Table of Contents

E70 Voltage Supply and Bus Systems Workbook

Subject Page

E70 Voltage Supply 5
- Overview of System Components 6
  - Vehicle Battery 6
  - Distribution Box (on battery) 6
- Energy Management 7

Bus Systems 10
- New Bus Systems on the E70 10
- Diagnosis CAN 11
  - Location of D-CAN Connector 11
- FlexRay 12
  - FlexRay in the E70 13
- MOST Bus 14
  - MOST Users 14
  - MOST Access 14
- Car Access System 3 (CAS3) 17
  - History of the Car Access System 17
  - Functional Overview 17
- Electronic Vehicle Immobilizer 3 (EWS 3) 18
  - Electronic Vehicle Immobilizer 4 (EWS 4) 18
    - Design of EWS 4 18
  - Start Enable through EWS 19
    - Data Transmission 19

Initial Print Date: 12/06 Revision Date:

Table of Contents

Subject Page

Secret Key 19
Gearbox Enable 20
Start Value Matching 20
Emergency Release 20
Vehicle Data Storage 21
Data for Condition-based Service 21
Manual Update of CBS Data 21
Manual Update of Fault Memory Data 21
Control Unit Replacement 21

Table of Contents

Subject Page

Voltage Supply and Bus Systems

Model: E70

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe changes to the E70 Voltage Supply Systems
- Understand the Bus Systems as applied to the E70
- Understand the new D-CAN and FlexRay

E70 Voltage Supply

With regard to voltage supply on the E70, much of the vehicle is configured in a similar manner to the E9X vehicles.

With increases in technology, there is an ever-increasing load on the electrical system. As with every new model, the power supply system becomes more significant.

In the E70, there are two power distribution boxes. The front distribution box (2) is below the glovebox and the rear power distribution box (1) is on the right hand side of the luggage compartment.

The illustration above shows the layout of the primary power supply system components.

Also, there is a distribution box on the battery which contains large capacity fuses.

Overview of System Components

The power supply system of the E70 consists of the following components:

- Vehicle battery
- Distribution box on the battery
- Rear distribution box on the right-hand side of the luggage compartment
- Battery cables
- Front distribution box behind the glove compartment
- Junction box control unit
- E-box engine compartment
- Jump start connection point
- Alternator.

The most important new features/changes to the power supply system in the E70 are described below.

Vehicle Battery

The vehicle battery is installed in the luggage compartment floor.

The vehicle batteries are AGM type, and depending upon equipment, they are either 70 Ah or 90 Ah.

Distribution Box (on battery)

The distribution box in the luggage compartment of the E70 is mounted directly on the vehicle battery. The rear distribution box on the battery is secured on the vehicle battery by means of a metal tab. The metal tabs must be pressed downward and outward in order to release the distribution box.

The distribution box on the battery is equipped with fuses for the following electric loads:

- Electrical auxiliary heater (100 A)
- Valvetronic or common rail system (80 A)
- Intelligent battery sensor IBS
- Reserve
- Front distribution box (250 A)
- Rear distribution box (100 A)
- Large electric fan 850 W (100 A)
- Reserve.

The distribution box on the battery should be replaced only as a complete unit.

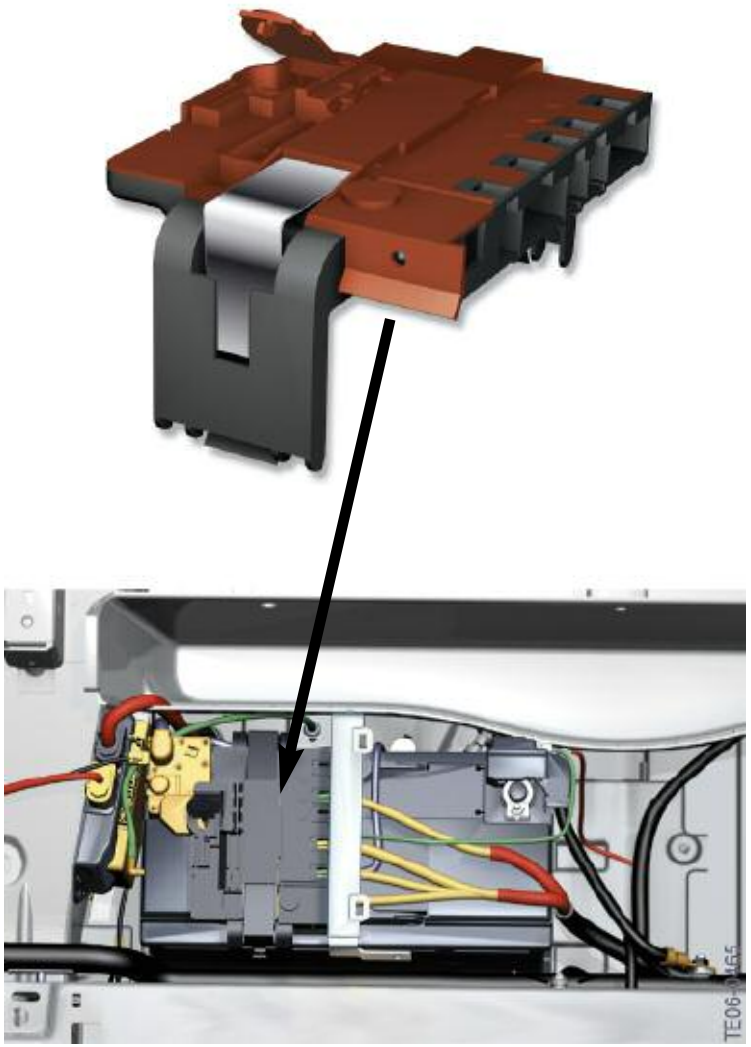
The fuses are integrated as a complete unit in the housing of the distribution box on the battery. The fuses differ in terms of their power rating. The distribution box additionally contains the power supply for the BS.

Note: The connectors are color coded and mechanically coded to avoid confusion. These are high power connections, therefore always ensure correct contacting!

When replacing or working on the distribution box, always make sure the plug connections and, above all, that the screw connections are secured properly.

Connection between battery terminal and distribution box =15 Nm.

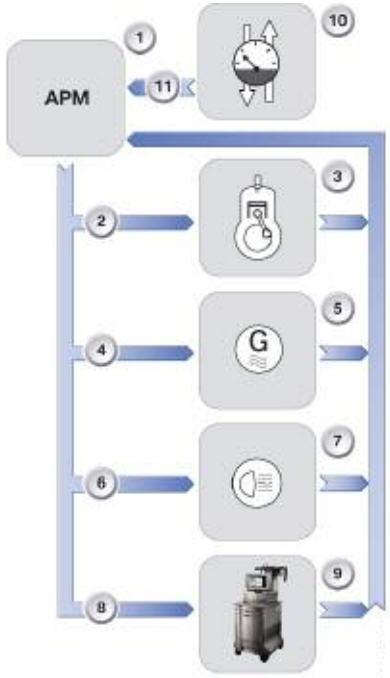
Distribution Box (on battery)



Energy Management

The E70 is equipped with Advanced Power Management. This simply means that the power management system includes the Intelligent Battery Sensor (IBS).

Much of the system functions the same as the E90 on which it is based.

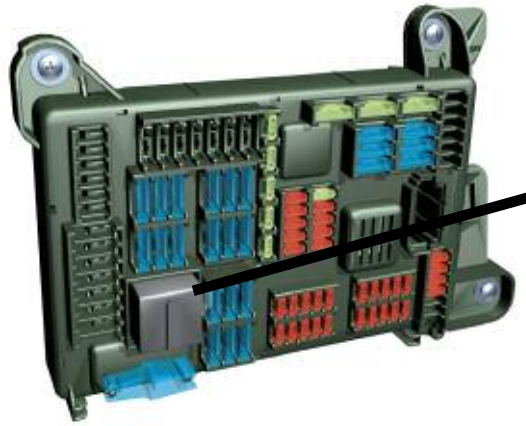


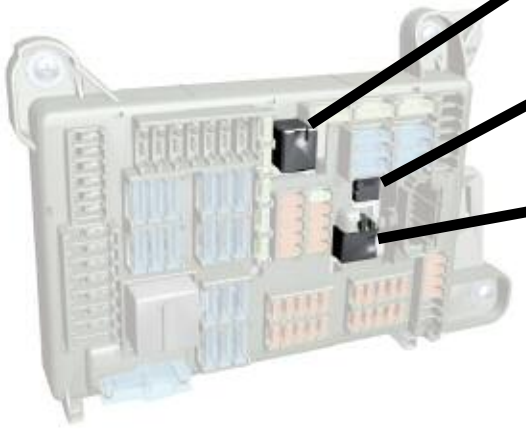
Index	Explanation	Index	Explanation
1	Advanced Power Management	7	Electrical loads
2	Idle speed boost	8	Electrical system and battery diagnosis
3	Engine	9	BMW Diagnostic System
4	Charging voltage target value	10	Intelligent Battery Sensor
5	Alternator	11	Battery Data
6	Electrical load reduction		

Workshop Exercise - Power Supply

Using the instructor designated vehicle and the ETM's in WebTIS, locate the relays in the front & rear power distribution boxes.

Fill in the chart at the right denoting the relay designation and whether or not it is soldered to the PC board.

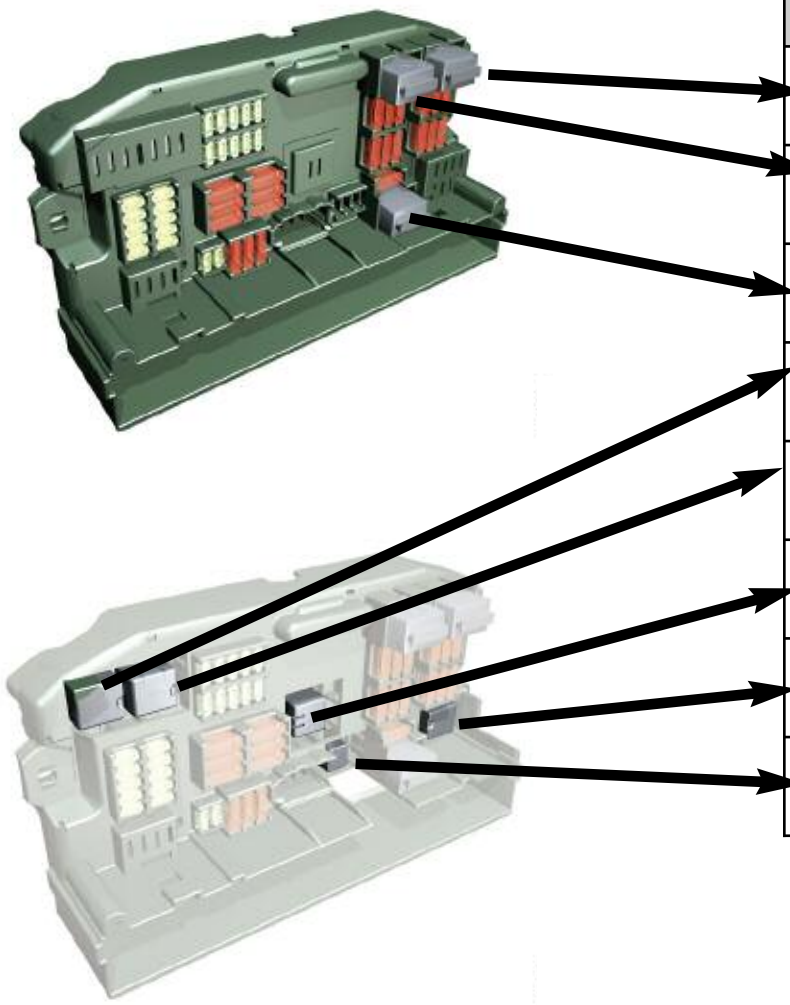




Relay Designation	Soldered	
	Yes	No

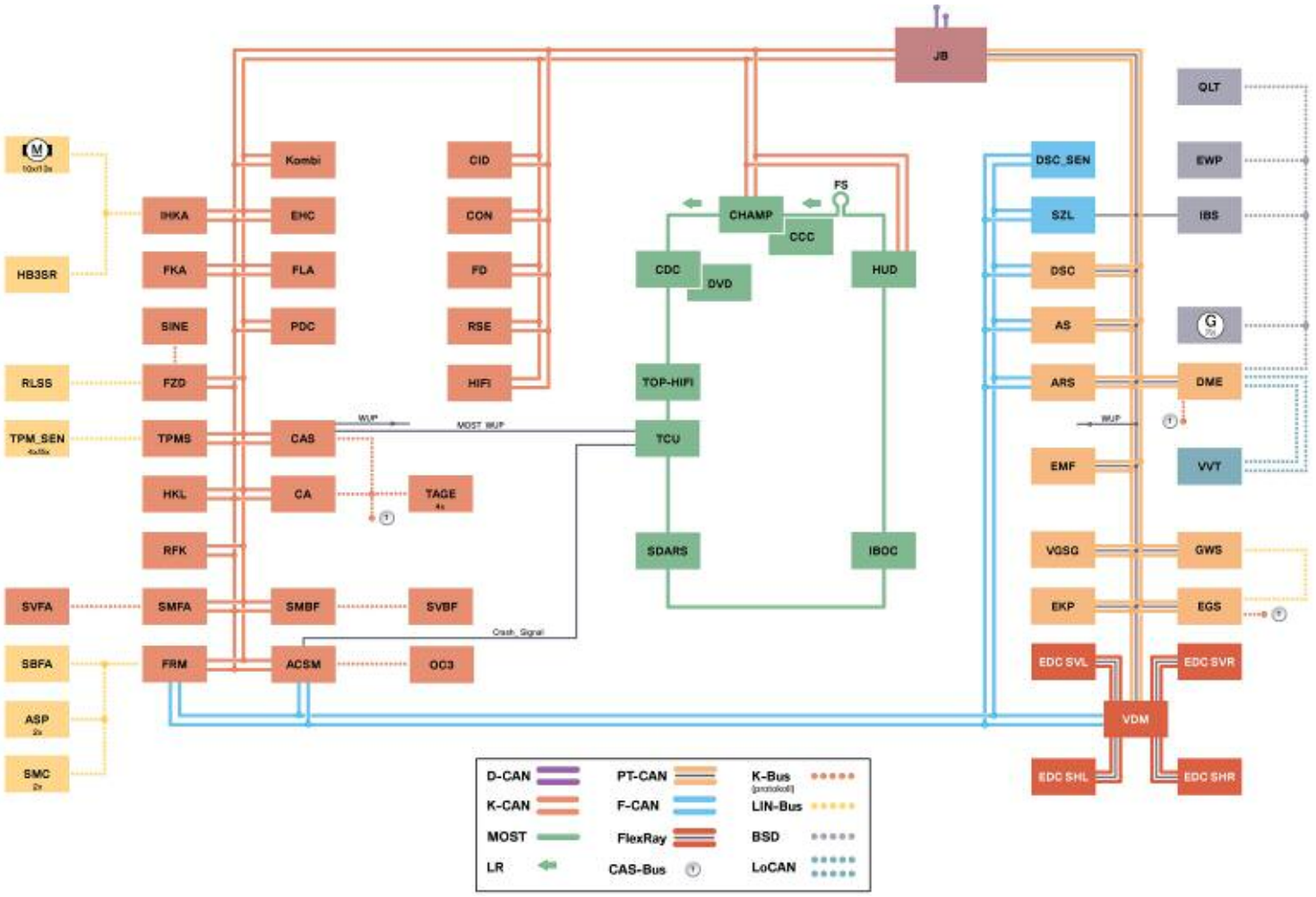
Exercise - Power Supply

Continue with the exercise using the front power distribution box.



Relay Designation	Soldered	
	Yes	No

Bus Systems



New Bus Systems on the E70

The bus network on the E70 is built upon the foundation from the E90. Many of the bus systems have been carried over. As far as the E70 bus systems are concerned, there are two new systems not previously used:

- D-CAN - This is the Diagnosis CAN which will be phased into all models from this point.
- FlexRay - FlexRay is currently used only on the Vertical Dynamics Management System (VDM).

Diagnosis CAN

After connecting a BMW diagnostic system, the gateway (junction box control unit) places the requests of the BMW diagnostic system on the internal buses. The responses undergo the same process in opposite direction.

In future, a new communication protocol will be used for diagnosis. The D-CAN will replace worldwide the previous diagnostic interface and its protocol which is based on KWP 2000 (Keyword Protocol 2000).

The reason for the changeover is a new legal requirement in the USA requiring that all vehicles be equipped with the D-CAN as from model year 2008. The transitional phase will begin in September 2006.

This modification will then be phased-in on all BMW models.
In order to connect diagnostic equipment to a vehicle equipped with D-CAN, only the OPS or OPPS can be used in conjunction with the correct cable shown below.

The cable should have the appropriate “CAN Included” markings.

Location of D-CAN Connector

The diagnosis socket is located under the dashboard on the driver's side in the same location as previous diagnostic connectors.

D-CAN support with the diagnostic head is technically not possible.
The following interfaces can be used:

- OPS
- OPPS

OBD access in the vehicle will remain unchanged.
The pin assignments are as follows:

- 16 = Terminal 30
- 5 = Terminal 31
- 14 + 6 = Communication connections

The diagnosis socket is located under the dashboard on the driver's side.

FlexRay

Up until now, the CAN bus format has provided the necessary speed required for today's vehicle systems. From this point on, many of the new features and systems will require a more robust network with much higher communication speeds.

Therefore, in 1999, the FlexRay consortium was founded by BMW AG, Philips, Motorola (Freescale) and Daimler Chrysler AG. This consortium set forth developing innovative communication technology for the future of the automobile.

Since 1999, the FlexRay consortium was joined by additional partners including GM, Ford, Mazda, Bosch, and Siemens VDO.

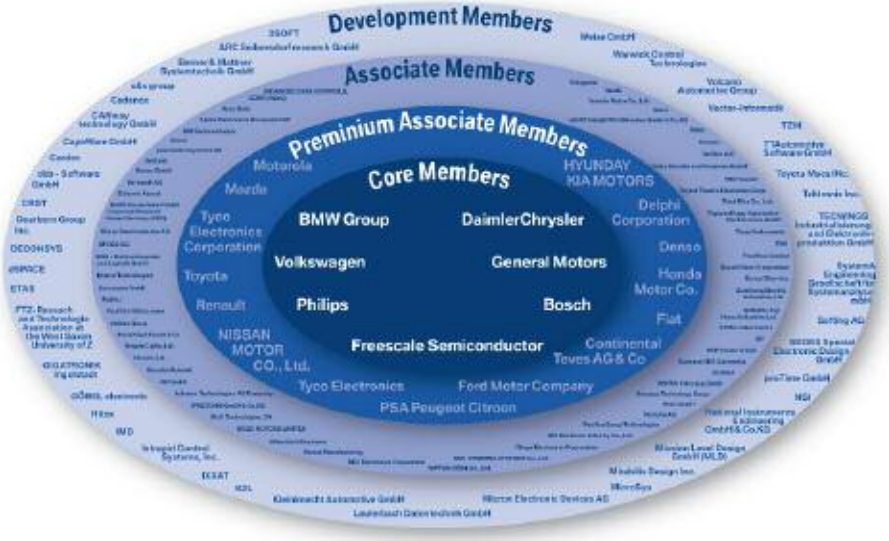
Soon after many other automotive industry concerns have signed on allowing FlexRay to become an industrial standard.

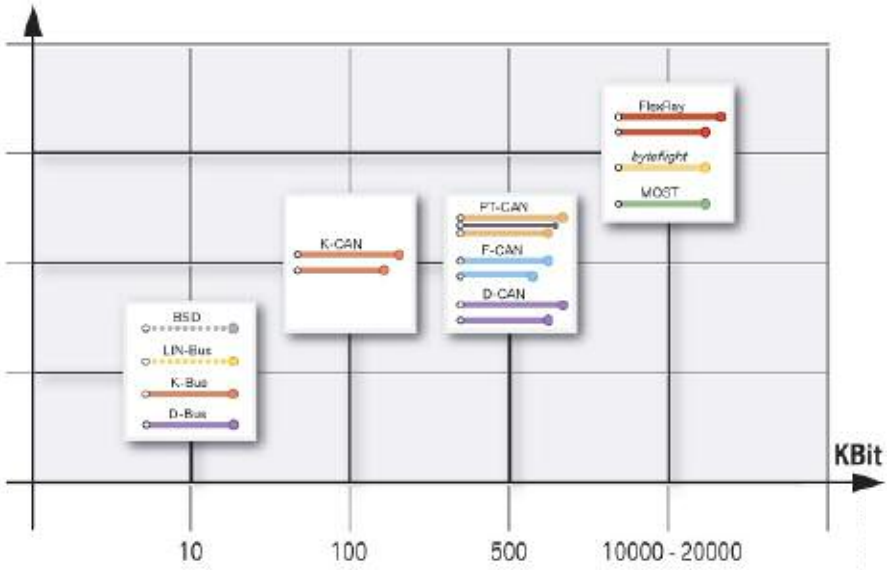
Flexray, with a communication speed of 10 Mbits/second, far exceeds the current CAN based systems at 500 Kbits/second.

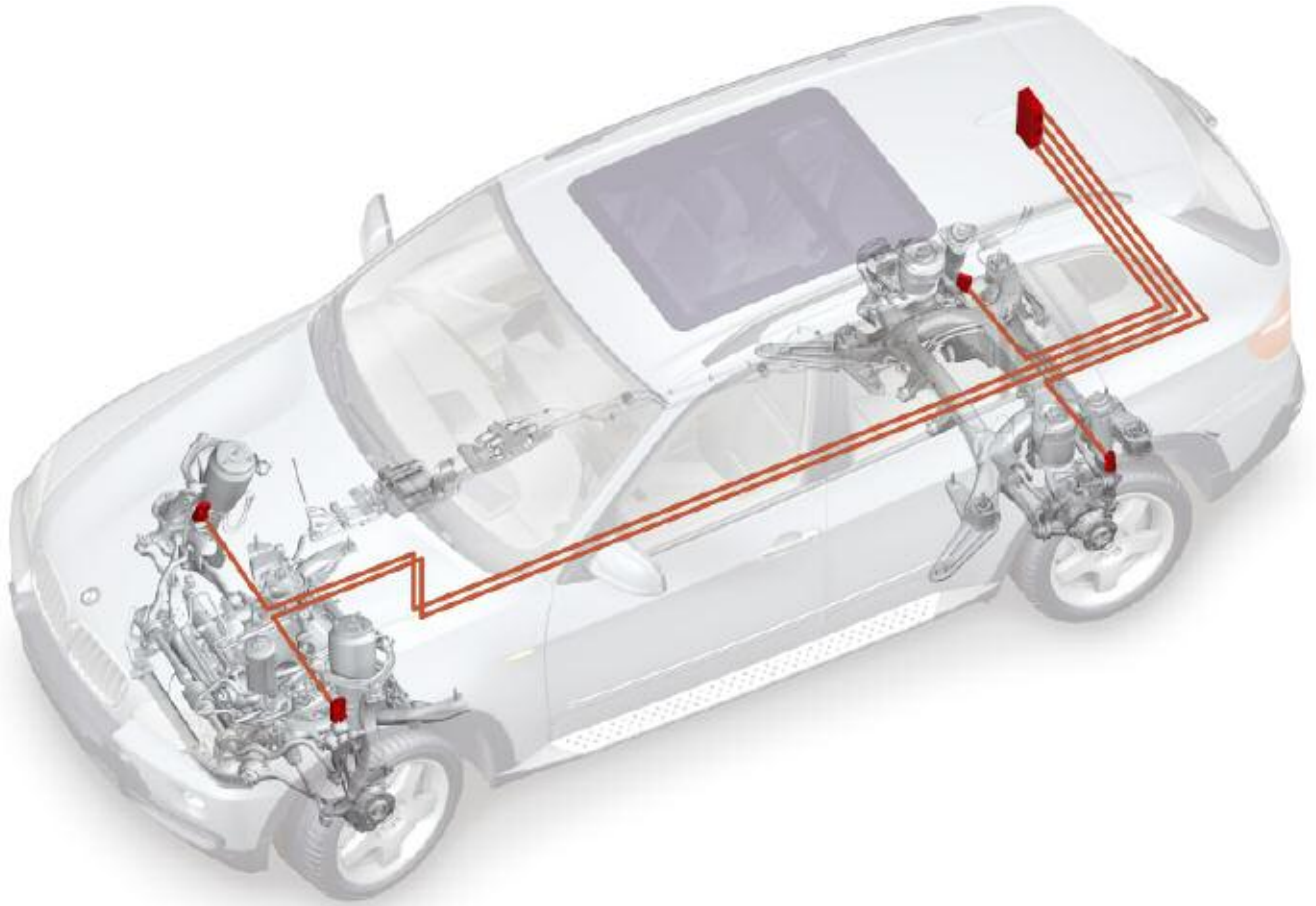
In addition to speed, FlexRay offers efficient “real time” capabilities.

The following outlines the advantages of FlexRay:

- High bandwidth (10 Mbits/s compared to 0.5 Mbits/s of the CAN)
- Deterministic (= real-time capabilities) data transmission
- Reliable data communication
- Supports system integration
- Standard in automotive industry







Currently, the only system on the E70 which uses the FlexRay bus system is the Vertical Dynamics Management (VDM). This system is similar to the EDC system known from existing vehicle.

The use of FlexRay will be expanded in future models. Many powertrain and chassis systems will adopt this format in order to be compatible with the requirements of future systems.

For more information on FlexRay and VDM, refer to the Chassis Dynamics section of this workbook.

MOST Bus

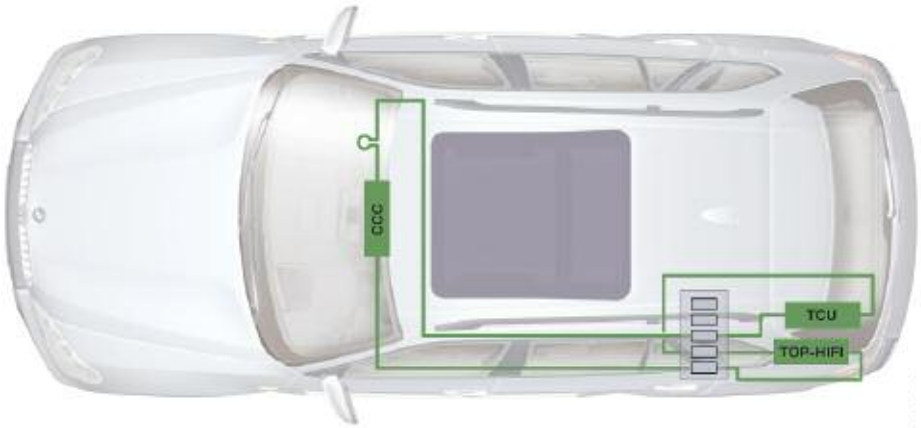
MOST Users

In the E70, the MOST but is used for the components in information/communication systems. The CCC, M-ASK or the CHAMP is used as the master control unit.

Other bus users may be:

- CD changer/DVD changer
- Top-HiFi amplifier
- Satellite tuner SDARS, IBOC (U.S only)
- Telephone
- Head-up display HUD

The following overview shows a possible equipment configuration.



MOST Access

As on all vehicles equipped with a MOST bus system, direct MOST access is also provided on the E70.

The direct MOST access is located on the right hand side under the dashboard in the vehicle interior.

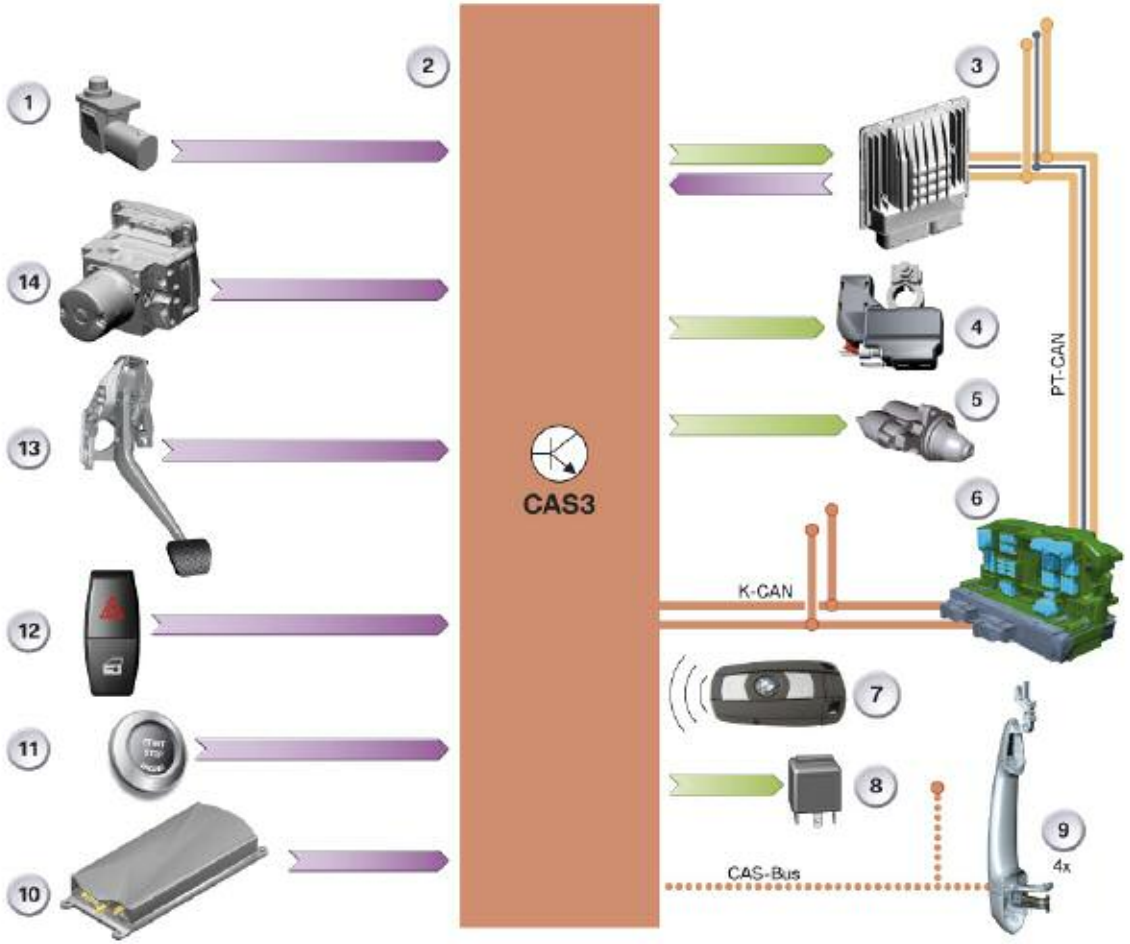
A cover provides direct access to the MOST.

The two connectors are then plugged together. The OPS/OPPS can now be connected to the connector as usual.

The two connectors must be removed from the holder secured on the cover.

NOTES PAGE

Car Access System 3



Index	Explanation	Index	Explanation
1	Hood contact switch	8	Terminal 15
2	Car Access System 3	9	Electronic Outer Door Handle Module
3	Digital Motor Electronics	10	Telematics Control Unit
4	Intelligent Battery Sensor	11	START-STOP Button
5	Starter	12	Central Lock Button
6	Junction Box Control Unit	13	Brake Light Switch
7	Identification Transmitter	14	Dynamic Stability Control

Car Access System 3 (CAS3)

The Car Access System now features the 3rd generation of control units. The electronic vehicle immobilizer 4 (EWS 4) is also used in connection with the Car Access System 3.

The previous functions of the electronic vehicle immobilizer 3 have been retained. The Car Access System 3 can therefore be operated together with the electronic vehicle immobilizer 3 or 4.

The digital motor electronics and the Car Access System 3 are incorporated in the overall electronic vehicle immobilizer system in the E70.

In addition, the electronic transmission control is used as a further immobilizer in the E70. The electronic vehicle immobilizer 4 improves the anti-theft properties of the vehicle.

A longer cryptic code is used for the data exchange. The cryptic code provides the enable to start the engine. The Car Access System 3 is backwards compatible with the Car Access System 2. This means the functions of the Car Access System 2 are also included in the Car Access System 3.

The electronic vehicle immobilizer 3 or the electronic vehicle immobilizer 4 is used depending on the engine installed and the associated digital engine management.

The table below shows the assignment of the engine management to the respective electronic vehicle immobilizer.

Vehicle	Launch Date	Engine	Engine Management	EWS Function
E70	10/06	N62B48O1	ME9.2.3	EWS 3
E70	10/06	N52B30O1	MSV80	EWS 4

History of the Car Access System

The Car Access System was used for the first time in the E65 (03/2002). It has undergone continuous further development and has been successively introduced in various BMW models.

Functional Overview

The Car Access System 3 is responsible for many functions, including the master for the following functions:

- Central locking
- Power windows
- Panoramic glass roof
- Comfort Access

The Car Access System 3 enables or interrupts the execution of the aforementioned functions.

The control units which execute the functions are:

Control units which execute functions	
Junction Box Control unit (JBE)	Central Locking
Footwell Module (FRM)	Power Windows
Roof Functions Center (FZD)	Panoramic Glass Roof
Comfort Access (CA)	Comfort Access

Further functions are integrated in the Car Access System 3.

They are:

- Terminal control
- Electronic vehicle immobilizer 4
- Vehicle data storage

Electronic Vehicle Immobilizer 3 (EWS 3)

The familiar functions of the previous EWS 3 system have been retained. The CAS 3 system is integrated in the system network via the K-CAN. The vehicle key data are read into the Car Access System 3 via the key slot.

Pin 20 is used in connection with the Car Access System 3. The enable code is signalled to the digital motor management via this pin.

The Car Access System 3 contains the start relay that is activated by means of an integrated circuit. The integrated circuit is informed via a separate line (A_S_Start) that the digital engine electronics is ready to start. Furthermore, the start procedure is terminated via the A_S_Start line if the engine does not start up because, for example, there is a fault in the PT-CAN system. Data transmission is unidirectional.

Electronic Vehicle Immobilizer 4 (EWS 4)

The electronic vehicle immobilizer 4 is an immobilizer system that prevents unauthorized engine start. It was used for the first time in the CAS 3 system in the E92.

The EWS 4 system uses a new, modern encryption system. A 128 bit long secret key is assigned to each vehicle and stored in the BMW database. This secret key is known only to BMW. The secret key is programmed and locked in the Car Access System 3 and in the digital engine management.

Once entered in the control unit, the secret key can no longer be changed, deleted or read. This therefore means that each control unit is assigned to a specific vehicle.

The electronic vehicle immobilizer 4 operates with bidirectional and redundant data transmission. The K-CAN (CAN protocol) and CAS-bus (K-bus protocol) are used for this purpose.

Pin 30 of the CAS 3 system serves as the connection to the CAS-bus.

The redundant data transmission enables operation of the electronic vehicle immobilizer even if a bus system fails due to a defect.

Design of EWS 4

The vehicle immobilizer consists of the identification transmitter which identifies itself to the vehicle and therefore to the Car Access System 3. The Car Access System 3 exchanges data via the CAS-bus with the digital motor electronics and thus cancels the immobilizer function.

The software for the electronic vehicle immobilizer as well as the enable for the starter is resident in the CAS 3. The digital engine management is responsible for issuing the enable for the ignition and fuel injection.

The gearbox functions are enabled by the electronic transmission control. The remote control or the identification transmitter must be identified as matching the vehicle before the electronic vehicle immobilizer issues the start enable. This already takes place before a vehicle is unlocked.

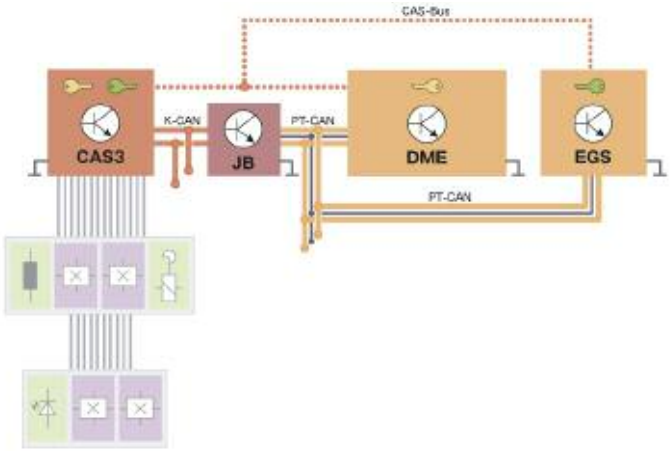
A renewed check (authentication) must be performed as soon as an attempt is made to start the engine. The check establishes whether the remote control matches the vehicle or the identification transmitter is located in the vehicle interior.

The vehicle can be started if the check is successful. Authentication starts with the status "Terminal 15 ON".

Note: The start enable can be given only by a remote control matching the vehicle or a suitable identification transmitter.

Start Enable through EWS

The start procedure is enabled by means of a special request and response procedure known as challenge-response. As from "Terminal 15 ON", the digital engine management sends an encrypted random number to the CAS 3. The DME (ECM) control module generates the random number in a random number generator.



From this random number together with its secret key, the CAS 3 system calculates a response and sends it to the DME. In the meantime, the digital engine management calculates the expected response from the random number with its secret key.

The CAS 3 system and the DME use the same secret key and algorithm for the calculation. The electronic vehicle immobilizer is cancelled if the value which the CAS 3 sends to the digital engine management agrees with the value calculated by the engine management.

The engine can now be started.

Note: As from "Terminal 15 ON", a cyclic query (challenge-response) is performed as long as the engine is not yet running. A fault code is entered in the CAS 3 if there is no query from the digital engine management approximately 10 seconds after the start of the request.

Data Transmission

Data transmission is redundant via the bus systems. The signal from the DME reaches the CAS 3 via the K-CAN and the CAS-bus.

The DME, however, is connected to the PT-CAN. For this reason, the signal is sent via the gateway of the junction box control unit to the K-CAN. The runtime of the signals via the bus systems is of no significance as the signal that reaches the DME first is used for the electronic vehicle immobilizer.

The authentication is repeated in response to following events:

- Transmission and response time exceeded
- Transmission problems
- Response with the secret security code incorrect (e.g. incorrect secret key due to control unit from another vehicle).

Secret Key

The control units are assigned a secret key on the assembly line. This secret key is generated from a random number. The secret key is valid for a pair of control units and linked to the specific vehicle. This means that one pair of control units receives the same secret key. Once the secret key has been entered, the control unit is locked. From this point on, the control unit is permanently tied to this secret key and the vehicle.

The CAS 3 and the digital motor electronics form one pair of control units.

Note: Since the control units are assigned to the specific vehicle, replacement with a unit from another vehicle is not possible. When replacing a control unit, the new control unit must be ordered from BMW. Matching of the control units to each other is no longer necessary.

Gearbox Enable

The enable is based on a procedure similar to that used for EWS 3. As from "Terminal 15 ON", the CAS 3 sends encrypted individual codes to the electronic transmission control. The electronic transmission control deciphers and checks these individual codes. If the check is successful, the gearbox control unit will enable the gearbox functions.

The electronic gearbox control unit forms a pair of control units together with the CAS 3.

Start Value Matching

A start value matching procedure between the CAS 3 and the electronic transmission control is performed on the assembly line. As part of this procedure, the CAS 3 transfers in encrypted form an individual code to the electronic transmission control.

Consequently, the electronic transmission control knows the individual code and can check whether the gearbox functions can be enabled.

Emergency Release

The parking lock cannot be released in the event of a defect or data transmission error. For this reason, the E70 features a mechanical emergency release facility for the parking lock.

A handle for the emergency release of the parking lock is located in the luggage compartment. This handle must be plugged in under the left cup holder, turned through 90° and pushed down.

The gearbox is released as soon as the handle has been locked in position. The vehicle can now be towed but not driven.

Note: The handle must remain locked in position while the vehicle is being towed. The parking lock will engage if the handle is removed while the vehicle is being towed.

This could cause an accident in unfavorable towing situations.

Vehicle Data Storage

The Car Access System 3 stores the following vehicle data:

- Personal Profile, the Car Access System 3 stores data for the Personal Profile
- Vehicle order, the vehicle order is stored in the footwell module
- Redundant data storage for instrument cluster
- Data for condition-based service CBS
- Authentication for diagnosis access to vehicle

Data for Condition-based Service

The data for condition-based service are stored and transferred to the remote control.

This data can be read out via the key reader for service purposes. The data for the condition-based service are updated during vehicle operation. The data in the fault code memory are also updated during vehicle operation.

The conditions are:

- "Terminal 15 ON", Speed above 50 km/h and below 30 km/h
- The data are updated after covering a distance of 10 km and at a speed below 30 km/h.

Manual Update of CBS Data

The procedure for transferring current data to the remote control during servicing is as follows:

- Insert remote control in its holder
- Press and hold center-lock button and select "terminal 15 ON" with the STARTSTOP button.
- After 15 s the CBS data will have been transferred to the remote control.
- Read out remote control.

Manual Update of Fault Memory Data

The procedure for transferring current data to the remote control during servicing is as follows:

- Press and hold center-lock button
- Insert remote control in its holder
- Select "Terminal 15 ON" with the START-STOP button
- The fault code memory data are transferred to the remote control after 15 seconds.
- Read out remote control.

Control Unit Replacement

A defect in the control units belonging to the EWS represents a challenge for the Service technician. Since a defective control unit cannot be replaced by control units from other vehicles particular care is necessary when performing the diagnostic procedure.

A defective control unit can be ordered through spare part channels. However, it is important to bear in mind that the digital engine management and the CAS 3 were supplied already coded to the vehicle.

This has the advantage that only the control unit is replaced and the matching procedure with the electronic vehicle immobilizer is not necessary. There is no point in ordering a control unit to be kept in stock as the secret key is assigned to the control unit and the vehicle.

A matching procedure is necessary for the electronic transmission control after replacement. As part of this procedure, the CAS 3 transfers the individual code to the electronic transmission control.

Note: The matching procedure can take several minutes.

Classroom Exercise - Review Questions

1. Which of the following devices is NOT compatible with D- CAN equipped vehicles? (Cross out those not applicable)



2. Which of the following test cables is compatible with a D-CAN equipped vehicle? (Circle those that apply)

3. Circle the bus systems which have NOT been in use prior to the introduction of the E70?

LIN byteflight MOST K-CAN D-CAN
BSD PT-CAN F-CAN FlexRay Lo-CAN

4. What is the communication speed of the FlexRay system? (circle the applicable answer)

10 Mbits/s 500K/bits/sec 22.5 Mbits/sec

5. On the E70, which system incorporates the new FlexRay technology? (Circle those that apply)

VDM CCC DSC FRM
HUD AS ARS DME

6. The D-CAN signal wires are incorporated into the OBD connector at pins: (Circle the applicable answer)

5 and 16 16 and 14 5 and 6 14 and 6

7. The CAS-bus connects: (circle the applicable answer)

DME, CAS 3 and JB

DME, EGS and CAS 3

EGS, GWS and DWA

EGS, JB and FRM

8. The CAS 3 system is the master for which of the following functions: (Circle those that apply)

Central locking Power Windows
Panorama Roof Comfort Access

9. On the E70, the KL30g_f relay is located: (Circle those that apply)

In the front power distribution box

In the rear power distribution box

In the FRM

In the CCC