 Ohm resistors are located in the wire harness (no longer in the control units as on previous systems). The resistors are located:

- Ahead of the right front wheel. (Behind bumper)
- Below the rear seat.

The resistance is measured by connecting the appropriate adapter to any of the modules on the PT-CAN and measuring resistance between CAN-H and CAN-L.

The measured resistance should be close to 60 Ohms.

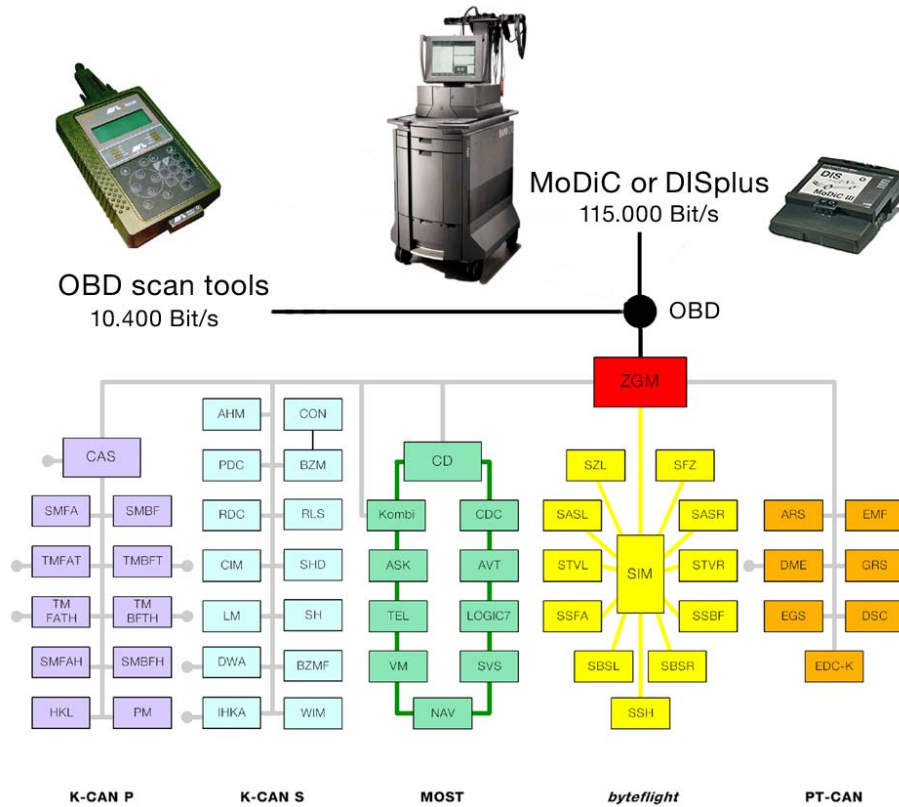




# Diagnosis Bus

## Introduction

The aim of diagnosis is to enable a Technician to reliably identify a defective component. By the use of appropriate hardware and monitoring software, the microprocessor of a control unit, for example, is able to detect faults in the control unit and its peripherals.



Faults identified are stored in the fault memory and can be read out using the Diagnosis Program. Data transfer between the vehicle and the diagnosis tool takes place via the Diagnosis bus (D bus). The new features of the diagnosis bus are:

- Faster data transmission speed of 115 kBd.
- Central diagnosis access point (OBD connector).
- Single diagnostic cable (TxD II) for the entire vehicle.
- Omission of the TxD1 cable.
- Access to diagnosis functions requires "Authorization".
- Diagnosis protocol "KWP 2000" (Keyword Protocol 2000).
- Standardized diagnosis structure for all control units.



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## Diagnosis Concept

The "BMW Fast" (BMW fast access for service and testing) diagnosis concept introduced on the E65 is applied. This concept is based on the "Keyword Protocol 2000" (KWP 2000)

diagnosis protocol defined as part of the ISO 14230 standard. Diagnosis communication takes place entirely on the basis of a transport protocol on the CAN bus.

The Diagnosis bus is connected to the Central Gateway Module. All bus systems apart from the MOST bus are connected to the Central Gateway Module (ZGM).

## Vehicle Diagnosis Access Point

The diagnosis tool is connected to the vehicle by means of the diagnosis connector OBD ( On-Board Diagnosis ). The connector is located behind a small cover in the drivers side kick panel trim. There is a black plastic cap that bridges KL-30 to the D-bus when the connector is not being used. This cap must be removed before installing the diagnosis cable.



The TxD lead is located in pin 7 of the OBD socket and is connected directly to the ZGM.

The ZGM detects by means of the data transmission speed whether a BMW diagnosis tool (DISplus, GT-1) or an aftermarket scanner is connected.

The DME allows access to different data depending on the diagnosis tool connected.

**Note: When using an OBD scan tool for diagnosis, the transmission speed is 10.4 KBit/s.**



## Workshop Exercise - PT-CAN

*Using an instructor designated vehicle, access the DME (ECM) and connect the appropriate breakout box and test cables. Using the Oscilloscope, obtain a pattern of the CAN High signal.*

What is the voltage of the CAN High signal? And what else can be observed of the CAN High signal?

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What is the wire color for CAN High? \_\_\_\_\_

*Record you oscilloscope setting and connections below.*

Voltage \_\_\_\_\_ Frequency \_\_\_\_\_

Connections: MFK 1 or 2 Describe positive and negative connections below:

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*Using the Oscilloscope, obtain a pattern of the CAN Low signal.*

What is the voltage of the CAN Low signal? And what else can be observed of the CAN Low signal?

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What is the wire color for CAN Low? \_\_\_\_\_

*Record you oscilloscope setting and connections below.*

Voltage \_\_\_\_\_ Frequency \_\_\_\_\_

Connections: MFK 1 or 2 Describe positive and negative connections below:

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## Workshop Exercise - PT-CAN

*Using the DISplus or GT-1 (with MIB), display the CAN High and CAN low signal together.*

What can be observed regarding these two signals?

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*Using the multi-meter functions of the DISplus/GT-1, measure the resistance between CAN High and CAN Low.*

What is the total resistance between CAN High and CAN Low?

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What causes the resistance readings obtained?

Where are the PT-CAN terminal resistors located in this vehicle? What is the resistance value of the PT-CAN terminal resistors?

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What occurs when CAN High is grounded?

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What occurs when CAN High is grounded?

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## Workshop Exercise - K-CAN

*Using an instructor designated vehicle, access the K-CAN circuit and display pattern on oscilloscope.*

What is the voltage of the K-CAN (High and Low)?

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What are the major differences between the K-CAN and PT-CAN scope patterns?

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What occurs if there is a malfunction of the K-CAN Low circuit? (i.e. open/grounded)

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What occurs if there is a malfunction of the K-CAN High circuit? (i.e. open/grounded)

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***Measure the resistance between K-CAN High and K-CAN low.***

What is the total resistance between K-CAN High and K-CAN Low?

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Where are the K-CAN terminal resistors located? What are the ohmic values of these resistors?

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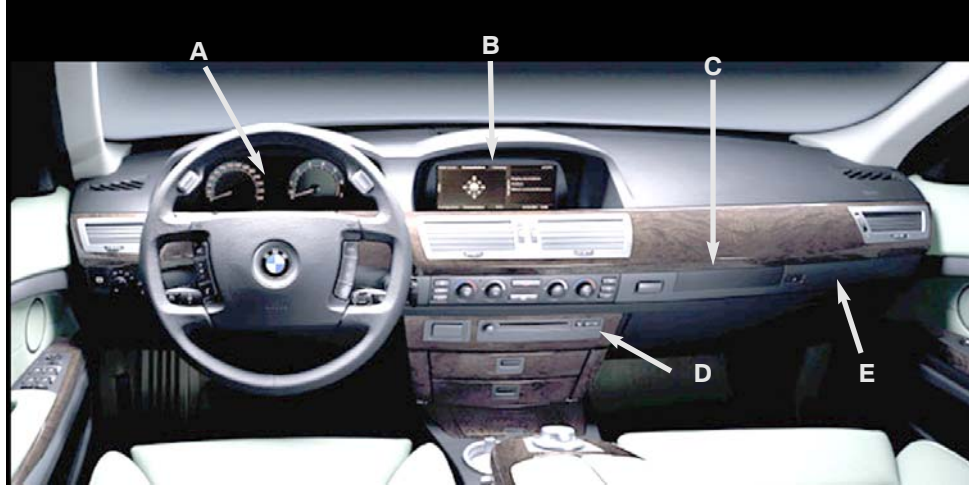
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## Classroom Exercise - Review Questions

1. Fill in the component location below:



- A. \_\_\_\_\_ B. \_\_\_\_\_  
C. \_\_\_\_\_ D. \_\_\_\_\_  
E. \_\_\_\_\_

2. In the E65, which modules perform the task of “Gateway”?

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3. What are some of the handling precautions when working with fiber-optic cables?

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4. What is the difference between the fiber-optic connector of a MOST component and a byteflight component?

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5. What is the difference between the D-Bus of the E65 and other BMW models?

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6. How many terminal resistors are located in the PT-CAN? Where are they located? What should the total resistance be on the PT-CAN?

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7. During a diagnosis of the MOST bus on an E65, the technician finds a recorded fault in the SVS. The fault is "A control module does not switch off light". Which control module is most likely the cause of this fault? And why? (explain answer)

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8. When performing the "ring break" diagnosis test, battery voltage must be interrupted to MOST bus control units. What is the difference between the methods of disconnecting voltage on the E65 versus the E60?

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