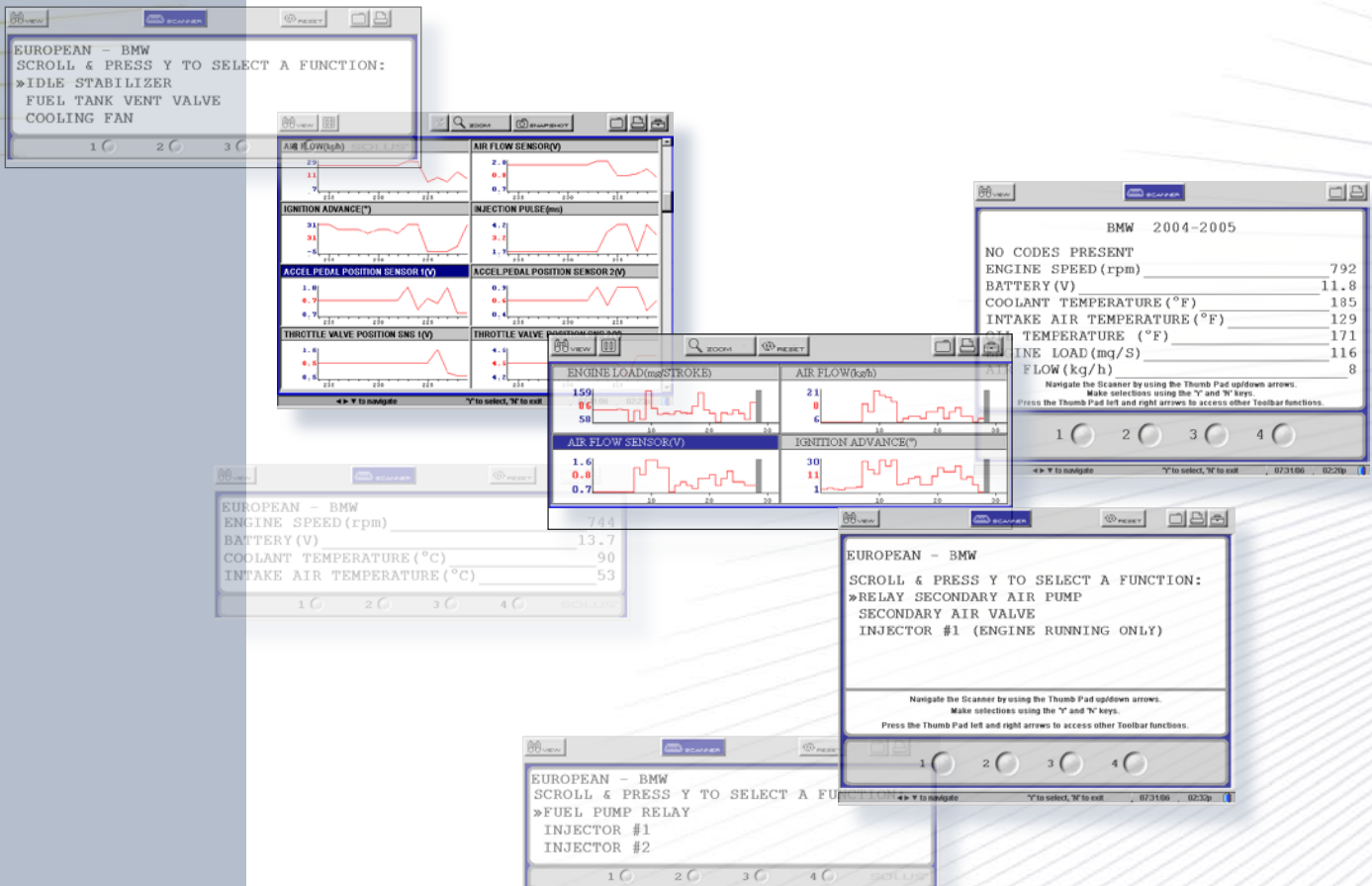# BMW Vehicle Communication Software Manual

BMW
Vehicle Communication
Software Manual

February 2007

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Form 8-13963A03 Rev. A

Safety Information

For your safety and the safety of others, read, understand and follow all safety messages and instructions in this manual, on the test equipment and in the tool user's manual.

Your diagnostic tool is intended for use by properly trained, skilled professional automotive technicians. The safety messages presented below and throughout this manual are reminders to the operator to exercise extreme care when using a test instrument.

There are many variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. Because of the vast number of test applications and variations in the products that can be tested with this instrument, we cannot possibly anticipate or provide advice or safety messages to cover every situation. It is the responsibility of the automotive technician to be knowledgeable of the system being tested. It is essential to use proper service methods and test procedures and to perform tests in an appropriate and acceptable manner that does not endanger your safety, the safety of others in the work area, or vehicle or equipment being tested.

It is assumed the operator has a thorough understanding of vehicle systems before using a diagnostic tool. Understanding of these system principles and operating theories is necessary for competent, safe and accurate use of this instrument.

Before using a diagnostic tool, always refer to and follow safety messages and applicable test procedures provided by the manufacturer of the vehicle or equipment being tested. Use equipment only as described in this manual.

Safety Conventions

Safety messages in this manual contain a signal word with an icon. The signal word indicates the level of the hazard in a situation. Signal words used in this manual are explained below.

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury to the operator or bystanders.

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to the operator or to bystanders.

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in moderate or minor injury to the operator or to bystanders.

Safety messages contain three different type styles:

- Normal type states the hazard.
- **Bold** type states how to avoid the hazard.
- *Italic* type states the possible consequences of not avoiding the hazard.

An icon, when present, gives a graphical description of the potential hazard. An example is shown below.

⚠WARNING Risk of unexpected vehicle movement.
- **Block drive wheels before performing a test with the engine running.**
A moving vehicle can cause injury.

A universal warning triangle is used when an icon for the specific hazard is not available. In these instances, the safety message is proceeded by the signal word in bold type. An example is shown below.

WARNING The engine compartment contains electrical connections and hot or moving parts.
- **Keep yourself, test leads, clothing, and other objects clear of electrical connections and hot or moving parts.**
- **Do not wear watches, rings, or loose clothing when working in an engine compartment.**
- **Do not place tools or equipment on fenders or other places in the engine compartment.**
- **Barriers are recommended to help identify danger zones in test area.**
Contact with electrical connections and hot moving parts can cause injury.

Important Safety Instructions

For a complete list of safety messages, refer to the Safety Information chapter in the user's manual for the diagnostic tool associated with this software product.

Table of Contents

Chapter 1   Using This Manual

This manual contains instructions for testing BMW behicles with the following Snap-on®
diagnostic tools:

- MT2500 Scanner™ scan tool
- MTG2500 Color Graphing Scanner™ scan tool
- MODIS™ unit with the Scanner™ Plug-in
- SOLUS™ scan tool

Some of the Illustrations shown in this manual may contain modules and optional equipment
that are not included on your system. Contact a Snap-on Sales Reperesentative for
availability of other modules and optional equipment.

1.1 Conventions

This manual uses the conventions described below.

1.1.1 Bold Text

Bold text is used for emphasis and to highlight selectable items such as buttons and menu
options.

Example:

- Press the **Y** button.

1.1.2 Terminology

Certain terms are used to command specific actions throughout this manual. Those terms are
described below.

Select

The term "select" will be used to mean selecting a menu item or other option with the
Thumbwheel (Scanner™) or Thumb pad (MODIS™) and pressing the **Y** button to confirm the
selection.

Example:

- Select **FUNCTIONAL TESTS**.

Scroll

The term "scroll" will be used to mean moving the cursor or changing data by turning the Thumbwheel (Scanner™) or pressing the Thumb pad (MODIS™).

Example:

- Scroll to see any other codes and the data list.

Scan Tool

The term "scan tool" will be used to refer to either the MT2500 Scanner™ scan tool, the MTG2500 Color Graphing Scanner™ scan tool, or the Scanner™ Plug-in for MODIS™, or the SOLUS™ scan tool. When necessary, the term "Snap-on® scan tool" will be used to distinguish Snap-on® equipment from another diagnostic device, such as the manufacturer's scan tool.

1.2 Notes and Important Messages

The following messages appear throughout this manual.

1.2.1 Notes

A NOTE provides helpful information such as explanations, tips, and comments.

Example:

NOTE:
For additional information refer to...

1.2.2 Important

IMPORTANT indicates a situation which, if not avoided, may result in damage to the test equipment or vehicle.

Example:

IMPORTANT:
Never install vehicle communication software cartridges in both slots of the Scanner™. This can cause damage to the software cartridges.

Chapter 2

Introduction

This manual contains instructions for testing BMW vehicles with the Snap-on® MT2500 Scanner™, the MTG2500 Color Graphing Scanner™, or the Snap-on® MODIS™ (Modular Diagnostic Information System) with the Scanner™ Plug-in.

Some of the illustrations shown in this manual may contain modules and optional equipment that are not included on your system. Contact a Snap-on Sales Representative for availability of other modules and optional equipment.

This chapter provides an overview of the conventions used in this manual. The remainder of this guide is divided in to the following chapters:

- "Chapter 3 Operations" offers general software operating explanations and procedures.
- "Chapter 4 Testing" offers testing information and procedures for various BMW control systems.
- "Chapter 5 Data Parameters" provides data parameter definitions.
- "Appendix A Terms and Acronyms" lists terms and acronyms used in this manual and in BMW literature.
- "Appendix B Frequently Asked Questions" provides information about data bus systems.
- "Appendix C Electronic Control Module Coding and Programming" provides information useful when replacing control modules.

Operations

This chapter explains how to begin using the scan tool's basic test functions, such as identifying a vehicle, selecting a system for testing, and connecting to a vehicle. This information is specific to BMW vehicles. For general scan tool functionality, see the user's manual appropriate to your diagnostic tool.
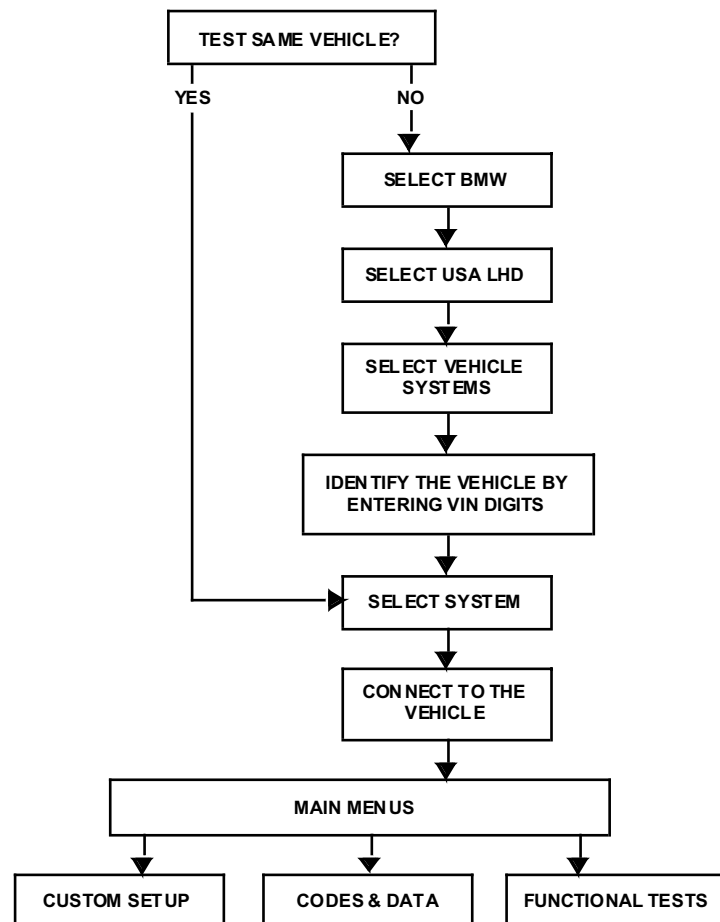
Figure 3-1 *Basic BMW scan tool test routine*

3.1 Identifying the Vehicle

The scan tool typically identifies a vehicle using certain characters of the vehicle identification number (VIN). The vehicle identification process prompts to you enter VIN characters and answer questions about the vehicle to be tested.

If you are powering up the scan tool after just installing the BMW software, or if you pressed N from the Current Vehicle Identification screen, the following screen displays (Figure 3-2).

```
>BMW                        (ENGLISH) V 6.0


CONTINUE: PRESS Y
HELP: PRESS N
```

Figure 3-2 *Software confirmation screen*

▶ **To enter vehicle identification:**

1. Press the Y button to confirm the software selection.

   If you have just installed the BMW software cartridge after using the scan tool with a different software cartridge, the Market Selection menu displays (Figure 3-3).

```
SCROLL & PRESS Y TO SELECT MARKET:
> EUROPEAN LHD
  EUROPEAN RHD
  USA LHD
```

Figure 3-3 *Market Selection menu*

2. For U.S. market BMWs, select **USA LHD**.

   The following menu displays (Figure 3-4).

```
SCROLL & PRESS Y TO SELECT:
> VEHICLE SYSTEMS
  MARKET SELECTION
  DEMONSTRATION
```

Figure 3-4 *Menu after selecting USA LHD*

NOTE:

ⓘ USA LHD will stay in scan tool memory until another market is selected or until different software is selected.

3. Select **VEHICLE SYSTEMS**.

   The following screen displays, prompting you to select the model year, the 10th VIN character (Figure 3-5).

```
SELECT: MODEL YEAR          BMW
VIN:
VEHICLE:   1988   (10TH VIN CHAR. 'J')
ENGINE:
```

Figure 3-5 *Sample Vehicle ID screen, model year request*

4. Select the model year.

   The scan tool displays your selection and prompts you to enter the first character of the vehicle model code, usually the 4th VIN character (Figure 3-6). VIN characters requested may vary by model and year.

```
SELECT: 1ST CHAR. MODELCODE
VIN:      A...  (4TH CHAR. OF VIN)
VEHICLE:  1999  (10TH VIN CHAR. 'X')
ENGINE:
```

Figure 3-6 *Sample Vehicle ID screen, model code request part 1*

5. Enter any further VIN character requests and press **Y** or **N** to answer any yes or no questions.

    When you have answered all questions relevant to the vehicle you are testing, the following screen displays (Figure 3-7). This screen lists the information you have selected during the vehicle ID process.

```
SELECT OPTIONS
VEHICLE:  1999 BMW 5-SERIES [E39]     A/C
ENGINE:   4.4L V8 MPI M62Tu
PRESS Y TO CONTINUE.   N FOR NEW ID.
```

Figure 3-7 *Vehicle ID confirmation*

6. Press **Y** if correct or press **N** to identify a different vehicle.

3.1.1 Identifying a Mini Cooper

The 2002–03 Mini Cooper uses BMW control systems and communicates with the scan tool through the European market selection.

▶ **To identify a 2002–03 Mini Cooper:**

1. Press the Y button to confirm the software selection.

    The following menu displays (Figure 3-8).

```
SCROLL & PRESS Y TO SELECT:
> VEHICLE SYSTEMS
  MARKET SELECTION
  DEMONSTRATION
```

Figure 3-8 *Menu to select VEHICLE SYSTEMS*

2. Select **MARKET SELECTION**.

    The Market Selection menu displays (Figure 3-9)

```
SCROLL & PRESS Y TO SELECT MARKET:
> EUROPEAN LHD
  EUROPEAN RHD
  USA LHD
```

Figure 3-9 *Market Selection menu*

3. Select **EUROPEAN LHD**.

    The following menu displays (Figure 3-10).

```
SCROLL & PRESS Y TO SELECT:
> MARKET SELECTION
  DEMONSTRATION
  CUSTOM SETUP
```

Figure 3-10 *Menu after selecting a market*

4. Select **VEHICLE SYSTEMS**.

   The following vehicle ID screen displays (Figure 3-11).

```
SELECT: MODEL YEAR          BMW
MODEL:
VEHICLE:  1986
ENGINE:
```

Figure 3-11 *Sample Vehicle ID screen, model year request*

5. Select **2002** or **2003**, as appropriate for the test vehicle.

   Your selection displays and prompts you to enter the model type (Figure 3-12).

```
SELECT: MODEL TYPE          BMW
MODEL:    3-SERIES [E46]
VEHICLE:  2002
ENGINE:
```

Figure 3-12 *Sample Vehicle ID screen, model type request*

6. Select **Mini R50/R53**.

   The screen displays your selection and prompts you to continue (Figure 3-13).

```
SELECT: ENGINE TYPE         BMW
MODEL:    MINI R50/R53
VEHICLE:  2002
ENGINE:   1.6L            =W10B16A
```

Figure 3-13 *Sample Vehicle ID screen with Mini Cooper selected*

7. Continue the vehicle identification process according to the previous procedure.

3.1.2 Quick Vehicle ID for Service Lamps Reset

You do not need to go through the entire vehicle identification process if you only want to reset the oil service or inspection service lights. Use the procedure below for a shortcut to the service lights reset functional tests. See "Resetting Service Lamps" on page 28 for more information.

NOTE:
The following procedure works for U.S. market BMWs only.

▶ To access the Service Lights Reset functional test from vehicle ID:

1. Begin the vehicle ID process described on page 6 until you reach the following Vehicle ID screen (Figure 3-14).

```
SELECT: MODEL YEAR          BMW
VIN:
VEHICLE:  1988  (10TH VIN CHAR. 'J')
ENGINE:
```

Figure 3-14 *Sample Vehicle ID screen*

2. Select any year between 1988 and 1999.

   The scan tool displays your selection and prompts you to enter the first character of the vehicle model code, the 4th VIN character (Figure 3-15).

```
SELECT: 1ST CHAR. MODELCODE
VIN:      A...  (4TH CHAR. OF VIN)
VEHICLE:  1999  (10TH VIN CHAR. 'X')
ENGINE:
```

Figure 3-15 *Sample Vehicle ID screen, model code request part 1*

3. Select "S" as the 4th VIN character.

   The scan tool displays "SERVICE LIGHTS" after the year selected and prompts you to enter the second character of the vehicle model code, the 5th VIN character.

```
SELECT: 2ND CHAR. MODELCODE
VIN:      SL..  (5TH CHAR. OF VIN)
VEHICLE:  1988 SERVICE LIGHTS
ENGINE:
```

Figure 3-16 *Sample Vehicle ID screen, model code request part 2*

4. Select "L" as the 5th VIN character.

   The screen displays "CLEAR LAMPS" after "ENGINE" on the fourth line (Figure 3-17).

```
SELECT: MODELCODE
VIN:      SL01  (6/7TH CHAR. OF VIN)
VEHICLE:  1988 SERVICE LIGHTS
ENGINE:   CLEAR LAMPS
```

Figure 3-17 *Sample Vehicle ID screen, clear lamps mode*

5. Press Y to accept the defaults until the connection message displays (Figure 3-18).

```
CONNECT BM-1B TO ROUND CONNECTOR
LOCATED ON RIGHT SIDE OF ENGINE
COMPARTMENT.
PRESS Y TO CONTINUE.
```

Figure 3-18 *Connection message*

6. After following the on-screen instructions, press Y.

   A Main Menu displays with FUNCTIONAL TESTS as the only testing option (Figure 3-19).
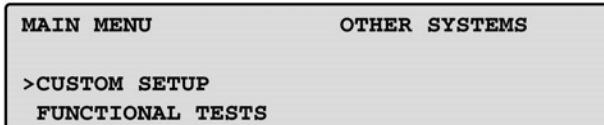
```
MAIN MENU              OTHER SYSTEMS

>CUSTOM SETUP
 FUNCTIONAL TESTS
```

Figure 3-19 *Main Menu from quick ID shortcut*

7. Select **FUNCTIONAL TESTS**.

    A Functional Tests menu displays with only the service lamp reset options available (Figure 3-20).

```
>RESET OIL SERVICE LAMP
 RESET INSPECTION SERVICE LAMP
```
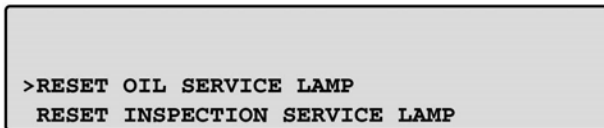
Figure 3-20 *Functional Test menu from quick ID shortcut*

From here, the service lamp reset functional tests work as described in "Resetting Service Lamps" on page 28.

3.2 Selecting a System

Once you have confirmed a vehicle identification, the following menu displays (Figure 3-21). The items that appear on this menu vary depending on the vehicle you are testing.

```
SCROLL TO SELECT SYSTEM: (IF FITTED)
>  ENGINE (RIGHT)
   ENGINE (LEFT)
   EML/EMS
```
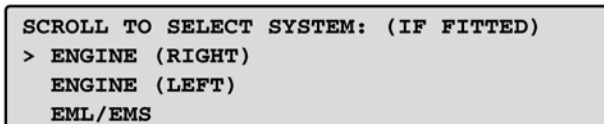
Figure 3-21 *Sample menu to select a system for testing*

> **NOTE:**
> Note the following when selecting a BMW system for testing:

- The ENGINE (RIGHT) and ENGINE (LEFT) selections are used on 12-cylinder engines that have two ECMs controlling the engine, one for each bank of cylinders. The scan tool calls Bank 1 (cylinders 1–6) on the passenger side, "ENGINE (RIGHT)," and Bank 2 (cylinders 7–12) on the driver's side, "ENGINE (LEFT)." Bank 1 is controlled by DME 1 and Bank 2 is controlled by DME 2.
- For the V12 engine, long intake runners with each bank's MAF sensor are located on the opposite side of the engine.
- The EML/EMS selection is for vehicles with an electronic throttle.

3.3 Connecting to the Vehicle

Once a vehicle has been identified and a system has been selected, a scan tool connection message appears, instructing you to use the supplied vehicle test adapters to connect the scan tool for testing (Figure 3-22).

```
CONNECT BM-1B TO ROUND CONNECTOR
LOCATED ON RIGHT SIDE OF ENGINE
COMPARTMENT.
PRESS Y TO CONTINUE.
```

Figure 3-22 *Sample connection message*

Each test adapter plugs into a specific vehicle diagnostic connector and attaches to one end of the data cable. The other end of the cable attaches to the scan tool. Captive screws secure both data cable ends.

The following adapters are available to connect the scan tool to BMW vehicles.

- BM-1B—(MT2500-74, Figure 3-23) test adapter for the 20-pin underhood connector. Attaching the BM-1B test adapter to the 20-pin underhood connector may require the removal of a connector cap. Be sure to replace this connector cap when finished. The ECM requires this cap for internal communications.
- DL-16—(MT2500-68, Figure 3-24) test adapter with the S28 Personality Key for OBD-II vehicles with the 16-pin underdash connector.
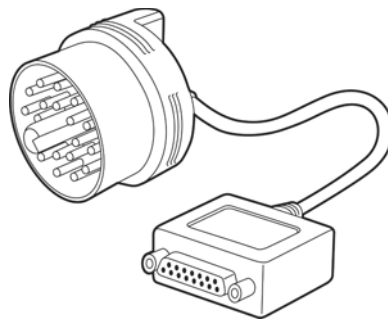
Figure 3-23 *BM-1B adapter*
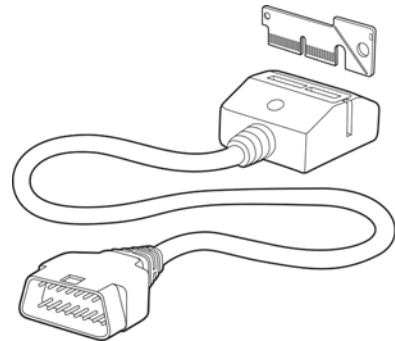
Figure 3-24 *DL-16 adapter with the S28 Personality Key*

Only connect the DL-16 test adapter to the 16-pin underdash connector when the 20-pin underhood connector is unavailable. The underhood connector always provides better functionality even if both connectors are present on the vehicle.

In about 1995, some models were equipped with both the OBD-II underdash 16-pin and the underhood 20-pin connectors. The underdash 16-pin has limited system coverage for these models (engine, transmission, and electronic throttle only). For vehicles with only the underdash 16-pin connector (certain models starting in 2000), complete system coverage will be on this connector.

NOTE:
For generic OBD-II testing on vehicles that have both an underhood 20-pin and an underdash 16-pin, make sure the underhood 20-pin cover is installed or the scan tool will not communicate. This cover has jumper pins bridging a required connection.

The following vehicles have eliminated the underhood 20-pin connector in 2000:

- E46 (from June 2000)
- E39, E52, E53 (from September 2000)

The following vehicles still have the underhood diagnostic connector.

- E38 (ended 2001)
- Z3 (available for 2002)

Some early BMW models in 1987–88 may have a 13-pin vehicle connector which the scan tool does not connect with. There is no serial data available on these vehicles.

Table 3-1 provides hard-to-find OBD-II connector locations starting in 1995 with the 750iL (E38); all others start from 1996.

Table 3-1 *Hard-to-find OBD-II connector locations*

MODEL	CONNECTOR LOCATION
E36, E39, E46, E52, E53	Driver's footwell area.
E38*	Center of the console next to the cup holder. The trim panel snaps off the center console.
E65	Driver-side "A" pillar forward of driver's door. Covers are not marked (remove 2nd cover behind 1st cover).
Z3	Right side of center console.
*E38 and other early OBD-II models may have a cosmetic cover and a fastened DLC cover.	

To connect to a vehicle:

1. Follow the on-screen connection instructions (Figure 3-22 on page 11) and press Y. The following screen displays (Figure 3-25).

```
ECU NEEDS TO BE DETERMINED TO CORRECTLY
IDENTIFY THIS SYSTEM. TURN KEY ON AND
PRESS Y TO START IDENTIFICATION PROCESS.
THIS WILL TAKE ABOUT 15 SECONDS.
```

Figure 3-25 *System ID instructions*

2. Press **Y** to continue and the following screen displays (Figure 3-26):

```
WAITING FOR ECU TO COMMUNICATE WITH
SCANTOOL. ENSURE SCANTOOL IS CONNECTED.
TURN KEY ON.
                IN PROGRESS
```

Figure 3-26 *Connection in process*

When the Main Menu displays (Figure 3-27), you may begin testing.

```
MAIN MENU              OTHER SYSTEMS
> CODES & DATA
  CUSTOM SETUP
  FUNCTIONAL TESTS
```

Figure 3-27 *Sample Main Menu*

3.4 Demonstration Programs

For BMW vehicles, the demonstration programs are accessed before the vehicle identification phase of operations (Figure 3-28).

```
SCROLL & PRESS Y TO SELECT:
> VEHICLE SYSTEMS
  MARKET SELECTION
  DEMONSTRATION
```

Figure 3-28 *Menu to select VEHICLE SYSTEMS*

▶ **To access a demonstration:**

1. Select **DEMONSTRATION**.

    The following screen displays, prompting you to identify a vehicle with "DEMO" on line 1 (Figure 3-29).

```
SELECT: MODEL YEAR          DEMO
VIN:
VEHICLE:  1988   (10TH VIN CHAR. 'J')
ENGINE:
```

Figure 3-29 *Sample demo vehicle ID screen, model year request*

Though there are many vehicles you can identify from this screen, the demonstration program only contains two sample vehicles: 1.8L and 5.0L engines. Each engine offers different systems to select for test demonstrations.

2. For a 5.0L engine, scroll to 1993 or later, (VIN characters P to V) and keep pressing Y to select the defaults until a menu displays prompting you to select a system for testing. For a 1.8L engine, scroll to 1988 to 1992 (VIN characters J to N) and do the same as with a 5.0L engine.

    Depending on the engine type selected, the following menu displays, prompting you to select a demonstration system for testing (Figure 3-30).

```
SCROLL TO SELECT SYSTEM: (IF FITTED)
> ENGINE (RIGHT)
  ENGINE (LEFT)
  EML/EMS
```

Figure 3-30 *Demo menu to select a 5.0L engine system for testing*

3. Select menu items as you would if you were connected to a test vehicle.

Testing

This chapter provides information and procedures for using the scan tool with specific control systems. The systems discussed in this chapter are:

4.1 Testing Engine Systems

The following sections contain scan tool testing information for BMW engine systems.

The following testing options are available for engine systems on 1988–2002 models.

- Codes & Data
- Adaptation Reset
- Actuator Testing
- Service and Oil Lamp Reset

The scan tool *does not* perform electronic control module coding or programming, and *does not* provide Generic OBD-II information. See page 129 for information about BMW coding and programming.

4.1.1 Engine Applications

Table 4-1 lists engine models that communicate with the scan tool.

Table 4-1 *1988–2003 engine applications (sheet 1 of 2)*

DME VERSION	E SERIES	CAR SERIES	MODEL	ENGINE SIZE	YEAR	ENGINE TYPE
M1.2	E32	7 Series	750iL	5.0 V12	1988–90	M70
	E34	M Series	M5 Sedan	3.6L	1991–93	S38
M1.3	E30	3 Series	325i/is/ix	2.5L	1987–92	M20
	E32	7 Series	735i	3.5L	1988–93	M30
	E34	5 Series	525i	2.5L	1989–90	M20
			535i	3.5L	1989–93	M30
M1.7	E30	3 Series	318i/is/ic	1.8L	1990–93	M42
	E31	8 Series	850i/Ci	5.0 V12	1991–94	M70
	E32	7 Series	750iL			
	E36	3 Series	318i/is	1.8L	1992	M42
			318i/is/ic/ti	1.8L	1992–95	M42/DISA
M1.7.1	E31	8 Series	850CSi	5.6 V12	1994–95	S70
M1.7.2	E36	3 Series	318i/is/ic/ti	1.8L	1994–95	M42/DISA 2
M3.1	E34	5 Series	525i	2.5L	1991–92	M50
	E36	3 Series	325i/is	2.5L	1992	
M3.3	E31	8 Series	840Ci	4.0L V8	1994–95	M60
	E32	7 Series	740i/iL	4.0L V8	1993–95	
	E34	5 Series	530i/iT	3.0L V8	1994–95	
			540i	4.0L V8		
M3.3.1	E34	5 Series	525i	2.5L	1993–95	M50TU
	E36	3 Series	325i/is/iC			
			M3	3.0L (M3)	1995	S50 (M3)
M5.2	E31	8 Series	840Ci	4.4L V8	1996–97	M62
	E36	3 Series	318i/ti/is	1.9L	1996–98	M44
	E38	7 Series	740i/iL	4.4L V8	1996–97	M62
			750i/iL	5.4L V12	1995–97	M73
			850Ci			
	E39	5 Series	540i	4.4L V8	1997	M62
	Z3	3 Series	Z3 Roadster	1.9L	1996–98	M44
MS41.1	E36	3 Series	328i/is	2.8L	1996–99	M52
			323i/is	2.5L	1998–99	
	E39	5 Series	528i/iT	2.8L	1996–98	
	Z3	Z3	Z3 Roadster	2.8L	1997–98	
MS41.2	M3 (E36)	3 Series	M3	3.2L	1996–99	S52
M = Bosch; ME = Bosch with integral EML; MS = Siemens, TU = Technical Update; DISA = differential air intake system (dual length intake runners)						

Table 4-1 *1988–2003 engine applications (sheet 2 of 2)*

DME VERSION	E SERIES	CAR SERIES	MODEL	ENGINE SIZE	YEAR	ENGINE TYPE
M5.2.1	E38	7 Series	740i/iL	4.4L V8	1998	M62
			750iL	5.4L V12	1998–2001	M73TU
	E39	5 Series	540i/iT	4.4L V8	1998	M62
MS42	E39	5 Series	528i/iT	2.8L	1999–2000	M52TU
	E46	3 Series	323i/ic	2.5L		
			328i/is	2.8L		
	Z3	Z3	Z3 M Coupe, M Roadster	3.2L	1998–2000	S52
MS43	E36	Z3	Z3 Roadster	2.5L/3.0L	2001	M54
	E39	5 Series	530i	3.0L	2001–03	
	E46	3 Series	325i/Ci/xi/Cic/it	2.5L		
			330i/xi/Ci/Cic	3.0L		
	E53	X5	X5 3.0i			
MS45	E46	3 Series	325i/Ci/it	2.5L	2003	M54, M56
	E85	Z4	Z4 Roadster	2.5L/3.0L	2003–04	M54
MS52	E36	Z3	Z3 (3.0i Coupe, Roadster)	3.0L	2001	S54
ME 7.2	E38	7 Series	740i	4.4L V8	1999–2001	M62TU
			750i/iL	5.4L V12	1998–2001	M73
	E39	5 Series	540i/iT	4.4L V8	1999–2003	M62TU
	E53	X5	X5 4.4i	4.4L V8	1999–2002	
ME 9.2	E53	X5	X5 4.4i	4.4L V8	2000–03	M62 or M62TU
				4.6L V8	2002–03	
ME 9.2.1	E65/66	7 Series	745i/Li	4.4L V8	2002–04	N62
	E66	7 Series	760Li	5.4L V12	2003–04	N73
MSS52	E46	3 Series	M3	3.2L	2001–03	S54
MSS54	E39	5 Series	M5	5.0L V8	1999–2003	S62
	E52	Z8	Z8 (Roadster)			
EMS2	RM	Mini Cooper	R50/R53	1.6L	2003	N/A
M = Bosch; ME = Bosch with integral EML; MS = Siemens, TU = Technical Update; DISA = differential air intake system (dual length intake runners)						

NOTE:
Always verify the vehicle production date on the driver-side door jam for parts ordering.

NOTE:
Note the following regarding engine types:

- M50TU, M52 & M62TU = Single VANOS
- M52TU = Dual VANOS
- M73TU = Electrically-heated catalytic converters

NOTE:
The E Series designation defines the specific year, body, and chassis. The car series defines the body only and is not year-specific.

Use Table 4-2 below to convert the BMW E Series to the car series and year.

Table 4-2 *E Series conversion chart*

E SERIES	CAR SERIES	YEAR
E28	5 Series	1982–88
E30	3 Series	1984–92 (1992 convertible and coupe only)
E31	8 Series	1991–97
E32	7 Series	1988–94
E34	5 Series	1989–95
E36	3 Series	1992–99
E36/Z3	3 Series	1996–2001
E38	7 Series	1995–2002
E39	5 Series	1996–2003
E46	3 Series	1999–2003
E52	Z8	2000–03
E53	X5 SUV	
E65	745l	2002–04
E66	745Li	
	760Li	2003
E85	Z4	

Use the following information to determine the BMW model designation for the vehicle you wish to test. The vehicle systems that are available for selection from System Selection menus (see "Selecting a System" on page 10) are largely determined by model type. Table 4-3 gives two sample BMW model designations and their explanations, and Table 4-4 lists further model codes and descriptions.

Table 4-3 *Sample BMW model designations and explanations*

740iL	325xiT
7 = 7 Series 40 = 4.0L engine i = fuel-injected L = longwheel base	3 = 3 Series 25 = 2.5L x = all-wheel drive i = fuel-injected T = wagon

Table 4-4 *Model codes and descriptions*

MODEL CODE	DESCRIPTION	MODEL CODE	DESCRIPTION
C	Coupe	M	Motorsport
CiC	Convertible	S	Special or Sports
Csi	Coupe sport injection	SA	Special model/version
CSL	Coupe Sport Lightweight	T	Hatchback or Wagon
e or eta	High fuel efficiency engine	Ti	Touring international or Wagon
i	Fuel-injected	Tii	Touring international injected
L	Longwheel base	x	All wheel drive

4.1.2 Diagnostic Trouble Codes (DTCs)

The following section contains information for reading diagnostic trouble codes (DTCs) from BMW engine systems.

Important Tips for Reading Engine DTCs

- The BMW software displays pending codes which set before the malfunction indicator lamp (MIL), or check engine lamp, is turned on.
- An engine pending code (no engine MIL) may turn on transmission or ABS/ASC/DSC MILs.
- If the engine MIL is on and there are no engine codes stored, check EGS (transmission) for codes (transmission MIL may not be on).
- When a scan tool is hooked up and communicating with the DME (engine controller), the transmission MIL (an exclamation mark inside of a gear on some models) may light up or flash intermittently.
- On OBD-I vehicles (1988–1995), codes normally clear and engine adaptation learned values reset if the vehicle battery is discharged or disconnected. On OBD-II vehicles (1996 and newer), engine trouble codes should not clear and engine adaptation values usually will not reset if the battery is disconnected.
- It is usually not necessary to shut the engine off before clearing codes, but if codes do not clear, then try again with the engine turned off.
- After clearing codes, always turn the ignition off for 10 seconds before attempting to start the engine. Sometimes clearing codes results in a no-start condition if the key is not cycled.
- Under certain conditions, usually related to battery problems and voltage spikes, the engine controller may set false trouble codes. It is always best to record the set codes, clear the codes, road test, then re-check for codes. Be aware that unless the ignition switch is cycled multiple times, the MIL may not illuminate, but the scan tool will display any pending engine trouble code.

⚠ **IMPORTANT:**
A low or disconnected battery may set false trouble codes in the engine as well as other systems. Do not reconnect the battery with the ignition on or you may permanently damage electronic control modules. Always check and clear codes in all systems if the battery was low or disconnected.

OBD-II MIL Operation

The MIL, or check engine lamp, illuminates under specific fault conditions and drive cycles, as explained in Table 4-5 and the proceeding text.

Table 4-5 *OBD-II MIL operation*

ROW	DRIVE CYCLE #1			DRIVE CYCLE #2			DRIVE CYCLE #3			DRIVE CYCLE #4			DRIVE CYCLE #5			DRIVE CYCLE #43		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
1	Yes	Yes	Off															
2	Yes	Yes	Off	Yes	Yes	On												
3	Yes	Yes	Off	No	No	Off	Yes	Yes	On									
4	Yes	Yes	Off	Yes	No	Off	Yes	No	Off	Yes	Yes	Off	Yes	Yes	On			
5	Yes	Yes	Off	Yes	Yes	On	Yes	No	On	Yes	No	On	Yes	No	Off			
6	Yes	Yes	Off	Yes	Yes	On	Yes	No	On	Yes	No	On	Yes	No	Off	Yes	FAULT CODE ERASED	Off
1 = Function checked, 2 = Fault code set, 3 = MIL status																		

- Row 1—A fault code is stored in the ECM on the first occurrence of a fault in the system being checked.

- Row 2—The MIL will not be illuminated until the completion of the second consecutive "driving cycle" (ECT changes 104–140°F; open to closed loop transition; VSS input signal) where the previously-faulted system is again monitored and a fault is still present or a catalyst-damaging fault has occurred.

- Row 3—If the second drive cycle was not complete and the specific function was not checked, the ECM counts the third drive cycle as the "next consecutive" drive cycle. The MIL is illuminated if the function is checked and the fault is still present.

- Row 4—If there is an intermittent fault present and does not cause a code to be set through multiple drive cycles, two complete consecutive drive cycles with the fault present are required for the MIL to be illuminated.

- Row 5—Once the MIL is illuminated, it will remain illuminated unless the specific function has been checked without fault through three complete consecutive drive cycles.

- Row 6—The fault code will also be cleared from memory automatically if the specific function is checked through 40 consecutive drive cycles without the fault being detected.

Important Tips for Reading Codes from an OBD-II MIL

- In order to clear a catalyst-damaging fault from memory, the condition must be evaluated for 80 consecutive cycles without the fault reoccurring.

- Some codes set and turn the MIL on at the first occurrence of a fault (pending or developing code set). Other codes require two trip logic or the fault to occur in two consecutive trips or drive cycles before the MIL is turned on.
- Severe misfires will cause the MIL to flash, indicating possible catalytic converter damage.

Blink Code Pedal Faults

All 1989–94 BMW vehicles equipped with a self diagnostic system have the ability to retrieve engine fault codes by counting MIL flashes. These are four-digit fault codes (pedal faults) and have different code numbers than those retrieved by the scan tool. Pedal fault codes can be retrieved with the ignition on, engine off, and with the gas pedal rapidly depressed to the floor five times without interruption.

See Table 4-6 for pedal code descriptions for 1989–94 models.

Table 4-6 *Pedal fault codes for 1989–94 models (sheet 1 of 2)*

PEDAL CODE	DESCRIPTION
1211	DME control unit did not pass self-test. Disconnect from power and reconnect after 10 minutes.
1212	Oxygen (O2 or Lambda) Sensor 2 (cylinders 4–6)
1213	Lambda Control System Bank 2: The ECM has been unable to maintain Lambda (fuel mixture or fuel trim) on Bank 2 (cylinders 4–6) of the engine.
1215	Air mass/volume sensor
1216	Throttle potentiometer
1218	"Output Stage, Group 1"
1219	"Output Stage, Group 2"
1221	Oxygen (O2 or Lambda) sensor 1
1222	Lambda Control System Bank 1: The ECM has been unable to maintain Lambda (fuel mixture or fuel trim) on Bank 1 (cylinders 1–3) of the engine.
1223	Coolant temperature sensor
1224	Intake air temperature sensor
1225	Knock sensor 1
1226	Knock sensor 2
1227	Knock sensor 3
1228	Knock sensor 4
1231	Battery voltage/DME main relay
1232	Throttle switch—idle
1233	Throttle switch—WOT
1234	Speedometer A Signal
1237	A/C compressor cut off
1241	False air mass sensor code—update the EPROM and replace the idle valve
1242	A/C compressor
1243	Crankshaft pulse sensor
1244	Camshaft sensor

Table 4-6 *Pedal fault codes for 1989–94 models (sheet 2 of 2)*

PEDAL CODE	DESCRIPTION
1245	Intervention EGS
1247	Ignition secondary monitor
1251	Fuel injector 1 (or group 1)
1252	Fuel injector 2 (or group 2)
1253	Fuel injector 3
1254	Fuel injector 4
1255	Fuel injector 5
1256	Fuel injector 6
1257	Fuel injector 7
1258	Fuel injector 8
1261	Fuel pump relay control
1263	Purge valve
1264	Oxygen (O2 or Lambda) heater
1265	Fault lamp (check engine)
1266	VANOS
1267	Air pump relay control
1271	Ignition coil 1
1272	Ignition coil 2
1273	Ignition coil 3
1274	Ignition coil 4
1275	Ignition coil 5
1276	Ignition coil 6
1277	Ignition coil 7
1278	Ignition coil 8
1281	Control unit memory supply
1282	Fault code memory did not pass self-test. Disconnect from power and reconnect after 10 minutes. Check charging system for over-voltage.
1283	Fuel injector output stage (can be set by a faulty ignition coil)
1286	Knock control test pulse
1444	No failures

Important Tips for Reading Pedal Fault Codes

- Blink codes cannot be retrieved if the scan tool is communicating with the vehicle.

- Blink code retrieval can be used for comparison and backup to the scan tool.

- V12 engines have two ECMs, one for each engine bank. Codes need to be retrieved from each bank separately. The left engine bank is on the driver's side of the vehicle, which is Bank 2. The right passenger side is Bank 1. Be aware that each bank's induction system (MAF sensor and intake runners) are physically located on the opposite bank. To access the second ECM, depress the gas pedal to the floor six times. All cylinder 7–12 codes begin with a two.

Clearing ECM Codes

Selecting CLEAR ECU CODES clears all trouble codes from the selected control module.

NOTE:
Whereas "ECM" is the accepted SAE term for engine control module, "ECU" is still the accepted term in Europe. In the BMW software, the term "ECU" may refer to any electronic control module.

NOTE:
It may not always be necessary to shut the engine off before clearing codes. If clearing codes was unsuccessful with the engine running, then shut the engine off and try again.

To clear ECM codes:

1. From any Codes & Data display, press **N** to display the Codes & Data Exit menu.
2. Select **CLEAR ECU CODES**.

   The scan tool displays the following screen (Figure 4-1).

   ```
   TO CLEAR CODES, KEY MUST BE ON AND
   ENGINE MUST BE OFF.


   PRESS Y TO INITIATE CODE CLEARING.
   ```

   Figure 4-1 *Display after selecting CLEAR ECU CODES*

3. Press **Y**.

   Depending on the ECM, one of the following two messages may display (Figure 4-2 or Figure 4-3).

   ```
   IMPORTANT: ECU NEEDS TO BE RESET!
   TURN KEY OFF, THEN ON AND WAIT 10
   SECONDS. THEN START THE ENGINE.
   PRESS Y TO CONTINUE.
   ```

   Figure 4-2 *Clear ECU Codes Instruction screen 1*

   ```
   LET ENGINE RUN FOR 30 SECONDS AND THEN
   TURN ENGINE OFF. THEN TURN KEY ON.

   PRESS Y TO CONTINUE.
   ```
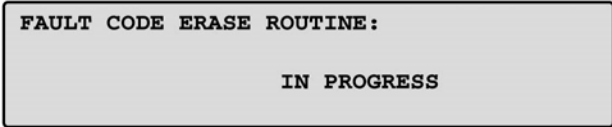
   Figure 4-3 *Clear ECU Codes Instruction screen 2*

   Or neither screen displays and you can go on to the next step.

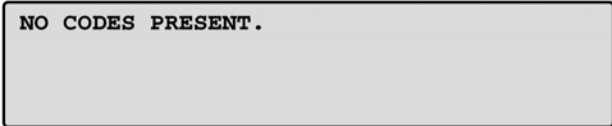4. Follow any additional instructions if necessary and press **Y**.

   The scan tool momentarily displays the following screen (Figure 4-4).

```
FAULT CODE ERASE ROUTINE:

                    IN PROGRESS
```

Figure 4-4 *Clear ECU Codes In Progress screen*

Line 1 indicates that DTCs are cleared by showing the following message (Figure 4-5).
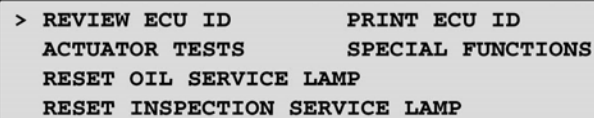
```
NO CODES PRESENT.
```

Figure 4-5 *Codes Cleared screen*

The scan tool re-displays the CODES & DATA screen. If the code-clearing operation fails for any reason, the previous DTCs reappear at the top of the data list in CODES & DATA.

5. Press **N** to return to the Codes & Data Exit menu and repeat the CLEAR CODES operation.

4.1.3 Functional Tests

Functional Tests allow you to activate and test components of the engine management system. Selecting FUNCTIONAL TESTS from the Main Menu displays a menu similar to Figure 4-6, depending on the vehicle and system identified.

```
> REVIEW ECU ID          PRINT ECU ID
  ACTUATOR TESTS          SPECIAL FUNCTIONS
  RESET OIL SERVICE LAMP
  RESET INSPECTION SERVICE LAMP
```

Figure 4-6 *Sample Functional Tests menu*

NOTE:
The scan tool displays only those tests available to the identified vehicle and system.

Review ECM ID

This test displays ECM identification information.

To display ECM ID information:

1. Select **REVIEW ECU ID**.

    A screen similar to Figure 4-7 displays.

```
ECU HW NO:0261200157   BMW HW NO:1744698
ECU SW NO:1267356165   BMW SW NO:123
                       SID = 0440

PRESS Y TO CONTINUE.
```

Figure 4-7 *Sample Review ECU ID screen*

Print ECM ID

Selecting PRINT ECU ID prints the ECM identification information. See the *Scanner™ User's Manual* or the *MODIS™ Display User's Manual* for information about using your scan tool with printers.

Actuator Tests

Actuator tests command the ECM to activate components and systems, such as injectors, the idle stabilizer, the purge control solenoid, and the oxygen sensor heater relay.

The scan tool only commands the ECM to activate a component; the scan tool does not check component operation. In most cases, you can hear whether a component functions correctly, such as when a relay clicks or a pump vibrates.

Read the on-screen instructions carefully. Run the engine only when instructed. On most engines, injector operation can be confirmed by listening for clicking noise. On some engines, such as the Motronic 1.7 and 1.7.2, it is difficult to hear this clicking action. For these, use a digital multimeter, a graphing meter, or a stethoscope to check injector operation.

NOTE:
Note the following regarding actuator tests:

- Before performing an actuator test on a component, physically check whether the component is installed on the vehicle.
- Actuators can be mounted anywhere in the vehicle, such as under the dashboard, hood, or trunk. If you hear no reaction where one is expected, test the actuator circuit with a digital multimeter or a digital graphing meter, such as the Snap-on® Vantage® meter, to confirm whether the ECM properly controls the component.
- After performing actuator tests, make sure to cycle the ignition key off for ten seconds or the engine may not start. Read the on-screen instructions carefully. Run the engine only when instructed.

The following procedure features, as an example, INJECTOR VALVES (ODD CYL).

To conduct an actuator test:

1. From the FUNCTIONAL TESTS menu, select **ACTUATOR TESTS**.

   The scan tool displays the following menu (Figure 4-8).

```
SCROLL & PRESS Y TO SELECT A FUNCTION:
>IDLE STABILIZER
 PURGE CONTROL SOLENOID
 INJECTOR VALVES (ODD CYL)
```

Figure 4-8 *Sample Actuator Tests menu*

2. Select **INJECTOR VALVES (ODD CYL)**.

    The scan tool displays an instructional screen similar to Figure 4-9.

```
BEFORE PERFORMING TEST, ENSURE THAT KEY
IS ON AND ENGINE IS OFF. WHEN ENGINE IS
RUNNING SWITCH KEY OFF FOR 10 SECONDS,
THEN ON AGAIN.  PRESS Y TO ACTIVATE TEST
```

Figure 4-9 *Actuator Test Instruction screen*

3. Follow the instructions and press **Y** to begin the test.

    The scan tool momentarily displays the following screen (Figure 4-10).

```
ACTIVATING INJECTOR VALVES (ODD CYL)
FOR 5 SECONDS.
                IN PROGRESS
PRESS N TO ABORT TEST.
```

Figure 4-10 *Sample Actuator Test In Progress screen*

Then the scan tool displays the following screen (Figure 4-11).

```
INJECTOR VALVES (ODD CYL)
FUNCTION HAS BEEN COMPLETED
PRESS Y TO REPEAT FUNCTION
PRESS N FOR MENU
```

Figure 4-11 *Sample Actuator Test Complete screen*

Special Functions

The BMW engine management system adapts as operating conditions change either from normal wear or a fault condition. The scan tool has the ability to reset individual adaptations or reset all adaptations at one time.

The items listed in the Special Functions submenu depend on the ECM and the vehicle under test. Each item names a learning value, or "adaptation" that can be reset, such as:

*   Knock sensor adaptation
*   Idle adaptation
*   O2 adaptation
*   Throttle adaptation
*   Reset all adaptations

Important Tips for Using Special Functions

- On most 1990–95 vehicles, adaptations reset automatically when the battery is discharged or disconnected, but on most 1996 and newer vehicles, adaptations must be reset using a scan tool.
- Resetting adaptations using the Snap-on® scan tool does not clear stored trouble codes, which is a separate function (see page 23).
- Individual resets available may vary by year, model, and engine management system. Some systems may have only one selection, "Reset All Adaptations."

NOTE:
Resetting throttle adaptation may cause loss of throttle response and poor run condition on some models. To re-learn throttle adaptation, turn the ignition on (do not start engine) for 30 seconds, then turn ignition off for 10 seconds. Now start the engine and throttle control should be OK.
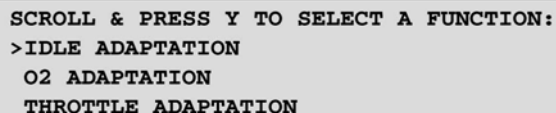
NOTE:
After performing a reset, make sure to cycle the ignition key or the engine may not start.
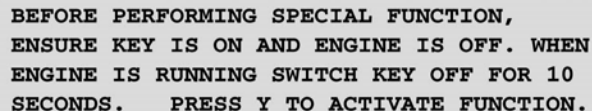
To reset an adaptation:

1. From the FUNCTIONAL TESTS menu, select **SPECIAL FUNCTIONS**.

   The scan tool displays a screen similar to Figure 4-12.

```
SCROLL & PRESS Y TO SELECT A FUNCTION:
>IDLE ADAPTATION
 O2 ADAPTATION
 THROTTLE ADAPTATION
```

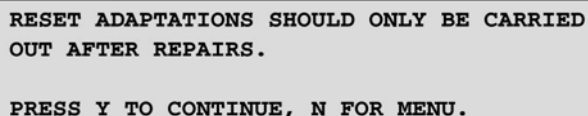**Figure 4-12** *Special functions screen*

2. Select an adaptation.

   The scan tool displays an instructional screen similar to Figure 4-13.

```
BEFORE PERFORMING SPECIAL FUNCTION,
ENSURE KEY IS ON AND ENGINE IS OFF. WHEN
ENGINE IS RUNNING SWITCH KEY OFF FOR 10
SECONDS.   PRESS Y TO ACTIVATE FUNCTION.
```

Figure 4-13 *Sample special functions instructional screen*

3. Press Y.

   The scan tool displays a screen similar to Figure 4-14.

```
RESET ADAPTATIONS SHOULD ONLY BE CARRIED
OUT AFTER REPAIRS.

PRESS Y TO CONTINUE, N FOR MENU.
```

Figure 4-14 *Sample special functions instructional screen*

4. Follow the instructions and press Y to begin the test.

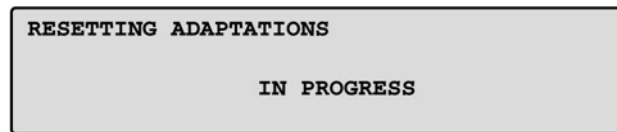The scan tool displays a screen similar to Figure 4-15.

```
RESETTING ADAPTATIONS

              IN PROGRESS
```

Figure 4-15 *Sample special functions instructional screen*

5. Press Y to continue.

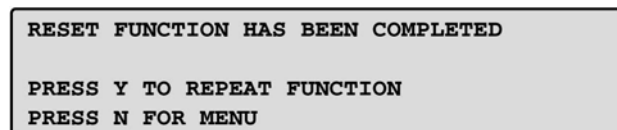   The screen displays "RESETTING ADAPTATIONS" for a few seconds, then displays a screen similar to Figure 4-16.

```
RESET FUNCTION HAS BEEN COMPLETED

PRESS Y TO REPEAT FUNCTION
PRESS N FOR MENU
```

Figure 4-16 *Sample special functions completed screen*

Resetting Service Lamps

The Service Indicator System (SIA) is designed to alert the driver when the vehicle is due for a service. The BMW Maintenance System includes the Engine Oil Service and Inspections I (minor service) and II (major service). Different years and models have display variations depending on the instrument cluster level type.

NOTE:
Note the following regarding SIA systems:

- Oil changes are always done during an inspection.
- Service resets always alternate between OIL (first) and INSPECTION (second).
- It is not recommended to reset either OIL or INSPECTION services early. If oil is changed more frequently, keep a separate record.
- After performing a reset, make sure to cycle the ignition key or the engine may not start.

There are three different SIA types:

- SIA II
- SIA III
- SIA IV

SIA II

The SIA II is found on all 1986–96 models except the E36, which continued using it up through 1999. With this type, optimal maintenance intervals are calculated using actual operating conditions (not limited to mileage accumulation only). Other inputs in determining the optimal oil change and service interval may include coolant temperature, engine speed, vehicle speeds, number of short and long trips, number of engine starts, etc.

The lower level lamp display contains seven lamps (Figure 4-17):

- **5 green lamps**—The number of illuminated lamps decreases as the time for the next inspection approaches. Each green LED represents approximately 1500 miles.
- **1 yellow lamp**—When all green lamps are off and only the yellow lamp is illuminated along with "OIL SERVICE" or "INSPECTION," service is due.
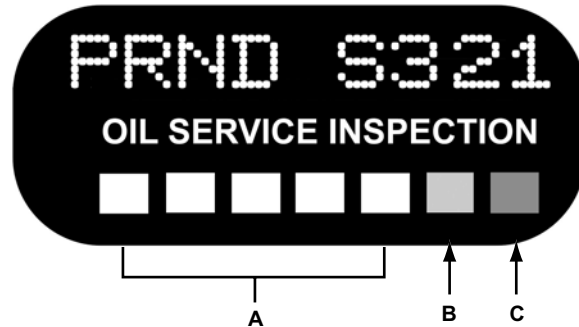- **1 red lamp**—Maintenance is overdue when this lamp is illuminated.

Figure 4-17 *Sample SIA lamp display*

A—Green lamps
B—Yellow lamp
C—Red lamp

Vehicles using SIA II have oil changes due about every 7500 miles and inspections about every 15,000 miles. When service is due, all green LEDs will be out and the yellow LED will be lit and may stay on when the engine is running. In addition, "OIL SERVICE" or "INSPECTION" will be illuminated, indicating what type of service is required. After the vehicle has been driven an approximate additional 1,000 miles, the red LED will illuminate along with the yellow LED (usually staying on when the engine is running).

The OIL and INSPECTION resets are two separate functions. Depending on driving conditions, the time to service may be less than 7500 miles but not more. Services alternate between OIL and INSPECTION. Resetting a service early or before the yellow lamp is on causes the next service to also set earlier than the vehicle mileage will indicate.

SIA III

The SIA III is used on the E38, E39, E53 from 1996 to the present, though it was not used on the E36 until 1999. SIA III uses the same green, yellow and red LEDs as SIA II, along with the corresponding INSPECTION message. The difference is that SIA III uses only fuel consumption using the DME ti input (injection pulse) to calculate the service interval. Each green LED represents 20% of the total fuel calculated consumption value (variable according to engine and model) that is stored in the SIA memory. The yellow LED represents 100% of the total fuel consumption stored value, and the red LED represents 108%. If the vehicle is driven hard, more fuel will be consumed and the LEDs will count down more quickly.
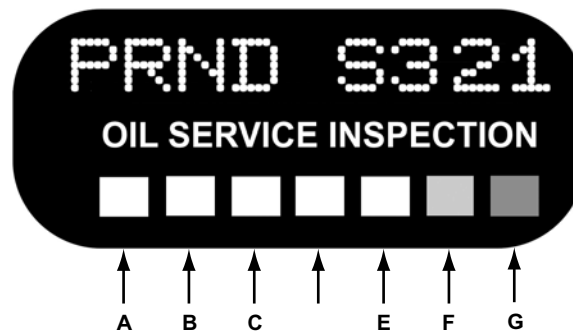
Figure 4-18 *Sample SIA III lamp display*

A—Green lamp—20% of total fuel calculated consumption value

B—Green lamp—40% of total fuel calculated consumption value

C—Green lamp—60% of total fuel calculated consumption value

D—Green lamp—80% of total fuel calculated consumption value

E—Green lamp—100% of total fuel calculated consumption value

F— Yellow lamp—100% of total fuel calculated consumption value—service reminder

G—Red lamp—108% of total fuel calculated consumption value—service past due

BMW recommends that most 1999 and newer vehicles use synthetic oil with oil changes performed at 15,000-mile intervals. Depending on fuel consumption, the SIA system may turn on the yellow LED sooner or later than actual 15,000 miles driven.

Services will always alternate between "OIL" and "INSPECTION." Services can be reset early without affecting the time to the next service (as with SIA II) because the calculation for SIA III is not mileage-based. However, note that resetting a service early means that the system will use the reset as the new starting point for calculating fuel consumption until the next service.

NOTE:

Note the following regarding SIA III:

- This system is designed to calculate normal driving fuel consumption with an equivalency of approximately 15,000-mile intervals. A greater number of early resets will cause the service lights to vary more from actual odometer mileage.

- Field reports indicate many BMW repair shops recommend changing oil more frequently than the 15,000-mile interval. Usually, an oil change schedule based on mileage and consultation with the owner determines how frequently the oil is changed, however, most shops are not resetting the service lamps early when they change the oil unless the service lamps reset is or will be due soon.

SIA IV

SIA IV is used on 1999/2000 and newer 3 Series (E46) as well as on most other 2001 and newer models. This type instrument cluster no longer has the green, yellow and red lights, but instead uses a digital countdown system. With every ignition cycle, the instrument cluster briefly displays the next scheduled service and the remaining miles before the service is due. A flashing message and a minus symbol before the mileage display indicates that a service is

past due. As with SIA III, if the vehicle is driven hard with higher than normal fuel consumption, the mileage count down will be quicker.

The services always alternate between "OIL" (first) and "INSPECTION" (second). Services can be reset early without affecting the time to the next service (as with SIA II) because the calculation is not mileage-based. However, as with SIA III, resetting a service early means that all subsequent services will be skewed according to that service.

NOTE:
Note the following regarding SIA IV:

- The SIA IV system can not be reset again until the vehicle has consumed at least 2½ gallons of fuel.
- SIA IV will not allow a reset of the service not currently displayed (OIL or INSPECTION). It will only reset the service that is currently displayed with miles remaining to the next service.

The following sections provide information about resetting the oil service and inspection service lamps. For a shortcut to these functional tests, see "Quick Vehicle ID for Service Lamps Reset" on page 8.

Reset Oil or Inspection Service Lamps—Scan Tool Procedures

Use the following procedures with the Snap-on® scan tool for vehicles up to the 2000 model year, except vehicles without the 20-pin underhood connector. See page 12 for information about which vehicles no longer have the 20-pin underhood connector.

▶ **To reset the oil or inspection service lamps:**

1. From the FUNCTIONAL TESTS menu, select **RESET OIL SERVICE LAMP**.

   The scan tool displays the following screen (Figure 4-19).

```
RESET OIL SERVICE LAMP
(MAKE SURE ENGINE IS OFF.)
PRESS Y TO CLEAR SERVICE LAMP
PRESS N TO RETURN
```

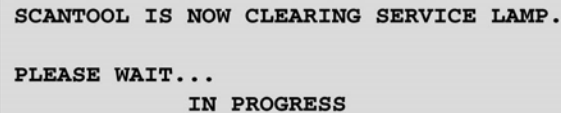**Figure 4-19** *Reset Oil Service Lamp Instructions screen*

NOTE:
Once the scan tool has reset the oil service lamp, it cannot be returned to its previous state. Make sure that this lamp needs to be reset before performing this function.

2. Make sure the ignition switch is in the on position and that the engine is not running.
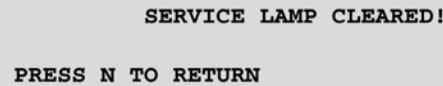3. Press **Y**.

   The scan tool momentarily displays the following screen (Figure 4-20).

```
SCANTOOL IS NOW CLEARING SERVICE LAMP.

PLEASE WAIT...
               IN PROGRESS
```

Figure 4-20 *Reset Oil Service Lamp In Progress screen*

After approximately 30 seconds, the scan tool usually displays the following screen (Figure 4-21).

```
               SERVICE LAMP CLEARED!

PRESS N TO RETURN
```

Figure 4-21 *Reset Oil Service Lamp Complete screen*

Use the following scan tool procedure for 2000 and later vehicles without the underhood 20-pin connector and some vehicles that have the underhood connector and communicate with the instrument cluster.

▶ **To reset the oil or inspection service lamps:**

1. From the System Selection menu, select **INSTRUMENT CLUSTER**.
   The Main Menu displays.
2. Select **FUNCTIONAL TESTS**.
   The Functional Tests menu displays.
3. Select **SPECIAL TESTS**.
4. Select **RESET OIL SERVICE** or **RESET INSPECTION**.

Reset Oil or Inspection Service Lamps—Manual Procedures

The following procedures guide you through resetting the oil service lamps without a diagnostic tool.

Use the following procedure for 2000 and later vehicles that have instrument dash panels with only one button (odometer) and without the underhood 20-pin connector. This manual reset procedure can be interrupted and aborted if the ignition key position is changed.

ⓘ **NOTE:**
Field reports advise closing all doors before beginning the manual reset procedure. Also, be aware that it is easy to turn the ignition switch too far. Be sure that it is in position 1 (accessory), and not position 2 (ignition on).

▶ **To manually reset the oil service lamp on 2000 and later vehicles[1]** without the underhood 20-pin connector:

1. Turn the ignition switch to the off ("0") position.
2. Press and hold the trip odometer button in the instrument cluster and turn the ignition key to the accessory ("1") position.

3. Keep the button pressed for approximately 5 seconds until either of the following words appear in the instrument cluster display: "Oil Service" or "Inspection" with "Reset" or "Re".

4. Press the button again and hold for approximately 5 seconds until "Reset" or "Re" flash.

5. While the display is flashing, press the button briefly to reset the Service Interval.

   After the display is reading the new interval, the following message will appear in the display for approximately 2 seconds, "END SIA."

   The system can not be reset again until the vehicle has been driven approximately 50–75 miles (until it consumes at least 2½ gallons of fuel). If the display reads "Reset" or "Re" when resetting, this indicates the minimum driving distance has been fulfilled and the system can be reset.

Use the following procedure to manually reset the oil service lamp for 2002–03 E65 and E66 with the high instrument cluster.

▶ **To manually reset the oil service lamp on 2002–03 E65 and E66:**

1. Press the reset button on the top left side of instrument cluster for more than 10 seconds.

   This brings you directly to Reset mode. A four-line menu appears in the speedometer. At the top is the Back function, then the first three service and maintenance items sorted by priority along with the residual wear or the remaining time (may have a minus sign).

   – The "!" symbol means that this service item can be reset.

   – A "0" indicates that this service item cannot be reset (must exceed the first 20% of service interval before reset is possible).

2. Scroll through the service and maintenance items by pressing the reset button or the lower button on the turn signal/high beam switch.

3. Select the item to reset and press the reset button for a few seconds, which displays a 2-line menu in the tachometer.

   This 2-line menu in the tachometer displays the back function and the service or maintenance item previously selected.

4. Press either button again for a few seconds.

   If the reset was successful, a third menu item confirms the reset. The new service interval for this service or maintenance item should now be highlighted in the Service Need Display. With the ignition first turned on, the Service Need Display appears under the speedometer in the instrument cluster for 10 seconds replacing the fuel level. The first line corresponds to mileage-dependent service items, specifying the mileage when the next service is due. A minus sign means that mileage has been exceeded and service is overdue. The second line corresponds to the time-dependent service items and is displayed with a clock symbol. It specifies the weeks/months/years until the next service is due. More information on the actual service or maintenance item can be viewed in the Control Display.

4.2 Testing Transmission Systems

The scan tool offers the following testing options for electronic automatic transmissions.

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1. Except for 2002–03 E65 745i, E66 745i and 760i. To manually reset the oil service lamp on these vehicles, use the procedure on page 33.

- Codes and Data
- Functional Tests
- Special Functions
- Shift Adaptation Reset (Transmission)
- ECU Identification

4.2.1 Transmission Applications

Table 4-7 lists BMW electronic transmissions and their features, and Table 4-8 lists BMW electronic transmissions with the 1988–2003 models where they are found.

Table 4-7 *Transmission types and system descriptions (sheet 1 of 2)*

TRANSMISSION	TRANSMISSION FEATURES	NOTES
ZF 4HP 22 EH	4-speed RWD 3 shift programs: Economy, Sport and Manual TCM 35-pin TCC On/Off	First electronic transmission in the U.S.
ZF 4HP 24 E9:	4-speed RWD 3 shift programs: Economy, Sport and Manual TCM 35-pin TCC On/Off	Identical to the 4HP22 but can handle higher torque.
A4S 310 R THM R1	4-speed RWD 3 shift programs: Economy, Sport and Manual Warm-up phase (sport shift, cold) TCM 55-pin TCC On/Off	Introduced on the 1990 525 as THM R1, changing to A4S 310R. This was GM's first BMW transmission in the U.S. Uses Bosch control system.
A4S 270R (4L30-E)	4-speed RWD 3 shift programs: Economy, Sport and Manual Warmup phase (sport shift, cold) TCM 88-pin TCC On/Off	Mechanically identical to A4S310R but uses Ravigneaux planetary gearset for lower torque rating.
A5S 360R 390R 5L40 OR GM5	5-speed RWD AGS adapt logic TCC variable lockup 3rd, 4th, and 5th TCM = SKE 134 pin	Introduced on the E46; control system joint Bosch, GM, and BMW design.
A5S 310Z ZF5HP18	5-speed RWD AGS adapt logic (1994 and later) 3 shift programs: Economy, Sport and Manual PWM pressure regulation SOLs TCC Variable Lockup TCM = 88 pin	Introduced to U.S. in 1993 as a lighter duty alternative to the A5S 560Z.

Table 4-7 *Transmission types and system descriptions (sheet 2 of 2)*

TRANSMISSION	TRANSMISSION FEATURES	NOTES
A5S 440Z ZF 5HP24	5-speed RWD Steptronic capable 3 shift programs: Economy, Sport and Manual TCC variable lockup Lifetime oil TCM = SKE 134 pin (1998 and later) TCM = 88 pin (1997)	Introduced in 1997 as a lighter weight alternative to the A5S 560 Z.
A5S 560Z ZF5HP30	5-speed RWD Steptronic capable 3 shift programs: Economy, Sport and Manual TCC variable lockup Lifetime oil TCM = 88 pin	Developed for high output engines (V8, V12). First BMW transmission with overlap shift.
GA6HP26Z	6-speed Overdrive in 5th and 6th Lighter and shorter than A5S560Z Parts reduced from 660 to 470 Shift-by-wire Stand-by-Control clutch (uncoupled turbine shaft to reduce engine load with vehicle stationary Mechatronics Module may be integrated in valve body (replaced as unit with valve body)	
Sequential Manual Gearbox (SMG, SMG II)	Manual shift with computer-controlled electro-hydraulic clutch and gear change SMG II has two modes: (1) Manual (S mode) 5 different drivelogic shift programs and (2) Automatic (A mode) shifting performed by computer 6 different shift programs	Enables driver control for greater shift accuracy with the convenience of automated shifting. SMG II has drivelogic enabling driver to change up to 5 or 6 different shift programs.
A5S325ZF 5HP19	5-speed RWD Steptronic-capable 3 shift programs: Economy, Sport and Manual TCC variable lockup Lifetime oil TCM = 88 pin	

Table 4-8 *1988–2003 transmission applications (sheet 1 of 3)*

TRANSMISSION	MODEL	YEAR	CONTROL SYSTEM VERSION
ZF 4HP 22 EH	325i/is/iX (E30)	1991–92	GS 1.2x
	535i/ia/iL (E34)	1989–93	
	735i/ia/iL (E32)	1988–92	
ZF 4HP 24 E9	750iL (E32)	1988–94	GS 1.27 (EGS)
	850i/Ci (E31)	1990–94	GS 1.29 (EGS)

Table 4-8 *1988–2003 transmission applications (sheet 2 of 3)*

TRANSMISSION	MODEL	YEAR	CONTROL SYSTEM VERSION
A4S 310 R THM R1	318i/is/ic/ti	1992–95	GS 4.14 (EGS)
	325i/iS	1992	
	325i/is/iC	1993–95	GS 4.16 (EGS)
	525i (E34)	1991–92	GS 4.14 (EGS)
	525i/it	1993–95	GS 4.16 (EGS)
A4S 270R (4L30-E)	318i/is/iC	1996–97	GS 8.34 (EGS)
	323is/iC	1997–2000	
	328i/is/ic	1996–2000	GS 8.34 (EGS)
	528i	1997–99	
	Z3 2.3/2.8L	1996–2000	
A5S 360R 390R 5L40 OR GM5	323i/328l (E46)	1999–2000	GS 20 (AGS)
	325it (E46)	9/00–3/01	
	325xi/it/330xi (E46)	2001–03	
	525i/530l (E39)	9/00–3/00	
	528I (E39)	9/99–9/00	
	X5 3.0l (E53)	2001–03	
	Z3 2.5/3.0L		
A5S 310Z ZF5HP18	530i/it (E34)	1993	GS 7.3 (EGS)
		1994–95	GS 7.32 (AGS)
	M3 (E36)	1995	GS 7.11 (EGS)
	M3 (E36)	1996–99	GS 8.32 (AGS)
A5S 440Z ZF 5HP24	540i (E39)	1997	GS 8.55 (AGS) CAN INDEX 50
		1998	GS 8.60.2 (AGS) CAN INDEX 60
		1999–2003	
	740i/iL (E38)	1/97–4/97	GS 8.55 (AGS) CAN INDEX 50
		5/97–8/97	GS 8.55 (AGS) CAN INDEX 60
		1999–2002	GS 8.60.2 (AGS) CAN INDEX 60
	840 Ci (E31)	1997	GS 8.55 (AGS) CAN INDEX 50
	X5 4.4i (E53)	2000–03	GS 8.60.2
A5S 560Z ZF5HP30	540i (E34)	1994–95	GS 9.22 (AGS)
	740i/iL (E32)	1993–94	GS 9.2 (EGS)
	740l/i/iL	1995	GS 9.22 (AGS)
	740i (E38)	1995–2001	GS 9.22.1
	750iL (E38)		
	840Ci (E31)	1994–95	GS 9.22
		1996	GS 9.22.1
	850Ci (E31)	1995–97	
GA6HP26Z	E65 745i 745Li 760Li	2002–03	EGS/AGS GS 19

Table 4-8 *1988–2003 transmission applications (sheet 3 of 3)*

TRANSMISSION	MODEL	YEAR	CONTROL SYSTEM VERSION
Sequential Manual Gearbox (SMG, SMG II)	*The SMG transmission is a dealer option for M3, M5, and Z4.	2002–04	Sport Manual shift
A5S325ZF 5HP19	323i/Ci (E46)	3/00–9/00	GS 8.36 (EGS/AGS)
	325i/330l (E46)	6/00–2003	
	325i/Ci/CiC 330i/Ci/CiC 525i, 530i (E39)	2000–03	
	525i/530l (E39)	3/01–2003	
	Z4	2003	

Table 4-9 provides two sample interpretations of BMW automatic transmission identification codes, located on the transmission side plate.

Table 4-9 *Sample BMW automatic transmission ID codes and explanations*

A5S 310Z	4HP24 (EH)
A = Automatic, or S for Standard 5 = Number of gears Overdrive Ratio: S = Top Gear Overdrive; D = Top Gear Direct Drive 310 = Maximum Input Torque Rating in Nm Z = Manufacturer: R = Hydramatic; Z = ZF	4 = Number of Gears HP = Hydraulic Planetary 24 = Maximum Torque Rating in Nm (22-220) EH = Electro-Hydraulic Valve Body; H = Hydraulic Valve Body

4.2.2 Transmission Systems

BMW uses automatic transmissions made by two different suppliers: GM and ZF.

- GM—Hydramatic is a manufacturing division of GM located in Strasbourg, France producing smaller transmissions used for lower output engines such as the M42 and M50.
- ZF—German company, "Zahnradfabrik Friedrichshafen" commonly known as ZF transmissions. ZF manufactures both manual and automatic transmissions.

There are approximately 24 different control system versions. The transmission and control system technology becomes more sophisticated through the model years. The advancement is mainly due to the integration of total vehicle system communications sharing information on a common communication bus (see page 55). This allows the transmission control module to read information from other controllers on the same vehicle, which it uses for smoother and more efficient shift control regardless of the operating conditions.

BMW transmission control systems are listed as EGS or AGS.

- EGS is German for "Electronic Getriebestuerung" or "Electronic Gearbox."
- AGS is German for "Adaptiv Getriebestuerung" or "Adaptive Gearbox Control."

Both EGS and AGS have different driver-selectable shift programs. However, AGS can automatically adapt and select the appropriate shift program depending on driving style or operating conditions. AGS has everything that EGS has plus the following:

- Shift points adapted to driving style
- No upshifting when driving in a curve
- Auto determination and selection of winter program to improve traction (2nd gear start-up)
- Stop and go traffic auto recognition, eliminating 1st gear for improved comfort

Both EGS and AGS have adaptive hydraulic pressure control. Transmission slip ratio (input speed to output speed) and slip time (amount of slippage during a shift) are monitored by the TCM. By comparing target and actual slip, the TCM can adapt by modifying the pulse width modulation of the main pressure solenoid. This increases clutch apply pressures compensating for internal slip resulting from clutch wear and optimizes shift performance.

4.2.3 Important Tips for Testing Transmission Systems

- Make sure that you identify the SMG transmission to the scan tool as an automatic to obtain codes and data.
- Some transmissions may have different controllers that can be EGS or AGS.
- On OBD-II (1996 and later) vehicles, the transmission MIL may turn on simultaneously with the engine MIL for any emission-related DTC.
- Engine pending codes may turn on the transmission MIL.
- With the transmission MIL on, the transmission will be in limp home mode (4th or 5th gear).
- With a DTC set, the transmission MIL is either a gear sign with an exclamation mark in the middle, or the instrument panel illuminates with "TRANS PROGRAM," depending on the instrument cluster type.
- Disconnecting the battery will not erase transmission or engine codes (late model OBD-II vehicles) but may turn the transmission MIL off. On OBD-I vehicles (1988–95), codes clear and adaptations usually reset with the vehicle battery disconnected.

⚠️ **IMPORTANT:**
Do not leave the key on when disconnecting or connecting the vehicle battery or module failure may result.

4.2.4 Functional Tests

Functional Tests allow you to activate and test components of the transmission electronic control system. Selecting FUNCTIONAL TESTS from the Main Menu displays a menu like the following, depending on the vehicle and system identified.
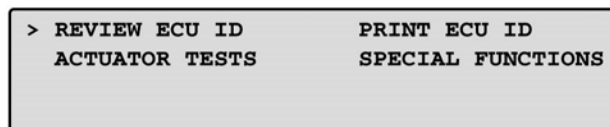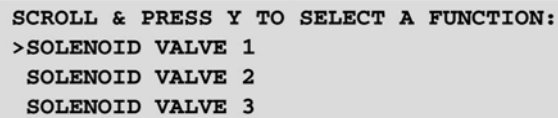
```
> REVIEW ECU ID        PRINT ECU ID
  ACTUATOR TESTS       SPECIAL FUNCTIONS

```

Figure 4-22 *Sample Transmission Functional Tests menu*

Actuator Tests

Selecting ACTUATOR TESTS opens a menu similar to Figure 4-23.

```
SCROLL & PRESS Y TO SELECT A FUNCTION:
>SOLENOID VALVE 1
 SOLENOID VALVE 2
 SOLENOID VALVE 3
```

Figure 4-23 *Sample Actuator Tests menu*

As each actuator test is selected, the following actuators are pulsed On/Off for a pre-determined period of time.

Available actuator tests may vary from the list below, depending on the transmission:

- Solenoid Valve 1
- Solenoid Valve 2
- Solenoid Valve 3
- Pressure Regulator 1
- Pressure Regulator 2
- Pressure Regulator 3
- Pressure Regulator 4
- Shift Lock Solenoid Valve

Special Functions

The SPECIAL FUNCTIONS selection from the Functional Tests menu for transmission systems can work differently than for other systems, depending on the type of transmission. See "Special Functions" on page 26 for instructions on resetting adaptations.

Important Tips for Resetting Transmission Adaptations

- On some transmissions, the Special Functions menu may have only one selection which reads "RESET ALL ADAPTATIONS."
- Using the scan tool to reset transmission adaptations for either EGS or AGS transmissions only clears the adaptive pressure control values. EGS/AGS shift adaptation to driving style is not cleared with the scan tool because it is not stored in long-term memory. The transmission re-learns with each new key cycle. Clearing adaptive pressure control values can temporarily cause bad shift quality until the transmission has completed the re-adaption. Do not reset adaptation (pressure) values for shift complaints. Only reset after a transmission repair or replacement. After performing an adaptation reset, cycle the ignition switch off for 10 seconds, then on again before continuing (or engine may not start).
- Similar version transmission control systems in the same year may be different between models.
- On most 1990–95 vehicles, adaptations reset automatically when the battery is discharged or disconnected, but on most 1996 and newer vehicles, transmission adaptations must be reset using the scan tool.

4.3 Testing ABS and Traction Control Systems

The scan tool offers the following testing options for ABS and traction control systems.

- Codes
- ECU identification

NOTE:
The ABS dash lamp may light up during scan tool communications with the ABS connector.

4.3.1 ABS and Traction Control Applications

The scan tool communicates with the traction control systems (ABS/ASC/DSC) in Table 4-10.

Table 4-10 *Traction control types applications (sheet 1 of 2)*

E SERIES	YEAR	SYSTEM	SCAN TOOL NAME	DESCRIPTION
E32/E34 M30 E32 M70 E31 M70A	1988–90	ASC	No scan tool diagnostics; flash codes only	Bosch: slip control only
E32 M70 E31 M70A	1990–91	ASC+T	No scan tool diagnostics; flash codes only	Bosch: slip control + traction (cuts engine power)
E32 M60 E31 M60 E34 M60	1993	ASC+T	ABS/ASC Micro C	Bosch: slip control + traction (cuts engine power)
E32 M60 E31 M60 E34 M60	1993	ADS II	ABS/ASC Micro C	Bosch: traction system with second EML throttle valve (V12)
E34 M50 E31 M60/M62 E38 M60/M62 E39 M62	1994–2000	ASC/5	ABS/ASC5	Bosch: more sophisticated traction control integrated with transmission
E36 M42/M44	1994	Mark IV (open)	MK4-3	Teves 3 channel
E36 M43/M44	1994–96	Mark IV (closed)	MK4-G	Teves 4 channel
E38, E31	1994	DSC II (ABS/ ASC+T5)	ABS/DSC 2	Bosch: early version dynamic stability control added to traction system
Z3, E36	1996	ASC-EZA	ABS/ASC ITT	Teves: traction system with no throttle control used on 4-cylinder engines
E38, E39 E46 AWD X5, Z8 E65 745i E66 760Li, 745Li	1998–2003	DSC III V 5.7	Bosch ABS/ DSC 3	Bosch: First introduced on E38/ E39 in 1998 (V5.3). Increased functionality in 1999 combined rotational rate/lateral acceleration sensor. For E38, also includes DSC, auto reduces driver brake pedal force during panic stop.

Table 4-10 *Traction control types applications (sheet 2 of 2)*

E SERIES	YEAR	SYSTEM	SCAN TOOL NAME	DESCRIPTION
E46	1999	Mark 20 EI	ASC MK20/1	Teves: ABS + traction + DSC III
E46, Z3, Z4	2001–03	Mark 60	ABS/ASC MK 60MK 60	Teves: ABS + traction + DSC III (more compact and sophisticated strategies)

4.3.2 ABS and Traction Control Systems

BMW uses both Bosch and Teves ABS/Traction Control Systems. ABS and Traction Control (and later DSC) are integrated into one control module (see Table 4-10 for different system descriptions). BMW calls traction control "ASC," Automatic Slip or Stability Control. At speeds up to 24 MPH (39 KPH), braking individual rear wheels have the same traction effect as a limited slip differential.

ASC came out in 1988 on the E31, E32, and E34. This early system used the ABS system to apply the rear wheel brakes to prevent wheel slippage. It is important to note that these early systems had no scan tool diagnostics (flash or blink code only).

In approximately 1990, ASC+T came out, adding traction control or engine power cutout to ASC. In addition to using the ABS for ASC, this system had the ability to reduce engine torque to the rear wheels by either applying throttle valve control, retarding ignition timing, or shutting down fuel injection.

By the mid-1990s, more sophisticated systems phased out ignition and limited fuel injection control by integrating engine and transmission control, resulting in smoother operation, such as preventing shifting during a traction control event. Next, additional traction control refinement resulted in MSR (Motor Speed Regulation) under deceleration. During deceleration, engine braking under certain slippery conditions can cause wheel slip. Traction control systems equipped with MSR will detect this condition and automatically increase engine speed until wheel slippage stops.

In approximately 1995, Dynamic Stability Control (DSC II) came out on the E31 and E38. DSC is an enhancement feature integrated into the ASC+T system. DSC provides additional stability during cornering and avoidance maneuvers as well as monitors steering angle, lateral acceleration, brake pressure, and vehicle vertical axis movement. In addition to rear wheel control, a DSC-equipped system can also brake the front wheels to stabilize the vehicle.

BMW uses both a Teves and Bosch DCS III system. In 1998, the E38 and E39 featured Bosch DSC III version 5.3. Enhanced in 1999, Bosch version 5.7 came out with a new rotational rate/lateral acceleration sensor. The new 1999 E46 came out with Teves DSC III, which is similar in function to the Bosch DSC III.

The E46 all-wheel drive uses Bosch DSC III 5.7. The E46 2-wheel drive uses Teves DSC III MK 60. Note that these systems have different components and operations.

Dynamic Stability Control (DSC)

With the introduction of DSC systems, lateral and rotational vehicle movement is monitored. The DSC III systems compensate if the control unit detects a difference between the driver's steering and the actual rotation angle of the vehicle. The control unit determines vehicle stability based on:

- Steering wheel angle
- Wheel speed
- Transverse acceleration forces
- Rotation angle and speed (yaw)

If the DSC control unit determines that the vehicle is in an unstable situation, it also computes whether it is an oversteer or understeer condition. It needs this information in order to determine the correct control strategy for stabilizing the vehicle.

DSC III is comprised of three main systems:

- ABS
- ASC+T (Traction)
- DSC

DSC regulation may use the following sub-systems:

- Engine intervention
- Engine and brake intervention (any wheel)
- Brake intervention

Based on signals coming from the various sensors, DSC III will determine the best system to control the vehicle. In addition to the three basic systems, there are sub-functions activated only during very specific conditions.

Corner Brake Control (CBC)

If the DSC III system detects transverse acceleration in excess of 0.6 G-Force and the brakes are applied, it activates the CBC subsystem which limits brake pressure to the inside rear wheel to counteract oversteer. The difference in braking force between the two rear wheels creates an oversteer opposing force. The DSC III control unit closes the inlet valve, limiting brake pressure at the inside wheel brake caliper.

NOTE:
CBC will not activate if ABS is engaged.

Electronic Brake Force Distribution (EBV)

Electronic Brake Force Distribution (EBV) adjusts brake pressure based on the rate of rear axle slowdown, ensuring even brake force between the front and rear of the vehicle. With a high load in the vehicle, the rear axle takes longer to slow down, which means rear wheel brakes can then be applied at a higher pressure. Conversely, with a low load, brake pressure must be lowered to keep the vehicle stable. The control unit monitors the wheel speed when

the brakes are applied and compares the deceleration rate of the front and rear axle to determine if the real axle brake pressure should be increased or decreased.

EBV has the following advantages:

- Brake force is more evenly distributed.
- Vehicle rear wheel brake size can be increased.
- Front and rear brake wear will be more equal.

Automatic Stability (Slip) Control (ASC+T)

ASC controls drive wheel slip. The DSC III control unit determines if there is traction loss due to excessive wheel slip based on wheel speed sensor input.

The DSC III system controls wheel slip using two subsystems:

- Automatic Stability (Slip) Control (ASC)—engine Intervention
- Automatic Differential Brake (ADB)—brake intervention

ASC Engine Intervention

Engine torque may be reduced by one of three methods:

- Reducing the throttle opening angle
- Retarding the ignition
- Canceling fuel to individual cylinders

The DSC III control unit determines the amount of torque reduction that is necessary and sends the request for regulation to the DME via the CAN bus.

ASC Engine Drag Torque Reduction (MSR)—Deceleration Slip Control

During deceleration, if the front wheels are turning faster than the rear wheels, the DSC III control unit signals the DME (via the CAN bus) to accelerate the engine. The DME cancels fuel cut-off and allows the engine speed to increase, which accelerates the rear wheels to match the front wheels. This situation could happen if the driver shifts into too low a gear when coasting downhill, causing the rear wheels to slow down due to the engine braking effect, which could cause vehicle instability.

NOTE:
MSR regulation is cancelled if the brake pedal or hand brake is applied.

Automatic Differential Brake Intervention (ADB)

The Automatic Brake Differential (ADB) is an automatic differential lock that improves traction. A slipping wheel is braked, which allows the drive torque to be transferred to the wheel with the greater traction. This function acts much like a limited slip differential. ADB intervention is applied to the slipping wheel by regulating the brake pressure in the following manner:

1. Pressure build
2. Pressure hold
3. Pressure release

Dynamic Brake System (DBS)

Dynamic Brake System (DBS) is designed to assist the driver in emergency braking situations by automatically increasing pressure to the brake system. This allows the vehicle to stop in the shortest distance possible. DBS was first available in 1999 on Bosch DSC III 5.7 systems.

The DBS system contains two subsystems:

*   Dynamic Brake Control (DBC)
*   Maximum Brake Control (MBC)

DBS functions are programmed into the DSC III control unit, requiring no additional components.

Dynamic Brake Control (DBC) is designed to provide an increase in braking pressure up to the ABS threshold during rapid (emergency) braking situations. The DSC III control unit monitors the inputs from the brake light switch and the brake pressure sensor. The triggering criteria for activation of DBC is how rapidly the brake pressure is increasing, using the following factors:

*   Brake light switch on
*   Brake pressure in the master cylinder above threshold
*   Brake pressure build-up speed above threshold
*   Vehicle road speed above 3 MPH (5 KPH)
*   Pressure sensor self-test completed and sensor not faulted
*   Vehicle travelling forward
*   ABS inactive

If the threshold for DBC triggering is achieved, the DSC III control unit will activate a pressure build-up intervention by activating the pre-charge and return pump. The pressure on all wheels is increased up to the ABS regulation point. This ensures that the maximum brake force is applied to the vehicle. When DBC is activated, the rear axle is controlled with Select-Low logic and the front wheels are regulated individually. DBC will continue until one of the following conditions occurs:

*   The driver releases the brake pedal.
*   Brake pressure falls below threshold.
*   Vehicle road speed falls below 3 MPH.
*   A fault occurs with any of the necessary input sensors.

A DBC fault will illuminate the yellow "BRAKE" (ABL) lamp to warn the driver. Depending on the failure, the DSC lamp may be illuminated as well.

Maximum Brake Control (MBC) is designed to support driver-initiated braking by building up pressure in the rear brake circuit when the front wheels are already in ABS regulation. The additional braking pressure is designed to bring the rear wheels up to the ABS regulation point, shortening the stopping distance. MBC is triggered when the brakes are applied more slowly than the threshold needed for a DBC regulation. The triggering conditions are:

- Both front wheels in ABS regulation
- Vehicle road speed above 3 MPH (5 KPH)
- DBC and pressure sensor initialization test successful
- Vehicle moving in a forward direction
- Rear wheels not in ABS regulation

If the threshold for MBC triggering is achieved, the DSC III control unit will activate a pressure build-up intervention by activating the return pump. The pressure at the rear wheels is increased up to the ABS regulation point. This ensures that maximum brake force is applied to the vehicle. The MBC function will be switched off if one of the following conditions occurs:

- The front wheels drop out of ABS regulation.
- The driver releases the brake pedal.
- Brake pressure falls below a specific threshold.
- Vehicle road speed falls below 3 MPH (5 KPH).
- A fault occurs with any of the necessary input sensors.

A MBC fault will illuminate the yellow "BRAKE" (ABL) lamp to warn the driver. Depending on the failure, the DSC lamp may be illuminated as well.

Teves DSC III MK 60 Wheel Speed Sensors (Hall Effect)

For Teves DSC III MK 60 systems, active wheel speed sensors operate on the principle of the Hall effect. The sensor element is a ferromagnetic alloy that changes its resistance based on the influence of magnetic fields. The sensor element and evaluation module are two separate components within the sensor housing. The active sensing of the magnetoresistive sensor is particularly suitable for advanced stability control applications in which sensing at zero or near zero speed is required. A permanent magnet in the sensor produces a magnetic field with the magnetic field stream at a right angle to the sensing element. The sensor element is affected by the direction of the magnetic field, not the field strength. The field strength is not important as long as it is above a certain level. This allows the sensor to tolerate variations in the field strength caused by age, temperature, or mechanical tolerances.

ASC/DSC Lamp and Brake Lamp

Vehicles with ASC or DSC usually have a separate console or dash switch to turn the system ON or OFF.

Figure 4-24 *ASC/DSC and brake lamps*

A—ASC/DSC lamp

B—Brake lamp
> Can be red or yellow depending on the problem.

ASC/DSC Lamp

For Teves DSC III MK 60 on the E46 (2-wheel drive), the DSC control switch button has two different functions, depending on the time the button is held down:

- When you press the button for *less than 2½ seconds*, only the yaw control of the DSC is disabled. ADB and DBC or maximum braking force for panic stop are still engaged. A higher slip ratio is allowed up to 42 MPH (67 KPH) for the purpose of improving traction in slippery conditions. In addition, the traction control does not engage as quickly. Only the DSC Lamp will be ON.

- When you press the button for *more than 2½ seconds*, all ASC, DSC, ADB, GMR (yaw control) and DSC control functions are deactivated. This is used for service and dynamometer testing. Both the DSC lamp and the yellow brake lamp will be illuminated.

Brake Lamp

For Teves DSC III MK 60 and Bosch DSC III 5.7, the yellow brake lamp illuminates under the following conditions:

- When there is an ASC/DSC fault (the ASC/DSC lamp will also be on)
- When the complete system is manually shut down (on E46 2-wheel drive)

The red brake lamp illuminates under the following conditions:

- Low brake fluid
- Low brake pad (low brake pad warning lamp should also be illuminated)
- Hand brake on

NOTE:
Note the following regarding ASC/DSC lamps and brake lamps:

- On most systems, the ASC or DSC dash lamp will be ON with the system disabled and the control switch in the OFF position.
- The ASC/DSC dash lamp will flash when the system is active. It also stays on solid if a fault is stored.
- Low Brake Fluid may turn the ASC/DSC lamp ON along with a red brake lamp
- With the ASC/DSC system OFF, the ABS system is still ON or activated
- Fault codes for both ASC/DSC and ABS faults are stored in the integrated ASC/DSC/ABS controller. Use the ABS menu selection on the scan tool to access all fault codes.
- For Bosch 5.7 DSC III (E46 all-wheel drive), turning the DSC button "OFF" only deactivates ASC engine and DSC yaw intervention. Brake intervention remains active for anti-spin control in slippery conditions.
- For Bosch 5.7 DSC III (X5), turning the DSC button OFF deactivates the DSC yaw intervention only, not the ASC engine intervention. Engine traction control intervention remains active as well as brake intervention for off-road operation.

Important Tips for Testing ABS and Traction Control

- When the scan tool is accessing the ABS system, the ABS warning lamp may illuminate. The lamp may stay on until the scan tool is disconnected and the ignition key is cycled.
- In most cases, the BMW ABS systems will not communicate with the scan tool if the vehicle is driven.
- If the battery voltage drops below about 11.8V, the ABS/DSC system may have problems communicating with the scan tool.
- For 1992–95 systems with ASC, a malfunction in one system may turn on the warning lamp for both ABS and ASC.
- ABS or traction control codes may sometimes also turn on the engine MIL.
- ASC/DSC codes may also turn on the brake lamp (hydraulic problem) which should go out when codes are cleared.
- On systems with integrated ABS and traction control, clearing ABS codes with the scan tool also turns off the ASC/DCS fault lamps.
- Late models equipped with DSC may have a special warning lamp usually located between the speedometer and the tachometer.
- For vehicles equipped with ASC, always turn the ASC switch off during dynamometer testing or a fault code will set and the warning lamp will stay on, though it should go out with next drive cycle. Vehicles with DSC-III can be safely tested on a dynamometer without any problems.

⚠ **IMPORTANT:**
Antilock brake diagnosis with the scan tool does not require opening the hydraulic system or disassembling mechanical parts. Complete antilock brake service, however, may require opening the hydraulic system. Antilock brake hydraulic systems operate with pressures of approximately 2000 psi or higher. Some systems may need to be completely depressurized before opening any hydraulic connection. In most cases, you can depressurize the system by applying and releasing the brake pedal at least 40 times. Follow BMW's service manual for specific ABS type hydraulic system service and safety instructions.

4.4 Testing Airbag Systems

The scan tool offers the following testing options for airbag systems.

- Codes
- ECU identification

4.4.1 Airbag Applications

Table 4-11 lists BMW airbag systems.

Table 4-11 *Airbag applications*

CAR SERIES	YEAR	AIRBAG SYSTEM
E31	1991–93	5 WK4 060
	1993	CIPRO SIEMENS 2B/2C
	9/93–1996	ZAE/ZAE II
E32	1991–93	5 WK4 060
	1993–94	CIPRO SIEMENS 2B/2C
E34	1991–93	5 WK4 060
	1993	CIPRO SIEMENS 2B/2C
	1994–95	ZAE/ZAE II
E36	1991–93	5 WK4 060
	1993	CIPRO SIEMENS 2B/2C
	1993–99	ZAE/ZAE II
	1/99–3/99 (Z3)	MRS II
	3/99–2000 (Z3)	MRS III
E38	1995–97	ZAE/ZAE II
	1998–3/99	MRS II
	3/99–2001	MRS III
E39	1996	ZAE/ZAE II
	1997–99	MRS/MRS II
	1999–2003	MRS III
E46	1999–2003	
E53	2000–03 (X5)	

4.4.2 Important Tips for Testing Airbag Systems

- The current software may only identify the 5WK 40 060 system for 1993. For earlier vehicles with this airbag system (1991–92), try identifying the vehicle to the scan tool as a 1993 model to obtain the AIRBAG menu selection.
- The replacement of airbag modules always require ZCS coding at installation before they are put into operation.
- Always disconnect the battery and wait a minimum of 10 minutes for the airbag module capacitor to discharge before working on any airbag system.

4.5 Testing Electronic Throttle Systems

The scan tool offers the following testing options for electronic throttle systems.

- Codes
- ECU identification
- Reset adaptations (for E38 and 5.4L E31 only)

4.5.1 Electronic Throttle Applications

Table 4-12 lists BMW electronic throttle systems.

Table 4-12 *Electronic throttle applications*

CAR SERIES	E SERIES	YEARS	ENGINE TYPE	ENGINE SIZE	ENGINE CODE	SYSTEM
7 Series	E32	1991–92	M30	3.4L	346EC 346KB	Bosch EML 2.1
		1988–94	M70	5.0L	5012A	Bosch EML 2.2
	E38	1995–99	M73	5.4L	54121	Siemens EML-IIIS
		1997–2001	M73	5.4L	54122	
8 Series	E31	1990–94	M70	5.0L	5012A	Bosch EML 2.2
		1995–97	M73	5.4L	54121	Siemens EML-IIIS
		1994–95	S70	5.6L	56121	Bosch EML

4.5.2 Electronic Throttle Systems

There are three types of electronic throttle systems:

- EML
- MDK
- EDK

EML

EML is the electronic control module for throttle regulation and is available for selection on the System Selection menu for some vehicles (see "Selecting a System" on page 10). There are two different EML systems:

- Bosch EML for M30, M70 and S70 engines
- EML IIIS for E38 (V12)

Bosch EML for M70 and S70 Engines

This is the first, full drive-by-wire electronic throttle system (used in U.S. only on the 7 and 8 Series). On the V12, a separate control module called EML synchronizes and controls dual throttle valve assemblies called DKs.

Whenever power has been disconnected or EML components have been replaced, the EML system usually requires re-adaptation to synchronize and coordinate system components. Use the following throttle synchronization procedure for the M70 engine.

▶ **To synchronize the EML throttle:**

1. Disconnect the battery for at least 1 hour.
2. Re-connect the battery and start the engine. Let the engine reach operating temperature without touching the accelerator pedal.
3. With the transmission in first gear, accelerate until engine speed is over 5000 RPM.
4. Release the accelerator pedal and coast until engine is at idle.
5. Repeat the above operation two consecutive times.
6. Allow the engine to idle in neutral or park for at least 5 minutes.
7. Turn the engine off.
8. Restart the engine.

   The EML throttle should now be synchronized.

EML IIIS for E38 (V12)

The EML IIIS came out in approximately 1995 in the U.S. and is used on E38, M73, and M73TU engines (5.4L V12). This system has the EML module installed on the CAN communication bus. This system uses two throttle valve assemblies mounted on each intake manifold. There is only one pedal position sensor (PWG) connected to the accelerator pedal.

The EML IIIS control module uses two separate processors. Each throttle valve is controlled by two separate stepper motors, which are each controlled separately by the two processors. On this system, the PWG sensor is not a potentiometer or a Hall effect sensor. Instead, it uses three separate inductive coils, each coil supplied with an AC voltage at a specific frequency from the EML module. As the pedal is moved, the concentric shape of the iron core moves closer to the PWG coils changing the inductance of the coils. This increasing inductance reduces the amplitude of the AC frequency.

The throttle valves are synchronized automatically. The EML III control module processes both signals from the two DME control modules. If there is a difference (under 10%) the EML adjusts the throttle valves to achieve equal air on both banks. Over 10% difference will set a fault code and the system will not be synchronized.

Important Tips for Testing EML Systems

- The BMW software currently does not display data from the EML module. On vehicles with EML IIIS, there may be no or limited throttle-related parameters available to view in the DME data.
- The EML module stores up to five codes. If more faults are present, then higher priority faults will displace lower priority faults.

MDK

In 1998 and 1999, a new electronic throttle system called MDK was added to the E46 and E39. These later systems with electronic throttle discontinued the separate EML module and instead had the throttle control integrated into the engine control unit (DME).

MDK is a hybrid, drive-by-wire system found on 1999–2000 U.S. market BMWs with MS42 only. MDK still has a throttle cable, but it uses an overriding clutch mechanism which allows traction and cruise control to operate the throttle independent of the driver pedal position. Idle speed is controlled using a separate dual winding rotary idle control valve, which bypasses the throttle plate. MDK uses dual throttle position sensors that read the same and are integral with the MDK housing.

EDK

In about 1999, BMW introduced EDK, which is a full drive-by-wire system with no mechanical throttle linkage. An electronic actuator controls the throttle valve under all operating conditions. In an emergency, if one potentiometer or Hall sensor fails, the system switches over to the second potentiometer or Hall sensor. The voltages from both potentiometers should change simultaneously with throttle changes.

There are the two types of EDK systems:

- MS43 (E46, E39, E53 and Z3)
- ME7.2 (E39, E38, E53)

MS43 (E46, E39, E53 and Z3)

EDK uses two Hall sensor pedal positions mounted in the pedal position module. There are two feedback potentiometers mounted in the EDK actuator housing—the second potentiometer cross-checks the first for safety redundancy in case one fails. The important difference is that this system uses a separate idle control motor.

The two Hall sensors read differently and are integral with the accelerator pedal module:

- Pedal position 1 (Hall sensor 1): 0.5–4.5V
- Pedal position 2 (Hall sensor 2): 0.5–2.0V

ME7.2 (E39, E38, E53)

The ME7.2 system does not use two Hall sensors for pedal position, but instead uses two potentiometers mounted in the PWG sensor housing at the driver's footwell. Also, ME7.2 does not use a separate idle control motor.

The pedal position sensors should read approximately the same for any throttle position:

- Pedal position 1 (potentiometer 1): 0.5–4.5V
- Pedal position 2 (potentiometer 2): 0.5–4.5V

Clearing EDK Throttle Values

Whenever the adaptation values are cleared, a new DME is installed, or the EDK unit is replaced, the throttle settings must be re-configured in the DME. The adaptation process takes about 20 seconds. If the adaptation process has not successfully completed, then the engine will not start.

▶ **To clear EDK throttle values:**

1. Turn the ignition on for 10 seconds (do not start the engine).
2. Turn the ignition off for 10 seconds.
3. Start the engine.

⚠ **IMPORTANT:**
To prevent damage to the control module, allow at least 3 minutes for the ECM/TCM to power down after the ignition is turned off before disconnecting it.

🛈 **NOTE:**
Resetting the throttle adaptation on EDK systems may cause lose of throttle response and poor run condition. To re-learn the throttle adaptation, turn the ignition on (do not start the engine) for 30 seconds, then turn ignition off for 10 seconds. Now start engine and throttle control should be OK.

4.5.3 All Systems Failsafe Emergency Operation

If a fault is detected, both the MIL and EML lamps may be illuminated. The system will initiate failsafe measures depending on the effect of the fault (increased airflow or decreased airflow). If there is a fault in the idle speed actuator/circuit, the system will compensate to maintain idle. If the fault causes increased air flow (actuator failed open), then VANOS (variable valve timing) and knock control are deactivated, noticeably reducing engine performance.

Emergency operation normally is divided into two modes of operation:

- Emergency Operation 1—This is when faults occur which do not impair actuator control, but do affect the system from functioning properly. For example, if one of the potentiometers fails, the engine will slowly reach maximum speed with limited power (half throttle capacity).
- Emergency Operation 2—This is when faults occur which impair actuator control. Engine speed is limited to 1300 RPM and vehicle speed is limited to 20–25 MPH.

🛈 **NOTE:**
Emergency operation can be caused by power braking (simultaneously pressing both accelerator and brake pedal).

4.6 Testing Climate Control Systems

The scan tool can read Codes & Data from BMW climate control systems (Airco). Table 4-13 lists BMW climate control systems.

Table 4-13 *Climate control types and system description*

CAR SERIES	E SERIES	YEAR	SYSTEM
3 Series	E46	1999–2003	IHKR
			IHKA E46
5 Series	E39	1997–2003	IHKR
			IHKA E39
X5	E53	2000–03	IHKR, IHKA

4.6.1 Types of Climate Control Systems

BMW climate control systems are either fully manual, semi-automatic, or fully automatic. BMW refers to these systems as IHKS (manual), IHKR (semi-automatic) and IHKA (fully automatic). IHK translates from German into "integrated heating and air conditioning system."

- IHKR—standard equipment, semi-automatic heating and air-conditioning system. This system is single zone, regulating temperature based on a manually-selected temperature. Blower control, air distribution, and flap positions are all manually operated.
- IHKA—is fully automatic and may have dual controls for driver and passenger. Air distribution, air temperature and blower speed are controlled by the system. This system has "set and forget" automatic functions which will maintain interior comfort regardless of ambient temperatures.
- IHKA IV—same as IHKA except it has an integrated solar sensor and the REST button has been replaced with a MAX button. The MAX button has two different functions: Maximum Cooling and Residual Heat.

4.6.2 Important Tips for Testing Climate Control Systems

- The scan tool only communicates with IHKA systems (1997–2002 E39 and E46).
- Some of the IHKA inputs may communicate with other modules sent to the IHKA on the bus communication line. Therefore, it may not always be possible to test an IHKA input directly. Also keep in mind that the IHKA will display substituted scan tool values for faulty inputs, which, except for the evaporator, are designed to keep the system operating.
- The IHKA On Board Self Diagnostic System stores up to seven codes. Not all faults will set codes.
- Constant battery power supply (KL30) is necessary for IHKA operation as well as memory (early systems). Before performing a battery parasitic draw test, allow the IHKA to power down for 16 minutes to enter "sleep" mode. Switched ignition power (KL15) is required for IHKA operation when the ignition is in the "run" position. This allows the system to operate after the vehicle has been started (or limited IHKA operation if the engine is not running).
- In accordance with federal law, the electronic climate control system defaults to the defroster mode of operation with the fan on LOW every time the vehicle is started or the ignition key cycled. This ensures that the windshield will remain clear to prevent a safety

hazard if the system malfunctions. The system should restore owner preferences just after startup if all checks are successful.

4.6.3 IHKA Special Features

IHKA systems have some special features explained in the following sections.

Cold Start Interlock

Cold start interlock is active in the AUTO program with a driver's side heater core temperature below 68°F (20°C). In this program, the defrost flaps are 100% open, and the footwell and face vents are closed. The blower fan will run at the set speed.

Service Station

The Service Station feature prevents hot coolant from entering the heater cores after the engine is switched OFF. It is designed to prevent a blast of hot air on a restart that would arise from coolant bleeding into the heater cores (heat surge) when the engine is switched off. If the coolant temperature is above 59°F (15°C), the water valves are powered closed for three minutes when the vehicle is switched off.

Parked Car Ventilation

The parked car ventilation feature on the E38 IHKA system is retained on the E39 IHKA System (with high end instrument cluster). The signal to activate the venting function is generated by the IKE and passed over the K Bus to the IHKA for fan and flap activation. The signal prompts the IHKA to open the face vent flaps to 100%. The blower relay is energized and the blower output stage is sent a 4V signal. The blower is run at 7V operating power to provide adequate venting. If battery voltage drops below 11.5V, the function is cancelled.

Rest

The interior of the vehicle can continue to be heated with the engine switched off using the Rest feature of the IHKA. This feature is activated by pressing the REST button on the IHKA control panel. When activated, the auxiliary water pump and blower motor are switched on. This feature will remain active for up to 15 minutes or until the coolant temperature drops below 86°F (30°C).

The Rest feature can only be switched on under the following conditions:

- Ignition switched OFF
- Rest button pressed
- Outside temperature less than 59°F (15°C)
- Coolant temperature more than 158°F (70°C)
- Battery voltage more than 11.4V

- Less than 15 minutes after ignition is switched off

When the Rest feature is activated, all of the IHKA functions are operable. This includes the blower speed, air distribution control and temperature settings. With the ignition switched off, the Rest feature is in a preset operating mode: the blower fan runs at medium speed and the temperature is set to allow maximum heat.

The Rest feature can only be switched off under the following conditions:

- Ignition switched on
- Battery voltage less than 11.4V
- Rest button pressed while system is on
- Coolant temperature less than 86°F (30°C)
- After 15 minutes time period

4.6.4 IHKA Substituted Values

Substituted values are operating parameters that are pre-programmed into the control module's non-volatile memory. The substituted values are used by the IHKA control module to maintain system operation if a sensor or circuit fails. This may not be true for the evaporator temperature sensor or the exterior temperature sensor which have a substituted value below the cycling point of the AC compressor (AC system will not operate).

Table 4-14 lists substituted values, and Table 4-15 lists temperature sensor resistance values at an ambient temperature of 77°F (25°C).

Table 4-14 *IHKA substituted values*

TEMP SENSOR	WORKING RANGE	SUBSTITUTED VALUE
Heat exchange sensor	41–255°F (5–124°C)	131°F (55°C)
Evaporator sensor	50–86°F (10–30°C)	32°F (0°C)
Interior temperature sensor	50–104°F (10–40°C)	68°F (20°C)
Exterior temperature sensor	Signal sent over the K Bus	32°F (0°C)
Coolant temperature sensor	Signal sent over the K Bus	212°F (100°C)

Table 4-15 *IHKA temperature sensor resistance values*

SENSOR	RESISTANCE	FAULT LIMIT
Heat exchange sensor	9K Ohms ±2%	Greater than 257°F (125°C)
Evaporator sensor	9K Ohms ±2%	Greater than 248°F (120°C)
Interior sensor	10K Ohms ±2%	Greater than 192°F (89°C) or Equal to or less than 115°F (46°C)

4.7 Testing Bus Systems

BMW has been using data bus systems since 1991 on the E31 8 Series. By 1993, most models were using CAN bus systems for the powertrain control modules (engine, transmission, and some models added ABS).

4.7.1 Bus Types

BMW vehicles use the following bus systems. Use the charts below for bus system application.

- **M**—IHKA climate control using smart stepper motors
- **K**—Body bus
- **P**—Peripheral bus (General, Door, Seat memory, and Sunroof modules)
- **I**—Information bus
- **D**—Diagnostic bus
- **CAN**—Controller Area Network
- **K CAN P**—K and P Bus integrated using a CAN bus
- **K CAN S**—K and S Bus integrated using a CAN bus
- **MOST**—Fiber optic communication systems
- **BYTE FLIGHT**—Fiber optic airbag system
- **Pt CAN**—Powertrain systems
- **Lo CAN**—Valvetronic control
- **BSD**—Alternator control
- **Lin**—IHKA, lamp control, driver's switch block, tire monitoring
- **F CAN**—Active steering
- **K CAN**—Body systems

Table 4-16 *1992–2002 bus system applications*

MODEL	M	K	P	I	D	CAN
E31 8 Series				YES	YES	YES
E32 7 Series					YES	YES
E34 5 Series					YES	
E36 3 Series					YES (Z3 only)	YES
E38 7 Series	YES	YES	YES	YES	YES	YES
E39 5 Series High Cluster	YES	YES	YES (1997 and later)	YES	YES	YES
E39 5 Series Low Cluster	YES	YES	YES		YES	YES
E46 3 Series	YES	YES			YES	YES
E52 Z8	YES	YES			YES	YES
E53 X5 High Cluster	YES	YES	YES	YES	YES	YES
E53 X5 Low Cluster	YES	YES	YES		YES	YES

Table 4-17 *2002 and later bus system applications, part 1*

MODEL	M	K	P	I	D	CAN	K CAN P	K CAN S
E65/66	YES				YES		YES	YES
E60 5 Series		YES			YES			
E85 Z4	YES	YES			YES	YES		
E46	YES	YES			YES	YES		

Table 4-18 *2002 and later bus system applications, part 2*

MODEL	MOST	BYTE FLIGHT	Pt CAN	Lo CAN	BSD	Lin	F CAN	K CAN
E65/66	YES	YES	YES	YES	YES			
E60 5 Series	YES	YES	YES		YES	YES	YES	YES
E85 Z4		YES			YES			
E46						YES (2003 and later)		

Table 4-19 *Bus system specifications*

SPECIFICATION	M	K	P	I	D	CAN HIGH	CAN LOW
Baud Rate	N/A	9.6 kb/s	9.6 kb/s	9.6 kb/s	10.4 kb/s	500 kb/s	500 kb/s
Supply Voltage	2.5–5 V	12V	12V	12V	12V	2.5–5V	0–2.5V
Minimum Operating Voltage	7V	7V	7V	7V	10.5V	10.5V	
Voltage Source	IHK	GM	GM	LCM/ LSZ	each module	each module	
Wake-up Signal Commanded By	IHK	GM	GM	LCM/ LSZ	each module	EWS or IKE	

NOTE:

Note the following regarding bus system voltage:

- Buses operating at 12V usually have a 7V minimum operating voltage.
- Voltages are checked using a breakout box or backprobing at the control module.

M Bus (Motor Bus)

The M Bus (motor bus) is for IHKA Stepper motor operation. It is used exclusively between the climate control module (IHKA/IHKR) and a set of stepper motors controlling air distribution. Each stepper motor is on the M Bus and transmits and receive data on a single wire. The M Bus consists of a three-wire ribbon which is separate from the vehicle wiring harness.

The M Bus has the following characteristics:

- Active anytime the ignition is on.
- Each stepper motor is connected in parallel to the IHK module via a three-wire ribbon (power, ground, and signal).

- The IHK module provides the 5V bus voltage (Master Controller).
- A 2.5V (average voltage) reading indicates that communication is occurring.
- Constant communication occurs until the GM sends a sleep command over the K Bus.
- Communicates at 650 microseconds with an average period of 50 microseconds.

NOTE:
To perform an operational check on the M Bus for 540/740/X5 models using the High Instrument Cluster system (digital display message center), see page 60.

P Bus (Peripheral Bus)

The P Bus (peripheral bus) is found exclusively on vehicles that have a GM III/ZKE III body module. The P Bus modules are connected to the GM III (General Module) via the P Bus.

NOTE:
Snap-on® scan tools currently do not communicate with the P Bus because it has no GM III (body control) interface. The P Bus is the only bus that communicates with the GM III module.

The P Bus is only used for body electronics that uses a single copper wire for serial communications. The P Bus is found on the vehicles in Table 4-20.

Table 4-20 *BMW models that use the P Bus*

E SERIES	MODELS	YEAR
E38	740i/iL, 750iL	1994–2001
E39	525i, 528i, 530i, 540i, M5	1997–2003
E53	X5 3.0/4.4L	1999–2003
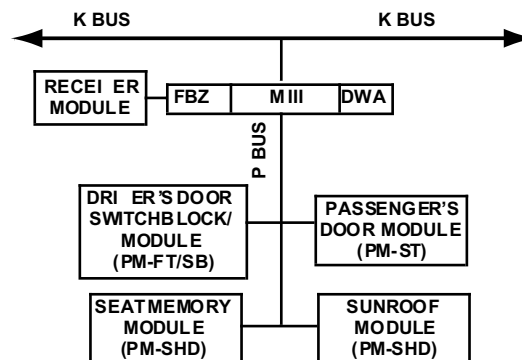
Figure 4-25 *Sample P Bus connections*

The P Bus has the following characteristics:

- The P Bus is similar in communication and speed to the I and K buses.
- Not designed for rapid data communications, instead designed for short control commands which allows P Bus modules to react more quickly (e.g., door lock or window).
- The GM module sends the Sleep Command to all the P Bus modules 16 minutes after the ignition is turned off and no messages are being sent.

- The "Wake-up call," done either by the GM or the driver/passenger door modules, pulls the P Bus voltage low.
- With every ignition cycle, the GM module polls the P Bus every 5 seconds to see if all the installed modules respond. The P Bus modules must respond in 5 seconds. If after 3 polling attempts the poll is unanswered, the GM module sets a fault code.
- The GM module communicates coding data to the modules on the P Bus.
- The GM module provides the 12V P Bus operating voltage.

P Bus Operational Check

Use the following procedure to check the operation of a P Bus.

▶ **To check P Bus operation:**

1. Check the driver's seat memory function.
2. Operate a rear window using the driver's switch block

   If both of these functions operate, the P Bus is up and running.

I Bus (Information Bus) and K Bus (Body Bus)

I and K buses are serial communication buses in which all modules send and receive over a single copper wire. I and K buses are identical, use varies by model.

The K Bus (body bus) allows data to be exchanged between the IKE (Instrument Cluster) and various control modules.
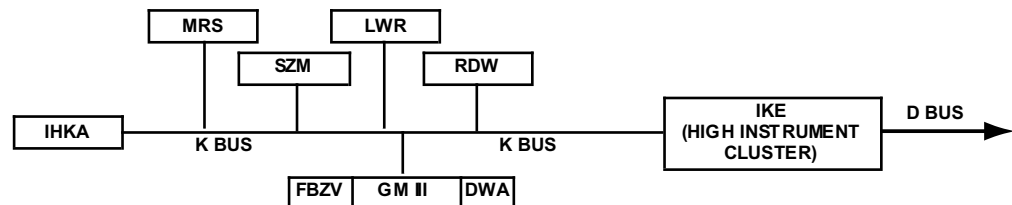
Figure 4-26 *Sample K Bus connections*

The driver's information system is on the I Bus (information bus):

- Instrument Cluster Module (IKE)
- Check Control (CCM)
- Lamp Control/Check (LM)
- Radio Amplifier (DSP)
- Multi-function steering wheel (MFL)
- Multi-information display (MID)
- Cellular phone
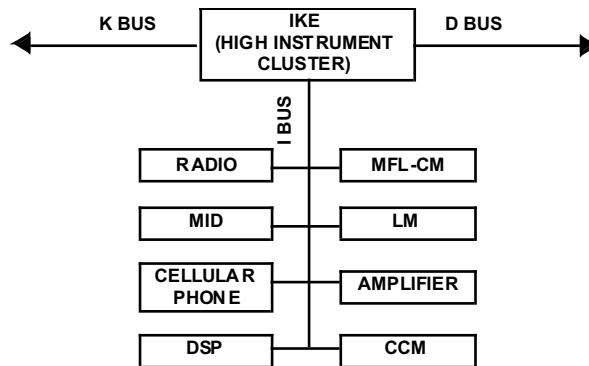
Figure 4-27 *Sample I Bus connections*

I and K Bus Operational Checks

Use the following procedure to check the operation of an I or K Bus.

▶ **To check I and K Bus operation:**

- Activate the 4-way flashers.

  I and K buses are working if the flash indicators light up on the instrument cluster.

- Turn the radio on and adjust the volume using MFL or MID/BMBT.

  I and K buses are working if the volume changes.

NOTE:

The following procedure is for 540/740/X5 models using the High Instrument Cluster system (digital display message center).

▶ **To check M, I, and K Bus operation:**

1. Press Recirculation using the multifunction steering wheel switch (MFL).

   If the vents move to the recirculation position, then the M, I, and K buses are up and running. The Recirculation signal is sent via the MFL to the I Bus, to the instrument cluster (KOMBI), to the K Bus, to IHKA, and finally to the M Bus (Figure 4-28). This test also checks the IKE (gateway).
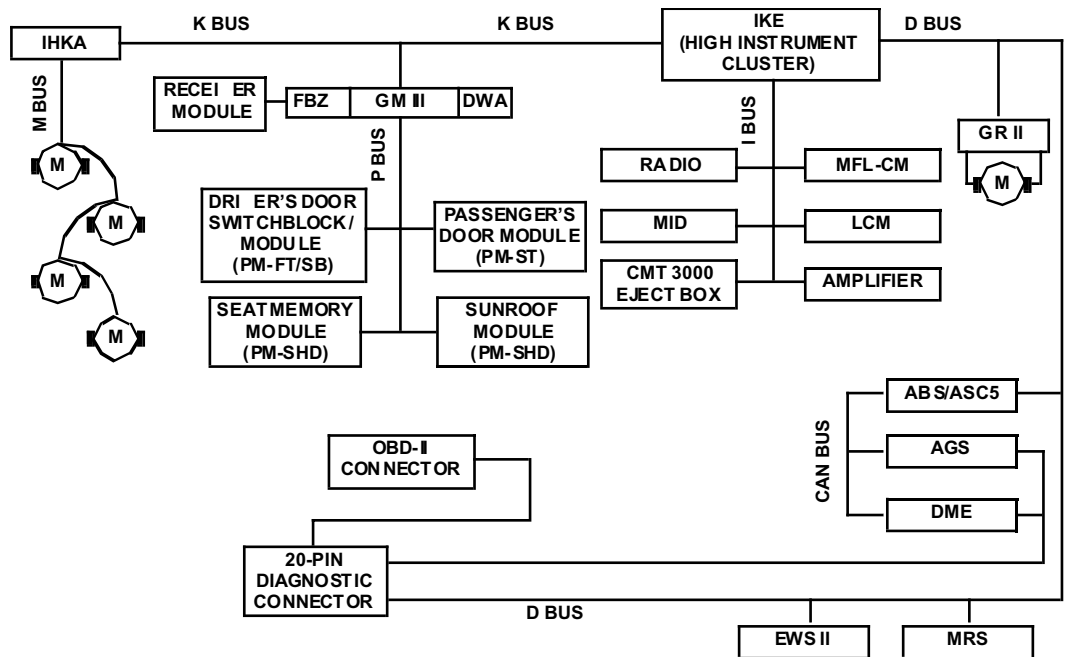
Figure 4-28 *Bus systems on a High Instrument Cluster system*

Lamp Control/Check (LM)

The LM transmits and receives status information concerning light operation. The LM transmits bulb status to the check control module. It also communicates to the IKE when turn signal, high beam, and fog light indicators need to be activated.

The Lamp Module (LM) for the E38 is designed to control and monitor all the outside lights on the vehicle. Various displays and switches are also illuminated by an LM function. The LM incorporates power transistor output stages with internal protection circuits. This eliminates the need for fuses and relays that are found on earlier lamp control systems. The LM is usually located in the passenger side kick panel behind the footwell speaker. This location provides airflow across the external LM heatsink for cooling.

The LM reduces a number of components that were used in the past, such as:

- Numerous relays
- Flasher unit
- Crash control unit (relay)
- Cold check relay
- Dimmer switch

NOTE:

Note the following regarding the LM module:

- The LM is informed by ZKE when a crash has occurred or the alarm was tripped for headlight/flasher activation.
- When reverse is selected, the LM is signaled to turn on the back-up lights.

- The LM can compensate for a burnt-out brake light bulb by using the tail light filament. It increases the light intensity by increasing the amperage through pulse width modulation. This may make it more difficult to diagnose a bad bulb, compare both rear lights, or check the one that is less bright.

D Bus (Diagnostic Bus)

The scan tool initiates communication on the D Bus (diagnostic bus). The D Bus is only active when the scan tool is connected to the diagnostic socket and there is two-way communication between the scan tool and a control module.

The D Bus is the oldest bus system used in BMW vehicles. It was introduced in 1987 as TXD, which provided communication between the DME and a scan tool. The D Bus may still be referred to as TXD in BMW training literature.

The D Bus communicates in series, one control unit at a time, with all control modules in the vehicle that are capable of communicating with a scan tool, some of which may be on other buses and communicate through the Instrument Cluster module or IKE gateway.

NOTE:
The D Bus communication speed to the scan tool may be considerably slower than the internal bus speed or the communication speed between buses.

The scan tool currently communicates via the D Bus to the following modules and buses:

- Powertrain (engine, transmission, EML, ABS, everything on the CAN bus)
- Airbag (MRS)—K Bus
- Climate Control (IHKA)—K Bus

On vehicles produced up to model year 2001, use the 20-pin underhood diagnostic connector. The two links are:

- RXD pin 15

  Later control modules (from 1997) no longer required the separate RXD to establish communication, so pin 15 may be removed.
- TXD pin 20

RXD initiates the communication with the control module. It is similar to the "ring" of a telephone, attempting to wake up a control module.

TXD is the "Transmit" or communication line between the scan tool and the control module. When a control unit is selected for diagnosis, the scan tool sends a diagnosis telegram to a specific control unit address. The scan tool request may ask that the control unit transmit codes and data information or may also command that a control unit perform an actuator test (also called bi-directional command).

On those vehicles that have both a underhood 20-pin connector and underdash OBD-II 16-pin connector, the underdash connector is mostly limited to powertrain module access (for generic scan tool).

With OBD-II, TXD II (pin 17 on the underhood 20-pin connector) was introduced as a separate communication line exclusive to DME (ECM), AGS (TCM), and EML (Electronic Throttle

Control). TXD II is technically identical to the D Bus (TXD). On vehicles that use only the 16-pin OBD connector, TXD is installed on pin 8 and TXD II is on pin 7.

NOTE:
The cap of the underhood 20-pin connector has bridging pins and must be installed for Generic OBD-II to communicate with the underdash 16-pin connector.

D Bus Operational Check

Use the following procedure to check the operation of a D Bus.

▶ **To check D Bus operation:**

1. Connect a scan tool to the diagnostic connector.

   If the scan tool communicates, then the D Bus is up and running.

CAN Bus

Controller Area Network (CAN) is a high-speed data transfer bus.

BMW uses CAN for the following systems:

- Engine management
- Electronic transmission
- ABS/Traction system

Data transfer within a CAN bus functions similarly to a telephone conference. A subscriber (control unit) "speaks" data into the line network while the other subscribers "listen" in to the conversation (data transferred). Each subscriber has a specific job and is only interested in the parts of the conversation (data) which helps it do its job. Other parts of the conversation are ignored. Each subscriber checks whether the data message identifier is on an internal list, and if identified, the message priority is then checked and processed accordingly.

CAN buses have the following characteristics:

- There are no Master controllers or Slave modules.
- All modules transmit and receive (some can request at the same time).
- No messages are discarded due to lack of time.
- Errors are detected by each controller to determine the severity of a problem.
- Modules automatically disconnect if a particular module is malfunctioning.
- Operation continues on one wire if either the CAN High or CAN Low wires break (only true for CAN B medium speed; not true for CAN C high speed).

CAN data transfer speeds may vary depending on the CAN type.

- CAN type A: 83.3 kb/s
- CAN type B: 125 kb/s
- CAN type C: 500 kb/s

BMW uses the high speed CAN C for Powertrain control, but the scan tool may update slowly regardless. Before the data is transferred to a scan tool, it goes through a gateway module

which acts as a translator so different buses can talk to each other. The gateway, changes the fast CAN high speed data to a slower speed D Bus (serial communication) which is what the scan tool reads.

> **NOTE:**
> CAN bus faults may turn on the ASC/DSC light.

CAN Bus Operational Check

Use the following procedure to check the operation of a CAN bus.

▶ **To check CAN Bus operation:**

1. Check the instrument gauges (i.e., coolant temperature, tachometer, fuel level) for correct operation.
2. Check that the transmission range selector is functioning.

   If these controls operate, the CAN bus is up and running.

CAN Bus Components

The CAN data bus is comprised of the following components:

- A **controller** receives the transfer data from the microcomputer integrated in the control unit. The CAN controller processes this data and relays it to the CAN transceiver. Likewise, the CAN controller receives data from the CAN transceiver, processes it and relays it to the microcomputer integrated in the control unit. The data bus does not have a designated receiver. Data is sent over the data bus and is generally received and evaluated by all subscribers.

- A **transceiver** is a transmitter and receiver in one. It converts the data which the CAN controller supplies into electrical signals and sends this data over the data bus lines. Likewise, it receives data and converts this data for the CAN controller.

- **Two data bus terminals** are resistors that prevent data sent from being reflected at the ends and returning as an echo, which would corrupt the data.

- **Two data bus lines** are bi-directional and transfer the data. They are referred to as CAN High and CAN Low.

Apart from the data bus lines, the components are located in the control units. The functions of the control units are the same as before.

CAN transfers data using the following process:

1. **Supplying the data**—The control unit provides data to the CAN controller for transfer.
2. **Sending data**—The CAN transceiver receives data from the CAN controller, converts it into electrical signals and sends them.

All buses send data serially, meaning one event at a time. In data transmission, the technique of time division is used to separate bits of data sent. The messages sent over all buses are configured serially. Each message consists of coded information. With non-CAN buses, not all of the connected control units will receive the information—the data is sent only to a control unit with a specific address. With CAN Buses, all of the connected control units will receive all bus data, but only the unit with a specific address will accept and react to the data.

Bus Gateway

BMW uses the Instrument Cluster or the Instrument Cluster module (IKE) as the connection or bus gateway between the following four buses.

- D Bus (RXD/TXD)
- I Bus
- K Bus
- CAN bus

NOTE:
Note the following regarding the IKE gateway:

- The IKE control module is mounted on the back of the instrument cluster and is connected to the cluster with two additional connectors containing the D, I and K buses.
- The IKE contains all of the processing electronics for the Instrument Cluster and on-board computer.
- Signals sent to a component that is on the I Bus must be passed on by the IKE.
- Diagnostic data must be passed through the IKE to the I and K buses as communication between a scan tool and I and K control modules takes place.
- The IKE stores the central coding key.

NOTE:
Because of the Instrument Cluster role as the gateway, always check complete Instrument Cluster warning lights and display messages as well as all gauges for functionality as indicators of proper bus operation.

To check bus gateway (IKE) operation:
1. Perform a full instrument check (all gauges, lights, tachometer, and speedometer operation).
2. Connect a scan tool and check for any I, K, or CAN bus faults stored in the IKE.

4.8 Testing Central Body Electronics (ZKE) Systems

ZKE is an acronym for the German words "Zentral Karosserie Electronics" or "Central Body Electronics." The ZKE system is comprised of several body electrical systems integrated in one control module. There is also a Central Vehicle Module (ZVM) system, which is a lesser version of ZKE used before ZKE was available for the E36.

ZKE system functions may include the following subsystems:

- Central locking
- Remote locking
- Alarm system (DWA)
- Electronic Drive Away Protection (EWS)
- Power windows/sunroof
- Windshield wiping/washing

- Interior lighting
- Electronic power protection

Since ZKE was first introduced on the E32 735i in 1988, several versions have evolved and are used depending on the model. Each new version expands features based on the previous version. Table 4-21 provides a list of ZKE and ZVM versions by body model:

Table 4-21 *Central body electronics applications*

CENTRAL BODY ELECTRONICS SYSTEM	MODELS
ZVM	All E36 before 9/94 and Z3 Roadster
ZKE	E32 E34
ZKE II	E31
ZKE III	E38 (740i/iL) E39 (525i, 528i, 530i, 540i, M5) E53 (X5 3.0L)
ZKE IV	E36 convertibles (from 5/94) All other E36 models except Z3 Roadster after 9/94
ZKE V	E46, E85 (Z4)

4.8.1 ZKE III and GM III

The main component of ZKE III is the General Module (GM III), which is the main processing and command center for the ZKE III system. The GM processes all the input signals and then commands (activates) operation of the appropriate component (e.g., activate a window motor). The GM III has integrated circuits which use internal resistors to control current through circuits and actuators.

The GM III has the following functions:

- Acts as a Master controller for all modules on the P Bus
- Acts as a gateway for modules on the P Bus to communicate with modules on other bus systems
- Communicates with the Remote Central Locking Module (FBZV) on the K Bus (all commands from transmitters are received by the FBZV and sent over the K Bus to the GM III for activation)

The GM communicates with the other ZKE III modules on the P Bus, such as:

- Driver/passenger door modules
- Driver-door switch block
- Sun roof module
- Seat/mirror memory module
- Keyless (remote) entry module

4.9 Testing Antitheft (DWA) Systems

The DWA is the vehicle alarm system, an integrated function of the GM III. Depending on the year and model, alarm monitoring may include doors, hood, interior, luggage compartment, and vehicle tilting.

The DWA may have a status LED located in the rear view mirror. On the E38, the status LED may be located on the dash vent grill or top center dash register. Table 4-22 explains the various LED state conditions.

Table 4-22 *DWA status LED indications*

DWA STATUS	LED STATUS
Disarmed	Off
Armed	Slow flash continuously
Armed but one or more monitored inputs is not in fully closed position (e.g., the trunk is not fully closed)	Rapid flash for 10 seconds
Alarm activated	Rapid flash for 5 minutes, then continued slow flash
Repeat arming in less than 10 seconds	On for 1 second
Disarmed after alarm was activated	Rapid flash for 10 seconds, then off

When the system has armed or disarmed successfully, the LED and lights flash once along with one horn beep. During arming, if a system input is faulty, the LED should flash rapidly for 10 seconds indicating a fault, after which the LED will continue to flash slowly (normal condition) indicating that system is armed.

The DWA system is either armed or disarmed by one of the following:

- Key is placed in the Driver's door lock
- Key is placed in the trunk lock
- Using the remote transmitter

During alarm arming or disarming, the Electronic Drive Away Protection (EWS) sends a command to the GM to deactivate or activate the alarm.

▶ **To disarm the alarm without the remote:**

1. For most systems, turning the ignition on with the key should disarm the system as long as the EWS system recognizes the key.

▶ **To deactivate the alarm system for towing:**

1. Arm the alarm and then rearm it (arm it twice) in less than 10 seconds.

▶ **To perform an alarm quick test:**

1. Press the lock button twice.

   This should deactivate the alarm motion and tilt sensor. If the alarm now activates, check for a faulty alarm motion or tilt sensor.

4.10 Testing Immobilizer (EWS) Systems

EWS stands for the German words "Electronic Wegfahrsperre" meaning electronic driveaway protection. Starting in 1994, BMW vehicles came equipped with EWS, which disables fuel and ignition using door locking input from the General Module to the DME.

There are three versions of EWS currently in use:

- EWS I
- EWS II
- EWS III

4.10.1 EWS I

Beginning with the 1994 model year, all cars were equipped with EWS I. This system still uses a mechanical key but added a "Starter Immobilization Relay" preventing the starter from operating. It functions as a smart relay which only allows starter activation if a specific combination of inputs is met.

The EWS I system is activated when the vehicle is locked from the outside with the key. When activated, the EWS I system performs the following functions:

- Prevents the engagement of the starter
- Disables the fuel injection system
- Controls the neutral safety switch

4.10.2 EWS II

At the start of the 1995 model year, EWS I was replaced with EWS II, which is used on E31, E34, E36, E38 and E39 vehicles. EWS II incorporates all of the functions of the previous EWS I but uses an electronic key. There still is a mechanical key, but an electronic component was added interfacing to the ignition switch which is part of the EWS function. EWS II provides immobilizer protection electronically through a coded chip imbedded in the key and prevents vehicle operation until the ignition key has transferred the correct code (random changing code) to the EWS control module. EWS II permanently assigns an "Individual Serial Number" or "ISN" to the DME, which is also stored in the EWS. The DME and the EWS modules must match the "ISN" every time the ignition is powered on or the engine will not start.

With EWS I and EWS II, the DME and the EWS are not permanently married or locked together. Diagnostic testing with either a used DME or EWS is possible (EWS II will require ISN re-alignment procedure as outlined below).

Up to 6 additional keys may be ordered as replacement keys. The EWS II control module is codeable for only 10 keys (4 delivered with vehicle and 6 replacement).
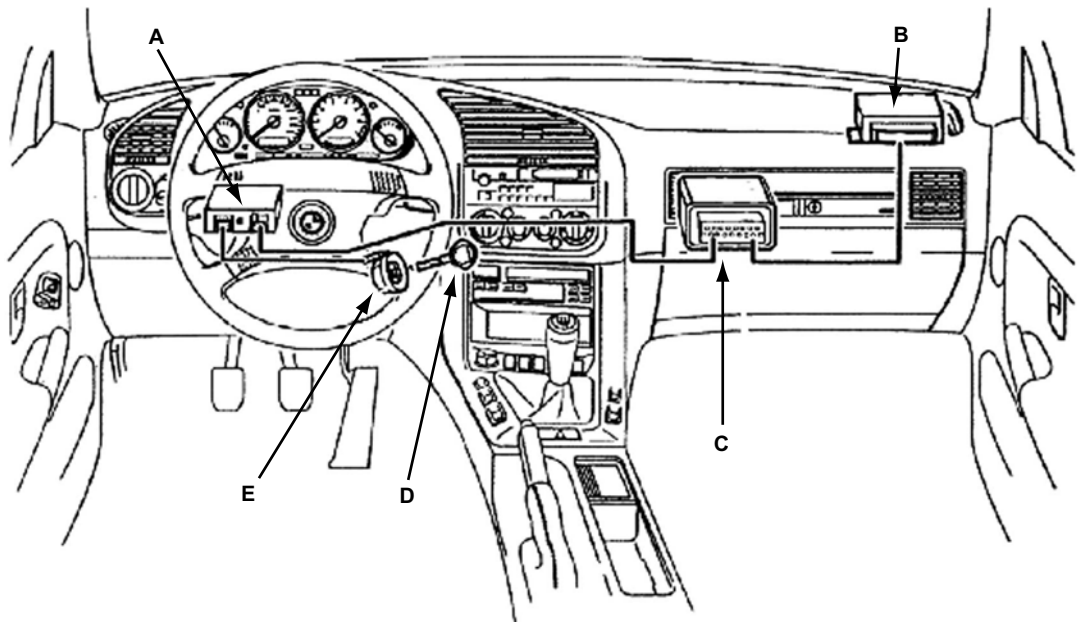
Figure 4-29 *EWS II components*

A—Transmitter/receiver module
B—DME control module
C—EWS II control module
D—Vehicle key
E—Ring antenna

EWS II Starting Procedure

When the key is inserted into the lock cylinder and switched on, the transmitter/receiver module is powered. The key coil and transponder chip are also powered by the induced voltage.

Data transfer now takes place between the transponder chip and EWS II control module in the following order:

1. The key identification code stored in the EEPROM of the key is sent to the transmitter/receiver module.
2. The transmitter/receiver module converts the amplitude modulated signal to a digital signal containing the same identification code. The code is sent to the EWS Control Module over a data link, such as a K Bus.
3. The EWS II control module must recognize the code as valid in order for engine starting to continue.
4. Once the identification code is accepted as valid, the EWS II sends the digital password to the transmitter/receiver module.
5. The transmitter/receiver module converts the signal into an AM signal and sends it to the transponder.
6. If the transponder accepts the received password as valid, starting continues.
7. With acceptance of the password, the transponder releases the changing code.

8.   The code is converted to a digital changing code and sent to the EWS control module.

9.   If the code is valid, the EWS control module accepts the key as valid.

10. The EWS II activates the internal starter relay and the starter circuit is energized.

11. The EWS II sends the ISN code to the DME. If the ISN code matches the code stored in the DME, the drive away protection is cancelled and the engine is allowed to start.

NOTE:
The data communication required for engine starting as described above takes place in milliseconds—there is no noticeable delay during starting.

IMPORTANT:
Starting problems caused by faulty ignition keys are common. Always have the owner bring in all keys for use in diagnosing a no-start condition.

Once the identification and verification of the data codes are complete, the EWS II sends a new changing code to the key for the next starting procedure. The changing code is a random number that is generated by the EWS II control module. The transponder stores this code until the next time the ignition is switched on.

The EWS II system is totally independent, in operation, from the mechanical key other than the key fob which contains one of the components. The system features a wireless communication link between a programmed EEPROM (transponder chip) housed in the ignition key and the EWS II control module. The system will not allow the starter to engage until a properly-coded transponder key is inserted into the ignition lock cylinder. The transponder chip operates independently from the mechanical key blade and tumblers.

NOTE:
EWS II may have auto start recognition which disengages the starter motor as soon as the engine is running.

Replacement of DME and EWS II Control Modules

Currently, replacement EWS control modules are ordered from the factory and come pre-programmed to recognize the VIN specific key codes. After installing the EWS II control module to the vehicle harness, it will need to be ZCS coded. If the original DME (ECM) was previously replaced, the EWS II control module must be synchronized with the DME by transferring the new DME ISN to the EWS II module. If the vehicle has the original DME and the EWS module is replaced, then synchronization or alignment should not be necessary.

NOTE:
There is no limit to the number of times the ISN can be changed in the EWS II control module.

EWS II DME/EWS Synchronization or Alignment

If a factory-coded, replacement EWS II control module is ordered and the vehicle will not start, if possible, check the service records if the original DME control module has been replaced.

If the DME has been or is replaced, the ISN of the replacement DME control module must be aligned with the EWS II control module. The alignment procedure copies the ISN from the new DME control module and installs it into the EWS II control module. If this task is not carried out properly, the engine will crank but not start.

NOTE:
Note the following regarding EWS II synchronization or alignment:

- The EWS II control module transmits the ISN to the DME continuously, whenever the ignition is switched on. It must be matched by the DME for each successful engine start.
- EWS synchronization or alignment is currently not performed with the Snap-on® scan tool.
- After the ignition is switched off, the ISN is still transferred to the DME for 10 seconds, which means that a vehicle with a possible EWS problem or faulty ignition switch key may start the engine within that 10-second window. Always wait 10 seconds before re-starting to fully check the system.

EWS III

There are two different versions of EWS III. **Version 3.2** is essentially the same as EWS II except that the transmitter/receiver module is integrated with the EWS module. This system does not have the rolling code security feature that was added for EWS III 3.3.

Version 3.3, used on EWS 3.3 has all the security features of EWS II. However, instead of using an ISN jointly shared between the EWS and DME, EWS 3.3 uses a higher level of security called "rolling code" technology. Rolling code technology uses a rolling code table permanently coded into both the EWS and the DME which cannot be overwritten by any coding or flash programming. With the ignition turned off, both the EWS and the DME automatically roll forward to the next code on the code table. In case one gets out of sync, the other will roll forward up to a maximum of 200 times to establish synchronization. The rolling code is a one-way signal from the EWS to the DME. The DME must perform its own calculation and match the EWS in order for the engine to start.

Table 4-23 *EWS III applications*

EWS III VERSION	E SERIES	YEAR
Version 3.2	E38	1997
	E39	9/97
Version 3.3	E38	5/97–1998
	E39	9/97–1998
	E46	All
	E52	
	E53	

Replacement EWS 3.3 control modules are ordered VIN-specific and are delivered preprogrammed with the same rolling code table as the original module. Once ZCS coded, the rolling code needs to be "reset" back to rolling code #1, providing synchronization of both modules.

Replacement DME control modules are blank and must be programmed for the specific vehicle. After programming, the factory tool informs the EWS 3.3 control module that a new DME has been installed. The next time the ignition is switched on, the EWS 3.3 module will send the entire rolling code table to the DME and reset it to rolling code #1.

The DME will automatically burn the rolling code table into its memory. Once performed, it *cannot* be changed. Once a DME is "married" to the vehicle, it will not work in any other vehicles. Under certain conditions, "alignment" of the DME and EWS 3.3 modules may still be necessary. The alignment procedure only resets the code table to code #1—it does not change the rolling code table.

Important Tips Regarding EWS III

- With EWS 3.3, the rolling code also changes the ISN every time the vehicle enters the start sequence. This means the DME is no longer the source for the ISN as with earlier EWS 3.2 and EWS II systems.
- EWS 3.3 DME or the EWS modules are permanently locked or married together and to the vehicle. They cannot be used in any other vehicles.
- All EWS III replacement DME modules are purchased blank and then flash programmed using the factory scan tool. Part of the programming includes the EWS sending the rolling code table to the new DME, which is then burned into memory. The EWS then resets its rolling code back to position 1.
- EWS/DME alignment resets the rolling code back to position 1 in both modules.

EWS III Key Activation/Deactivation

Keys that are lost or stolen may be deactivated or made to not operate the starter functions. The factory tool has the ability to activate and deactivate EWS III (3.3) keys. Any key may be "barred" except the key in the ignition at the time of deactivation. The lost or stolen key can be identified by the identification of the remaining keys. There is no limit to the number of times a key can be activated/deactivated.

NOTE:
Note the following regarding key activation:

- While checking key operation, don't forget to wait 10 seconds before inserting the next key because the ISN is still being transferred after the key is shut off (the EWS system is not activated until after 10 seconds). If you don't wait for 10 seconds, a bad key could still start the vehicle.
- A dead key battery does not affect vehicle starting.
- In approximately 2000, new style keys with non-replaceable batteries (featuring the blue and white BMW roundel) are only charged when the ignition switch is turned on. See "Key Type #3" on page 75.

EWS Encoding

The EWS control module stores the central coding key and the vehicle identification number (VIN). If the EWS control module is replaced, the vehicle systems must be encoded with the

central coding key and VIN. This process using the factory scan tool encoding program transfers either automatically or manually the central coding key ("Appendix C Electronic Control Module Coding and Programming" on page 129) and VIN to the appropriate modules. If the coding key and VIN can be read out from the defective EWS control module, it can be stored and transferred to the replacement EWS control module.

For EWS II, encoding will also transfer the ISN from the defective EWS to the replacement EWS control module.

Vehicle Keys

Non-electronic, mechanical keys with a separate keyless entry remote button were used up to about 1994.

Starting in about 1995 (EWS II), each BMW was delivered to the new owner with four electronic keys. There are two Master Keys, one spare emergency wallet key and one valet key. The two master keys contain the radio transmitters for keyless entry, burglar alarm, and key memory functions. All keys contain the electronic chip for EWS transponder signaling to start the vehicle.

BMW has four different key types, described in the following sections.

Key Type #1

Early keys have no remote keyless entry function, which is a separate button attachment.

Figure 4-30 *Key type #1*

Key Type #2

This key type has three buttons and an LED, as well as a replaceable internal battery. Key type #2 contains four keys (Figure 4-31).
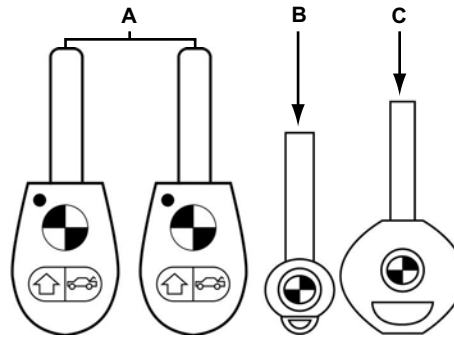
Figure 4-31 *Key type #2*

A—Master keys

B—Spare emergency wallet key

C—Valet key

   Does not open the glove box or trunk.

This type of Master key has the following features:

- A 3V lithium battery is used as the power supply for the key transmitters.
- An EEPROM is used to store the key data. The data is not lost when the battery is replaced and initialization is not required.
- The key incorporates an LED that signals the operator of signal transmitting, key initialization status, and key self-test indication.
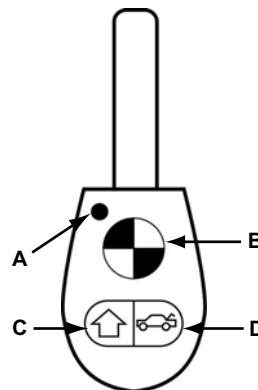
Figure 4-32 *Master key type #2*

A—LED

B—Button #1

C—Button #2

D—Button #3

The buttons in Figure 4-32 have the functions described in Table 4-24.

Table 4-24 *Key type #2 button functions*

BUTTON	FUNCTIONS
LED	One flash indicates that the message was sent and the batteries are OK. A quick flashing LED indicates that the convenience opening signal is being sent. A slow flashing LED indicates that initialization procedure was successful. A steady on LED indicates that the hardware/software of the transmitter are OK. No LED activity could indicate discharged batteries or a defective transmitter.
Button #1	When pressed once: locks doors, arms DWA, and turns interior lights When pressed twice: deactivates tilt monitoring
Button #2	When pressed once: unlocks driver-side door, disarms DWA, turns interior lights on When pressed twice: unlocks all doors When pressed once or twice: convenience opening when pressed and held
Button #3	Trunk lid opened when pressed. Panic mode when pressed and held (alarm activation).

Pressing buttons #1 and #3 at the same time will start a self-test of the transmitter. The transmitter is OK when the LED comes on steady for one second. If the LED fails to come on, try replacing the batteries before suspecting the transmitter.

The state of charge of the transmitter batteries is monitored by the control module. Once the voltage level of the transmitter drops below 4.5V, the LED will no longer signal transmitter operation. Convenience opening, initialization and self-testing are no longer possible. The control module will store the low battery level and post a message in the check control display when the door is opened.

NOTE:
Note the following regarding battery replacement of key type #2:

- There is usually a 1 minute time limit to replace the battery after the cover is removed. If you exceed this time, all keys will have to be re-initialized.
- Replacing the batteries within one minute will not require a new initialization procedure.

Key Type #3

This key type (blue and white BMW roundel) came out in approximately 2000 (Figure 4-33). It has no LED and has an internal rechargeable battery (charged by EWS ring antenna when key is in the ignition). The new larger button arrangement has same functions as key #2. The key housing cannot be opened (battery cannot be replaced).

Figure 4-33 *Master key type #3*

Key Type #4

This new electronic key has eliminated the mechanical key part (teeth and tumblers). This key is used on the new 7 series E65 starting in 2002 (Figure 4-34).
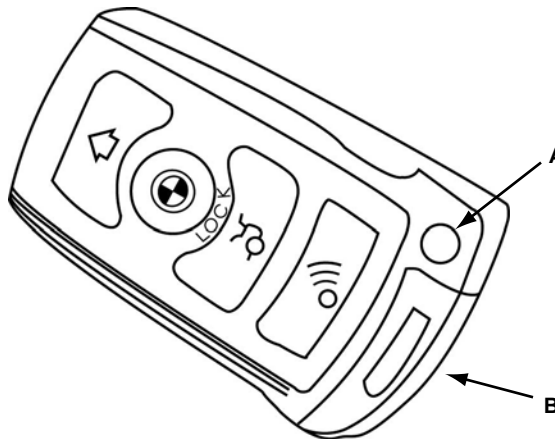
Figure 4-34 *Master key type #4*

A—Release button for mechanical key

B—Emergency mechanical key

Key Initialization

Up to four keys can be coded (initialized) to operate the remote system, but all must be initialized at the same time.

NOTE:
A successful initialization is followed by the doors locking/unlocking.

To initialize keys:

1. Make sure all doors are closed.
2. Switch the key to the accessory position (KL R) and then back off within 5 seconds.
3. Press and hold button #2 on the transmitter.
4. Press button #1 three times.
5. Release button #2.

   If the key has an LED, it flashes for 10 seconds.

6. All remaining transmitters must be initialized by completing steps 3 through 5.
7. When initialization is complete, switch the key back to KL R.

   If the acknowledgement signal of the doors locking/unlocking does not follow the initialization procedure, the process must be repeated. If the ignition is switched on during the process, the initialization procedure is cancelled.

Key Replacement for Lost or Stolen Key

Additional keys can be ordered and must be programmed with the factory scan tool to operate with the EWS system. The factory tool contains a "bar/release code" function that activates and deactivates ignition keys when connected to the EWS module. There is no limit to the number of times a key can be activated or deactivated. Up to six replacement keys may be ordered from the BMW center with a valid driver's license and proof of ownership.

Data Parameters

The following chapters provide definitions and operating ranges for the BMW vehicle data stream parameters that display on the scan tool.

When DATA is selected, the scan tool displays all of the operating parameters available from the electronic control module of the vehicle. The control module provides two basic kinds of parameters: digital (or discrete) and analog:

- Digital (discrete) parameters are those that can be in only one of two states, such as on or off, open or closed, high or low, rich or lean, and yes or no. Switches, relays, and solenoids are examples of devices that provide discrete parameters on the data list.
- Analog parameters are displayed as a measured value in the appropriate units. Voltage, pressure, temperature, time, and speed parameters are examples of analog values. The Scanner™ displays them as numbers that vary through a range of values in units, such as pounds per square inch (psi), kilopascal (kPa), degrees Celsius (°C), degrees Fahrenheit (°F), kilometers per hour (KPH), or miles per hour (MPH).

The scan tool displays some data parameters in numbers that range from 0 to 100, 0 to 255, or 0 to 1800. These ranges are used because in each case, it is the maximum number range that the control module transmits for a given parameter. However, many parameter readings never reach the highest possible number. For example, you never see a vehicle speed parameter reading of 255 MPH.

For BMW vehicles, the maximum range of a parameter often varies by year, model, and engine. On these applications, the word "variable" appears in the range heading. However, typical sampled values observed under actual test conditions are in the parameter description when available.

Parameters may also be identified as input signals or output commands.

- Input or feedback parameters are signals from various sensors and switches to the ECM. They may display as analog or discrete values, depending on the type of input device.
- Output parameters are commands that the control module transmits to various actuators, such as solenoids and fuel injectors. They are displayed as discrete (ON/OFF parameters, analog values or as a pulse-width modulated (PWM) signal.

In the following section, parameters are presented as they appear on the scan tool screen. Most parameter descriptions are in alphabetical order, but there are exceptions. Often, the same parameter goes by a similar, but different, name when used on more than one model, engine, or control system. In these instances, all of the applicable parameter names, as displayed on the scan tool, are listed in alphabetical order before the description.

To find the description of a parameter, locate it in the alphabetical index, then go to the indicated page. Parameters are listed in the index as they appear on the scan tool screen.

The data parameter descriptions in this manual were created from a combination of sources. For most parameters, some basic information was provided by the respective manufacturers, then expanded through research and field-testing. Parameter definitions and ranges may expand as more test results become available. For some parameters, no information is currently available.

The scan tool may display names for some data parameters that differ from names displayed by a factory tool and other scan tools.

Always use a power graphing meter, such as the Snap-on® Vantage® meter or a lab scope, to further validate the displayed values. If data is corrupted on multiple data parameters, do not assume that the control module may be faulty. This corrupt data may be caused by improper communication between the Scanner™ and the control module. See the troubleshooting sections of the *Scanner™ User's Manual* or the *MODIS™ Display User's Manual* for more details on communication problems.

Parameter names in parentheses represent either the name as it appears in the BMW factory scan tool or a clarification of the abbreviated name as it appears in the Snap-on® scan tool.

5.1 Alphabetical Parameter List

A

B

C

D

E

F

H

I

P

R

S

5.2 Engine Parameters

A/C CLUTCH_____ **ON/OFF**

This parameter is a feedback signal to the ECM from the A/C compressor clutch. Reads ON when the clutch is engaged and reads OFF when the clutch is disengaged.

A/C RELAY _____ **ON/OFF**

This parameter indicates the state of the A/C compressor clutch. Reads ON when the clutch is engaged and reads OFF when the clutch is disengaged.

A/C REQUEST _____ **ON/OFF**

This parameter indicates whether or not A/C operation has been requested by the instrument panel control settings. Reads ON when A/C is requested and reads OFF when A/C is not requested. Depending on operating conditions, the ECM may or may not energize the A/C compressor according to the switch request.

A/C SWITCH _____ **ON/OFF**

This parameter indicates the position of the A/C switch on the instrument panel. Reads ON when the switch is on and reads OFF when the switch is off.

ACCEL ENRICH (ACCELERATION ENRICHMENT) _____ **ON/OFF**

This parameter indicates whether the ECM is commanding acceleration enrichment.

ACTUAL EXHAUST CAMSHAFT (INLET CAMSHAFT)(°)ACTUAL EXHAUST CAMSHAFT1(°)ACTUAL EXHAUST CAMSHAFT2(°) _____ **see description**

These parameters indicate the actual exhaust camshaft position in degrees. On V-type engines with Dual VANOS, ACTUAL EXHAUST CAMSHAFT1 refers to that cylinder bank that includes cylinder #1. On North American models, cylinder #1 is on the passenger (right) side, or bank, of the vehicle. ACTUAL EXHAUST CAMSHAFT2 refers to driver (left) side bank. The actual value should mirror the required or requested value.

ACTUAL INLET CAMSHAFT(°)_____ **not available**

This parameter indicates the actual intake camshaft position in degrees of rotation. The actual value should mirror the required or requested value.

**ADAPTATION POSITION 1
(ADAPTATION ACCEL PED POS 1)(°)ADAPTATION POSITION 2
(ADAPTATION ACCEL PED POS 2)(°)** _____ **not available**

Used on vehicles with a drive-by-wire electronic throttle system. These parameters indicate how much the ECM is modifying accelerator pedal position sensor inputs based on throttle actuator position and internal programming. Reads approximately 18–22 degrees at idle.

**ADAPTATION VALVE 1
(ADAPTATION THROTTLE VALVE 1)(°)ADAPTATION VALVE 2
(ADAPTATION THROTTLE VALVE 2)(°)** _____ **not available**

Used on vehicles with a drive-by-wire electronic throttle system, these parameters indicate how much the ECM has adapted the throttle valve position to compensate for wear or faulty components. This parameter indicates that the ECM has gone through a learn procedure for the throttle valve stop setting and has adjusted the idle accordingly. The display reads the degrees the ECM has corrected for the throttle valve stop learn and successfully adjusted the idle speed.

AIRFLOW SENSOR(kg/h) _____ **0 to 99 kg/h**

Used on vehicles with a hot film Mass Airflow (MAF) sensor, this parameter indicates the mass of air flowing through the MAF sensor in kilograms per hour (kg/h). Reads 10–30 kg/h at normal hot idle with all accessories switched off.

AIRFLOW SENSOR(V) _____**0 to 12.0V**

This parameter displays the actual voltage from the airflow meter or mass airflow sensor. With an airflow meter, the variable voltage signal represents the volume of the inducted air. The signal is generated by a potentiometer attached to the airflow meter sensing flap. With a mass airflow sensor, the parameter is the voltage required to maintain a 311°F (155°C) temperature in the heated circuit of the mass airflow sensor.

Ranges vary slightly between systems. Typically, at a hot unloaded idle, with all accessories off, readings range from 0.5 to 1.5V.

On early systems, the scan tool may display a different mass airflow voltage than the BMW factory tool. Before suspecting a mass airflow sensor problem, monitor how readings change over different operating conditions and use the O2S and fuel trim values to help identify a

mass airflow sensor problem. Verify sensor voltage with a Vantage® power graphing meter or a lab scope.

Some control modules may include an integral ambient barometric pressure sensor. This sensor is not serviceable. The internal sensor is supplied with 5V and assists with the following functions:

- The barometric pressure signal along with calculated air mass provides an additional correction factor to further refine injection fuel-injector pulse-width modulation.

- Provides a base value to calculate the air mass being injected into the exhaust system by the secondary air injection system. This correction factor alters the secondary air injection, optimizing the necessary air flow into the exhaust system.

- Altitudes above a specific threshold are recognized, postponing DMTL activation for evaporative emission leak diagnosis.

ASC INTERVENT (ASC INTERVENTION)_____ ON/OFF

This parameter indicates whether the Automatic Stability (Slip) Control (ASC) or Dynamic Control System (DSC) is on. The DSC system is added onto ASC and works in conjunction with ASC. ASC/DSC uses engine drive torque reduction or engine drag torque (MSR) installed on late model vehicles which corrects oversteer or understeer, helping to improve the lateral stability of the vehicle and assisting in spin-out prevention. The ASC system turns on in the presence of severe drive wheel slippage and sends a "Shift Intervention Signal" to the TCM, resulting in temporary suppression of the coming gear change.

Pre-AGS systems with the driver-selectable winter program cancel the winter shift program when ASC is switched off. On ELM (drive-by-wire) electronic throttle systems, the throttle is electronically regulated. On other systems, a reel-in cable closes the ASC throttle plate, reducing intake air flow. The ASC throttle plate lies upstream from the main throttle plate, allowing the ASC system to control airflow regardless of how far the driver is depressing the accelerator pedal. The ASC system works in conjunction with the antilock brake system and other systems that together modify throttle position, ignition timing, and fuel injection.

AT SWITCH (AT POSITION SWITCH) _____ P-N--/-R-DL

This parameter indicates the position of the gear selector lever and the signal of the park/neutral position (PNP) switch. The display reads P-N-- when the selector is in park or neutral and reads -R-DL when the selector is in reverse or any forward gear. The park/neutral switch is closed (grounded) in park or neutral to allow starter motor engagement, and open in all other positions to prevent starter operation.

BANK 1 CRANKSHAFT SEGM. 1 ADAPTBANK 1 CRANKSHAFT SEGM. 2 ADAPT BANK 1 CRANKSHAFT SEGM. 3 ADAPTBANK 1 CRANKSHAFT SEGM. 4 ADAPT BANK 1 CRANKSHAFT SEGM. 5 ADAPTBANK 1 CRANKSHAFT SEGM. 6 ADAPT BANK 2 CRANKSHAFT SEGM. 1 ADAPTBANK 2 CRANKSHAFT SEGM. 2 ADAPT BANK 2 CRANKSHAFT SEGM. 3 ADAPTBANK 2 CRANKSHAFT SEGM. 4 ADAPT BANK 2 CRANKSHAFT SEGM. 5 ADAPTBANK 2 CRANKSHAFT SEGM. 6 ADAPT _ not available

These parameters represent the crankshaft segment gear adaptation mean value and reflects the addition of a supplementary correction factor designed to compensate for phase error in the crankshaft sensor. This information is used to compute actual ignition timing. Each segment represents the duration between each new ignition cycle. Ignition, injection, and engine speed derived from segment duration are recalculated for each segment.

The engine is constantly monitored for misfire to protect the catalytic converter. The engine is analyzed by evaluating the crankshaft position (CKP) sensor using a sophisticated mathematical method to determine whether precise time synchronism exists between individual combustions. Each individual combustion must produce a characteristic acceleration at the flywheel. If misfire occurs, flywheel rotation slows slightly. These parameters are the amount of correction the ECM is making to filter out vibration and prevent setting false misfire codes. The DME sets misfire detection to a less sensitive setting when driving on a poor road surface. Normal engine running values with no misfire and no correction factor read about 1.000.

The engine speed (RPM) and crankshaft position input signals are provided by the inductive pulse sensor that scans the incremental gear wheel mounted on the flywheel of the engine. The rotation of the gear wheel generates an AC voltage signal in the sensor as each tooth of the wheel produces one pulse. The engine control module counts these pulses and determines engine speed and crankshaft position.

The signal from the crankshaft sensor is also used for OBD-II monitoring for misfire detection.

BATTERY(V)_____**0 to 25.5V**

This parameter is an ECM-calculated value of battery voltage based on a sensing circuit across the supply voltage circuit. Readings should be close to regulated charging system voltage with the engine running, typically 13.5–14.5V at idle. Compare the displayed value to voltmeter measurements taken across the battery terminals. The ECM uses this parameter primarily for self-diagnostic purposes. However, the ECM may modify some functions if readings are too high or too low.

BRAKE SWITCH _____ **ON/OFF**

BRAKE SIGNAL_____ **YES/NO**

This parameter indicates the position of the brake pedal. The display reads ON when the pedal is depressed and the brakes are applied, and reads OFF when the pedal is released and the brakes are not applied.

With the brake switch input, the TCM deactivates the shift lock solenoid (prevents the gear selector from being moved out of Park or Neutral with the key on unless the brake pedal is depressed). Also, the TCC will disengage when the brake pedal is depressed. AGS-controlled transmissions monitor the frequency of brake pedal use to adapt the shift program to momentarily match the driver's style of driving (sport mode activated).

Starting with the 1995 E38, the brake light switch was replaced by a Hall effect sensor (brake signal). With the pedal depressed, a high signal is sent to the AGS control module. With the pedal in the up position, a low signal is present. If the sensor or circuit is faulty, the brake lights will be on continuously.

BRAKE TEST SWITCH _____ **ON/OFF**

This parameter is a backup to the BRAKE SWITCH parameter. Readings vary by model. On some applications, readings are identical to those for the BRAKE SWITCH; on others, readings are opposite to those for the BRAKE SWITCH.

CAMBANK1(°)CAMBANK2(°) _____ **see description**

Used on V-type engines with a Dual VANOS system on each camshaft. These parameters indicate intake camshaft position (CMP) for each bank. Readings may vary and have different measurement values depending on the year and engine. May read 25 degrees at 2,500 RPM and about -5 to +5 degrees at idle.

CAMBANK1 refers to the cylinder bank that includes cylinder #1. On North American models, cylinder #1 is on the passenger (right) side, or bank, of the vehicle. CAMBANK2 refers to driver (left) side bank.

CAMSHAFT POSITION(°) _____ **not available**

Used on engines with Single VANOS (variable intake camshaft timing). This parameter uses the camshaft position sensor (CMP) to determine intake camshaft position in degrees of advance or retard. Readings may vary and have different measurement values depending on the year and engine. May read 25 degrees at 2,500 RPM and about -5 to +5 degrees at idle.

The CMP sensors monitor the position of the camshafts to establish the start of the ignition firing order, to set up sequential fuel injection triggering, and for accurate camshaft advance and retard timing feedback. Most camshaft sensors are Hall effect, however, the MS 41.1 engine control system camshaft position sensor (Angle Pulse Generator) differs in operation from either the Hall- or inductive-type sensors used on previous systems. The angle pulse generator consists of two windings (primary and secondary) that are connected together at one end, and a magnetic core. This sensor produces a clock frequency which is used to more accurately pinpoint piston position for precise fuel delivery and ignition timing.

CANISTER PURGE _____ **0 to 100%**

This parameter indicates the ECM-commanded status of the canister purge valve. At 0%, the valve is closed, preventing fuel vapor purging from the evaporative canister. At 100%, the valve is completely open to allow purging. Purging normally takes place when the engine has reached normal operating temperature and cruising speeds.

Some systems may use a purge valve that is sprung closed and powered open. The valves are cycled periodically during engine operation. The duty cycle of the purge valve solenoid may vary between 0 and 100%, depending on engine operating conditions. The evaporative purge system is monitored for flow check after fuel system adaptation is complete and the ECM oxygen sensor feedback is in closed loop. The diagnosis starts during normal purge operation. After the system has completed a purge cycle, the valve is cycled abruptly several times. In addition to the rich/lean shift, the engine idle speed will vary. If the predetermined values are reached, the system is functioning properly. The flow check will operate after the following conditions have been met:

- Vehicle speed = 0
- Oxygen sensors in closed loop
- Engine at idle speed
- Coolant temperature above set limit

COOLANT TEMPERATURE SENSOR(°C) _____ **-40 to 199°C**

COOLANT TEMPERATURE SENSOR(°F) _____ **-40 to 389°F**

These parameters indicate the engine coolant temperature based on the engine coolant temperature (ECT) sensor signal.

On early systems, readings may be inaccurate due to a variance in conversion factors. Verify actual coolant temperature by testing directly with a pyrometer.

COOLANT TEMPERATURE SENSOR(V) _____**0 to 5.00V**

This parameter indicates the voltage from the engine coolant temperature (ECT) sensor. The ECT is a Negative Temperature Coefficient (NTC) sensor—resistance decreases as temperature increases. The display should read high voltage on a cold startup, then gradually drop as the engine warms up. The ECM switches to a failsafe default value if a sensor malfunction occurs.

The ECM uses the ECT signal to regulate fuel injection during numerous engine operating conditions. Some sensors may contain two NTC elements, one for ECM input and the other for the instrument cluster temperature gauge.

DISA VALVE (CTRL VALVE DIVIDED MANIFOLD) _____ **ON/OFF**

This parameter displays the state of the ECM-commanded differential air intake system (DISA) vacuum valve solenoid. Reads ON when the ECM is commanding the solenoid to energize, closing the change-over valve, and reads OFF when the ECM de-energizes the solenoid to open the change-over valve.

The change-over valve controls what path the intake air charge takes to reach the intake manifold. Below 4,840 RPM, the ECM commands the valve closed. This routes the intake air charge through the long intake pipe, resulting in increased engine torque. Above 4,840 RPM, the ECM commands the valve open. This routes the intake air through the short pipe, resulting in additional power output.

The change-over valve is normally held open by spring force and closed by vacuum. The ECM activates the DISA system by grounding the vacuum solenoid valve.

During deceleration from high speed, the ECM does not close the change-over valve until 4,760 RPM. The overlap between 4,760 and 4,840 RPM prevents repeated opening and closing of the valve while driving at a constant engine speed of 4,800 RPM.

DMTL PUMP (DIAGN TANK-LEAKAGE REED-SW) _____ **ON/OFF**

This parameter indicates the ECM-commanded status of the evaporative leak detection pump. At cold engine startup, the ECM commands the leak detection pump through a test cycle that may last up to 100 seconds. During the test cycle, the pump pressurizes the evaporative system, including the fuel tank. Reads ON when the test cycle is currently running and reads OFF when no test is currently taking place.

The leak detection pump uses a solenoid-controlled valve. The pump has two chambers separated by a diaphragm, each above and below the piston. A spring forces the piston to complete the downstroke, while vacuum applied to the upper chamber forces the piston to complete the upstroke. The solenoid-operated valve switches between applying vacuum and air at ambient pressure to the upper chamber.

When the ECM energizes the solenoid, engine vacuum collapses the upper chamber and forces the piston up. At the same time, ambient air pressure is drawn into the lower chamber by the first one-way valve.

When the ECM de-energizes the solenoid, engine vacuum switches off, allowing air at ambient pressure traveling through a balance tube to expand the upper chamber. The spring

then forces the piston down at the same time that air in the lower chamber is pushed into the evaporative system through a second one-way valve.

DMTL REED SWITCH (DIAGN MOD TANK-LEAKAGE REED-SW)_____ ON/OFF

This parameter indicates the feedback status of a reed switch built into the upper chamber of the evaporative leak detection pump. Reads ON if the ECM is currently receiving a frequency signal from the reed switch, and reads NO if the ECM is not currently receiving a signal.

During the evaporative system leak test, the pump pressurizes the system, including the fuel tank to 25 mb (0.363 psi). For a portion of the test cycle, the reed switch monitors the pump piston frequency. The higher the frequency, the greater the pumping effort. Excessive pump effort indicates a leak (over 0.5 mm, see explanations that follow).

Although the entire test cycle lasts up to 100 seconds, the measuring phase, where the reed switch is active, lasts between 38 and 63 seconds.

On some systems, the DC Motor LDP ensures accurate fuel system leak detection for leaks as small as 1.0 mm (0.040"). The pump contains an integral DC motor which is activated directly by the engine control module. The ECM monitors the pump motor operating current as the measurement for detecting leaks. The pump also contains an ECM controlled changeover valve that is energized closed during a leak diagnosis test. The changeover valve is open during all other periods of operation, allowing the fuel system to "breath" through the inlet filter (similar to the full down stroke of the current vacuum operated LDP).

DMTL Functional Overview:

1. When inactive, filtered fresh air enters the evaporative system through the sprung-open valve of the DMTL.
2. When the DME activates the DMTL for leak testing, it first activates only the pump motor. This pumps air through a restricter orifice (1.0 or 0.5 mm) which causes the electric motor to draw a specific amperage value. This value is equivalent to the size of the restricter.
3. The solenoid valve is then energized which seals the evap system and directs the pump output to pressurize it. The evap system is detected as having a large leak if the amperage value is not realized, a small leak if the same reference amperage is realized, or no leak if the amperage value is higher than the reference amperage.

DC Motor LDP Inactive—Normal Purge Valve Operation

When inactive, the pump motor and the changeover valve of the DC Motor LDP are not energized. When purge valve operation occurs, filtered air enters the fuel system, compensating for engine vacuum drawing on the hydrocarbon vapors stored in the charcoal canister.

Leak Diagnosis Test Preconditions

The ECM only initiates a leak diagnosis test every second time the criteria are met. The criteria are as follows:

*   Engine off with ignition switched off.
*   ECM still active, or what is known as "follow up mode" (Main Relay energized, control module and ECM components online for extended period after key off).
*   Prior to engine/ignition switch off condition, the vehicle must have been driven for a minimum of 20 minutes.
*   Prior to minimum 20 minute drive, the vehicle be off for a minimum of 5 hours.

- Fuel tank capacity must be between 15 and 85% (safe approximation: ¼–¾ of a tank).
- Ambient air temperature must be between 20 and 95°F (-7 and 35°C).
- Altitude must be less than 2500 m (8,202 feet).
- Battery voltage must be between 11.5 and 14.5V.

When these criteria are satisfied every second time, the ECM will start the fuel system leak diagnosis test. This test will typically be carried out once a day (i.e., once after driving to work in the morning).

Leak Diagnosis Test Phase 1: Reference Measurement

1. The ECM activates the pump motor.
2. The pump pulls air from the filtered air inlet and passes it through a 0.5 mm reference orifice in the pump assembly.
3. The ECM simultaneously monitors the pump motor current flow.
4. The motor current raises quickly and levels off (stabilizes) due to the orifice restriction.
5. The ECM stores the stabilized amperage value in memory.

The stored amperage value is the electrical equivalent of a 0.5 mm (0.020") leak.

Leak Diagnosis Test Phase 2: Leak Detection

1. The ECM energizes the changeover valve, allowing the pressurized air to enter the fuel system through the charcoal canister.
2. The ECM monitors the current flow and compares it with the stored reference measurement over a duration of time.

EGS INTERVENT (INTERVENTION ELECTR TRANSMISS) _____ ON/OFF

This parameter indicates traction control system operation. Reads ON when driving conditions require the system to intervene and take over transmission shift control and reads OFF during normal operation.

ENGINE LOAD(MS) _____0 to 99.9 ms

This ECM-calculated parameter displays the fuel injector on-time adjustment based on engine load. The ECM uses the mass airflow (MAF), intake air temperature (IAT), and engine speed sensors to make the calculation, and uses it for fuel injector timing and fuel trim.

Normally, at no load, hot idle parameter values range from 0.9 to 1.5 ms. At start up, this parameter usually displays a 1.5 ms load signal.

EXHAUST ADAPTATION(°) _____ not available

This ECM-calculated parameter indicates the exhaust camshaft timing adaptation required to maintain optimal engine performance and acceptable emissions levels for the current driving condition.

EXHAUST CAMSHAFT(°)INLET CAMSHAFT(°) _____ not available

These parameters are used on engines with full variable Dual VANOS control on both the intake and exhaust camshafts. These systems use either two or tour cam position sensors, depending on the engine. Readings may vary and have different measurement values depending on the year and engine.

EXHAUST FLAP _____ **ON/OFF**

This ECM-commanded parameter indicates the status of the exhaust flap damper control solenoid. Reads ON when the ECM commands the solenoid to energize and close the valve, and reads OFF at all other times.

Closing this valve decreases exhaust noise when idling up to 2,500 RPM, towing, and decelerating. When the solenoid energizes, vacuum collapses a chamber on one side of the valve actuator diaphragm. The diaphragm pushes against a rod that closes the valve. When the solenoid de-energizes, the actuator vents vacuum, opening the valve.

FAN _____ **0 to 100%**

This parameter indicates the ECM-commanded duty cycle of the engine cooling fan motor, which determines fan speed. The fan speed may be based on the following factors:

- Radiator outlet temperature sensor input exceeds a preset temperature
- IHKA signalling via the K and CAN bus based on calculated refrigerant pressures
- Vehicle speed
- Battery voltage level

FUEL ADAPTATION _____ **YES/NO or ON/OFF**

This parameter indicates whether or not the ECM is actively correcting the long-term fuel trim. Reads YES or ON when the ECM is making long-term fuel trim adjustments, and reads NO or OFF at all other times.

FUEL CUT-OFF _____ **ON/OFF**

This parameter indicates whether or not the ECM is commanding fuel to be shut off. The ECM is programmed to stop fuel delivery during deceleration to decrease hydrocarbon emissions and to prevent stalling. Reads ON when the ECM is commanding fuel delivery to stop and reads OFF at all other times. The ECM bases its decision on signals from the throttle position (TP), mass airflow (MAF), and engine speed sensors.

FUEL PUMP _____ **ON/OFF**

With most systems, after the ignition is switched on, the control module provides a pulse width modulated ground for the relay and the ground is maintained with the presence of the engine speed signal. While the pump delivers more volume and pressure, this creates more heat due to the increased power consumption. To lower the in-tank temperature, the fuel pump module will vary the pump speed (amperage). The control module will vary the ground signal (PWM) to the fuel pump module.

This variation is based on engine speed and load:

- Idle and part load = low pump speed
- Start-up (20 seconds) and full-load = full pump speed

The power to the fuel pump relay will be switched off in the event of an airbag activation (the MRS III control module will signal the ECM over K Bus and CAN bus).

Non-Return Fuel Rail System

Most newer engines have a regulated fuel supply controlled by the fuel pressure regulator integrated in the fuel filter assembly (a pressure testing tap may be available). A fuel return

line may be located on the filter/regulator assembly, but not at the fuel rail. On some models, the fuel filter and fuel pressure regulator assembly may be located in the fuel tank.

FULL LOAD _____ **YES/NO**

FULL POSITION SWITCH (FULL LOAD SWITCH)_____ **CLSD/OPEN**

These parameters indicate throttle position (TP) sensor position. Usually, YES and OPEN indicate that the throttle plate is fully opened. However, on some vehicles the opposite is true. Before relying on this parameter for diagnosis, confirm the definition of YES and OPEN by physically moving the throttle plate open and closed while noting which parameter variable the scan tool displays.

IAC(%) _____**0 to 100%**

IAC PWM(%)_____**0 to 100%**

These parameters indicate the idle air control (IAC) valve opening. Two different IAC valves are used: a 2-wire valve and a 3-wire valve.

On a 2-wire valve, one wire provides power and the other wire is grounded through the ECM. Spring force holds the valve in a closed position. The ECM regulates the ground circuit through pulse-width modulation to control how far the valve opens against spring force. As a failsafe, the ECM opens the valve a fixed amount to allow the engine to idle in the event of a power circuit failure.

A 3-wire valve is a dual-winding motor. The two windings oppose each other and the ECM adjusts valve position by varying the duty cycle of the signals to the windings. There are preset positions for starting, idling, decelerating, and shutting down, as well as a failsafe position of 21%. Approximate nominal idle readings vary around 36%, increasing to 45 to 50% at partial to full load. The valve is also used by the Vehicle Skid Control (VSC) system during engine drag torque (MSR) regulation to reduce engine braking effect during deceleration.

IAC ADAPTATION(kg/h) _____ **0 to 100 kg/h**

IAC ADAPTATION1(kg/h) _____ **0 to 100 kg/h**

IAC ADAPTATION2(kg/h) _____ **0 to 100 kg/h**

IAC ADAPTATION(m3/h)_____**0 to 100 m3/h**

IAC ADAPTATION P-N (IAC ADAPTATION IN P-N POSITION)(%) _____**0 to 100%**

IAC ADAPTATION R-D (IAC ADAPTATION IN R-D POSITION)(%)_____**0 to 100%**

IAC ADAPTATION A/C (IAC ADAPTATION WITH AIRCO)(%)_____**0 to 100%**

These parameters indicate the long-term correction applied by the ECM to the idle air control (IAC) valve. The greater the value, the wider the IAC valve opening. On V-type engines, IAC ADAPTATION1 refers to that cylinder bank that includes cylinder #1. On North American models, cylinder #1 is on the passenger (right) side, or bank, of the vehicle. IAC ADAPTATION2 refers to driver (left) side bank.

The characters P-N, R-D, and A/C after IAC ADAPTATION refer to parameters offering correction values during certain operating conditions.

- **P-N** refers to the interval when the transmission is shifted from PARK to NEUTRAL.

- **R-D** refers to the interval when the transmission is shifted from REVERSE to DRIVE.
- **A/C** refers to when the air conditioning system is running.

The data variables use percentages or units of mass, stated in kilograms per hour (kg/h) or cubic meters per hour (m3/h).

IAC INTEGRATOR(m3/h) _____ **0 to 99 m3/h**

IAC INTEGRATOR(%) _____ **0 to 100%**

These parameters indicate the short term correction applied by the ECM to the idle air control valve opening. The data variables use percentages or units of mass. Mass can be read in cubic meters per hour (m3/h).

IDLE FUEL TRIM (FUEL TRIM (IDLE LOAD))(ms) _____ **-100 to +100 ms**

Additive Mixture Adaptation

IDLE FUEL TRIM1 (FUEL TRIM 1 (IDLE LOAD))(ms) _____ **-100 to +100 ms**

Additive Mixture Adaptation, Bank 1

IDLE FUEL TRIM2 (FUEL TRIM 2 (IDLE LOAD))(ms) _____ **-100 to +100 ms**

Additive Mixture Adaptation, Bank 2

These parameters indicate a fine-tuning, long-term (LT) correction or adaptation that the ECM is applying to the fuel injection pulse width. A maximum one-count change in IDLE FUEL TRIM changes the duration of the fuel injection by 0.4 milliseconds (400 microseconds). Although these minute adjustments affect the entire engine speed range, they are most noticeable at idle or lower pulse-width operating conditions. A positive value indicates increased fuel-injection duration; a negative value indicates a decreased fuel-injection duration.

When the short-term (ST) correction value, which may be represented by the O2 INTEGRATOR parameter, reaches its upper or lower limit, the ECM resets ST correction and moves the long-term fuel trim (LTFT) value up or down by one count. The short-term fuel trim (STFT) moves quickly, while the LTFT moves slowly. The LTFT and STFT continue to work together until the fuel mixture problem is corrected, or until the LTFT reaches its upper or lower limit. When the LTFT reaches its limit, the ECM sets a DTC, and usually defaults into open-loop operation.

The factory term "Additive Mixture Adaptation" refers to the fact that the ECM is adding directly to the injector opening time for all memory cells. However, data is only updated under certain idle conditions. Be aware, IDLE FUEL TRIM works together with PART LOAD FUEL TRIM (page 100) to establish the LTFT.

On V-type engines, IDL FTRIM1 refers to that cylinder bank that includes cylinder #1. On North American models, cylinder #1 is on the passenger (right) side, or bank, of the vehicle. IDL FTRIM2 refers to driver (left) side bank.

IDLE LOAD _____ **YES/NO**

IDLE SWITCH (IDLE LOAD SWITCH) _____ **CLSD/OPEN**

These parameters indicate the position of the throttle position (TP) sensor. Usually, YES and CLSD indicate the throttle plate is in the idle position. However, on some vehicles the opposite

is true. Confirm the definition of YES and CLSD by physically moving the throttle plate open and closed and note which parameter variable the scan tool displays.

IGNITION ADVANCE(°) _____ **not available**

This ECM-commanded parameter indicates the current ignition timing advance in degrees of crankshaft rotation.

INJECTION TIME BANK1(ms) _____ **0 to 20 ms**

Injection Signal, Bank 1

INJECTION TIME BANK2(ms) _____ **0 to 20 ms**

Injection Signal, Bank 2

INJECTION TIME PULSE(ms)_____ **0 to 20 ms**

Injection Signal

These parameters display the amount of fuel injected into the engine. The BMW factory tool may display complete on-time, which includes the injector opening delay time. The Snap-on® scan tool injection time readings do not include delay time and therefore may display lower readings.

Early Motronic systems have a limited amount of hardware controllers available. When a test tool is connected to these early systems, the controller that normally regulates the second bank of fuel injectors is redirected to control the communications port. Therefore, an injection signal parameter is available only for injector bank number 1.

When using this parameter for diagnosis, record how much the injector opening time changes under different operating conditions rather than focusing on actual display values. Use the oxygen sensor and fuel trim parameter values to establish a diagnostic base line.

INLET ADAPTATION(°) _____ **not available**

This parameter indicates the degree of the intake camshaft timing adaptation being made to achieve optimal engine performance and to maintain low emission levels.

INTAKE AIR TEMPERATURE(°C) _____**-40 to 199°C**

INTAKE AIR TEMPERATURE(°F) _____**-40 to 389°F**

These ECM-calculated parameters indicate the intake air temperature based on the Intake Air Temperature (IAT) sensor signal voltage.

INTAKE AIR TEMPERATURE(V)_____**0 to 12.0V**

This parameter displays the intake air temperature (IAT) sensor voltage. The sensor has a negative temperature coefficient; as temperature rises, voltage decreases.

On mass airflow (MAF) systems, the IAT sensor may be mounted inside the mass airflow sensor, in the intake manifold, or inside the air cleaner. The ECM uses the IAT sensor to calculate ignition timing.

On airflow meter systems, the IAT sensor is mounted inside the airflow meter in front of the measuring flap. The ECM uses this IAT sensor to help calculate intake air density.

KNOCK(V)_____**0 to 5.00 V**

KNOCK 1 (KNOCK SENSOR 1)(V) _____**0 to 5.00 V**

KNOCK 2 (KNOCK SENSOR 2)(V) _____**0 to 5.00 V**

These parameters indicate the signal received by the ECM from the knock sensor or sensors. Knock sensors only generate a signal when detonation is detected. The higher the signal voltage, the greater the amount of detonation.

KNOCK CONTROL_____**ON/OFF**

This ECM-commanded parameter indicates the status of knock control. Reads ON when the ECM is detecting detonation or misfiring and is retarding the ignition timing to compensate.

MIL LAMP (MALFUNCTION INDICATOR LAMP) _____**ON/OFF**

This ECM-commanded parameter indicates the status of the malfunction indicator lamp (MIL). Reads ON when the ECM is commanding the lamp to light.

MIXTURE _____**RICH/LEAN**

This parameter indicates whether the engine is running a rich or lean air/fuel ratio. The parameter reads RICH or LEAN based on the voltage output from the oxygen sensor (O2S) mounted in the exhaust stream. The amount of oxygen in the exhaust stream is directly related to the oxygen content in the intake air/fuel mixture. Before beginning to vary the air/fuel ratio based on O2S signals, the ECM must be in closed-loop operation and the O2S must be at operating temperature.

MSR INTERVENT (MSR INTERVENTION) _____**ON/OFF**

This parameter indicates whether the engine drag torque control (MSR) system is on. The MSR system works in conjunction with the Dynamic Stability Control (DSC) system (see page 42) and other systems to help the driver maintain control during certain hazardous driving conditions.

While decelerating in a high gear and on a slippery road surface, the engine control module (DME) may cut off fuel. This could cause the drive wheels to drag and loose traction, causing the vehicle to become unstable. To prevent this, the MSR system opens the idle control valve and cancels deceleration fuel cutoff. This action accelerates the engine slightly, reducing wheel drag and increasing vehicle stability.

O2 SENSOR(V)O2 SENSOR 1(V)O2 SENSOR 2(V)O2 SENSOR AFTER CAT(V)O2 SENSOR AFTER CAT 1(V)O2 SENSOR AFTER CAT 2(V)O2 SENSOR BEFORE CAT(V) O2 SENSOR BEFORE CAT 1(V)O2 SENSOR BEFORE CAT 2(V)_____**variable**

These parameters indicate the amount of oxygen in the exhaust gas. High oxygen levels indicate a lean air/fuel mixture, while low oxygen levels indicate a rich air/fuel mixture. When the oxygen sensors (O2S) are at operating temperature and the system is operating in closed loop, the ECM constantly adjusts the air/fuel mixture to achieve a 14.7:1 ratio. The ECM uses O2S signals to determine how rich or lean the engine is running and to correct the mixture.

The following types of oxygen sensors are used:

* A titanium oxygen sensor is a resistor that changes resistance according to the amount of oxygen surrounding it. The ECM applies a 5V reference signal and monitors the voltage drop across the sensor. As oxygen increases (lean) or decreases (rich), so does voltage.

A range from 0 to 2.4V indicates a rich air/fuel mixture, and a range from 2.6 to 5.0V indicates a lean air/fuel mixture.

Titanium oxygen sensors are used on 1996–1999 E36 (323i/is/iC, 328i), E39 (528i/iT), and Z3 Roadster, all with the MS41.1 controller (M52 engine).

- A **zirconium oxygen sensor** is used as the upstream sensor on all other models, though on OBD-II vehicles, either a titanium or zirconium oxygen sensor may be used as the downstream sensor after the catalytic converter (CAT). A zirconium oxygen sensor generates a variable voltage signal according to the amount of oxygen surrounding it. This voltage is transmitted to the ECM as feedback of the air/fuel mixture. As oxygen increases (lean), voltage decreases; as oxygen decreases (rich), voltage increases. A range from 0.00 to 0.42V indicates a lean air/fuel mixture; a range from 0.48 to 1.00V indicates a rich air/fuel mixture. If a zirconium O2S fails, the ECM provides a fixed 0.45V substitute signal. This is also the reference voltage output by the ECM which should be present key on engine off and during open loop operation.

- A **Bosch planar wideband sensor** measures exact air/fuel ratio. "Wideband" means that it can measure very lean to very rich (exact voltage to air fuel ratio correlation). This sensor is used on Super Low Emission Vehicles (SULEV) for the upstream sensor on 2003 325i and 2002–03 745i/Li and obtains reference air through the sensor harness and plug. The plug connection needs to be clean from contamination or it will cause problems. Plug connection oxidation can sometimes be cleaned by disconnecting and reconnecting the sensor connector.

On V-type engines, O2 SENSOR 1, O2 SENSOR BEFORE CAT1, and O2 SENSOR AFTER CAT1, refer to the cylinder bank including cylinder #1. On North American models, cylinder #1 is on the passenger (right) side. O2 SENSOR 2, O2 SENSOR BEFORE CAT2, and O2 SENSOR AFTER CAT2 refer to driver (left) side bank.

O2S Location: 4–6 Cylinder Engines

Use these parameters for interpretation of O2S location and position for the following applications:

- 1996–98 4-cylinder 1.9L M44 engine (M5.2 controller) in the 318i/ti/is or Z3
- 1996–99 6-cylinder 2.5L (323i/is) and 2.8L (Z3) using the MS41.1 controller

These use only one pre or before CAT (upstream) oxygen sensor mounted in the exhaust header pipe (O2 SENSOR 1) and one post or rear CAT (downstream) oxygen sensor mounted after the one catalytic converter.

For other OBD-II inline 6-cylinder engines, O2 SENSOR BEFORE CAT1 refers to the upstream O2S in the front exhaust manifold (cylinders one to three), O2 SENSOR BEFORE CAT2 refers to the upstream O2S in the rear exhaust manifold (cylinders four to six), and O2 SENSOR AFTER CAT 1 refers to the downstream O2S for the front exhaust manifold. O2 SENSOR AFTER CAT 2 refers to the downstream O2S for the rear exhaust manifold.

M62TU engine (ME 7.2) uses two warm-up CATs and two main CATs. E46 uses two integral CATs to front and rear exhaust manifolds.

O2S Location: 8–12 Cylinder Engines

For OBD-II V8 engines, O2 SENSOR 1 (before CAT) and O2 SENSOR AFTER CAT refer to the cylinder bank including cylinder #1. Cylinder #1 is on the passenger side (right), and O2 SENSOR BEFORE CAT2 and O2 SENSOR AFTER CAT2 refer to driver (left) side bank.

For OBD-I V8 engines, O2 SENSOR 1 refers to bank 1 (cylinder 1 bank) or passenger side of engine. O2 SENSOR 2 refers to bank 2 or driver's side of engine.

For OBD-II V12 engines with 2 separate engine control systems, each bank runs independently with separate catalytic converters.

- DME 1—bank 1 (passenger-side), cylinders 1–6
- DME 2—bank 2 (driver-side), cylinders 7–12

The M73TU engine (1999–2001 V12) has an electrically-heated CAT.

For OBD-I V12 engines with two separate engine control systems, each bank runs independently with separate CATs, but there are no downstream O2Ss, only one OXYGEN SENSOR (pre-CAT) located on each bank.

The scan tool calls bank 1, the passenger side, "ENGINE (RIGHT)" and bank 2, the driver's side, "ENGINE (LEFT)". Long intake runners with each bank's MAF sensor are physically located on the opposite side of the engine.

Some models are equipped with an exhaust temperature sensor at the catalyst. The sensor is a PTC resistor which allows the ECM to monitor the catalyst temperature. This input is used for mixture control and for catalyst efficiency. In the event of an overheat situation, the ECM will illuminate the Malfunction Indicator Light (MIL) and set a fault code. Under certain load conditions, the fuel mixture is enriched to aid in cooling down the catalytic converters.

O2 SENSOR HEATER BEFORE CAT _____ **ON/OFF**

O2 SENSOR HEATER AFTER CAT_____ **ON/OFF**

O2 SENSOR HEATER BEFORE CAT(%) _____ **0 to 100%**

O2 SENSOR HEATER BEFORE CAT(%) _____ **0 to 100%**

O2 SENSOR HEATER AFTER CAT 1(%) _____ **0 to 100%**

O2 SENSOR HEATER AFTER CAT 2(%) _____ **0 to 100%**

These parameters indicate the status of the heated oxygen sensor (HO2S) heater circuit. Reads ON when the ECM is commanding the heater on. On some early systems, the ECM controls the heat intensity by modulating the duty cycle of the signal to the heater relay. On later models, the DME typically controls the O2 heater directly. Either system displays a percentage, the higher the percentage, the greater the heat intensity. At cold start, the downstream O2S duty cycle is usually delayed or minimized for a couple of minutes to prevent sensor shell shock (cracking). Heater duty cycle is also increased on deceleration to compensate for cooler exhaust temperatures.

See O2 SENSOR parameters for specific application interpretation.

Oxygen sensor heater relay ground is ECM-controlled and only operates under specific, pre-programmed conditions.

On deceleration, the duty cycle will be increased to maintain the heating of the sensors during closed throttle operation with fuel cut-off.

O2 SENSOR INTEGRATOR(%) _____ **-100 to +100%**

O2 SENSOR INTEGRATOR 1(%) _____ **-100 to +100%**

O2 SENSOR INTEGRATOR 2(%) _____ **-100 to +100%**

Integrator, Upstream O2S

These parameters are equivalent to the short term fuel trim (short term FT) correction during closed-loop operation. This correction is based on the oxygen sensor (O2S) input for a given engine load and speed. The ECM monitors engine operating conditions and calculates short-term and long-term adaptations to correct for engine wear.

Although the variable can range from -100 to +100, the value typically ranges from -25 to +25 on a normally operating engine. Positive values indicate the ECM is enriching the air/fuel mixture, and negative values indicate the ECM is leaning the mixture. During open-loop operation, the ECM runs at a base program without correction and the parameter displays a fixed 0% value. The ECM adjusts the air/fuel mixture by changing the fuel injector pulse width.

On V-type engines, O2 SENSOR INTEGRATOR 1 refers to the cylinder bank including cylinder #1. On North American models, cylinder #1 is on the passenger (right) side, or bank. O2 SENSOR INTEGRATOR 2 in on the driver (left) side bank.

The BMW factory tool displays the integrator as a numerical value. The scan tool uses the numerical value to calculate a percentage.

O2 READY _____ **ON/OFF**

O2 READY1 _____ **ON/OFF**

O2 READY2 _____ **ON/OFF**

These parameters indicate whether the ECM is operating in closed or open loop. Reads ON during closed-loop operation and reads OFF during open-loop operation. In closed loop, the ECM constantly adjusts the air/fuel mixture according to O2S input signals. The ECM switches from open to closed loop only after the O2Ss reach operating temperature.

Many faults, including some that set diagnostic trouble codes (DTCs), cause the ECM to return to open-loop operation. Some earlier vehicles normally return to open-loop operation at idle. On these vehicles, the slower velocity of exhaust gases passing through the tailpipe is not sufficient to maintain O2S operating temperature. Accelerating off idle warms the O2S, shifting the ECM back into closed-loop operation.

On V-type engines, O2 READY1 refers to the cylinder bank including cylinder #1. On North American models, cylinder #1 is on the passenger (right) side, or bank. O2 READY2 refers to the driver (left) side bank.

OIL TEMPERATURE(°C) _____ **-40 to 199°C**

OIL TEMPERATURE(°F) _____ **-40 to 389°F**

These ECM-calculated parameters indicate the engine oil temperature (EOT) based on the signal voltage from the EOT sensor. The electronic level sensor is located in the engine sump mounted to the engine oil pan.

The probe of the level sensor contains two temperature-sensing elements.

- One senses the engine oil temperature.

- The other is heated to 50°F (10°C) above the temperature of the engine and then is allowed to cool.

The length of time it takes to cool the heated element is how the sensor determines the engine oil level. When the oil level is high, it covers a larger portion of the probe submersed in the oil sump. The engine oil around the probe absorbs the heat of the heated element more quickly than if the level is low. The microprocessor in the base of the sensor produces a pulse width modulated signal proportional to the oil level. The pulse width decreases with a decreased level of oil.

The engine control module uses the EOT input signal to protect the engine during the cold engine warm-up phase. On some models, the visual warning LEDs in the tachometer will illuminate at cold engine start up and slowly be extinguished as the oil temperature increases.

The EOT sensor may also serve as an important input for VANOS operation, varying the solenoid control based on oil temperature because oil temperature/viscosity effects camshaft movement reaction time.

In the event of a oil temp/level sensor fault, the coolant temperature sensor reading may be used as the substituted value.

PART LOAD FUEL TRIM (FUEL TRIM (PART LOAD))(%) _____ **-100 to +100%**

Multiplicative Mixture Adaptation, Part Load

PART LOAD FUEL TRIM1 (FUEL TRIM 1(PART LOAD))(%) _____ **-100 to +100%**

Multiplicative Mixture Adaptation, Part Load, Bank 1

PART LOAD FUEL TRIM2 (FUEL TRIM 2(PART LOAD))(%) _____ **-100 to +100%**

Multiplicative Mixture Adaptation, Part Load, Bank 2

These parameters indicate the long term fuel trim (FT) correction the ECM is applying to the air/fuel mixture during closed-loop operation over the middle to upper range of engine operation. BMW uses the term "Multiplicative Mixture Adaptation" because it is a percent correction factor based on the individual base injection value for each memory cell.

Cells are constantly updated based on feedback operation. If any cell stores an update that is beyond the neutral feedback value, a correction is then factored into the injector pulse-width calculation. To maintain the optimal air/fuel ratio of 14.7:1 for catalytic converter efficiency, the ECM monitors the oxygen sensors and calculated load. From this information, the ECM calculates a percent value that indicates how much to enrich or lean the fuel mixture. Sometimes, the ECM makes fine tuning adjustments across the complete fuel map by adjusting the IDLE FUEL TRIM (for example, when a fine-tune adjustment is needed across the range to compensate for fuel injector drift).

PEDAL POSITION 1 (ACCEL.PEDAL POSITION SENSOR 1)(V)PEDAL POSITION 2 (ACCEL.PEDAL POSITION SENSOR 2)(V) _____ **variable**

These parameters indicate the position of the accelerator pedal position (APP) sensor on electronic throttle systems (EDK/MDK). The ECM determines accelerator pedal position using APP sensors and changes throttle plate position with an electronic throttle plate actuator. BMW uses two different systems: the MDK Hybrid and the EML full drive-by-wire system (see "Testing Electronic Throttle Systems" on page 49 for more information). The MDK Hybrid system uses an overriding clutch, which allows the traction and cruise control

systems to control the throttle independent of accelerator pedal position. This system uses two APP and two throttle actuator sensors, which are all located at the throttle body. The ECM relies on each second sensor for validation—if the first sensor fails, the ECM switches to the second sensor. The accelerator pedal controls the APP sensors using a throttle cable.

Both pedal position parameters should display very close to the same value. The more the accelerator pedal is depressed, the higher the signal voltage. The EDK full drive-by-wire system does not use a throttle cable or an overriding clutch. On EDK, an accelerator pedal position sensor (PWG) mounted near the accelerator pedal contains two potentiometer sensors or two Hall effect sensors that provide two separate signals. The ECM uses these signals to regulate the electronic throttle valve. A kickdown request signal for the automatic transmission is also provided by the PWG. If a fault is detected in an EML system, the ECM initiates failsafe measures based on the type of failure (increased or decreased airflow). With a fault in the idle speed actuator or circuit (decreased airflow), the system compensates to maintain idle speed and switches on the EML lamp. With an increased airflow fault, variable valve timing (VANOS) and knock control systems are disabled, which reduces engine performance.

The ECM also lowers the engine speed to idle when the brake pedal is depressed. Moving the throttle plate should bring about a proportional and simultaneous change in both sensor signal voltages. For both MDK and EDK systems, the working range for PEDAL POSITION1(V) and PEDAL POSITION 2(V) is 0.5 to 4.5V on models with an automatic transmission and 0.5 to 3.8V on models with a manual transmission. Throttle valve position sensor voltage readings should change inversely to each other as the throttle is opened. One APP sensor voltage reading range is approximately 0.4–2.0V. The other is approximately 0.8–4.0V.

POSITION(°) _____ **not available**

This ECM-calculated parameter indicates accelerator pedal position (APP) in degrees. The further the pedal is depressed, the higher the value. This parameter is used on drive-by-wire electronic systems.

RADIATOR(°C) _____**-40 to 199°C**

RADIATOR(°F) _____**-40 to 389°F**

These parameters indicate the temperature of the engine coolant at the exit of the radiator.

RADIATOR(V)_____**0 to 5.00V**

This parameter indicates the voltage from a special coolant temperature sensor mounted at the exit of the radiator. This sensor is a negative temperature coefficient (NTC) type; as temperature increases, voltage decreases.

Vehicles with this special coolant sensor often also have an electronically-controlled coolant thermostat. These two devices allow the ECM to raise coolant temperature to decrease hydrocarbon emissions, and to control the auxiliary radiator fan.

REFERENCE INLET CAM ANGLE(°)REFERENCE EXHAUST CAM ANGLE(°)_ not available

These parameters are an ECM-calculated value of the intake and exhaust camshaft positions (CMP) based on input from the crankshaft position (CKP) sensor.

REQUIRED IDLE(RPM) _____ **not available**

This parameter indicates the target idle speed that the ECM is attempting to maintain.

REQUIRED EXHAUST CAM(°)REQUIRED EXHAUST CAM 1(°)REQUIRED EXHAUST CAM 2(°) _____ **not available**

These parameters indicate the ECM-commanded (desired) exhaust camshaft position (CMP) on Dual VANOS systems. The data changes according to engine speed and load.

On V-type engines, REQUIRED EXHAUST CAM 1 refers to the cylinder bank that includes cylinder #1. On North American models, cylinder #1 is on the passenger (right) side, or bank, of the vehicle. REQUIRED EXHAUST CAM 2 refers to the driver (left) side bank.

REQUIRED INLET CAMSHAFT(°) _____ **not available**

This parameter indicates the ECM-commanded (desired) intake camshaft position (CMP). The data changes according to engine speed and load.

RPM_____ **not available**

This parameter indicates engine speed in revolutions per minute.

SECONDARY AIR PUMP _____ **ON/OFF**

This parameter indicates the ECM command to the secondary air (AIR) pump. Reads ON when the ECM switches the pump on and reads OFF when the pump is off. Secondary air injection reduces emissions at cold startup and during warmup by pumping air into the exhaust manifold. The ECM normally activates this system for approximately two minutes following engine startup and deactivates it after the engine operating temperature exceeds 104°F (40°C).

Most of the BMW secondary air injection systems consist of similar components. The control unit controls the vacuum vent valve and the secondary air injection pump relay separately but simultaneously. The AIR pump operates at a start temperature of 50–104°F (10–40°C). It continues to operate for a maximum of two minutes at idle speed. Some systems contribute an additional correction factor for secondary air "on" time with the additional input from the integral ambient barometric pressure sensor. This sensor provides a base value to calculate the air mass being injected into the exhaust system. This helps to "fine tune" the secondary air injection "on" time, optimizing the necessary air flow into the exhaust system which reduces the time to catalytic converter light-off.

SECONDARY AIR VALVE _____ **OPEN/CLSD**

This parameter indicates the ECM command status of the non-return valve solenoid. The non-return valve controls secondary air flow into the exhaust. Reads OPEN when the ECM is commanding the solenoid to energize and open the valve.

SMOOTH RUNNING VALUE ENGINE 1SMOOTH RUNNING VALUE ENGINE 2SMOOTH RUNNING VALUE ENGINE 3SMOOTH RUNNING VALUE ENGINE 4SMOOTH RUNNING VALUE ENGINE 5SMOOTH RUNNING VALUE ENGINE 6SMOOTH RUNNING VALUE ENGINE 7SMOOTH RUNNING VALUE ENGINE 8SMOOTH RUNNING VALUE ENGINE 10SMOOTH RUNNING VALUE ENGINE 11SMOOTH RUNNING VALUE ENGINE 12 _ not available

These numerical values indicate the combustion quality of individual cylinders. Values are obtained by evaluating the rate of crankshaft acceleration measured by the crankshaft position (CKP) sensor. An individual cylinder with poor combustion displays a higher value

than cylinders with more normal combustion. Engine speed is measured at the incremental wheel on the crankshaft by a Hall effect sensor. In addition, the smooth running of the engine is monitored by the ECM as a measure of misfire detection.

In general, use these numbers for relative cylinder comparison. Look for the cylinder(s) that are different from the others. On most engines, a value over 1.5 usually indicates a problem on that particular cylinder if all or most of the other cylinders are much lower than this. Nominal range varies from about 0.1 to 0.5. Technicians report that they start to get concerned when they see 0.7 on one or more cylinders but the majority are lower.

Factory scan tool smooth running values may read lower due to calculation difference. Regardless of the scan tool, always look for reading variation between cylinders.

To detect misfire, the ECM divides the incremental wheel into segments. The number of segments corresponds to the number of spark plug firings per crankshaft revolution (2 segments on a 4-cylinder engine, 3 on a 6-cylinder, 4 on an 8-cylinder, and 6 on a 12-cylinder). The ECM measures and evaluates the duration of each segment to determine crankshaft speed and rate of acceleration for each individual cylinder.

Maximum values for rough running are stored in ECM programming for various engine speeds, loads, and temperatures. If these values are exceeded within a certain number of combustion cycles, a misfire code is set for the offending cylinder.

TANK PRESSURE(kPa)_____ **not available**

This parameter indicates the pressure within the fuel tank. The ECM relies on the fuel tank pressure (FTP) sensor voltage signal to calculate this value. On a normally functioning system, expect this parameter to read 47.5 kPa at key-on, engine-off, 18.0 kPa at idle, and 47.0 kPa at 2,500 RPM.

TANK VENTILATION _____ **ON/OFF**

TANK VENTILATION(%) _____**0 to 100%**

These parameters indicate the position of the shut-off valve, which is located on the inlet side of the charcoal canister. Reads ON or 0% when the valve is closed and the fuel tank is sealed from atmospheric pressure and reads OFF or a percentage greater than zero when the valve is open and the ECM is allowing atmospheric pressure into the tank in order to conduct an evaporative system leak test.

THERMOSTAT _____ **ON/OFF**

This parameter indicates whether the ECM-controlled electric thermostat is active. It is used on Low Emission Vehicle (LEV) compliant engines using a dual stage, electrically-heated thermostat. This thermostat allows the engine to run hotter than a conventional thermostat. The second stage is controlled by the heater inside the thermostat.

The heater is turned on under the following conditions:

- Engine temperatures greater than 235°F (112°C)
- Intake air temperatures greater than 125°F (52°C)
- Load signal greater than 5.8 ms
- Vehicle speed greater than 100 MPH (161 KPH)

The heater inside the thermostat causes the thermostat to open further, thereby increasing coolant flow through the radiator and bringing the engine temperature down. The temperature of the coolant should drop to approximately 185°F (85°C) when the heater is activated.

THROTTLE (THROTTLE VALVE)(%)_____ **0 to 100%**

This parameter indicates the percentage of throttle opening. The ECM calculates this value from the throttle position (TP) sensor voltage signal. The greater the percentage, the wider the throttle opening.

THROTTLE VALVE (THROTTLE VALVE POSITION)(°) _____**not available**

This parameter indicates the throttle valve opening in degrees based on the throttle actuator valve sensor.

THROTTLE VALVE 1 (THROTTLE VALVE POSITION 1)(V)THROTTLE VALVE 2 (THROTTLE VALVE POSITION 2)(V)_____ **variable**

These parameters indicate the signal voltage from the throttle actuator valve sensors used on drive-by-wire systems. BMW uses two different systems: the MDK Hybrid drive-by-wire and the EML full drive-by-wire system (see "Testing Electronic Throttle Systems" on page 49 for more information). The MDK Hybrid system uses an overriding clutch that allows the traction and cruise control systems to control the throttle opening independent of accelerator pedal position. This system uses two accelerator pedal and two throttle actuator valve sensors, all located at the throttle body. The ECM relies on the second set of sensors for validation. If the first sensor fails, the ECM switches to the second sensor. The ECM always uses the lowest of the two sensor readings. If both signals are incorrect or readings are not plausible, the ECM switches to limp home mode, which allows only a limited engine speed. The accelerator pedal controls the accelerator pedal position (APP) sensors using a throttle cable.

For MDK hybrid drive-by-wire systems, the range is 0.5–4.5V. The two parameters should be very close to each other in value.

The EML full drive-by-wire system does not use an overriding clutch. This system uses an APP sensor located at the accelerator pedal along with a throttle actuator valve sensor that is located at the throttle body. The ECM relies on the sensors to validate each other. If one sensor fails, the ECM operates based on the second sensor. The ECM also lowers the engine speed to idle when the brake pedal is depressed. Moving the throttle plate should bring about a proportional and simultaneous change in both sensor signal voltages.

For EML full drive-by-wire systems, the range for THROTTLE VALVE1 is 0.5–4.5V. The range for THROTTLE VAVLE2 is 4.5–0.5V. When added together, the voltage values from both parameters should equal approximately 5V.

THROTTLE POSITION SENSOR ADAPT (THROTTLE POS SENSOR ADAPTATION)(%)_____ **0 to 100%**

Adaptation, Throttle-valve Potentiometer

This parameter is an ECM-learned corrective value for the throttle position (TP) sensor idle stop setting. As an engine ages, the ECM adjusts the idle stop to maintain the idle speed at original specifications. The greater the value, the greater the ECM compensation.

TPS(V) _____**0 to 5.10V**

This parameter indicates the voltage signal from the throttle position (TP) sensor. The greater the voltage, the greater the throttle opening. Typically, expect a value of 0.5V at idle, and 4.5V at wide open throttle. If the ECM detects a TP sensor circuit malfunction, the ECM substitutes a calculated value based on engine speed and the MAF sensor for the TP sensor signal.

VALVE RUN LOSS (RUN LOSS VALVE)_____ **SMALL/LARGE**

This parameter indicates whether the ECM is commanding the fuel pressure regulator bypass return valve to open or close. A solenoid controls the bypass valve. Reads SMALL when the ECM de-energizes the solenoid to open the valve, and reads LARGE when the ECM energizes the solenoid to close the valve.

The bypass return valve works with the fuel pressure regulator (on some models, the fuel pressure regulator may be an integral part of the Running Loss Valve) to manage the fuel supplied to the fuel rail. During the start-up period of 20 seconds, the ECM energizes the solenoid, causing the bypass valve to close, preventing fuel from being returned to the fuel tank. After the start-up period, the ECM de-energizes the solenoid, causing the bypass valve to open, allowing fuel to be returned to the fuel tank.

During normal engine operation, the bypass return valve and regulator allow unneeded fuel to bypass the fuel rail and return to the fuel tank. This lowers fuel temperature, reducing the amount of fuel vaporized in the fuel tank.

The ECM closes the bypass valve momentarily during engine misfire to perform misfire testing. Closing the valve increases fuel flow. If misfiring stops, then a lean fuel condition is at fault.

The non-return fuel rail system uses the same method of meeting running loss compliance. The regulated fuel supply is controlled by the fuel pressure regulator integrated in the fuel filter assembly (pressure testing tap). A fuel return line is located on the filter/regulator assembly.

This system provides even fuel distribution to all fuel injectors due to a "T" connection feeding both fuel rails. The fuel rails do not contain a return line.

VANOSVANOS 1VANOS 2_____ **RETARD/ADVANCE**

Variable Cam Timing

These parameters indicate whether the variable camshaft control (VANOS) system is commanding the camshaft(s) into retard or advance positions.

Control of the VANOS solenoids is an output function of the ECM. For dual VANOS (VANOS 1 & 2) there is one solenoid for each camshaft (intake and exhaust). For single VANOS, there is one solenoid controlling the intake camshaft. Control solenoids are installed on one side of the control piston. The engine control module regulates the solenoids through a pulse width modulated (PWM) signal to apply or drain control oil pressure from the VANOS pistons. Camshaft adjustment is based on several characteristic maps stored in the control module.

The main control parameters for camshaft adjustment are derived from the engine speed signal and the throttle valve position signal.

The VANOS system adjusts the camshaft timing for all engine operating conditions to optimize engine performance, reduce exhaust emissions, and improve fuel economy. The

system increases torque at the lower to mid-range engine speeds without sacrificing upper speed range power.

The VANOS system receives inputs from the engine speed, mass airflow (MAF), engine coolant temperature (ECT), and camshaft position (CMP) sensors. On some versions, VANOS may receive additional input from the engine oil temperature (EOT) sensor.

On Single VANOS, only the intake camshaft is controlled. When the control solenoid is energized, the intake camshaft is advance. When the solenoid is de-energized, spring tension forces the intake camshaft back into the retarded position.

On Dual VANOS, both the intake and exhaust camshafts are controlled. With VANOS solenoids energized, the intake camshaft is advanced and the exhaust camshaft is retarded. With the VANOS solenoids de-energized, the intake camshaft is retarded and the exhaust camshaft is advanced.

VEHICLE SPEED(KMH) _____ **not available**

VEHICLE SPEED(MPH) _____ **not available**

This parameter indicates the vehicle speed based on the vehicle speed sensor (VSS) input signal to the ECM.

5.3 Transmission Parameters

A/T OIL (A/T OIL TEMPERATURE)OIL TEMP _____ **variable**

This parameter displays the automatic transmission fluid (ATF) temperature based on the temperature sensor located inside the transmission. As the oil temperature increases, the sensor resistance decreases. The transmission controller converts the temperature sensor voltage into temperature. Transmission oil temperature greatly influences shift time and smoothness as well as torque converter clutch (TCC) lockup operation, especially at colder temperatures.

Reads near or above 266°F (130°C) when overheating. The engine and transmission controllers should change operation strategies in an attempt to cool the fluid long before it reaches the overheating temperatures.

KICKDOWN (KICKDOWN SWITCH)DOWNSHIFTING _____ **ON/OFF**

These parameters indicate whether the transmission kickdown mode is active. When the accelerator pedal is depressed beyond a certain point and the enable conditions for kickdown are authorized by the TCM, the transmission will downshift into a lower gear. The TCM monitors throttle position, vehicle speed, transmission input shaft speed and load to determine if kickdown should be enabled. AGS-equipped transmissions respond to kickdown by changing to sport mode.

PEDAL POSITION (ACCELERATOR PEDAL POSITION)(%)_____ **0 to 100%**

This parameter indicates throttle position calculated in percent by the TCM. The throttle position input to the TCM (DKV) is a processed-fixed frequency variable duty cycle signal provided by the DME control module. The higher the percent reading, the greater the throttle opening.

SHIFT LEVER PSHIFT LEVER RSHIFT LEVER NSHIFT LEVER DSHIFT LEVER MSHIFT LEVER +SHIFT LEVER - _____ P/R/N/D/M/+-

These parameters are used on the A5S 440/560Z with Steptronic-equipped shifting. Steptronic refers to the ability to manually step the transmission through the shifts by tilting the shift lever forward or backward.

The Steptronic shift console is unique as there are no positions for 4th, 3rd, or 2nd gear. There is also no program switch; instead, the shift lever console contains an automatic and a manual shift gate. The automatic gate contains the gear lever positions P/R/N/D. When the lever is placed in "D" all shifting is based on normal AGS shift programming. The manual shift gate contains the "M" (850Ci) or "M/S" (840Ci/740i) along with "+" and "-".

With manual mode Steptronic shifting, the bowden cable for gear changes is mechanically decoupled at the shifter, and all gear changes are based on microswitch inputs "+" and "-". The driver controls the shifting by tapping the shift lever toward the "+" for higher gears or "-" for lower gears. Spring force returns the shift lever to the center position.

On the 850Ci, the manual shift range is limited from 2nd to 5th gear (1st gear only during engine warm-up). On the 840Ci/740Ci, with the selector lever in the "M/S" gate (manual mode), the transmission will automatically shift using the sport program and the instrument cluster displays "SD". Tapping the selector lever "+" or "-" activates the Steptronic function, which changes the cluster display to "M" followed by the current gear. On the 850Ci, the instrument cluster also indicates the current mode of operation. In automatic mode, the cluster displays shift lever position P/R/N/D. In manual mode, it displays "M" followed by the selected gear.

All models using Steptronic shifting have the following automatic functions in Manual Mode:

- Un-allowed gear requests for non plausible shifts, which are ignored by the TCM (e.g., extreme downshifts at high speed).
- Engine overspeed protection prevents over-revving the engine by upshifting automatically to the next gear.
- Kickdown downshifts to the next lower gear when the kickdown switch is depressed.
- Deceleration signals the transmission to automatically downshift to the appropriate gear.

SHIFT PROGRAM _____ ECONOM/WINTER

PROGRAM SW -SPROGRAM SW -EPROGRAM SW -M_____ OPEN/CLOSED

This parameter indicates the program switch setting. Depending on the model, there are two or three position program switches. Both types provide a momentary ground input signal to the TCM requesting a specific shift program. The three-position switch options are "S" for SPORT, "E" for ECONOMY, and "M" for MANUAL. The two-position switch options are "A" for ECONOMY and "M" for MANUAL. Alternately, to "M" there may be a "*" for WINTER program.

The program switch setting is usually indicated next to the P/R/N/D in the instrument cluster. Economy program is for normal driving at peak fuel efficiency. The Manual program provides a manual shift program engaging only the gear selected (2nd–5th gear). The Winter program eliminates 1st gear when the selector range is either in the "D", or 4th gear position, and the manual selection of either 3rd or 2nd gear will lock that specific gear (no up or down shifting).

The M3 equipped with the A5S310Z EGS transmission uses a three-position program switch (A, M, and S positions). Most transmissions with a two-position program switch have a sport selection by moving the range selector lever into 4, 3, or 2 (program switch in "A").

5.4 Climate Control Parameters

AIRCO SWITCHAIRCO CLUTCH (AIRCO COMPRESSOR CLUTCH)AIRCO REQUEST 1 AIRCO REQUEST 2AIRCO ENABLE _____ **ON/OFF**

These parameters indicate either the switch and request status of the A/C button (snowflake button) located on the climate control faceplate, or the A/C compressor clutch and system status. The Airco switch pushed in is only a request for A/C COMPRESSOR ACTIVATION. The request signal (two requests if double control set) is sent from the climate control module to the ECM. On some systems, the ECM has the option to cancel the request. On other systems, the ECM decides to activate or not activate the A/C compressor. If the Airco or snowflake switch is on at engine startup, the compressor clutch activation is delayed until engine speed exceeds 600 RPM for at least 5 seconds. If the switch is turned off while the engine is running, the control module continues to cycle the compressor with increasingly longer off-times for up to 15 minutes (unless defrost is selected, which keeps the A/C on).

AUC FUNCTION _____ **ACTIVE/INACTV**

This parameter displays the status of the automatic recirculated air control (AUC) sensor.

AUC SENSOR(V)not available

Automatic recirculated air control (AUC) is an additional feature controlling the automatic operation of recirculated air. The AUC feature uses an oxidizable gas sensor usually mounted behind the right side of the radiator or the right side upper portion of the fan shroud (samples air quality as coolant fan pulls across the radiator). The AUC sensor contains a combined heating element (powered by the IHKA module) and a gas sensor. The gas sensor requires heating to work efficiently. The sensor produces a varying voltage based on air quality (concentration of hydrocarbons, NOX, SOX, and CO). The voltage increases as the air becomes more polluted. After it reaches a preset value, the IHKA closes the fresh air flaps. To prevent glass fogging, the system has built-in time limits: 3 minutes when heating and 12 minutes when cooling. With normal air quality, the AUC sensor reads about 0.5V. If the AUC sensor voltage increases to 3.0V, the ventilation or fresh air flaps will close (0%). At about 2.5V, the fresh flaps will read about 20% and 100% (fully open) at 2.4V.

BACK PRESSURE VALVE MOTOR (RAM AIR PRESSURE COMPENSATION) _____ **0 to 100%**

The air volume entering the IHKA system is compensated for at higher vehicle speeds. In the fresh air mode, the flaps are open 100% up to a road speed of approximately 37 MPH (60 KPH) at which point they are closed to 40%. When the vehicle speed reaches about 55 MPH (90 KPH) the flaps close to 30%. There is a hysteresis (overlap) built into the flap closing so that the flaps will not oscillate open/closed at one set speed.

BLOWER(%)not available

This parameter indicates the IHKA command position for the blower motor. At 0%, the blower motor should be off, and at 100%, fully on. The climate control module determines the appropriate blower speed based on the blower control manual switch input and the Y Factor (see "Y FACTOR(%)" on page 112 for an explanation of the Y Factor).

BLOWER CONTROL _____ **0 to 8V**

The blower motor is controlled through an output stage often mounted in a heat sink on the heater case. The control lead from the IHKA module supplies a varying voltage (2.0 to 8.0V) based on the position of the blower control rocker switch. The blower speed increases through the 15 steps until 8V is supplied to the control lead. At this point (the 16th step), the blower is running at maximum speed. The speed of the blower fan is also influenced by the Y Factor and the degree of heating or cooling power requested. When the IHKA system is switched ON, the blower fan will come on at a speed that is dependent on the Y Factor and system settings. The battery charge condition also contributes to blower speed. When the battery drops below 12V, the blower speed signal to the blower output stage is reduced proportionately. To switch the system off, the rocker switch must be stepped down to the lowest setting and then switched off.

Blower control operation is activated with the ignition switched on. The blower speed is controlled by regulating (varying) the ground circuit. The IHKA control module determines the appropriate blower speed using the following primary inputs:

- Blower control thumbwheel/rocker switch inputs
- The Y Factor

On some models, the requested blower speed selection is monitored by the control module which is remotely mounted. On all other models, the requested input selection for blower speed is internally monitored because the control panel and control module are combined.

COMPRESSOR SHUTOFF SIGNAL _____ **ON/OFF**

The IHKA module monitors the full load input from the ECM. If the ECM detects "full load" conditions, it signals the IHKA control module to disengage the A/C compressor.

Some of the conditions for compressor shutoff may be:

- Vehicle speed less than 10 MPH (16 KPH)
- Throttle is wide open
- Engine coolant temperature has reached a maximum temperature

The compressor may be turned off for a maximum of 4 minutes (actual duration may differ between systems).

COOLANT(°C) _____ **-40 to 199°C**

COOLANT(°F) _____ **-40 to 389°F**

These parameters indicate the engine coolant temperature (ECT) based on the ECT sensor signal sent over the K Bus communication line to the IHKA controller. The substituted default value most often used is 212°F (100°C).

COOLANT VALVES _____ **PWM-controlled 0 to 100%**

COOLANT VALVE LEFT _____ **PWM-controlled 0 to 100%**

COOLANT VALVE RIGHT _____ **OPEN/CLOSED**

COOLANT VALVE ON(ms) _____ **not available**

The coolant valves are electrically controlled and may be pulse-width modulated by the climate control module to control heater core temperature. At 100% duty cycle, or fully

powered up, the valves are in the closed position preventing coolant flow into the heater core. Usually, the valves are spring-loaded to the open position. Valve control is dependent on system voltage, driver input, and the Y Factor. The coolant valves are located next to the brake booster inside the engine compartment.

DEFOG FLAP MOTOR (DEFROSTER FLAP)(%) _____ **see description**

This parameter indicates the IHKA command position for the defroster air flaps. At 0%, the defroster air flaps should be fully closed, and at 100%, fully open. These flaps are controlled through a stepper motor which can adjust flaps in very fine increments.

EVAPORATER (EVAPORATOR TEMPERATURE)(°C/°F)_____**not available**

This parameter indicates evaporator temperature. This parameter is based on the signal of a negative temperature coefficient (NTC) type sensor located inside the evaporator. The climate control module uses this input to keep the evaporator at approximately at 35°F (2°C). The climate control keeps this temperature by cycling the A/C compressor on and off as needed. Sensor working range is 14 to 86°F (-10 to 30°C). The substituted default value most often used is 32°F (0°C).

This substituted value is below the cycling point of the A/C compressor, which is designed to shut down the A/C if the evaporator temperature sensor fails.

EXTRA COOLANT PUMP (ADDITIONAL COOLANT PUMP) _____ **ON/OFF**

This parameter indicates whether the auxiliary electric water pump is commanded on or off. The system commands the pump on at low temperatures to ensure that enough hot coolant is available at the heater core to more quickly heat up the interior. It also stays on for a short period if the engine is shut off to maintain circulation and prevent the interior temperature from dropping during short stops.

**HEAT EXCHANGE LEFT
(HEAT EXCHANGER TEMPERATURE LEFT)(°C/°F)** _____**not available**

**HEAT EXCHANGE RIGHT
(HEAT EXCHANGER TEMPERATURE RIGHT)(°C/°F)** _____**not available**

These parameters indicate the temperature of the left and right heater cores based on the signals of two sensors, both located behind the left and right heater core where they are exposed to the air that has just passed through the core. These are negative temperature coefficient (NTC) type sensors—as temperature increases, resistance decreases, and as temperature decreases, resistance increases. Working range of the sensors are 41–255°F (5–124°C). The substituted default value most often used is 131°F (55°C).

INSIDE TEMPERATURE(°C/°F) _____**not available**

This parameter indicates interior cabin temperature based on the signal of a negative temperature coefficient (NTC) type sensor and is located behind the protective grill of the climate control faceplate. The interior temperature sensor is the most important input for the climate control module to calculate the Y Factor. Working range of the sensor is 50–104°F (10–40°C). The substituted default value most often used is 20°F (68°C).

LEG ROOM FLAP MOTOR (FOOTWELL FLAP MOTOR)(%)not available

This parameter indicates the IHKA command position for the leg or footwell air flaps. At 0%, the flaps should be fully closed and at 100%, fully open. These flaps are controlled through a stepper motor which can adjust flaps in very fine increments.

OUTSIDE TEMPERATURE (AMBIENT TEMPERATURE)(°C/°F) _____ not available

This parameter indicates outside temperature based on the signal of the ambient temperature sensor. The ambient temperature sensor is a climate control module input, but is usually not a dedicated climate control module sensor. It is most commonly located under the left side of the vehicle, inside the brake-cooling duct. The information from the sensor is sent to the instrument cluster. From there, the instrument cluster will send ambient temperature information to any module that needs it over the K Bus data communication line. The working range of the sensor is approximately -30 to 120°F (-34 to 49°C). The substituted default value most often used is 32°F (0°C).

REAR COMPARTMENT FLAP MOTOR(%)not available

This parameter indicates the IHKA command position for the rear compartment air flaps. At 0%, the flaps should be fully closed and at 100%, fully open. These flaps are controlled through a stepper motor which can adjust flaps in very fine increments.

RECIRCULATING FLAP MOTOR (RECIRCULATION AIR FLAPS)(%)not available

This parameter indicates the IHKA command position for the recirculation air flaps. At 0%, the flaps should be fully closed and at 100%, fully open. These flaps are controlled through a stepper motor which can adjust flaps in very fine increments.

REQUESTED TEMPERATURESYSTEM REAR TEMP SUPPLY _____ 0 to 5V

The request for air temperature stratification is made by a thumbwheel located in the front center face vent outlet and the rear passenger console outlet (if equipped). The thumbwheel potentiometer receives power and ground from the IHKA control module, which also monitors the variable return voltage. In addition, the rear console outlet contains a micro-switch (on/off request) that signals to the IHKA control module to allow air flow to the rear console.

REQUESTED TEMPERATURE(°C/°F)REQUESTED TEMPERATURE LEFTREQUESTED TEMPERATURE RIGHT_____ not available

This parameter indicates the requested temperature set at the temperature dial on the control panel. The system will attempt to maintain the desired temperature. The range for E46 models is 59–90°F (15–32°C); the range for E39 models is 60–90°F (16–32°C).

SOLAR SENSOR(%) _____0 to 100%

SOLAR SENSOR RIGHT(V) _____ not available

SOLAR SENSOR LEFT(V)_____ not available

Interior temperature is calculated using a solar sensor located in the right side defrost outlet. It is used to control blower setting and air distribution to the center vent. The climate control system uses the solar sensor input to modify the base input from the inside temperature sensor to more accurately control the inside temperature.

SYSTEM (REFRIGERANT) PRESSURE SENSOR (V) _____**0 to 5V**

This sensor is used to read the refrigerant pressure in the system. The IHKA module supplies the power and ground path and monitors the variable voltage signal from the system pressure sensor (usually located in the receiver/dryer). Based on the refrigerant pressure, the IHKA module anticipates the startup torque of the A/C compressor. If the pressure is too low or high the compressor will be deactivated. This input may also used to vary the auxiliary fan speed.

VENTILATION FLAP MOTOR (FRESH AIR FLAPS)(%)not available

This parameter indicates the IHKA command position for the fresh air flaps. At 0%, the flaps should be fully closed and at 100% fully open. These flaps are controlled through a stepper motor which can adjust flaps in very fine increments.

Y FACTOR(%)_____ **-27.5 to 100%**

Y CONTROL(%) _____ **-27.5 to 100%**

This parameter is used to describe how much heating or cooling effort the system is putting out to achieve the desired interior temperature. Other names for "Y Factor" are "Adjusting Factor," "Master Controller" or "Guide Control." The climate control module calculates the Y Factor (on the IHKA dual control, there are two factors: left, or driver, and right, or passenger) based on the system's temperature inputs. Values of -27.5 to 20% indicate the climate control module is trying to cool the vehicle. Values of 20 to 100% indicate the climate control module is trying to heat the vehicle.

The climate control module computes the Y Factor based on three main inputs:

- Interior temperature
- Vehicle occupants' command for temperature
- Vehicle occupants' command for heat or A/C

On systems with dual controls, the left desired temperature has priority over the right when the left is set to either the minimum or maximum desired value.

Terms and Acronyms

A.1 Terms

The following terms are used throughout this manual to explain certain operations and displays:

blink code	A type of vehicle control system that has no serial data. Any trouble codes the control system set are extracted either by flashing the malfunction indicator lamp (MIL) or using a special break-out box.
code	A numerical code, generated by the vehicle control system to indicate a fault has occurred in a particular subsystem, circuit, or part.
cursor	The arrow that appears on menus and some other displays. In most displays, the cursor moves as you scroll.
fix	To lock a single line of the display in a fixed position on the screen to prevent it from scrolling. Data readings remain live while the parameter categories are fixed.
frame	One complete data package, or transmission cycle, from an electronic control module (ECM) that provides serial data of control system operating parameters.
hold	To capture and hold a single data frame for review or printing.
movie	A vehicle data record whose length depends on the number of selected data parameters.
menu	A list of vehicle tests or programs from which a selection can be made.
parameter	A measured value of control system input or output operation. Parameters include voltage signals, as well as temperature, pressure, speed, and other data.
release	To unlock a fixed line and allow it to scroll.
screen	Any given 4-line display.

A.2 Acronyms

The following acronyms are used in diagnostic trouble code definitions displayed by the Scanner™ or used in this manual.

A	Automatic transmission model
ABS, ANS	Antilock Brake System
AC	IHKA signal "Increase Idling Revs"
A/C	Air-Conditioning
ACC	Active Cruise Control
ADA	atmospheric pressure-dependent full-load stop
ADS II	engine intake air control

AE	display unit
AEGS	Independent electronic-hydraulic transmission control
AFM	Airflow Meter
AG	Automatic Transmission
AGR	exhaust gas recirculation
AGS	adaptive transmission control
AIC	Automatic Interval Control
AIR	Secondary air injection
AKF	activated carbon filter
AKS	controlled pressure windshield wiper
ALC	Adaptive Light Control
ALDA	absolute boost pressure-dependent full load stop
AMP	audio system amplifier
ANS, ABS	antilock brake system
APP	Accelerator Pedal Position
ARS	Anti-Roll Stabilization
AS	Active Seat
ASC	Automatic Stability Control
ASC+T	Automatic Stability Control plus Traction control
ASK	audio system controller
ASP	door mirror
AST	slip control (generic designation)
ASU	special exhaust emission test
AT	Antenna Tuner
ATF	Automatic Transmission Fluid
AUC	Automatic Recirculation Control
AUT	Automatic transmission
B	Body
B+	Battery positive voltage
BC	Onboard computer
BH	Rear door, passenger side
BM, BMBD	On-board monitor
BMS	BMW engine management
Brs	Brake Signal
BST	Battery Safety Terminal
BT	Passenger door
BZM	center console control center
BZMF	center console control center rear
C	Chassis

CAN	Controller Area Network
CARB	California Air Resources Board
CAS	Car Access System
CAT	catalytic converter
CaZ	Cetane rating
CBC	Corner Braking Control
CBT	Computer-Based Training
CC	Check Control or Cruise Control
CCM	Check Control Module
CD	Control Display
CDC	Compact Disc Changer
CDN	Canada (national market version)
CIM	Chassis Integration Module
CIM	Computer Integrated Manufacturing
CKP	Crankshaft Position
CMP	Camshaft Position
CO	carbon monoxide
CO2	carbon dioxide
CS	Crash Sensor
CS, CSA	Coupe Sport, Coupe Sport Automatic
CSi	Coupe Sport injection
CSt	centistokes (unit of kinematic viscosity)
Cyl	Cylinder
DA	Driver Airbag
DBC	Dynamic Braking Control
DD	diagnostic socket
DDK	turn/push button
DES	diagnosis development system
DIN	German industry standard
DIS	Diagnostic Information System
DISA	differential air intake system
D-Jetronic	pressure measuring fuel injection system
DK	throttle valve
DKI	engine control module throttle position pulse width modulated output signal to ASC
DKS	throttle valve motor
DKT	signal line for throttle angle and engine temperature
DLC	Data Link Connector
DME	Digital Motor Electronics (engine management system)
DMTL	Evaporative System Leakage Diagnosis

DOHC	Dual OverHead Camshaft
DOT	Department Of Transportation
DP	Driver Pretensioner
DR	pressure Regulator
DSA	Driver Side Airbag
DSC	Dynamic Stability Control
DSP	Digital Sound Processor
DTC	Diagnostic Trouble Code
DWA	anti-theft system
DWAH	GM signal "Anti-theft alarm horn"
DZF	output speed sensor
DZM	tachometer
E Box	Electronics box
EBV	electronic brake force distribution system
EC	Electro-Chrome
ECM	Engine Control Module
ECT	Engine Coolant Temperature
ECU	Engine Control Unit
EDC	electronic damper control
EDC-K	electronic dampening control-continuous
EDK	electric throttle valve
EDS	pressure regulator
EDU	European driving cycle
EEPROM	Electrically Erasable Programmable Read Only Memory
EFI	Electronic Fuel Injection
e.g.	For example
EGR	Exhaust Gas Recirculation
EGS/EHG	independent electronic-hydraulic transmission control
EH	Electronic Hydraulic (automatic transmission control)
EHC	Electronic Height Control
EKM	electronic body module
EKP	electric fuel pump
ELAB	electronic cutoff solenoid
EM	Electro-Mechanical
EMF	electro-mechanical parking brake
EML	electronic control module for throttle regulation
EMS	electronic throttle
EN	European standard
E-OBD	European On-Board Diagnostics

EPDW	electropneumatic pressure transducer
EPROM	Erasable Programmable Read Only Memory
ETM	Electrical Troubleshooting Manual
EU	European exhaust-emissions legislation
EV	injector valve
EVG	electric power unit (for xenon lights)
EWS	Electronic Watchdog (anti-theft) System
EWS	immobilizer
FBH	electric window, passenger side, rear
FBZV, FZV	radio frequency remote control for central locking
FCKW	chlorofluorocarbon (CFC) gasses
FD	fader (radio front to rear balance)
FFSR	Factory-Fitted SunRoof
FGR	cruise control
FH	electric window
FHK	rear passenger area heater
FIRST	Fully Integrated Road Safety Technology
FIS	radio frequency interior protection system
FPR	Fuel Pressure Regulator
FT	driver's door
FTP	Fuel Tank Pressure or Federal Test Procedure
FZV	keyless entry system
GAL	speed-dependent volume control
GM	General Module
GR, GR2	cruise control
GRL	luggage compartment lighting
GPS	Global Positioning System
GRS	rotation rate sensor
GSA	closed loop controlled the differential lock AWD
h	hydraulic automatic transmission control
H	speed category for tires up to 210 KM/H (130 MPH)
H2	xenon lighting system
HC	hydrocarbon
HD	Heavy Duty
HF	High Frequency
HFM	Hot Film Meter
HG	manual transmission
HHS	rear screen heating
HKK	boot/rear flap lid contact

HKL	boot/rear flap or rear flap lift
HLM	hot wire air mass meter
HO2S	Heated Oxygen Sensor
HPS	Head Protection System
HS	heating
Hz	Hertz
HWW	Headlight Wash Wipe
i	injection
IAC	Idle Air Control
IAT	Intake Air Temperature
IB	interior lighting
I Bus	Instrumentation Bus
IC	Integrated Circuit
ICV	Idle Control Valve
IDC	Information on Diagnosis and Coding
IHKA	automatic integrated heating and air-conditioning
IHKR	standard heating and air-conditioning
IHR	Integrated Heating Regulation
IKE	instrument cluster electronics
IL	Interior Light
IR	InfraRed
IRIS	Integrated Radio and Information System
IRS	Infrared Locking System
IRZV	Infrared remote control (for central locking system)
ISIS	Intelligent Safety Integration System
ISN	Individual Serial Number
ITS	head protection system
IUU	battery charger
IVM	integrated power supply module
KAT	with catalytic converter
K Bus	bodyshell bus
KD	Kick-Down
K-Jetronic	continuous fuel-injection system
KLR	ignition switch accessory reposition
KO	IHKA signal "Compressor Request"
KOREL	DME signal "Compressor Release"
KW	crankshaft
KOMBI	instrument cluster
KS	Knock Sensor

KSB	cold start accelerator
KSK	knock sensor control
KVA	fuel consumption indicator
KW	crankshaft
L	Long wheelbase version
L4	4-cylinder Longitudinal-Mounted Engine
LA	national market version
LAB	Lead Acid Battery
LAD	load dependent module
LCD	Liquid Crystal Display
LCM	Lamp Check Module
LDP	Leakage Diagnosis Pump
LED	Light-Emitting Diode
LEW	steering angle sensor
LEV	Low Emission Vehicle
LFB	load dependent injection start
LHM	bulb check module
L-Jetronic	air volume metering fuel system
LKM	lamp check module
LL	idle
LL	reading light or left-hand drive vehicle
LLS	idle actuator
LM	Light Module
LP	printed circuit board
LRA, LWR	automatic headlight vertical aim control
LSM	adjustable steering column
LSM	seat and steering wheel column memory
LSD	Limited-Slip Differential
LSZ	light switch center
LTW	Light Weight
LWR	head lamp range regulation
M	Motronic
MAF	Mass Airflow
MAP	Manifold Absolute Pressure
MBC	Maximum Braking Control
MBV	flow control valve
MCU	Motronic Controlled Units
MDK	idle speed control motor (hybrid drive-by-wire)
ME	engine intervention/ignition angle intervention

ME	torque reduction to the MCU
MFL	multifunction steering wheel
MFU	multifunction clock
MID	Multi-Information Display
MIL	Malfunction Indicator Lamp
MoDiC	Mobile Diagnostic Computer (factory scan tool)
MOZ, MM	motor method (octane number)
MPI	Multipoint Fuel Injection
MRS	Multiple Restraint System
MS	engine management
MSR	engine drag torque control (deceleration slip control)
MTK	partial engine cooling
MV	Magnetic Value (solenoid valve)
MV-B	solenoid valve brake band
MVR	solenoid valve
MY	Model Year
n-ab, N-out	output speed
n-Mot, N-eng	engine speed
NAV	Navigation/Navigation System
NAVI	Navigation module
NEDC	New European Driving Cycle
NF	low frequency
NG	tilt sensor
NGAG	GM signal "DWA Status"
NHTSA	National Highway Traffic Safety Administration
NSC	rear fog light
NSW	fog light
NTC	Negative Temperature Coefficient
NW	camshaft
O2S	Oxygen Sensor
OBC	On-Board Computer
OBD	On-Board Diagnostics
OBD11	EPA standardized diagnosis
OCV	Open Circuit Voltage
OHC	OverHead Camshaft
ORVR	On-board Refueling Vapor Recovery
P	Powertrain
P	electric power
PALA	ASC passive lamp

Pb	pin assignments
P Bus	Periphery Bus
PA	Passenger Airbag
PAS	Power Assisted Steering
PCM	Powertrain Control Module
PDC	Park Distance Control
PDC	Parts Delivery Center
PGS	Passive Go System
PM	Power Module/Periphery Module
PNP	Park/Neutral Position
Poti	Potentiometer
PP	Passenger Pretensioner
PROM	Programmed Read Only Memory
PSA	Passenger Side Airbag
PTC	Positive Temperature Coefficient
PT-CAN	Powertrain CAN bus
PTC	power down mode
PWG	accelerator pedal sensor
PWM	Pulse-Width Modulated
Q	electrical charge
Q	speed category for winter tires up to 160 KM/H
QZV	infrared signal to the GM for locks
R	Electrical resistance
RDC	Tire pressure control
RHR	Rear Hand Restraints
RL	Right hand drive vehicle
RLS	Rain-Light Sensor
RM	Relay Module (ZKE)
RPS	Roll-over Protection System
R-Sperre	Reverse lock-out
RSV	ignition coils signal
RxD	Diagnosis initiation line
RZV	multiple spark ignition system
SA	optional extras
SAC	Self-Adjusting Clutch
SAD	sunroof
SAE	Society of Automotive Engineers
SASL	satellite A-pillar left
SASR	satellite A-pillar right

SB	Switch Block
SBE	seat occupancy detection
SBBH	seat control, passenger
SBFA	seat control, driver
SBFH	seat module passenger side rear
SBSL	satellite B-pillar left
SBSR	satellite B-pillar right
SCA	Soft-Close Automatic
SFAH	seat module driver side rear
SFI	Sequential Fuel Injection
SG	control unit
SGS	seat integrated belt system
SHD	tilt/slide sunroof
SI	Service Indicator board
SIA	service interval display or service indicator system
SIB	Service Information Bulletin
Sila	safety lamp
SIM	Safety Information Module
SINE	siren/tilt sensor (clinometer) of anti-theft alarm system
SKE	standard shell construction
SKHD	sliding/vent roof
SM	seat memory
SMB	passenger seat memory
SMBF	seat module passenger side
SMBFH	seat module passenger side rear
SMFA	seat module driver side
SMFAH	seat module driver side rear
SMG	sequential gearbox
SOHC	Single OverHead Camshaft
SP	schematic
SPG	voltage supply
SPM	seat and mirror or position memory
SR	speed radial for tires up to 180 KM/H
SRA	headlights washer/wiper system
SRM	SRA module
SRS	Supplemental Restraint System
SSBF	seat satellite passenger side
SSFA	seat satellite driver side
SSH	seat satellite rear seat

SSM	servo lock control module
SSR	sun blind
St	connector (picture)
STGT	control unit
STVL	satellite left front door
STVR	satellite right front door
SVS	speech processing system
SWS	wind screen wiper control
SZ	optional accessories
SZL	switch center, steering column
T	Tank
T	ignition spacing (time)
TAGE	outside door handle electronics
TAS	temperature-dependent starting volume control
TBV	Throttle Butterfly Valve
TC	Traction Control
TCC	Torque Converter Clutch
TCM	Transmission Control Module
TD	engine speed signal (ignition interval)
TE	fuel evaporation control
TEL	car telephone
TE-V	fuel evaporation control valve
TEV	purge valve
Ti	injection time
tL	load signal
TL	part load signal
TLA	temperature-dependent idle speed increase
TLEV	Transmission Low Emission Vehicle
TMBFT	door module passenger side
TMBFTH	door module passenger side seat
TMFAT	door module driver side
TMFATH	door module driver side rear
Tmot	engine temperature
TP	Throttle Position
TR	crankshaft reference
TRI	Technical Reference Information
TSB	Technical Service Bulletin
TSH	door lock heating
TSZ-h	transistorized coil ignition with Hall-effect signal transmitter

TSZ-i	transistorized coil ignition, inductive
TSZ-i-s	transistorized coiled ignition, inductive with starting decoupling
TU	Technical Update
TUV	German automotive testing/certification authority
TWC	Three-Way Catalyst
TxD	diagnosis data line
TZV	center lock key
UB+	battery positive
U-batt	battery voltage
UIS	ultrasound monitoring system
ULEV	Ultra Low Emission Vehicle
URSS	roll over protection
U-Vers	supply voltage
V6	6-cylinder V-type Engine
V	Front of vehicle
V	vehicle speed signal "Velocity"
V	Volts
V-signal	Vehicle Speed Signal
VA	Load (appliance) shut-off signal
VANOS/VNC	Variable Camshaft Timing Control
VE	mechanical distributor-pattern injection pump
VF	traffic report radio system
VID	video module
VL	full load
VM	Video Module
VMX	top speed regulation
VNC	variable camshaft control
VSC	Vehicle Skid Control
VSS	Vehicle Speed Sensor
VVT	Valvetronic
W	electrical energy
WIM	Wiper Module
WK	torque convertor clutch
WOT	Wide Open Throttle
X	Four Wheel Drive
XEN	xenon lights
Y	factor for the integrated automatic heating and air-conditioning system
ZA	firing interval (crankcase angle)
ZA	request for fuel and injector cutoff

ZAB	ignition fade-out
ZAE	central airbag electronics
ZAR	ignition timing fade out (feedback)
ZAS	ignition switch
ZCS	central coating key, control module encoding
ZGM	central gateway module
ZKE	central body electronics
ZMS	hydraulically dampened dual-mass flywheel
ZR	tire speed category for speeds above 240 KM/H
ZS	central locking inhibit device
ZSR	ignition current monitoring
ZV	door lock actuator
ZVM	central locking module or central vehicle module
ZW	central warning light
ZWD	idle valve
ZWW	request for ignition timing retard or advance

Frequently Asked Questions

The following sections address general questions about how data bus systems work. See "Testing Bus Systems" on page 55 for bus information specific to BMW vehicles.

B.1 What is a data bus?

The data bus is a like a telephone line hooked between control units. It links the individual control units to form one large system. The more information a control unit has of the overall system, the better it can control specific functions that may affect the health of the whole system. Automotive computer networks are now radically transforming how automotive systems and components function.

Late model BMW vehicles have a major increase in vehicle electronic systems which need to exchange large volumes of information efficiently without taking up too much space. If a separate wire was required for each new item of information exchanged, the increase in wires and pins would be prohibitive. Buses reduce the number of wires and pins and at the same time increase available information. Buses make more space available through smaller control units and connector plugs.

Buses are used for the following reasons:

- **Fast communication speed**—Buses provide high-speed data transfer between control units.
- **High level of reliability**—The number of moving parts and connectors are reduced. Buses have a low error rate because they have continuous verification of the transmitted information.
- **Reduction in harness size**—The number of wires between control units is greatly reduced.
- **Multiple utilization of sensors**—One sensor's information can be used by multiple modules, eliminating the need for duplicate sensors.
- **Adding new bus functions**—More information can be transferred, which means it is easier to add new bus functions without first requiring additional data input.
- **Easy to add more controllers (expanding buses using software)**—Other controllers can be installed in the future without major changes to the harness or existing systems. If a new ECM with more information is added to the bus, often only software modifications are necessary.

NOTE:
The CAN data bus conforms to international standards—control units from different manufacturers can be installed on a bus and interchange data, even though they were built by different manufacturers.

B.2 How many bus systems are there on a late model BMW?

In general, there are about six main bus systems. The 7 Series E65 (2002–04) has over 70 modules on 16 different buses or sub-buses with about 8 modules now using the CAN bus protocol.

B.3 How does a module communicate on a bus?

Most BMW bus systems are activated when supplied with 12V (CAN and M Bus are 5V). When the bus is active, any control module can transfer data. When communication takes place, it is done by a module momentarily pulling the bus low. This creates a series of high and low digital pulses that all the modules on the bus receive. Each message is sent with an address to ensure it is received by the proper module and the sender is acknowledged after the message is heard and understood (except for the CAN bus where all modules receive all messages).

B.4 Are all modules on a bus the same or do some have special tasks?

That depends on the type of bus. On the CAN bus, all modules are equal. On other buses, some modules have special tasks such as:

- **Master Controller modules**—A Master Controller of a bus system provides the operating voltage and wake-up signals to the subscriber modules. This task may also be performed by several Standby Masters within a bus system, such as the P Bus General Module (GM) or Lamp Control Module (LCM). On the D Bus and the CAN Bus, each module provides their own Bus operating voltage and therefore do not have a Master Controller Module.

- **Stand-by or Slave modules**—Capable of generating bus operating voltage in case of Master Controller failure.

- **Gateway modules**—A Gateway module provides a link between different bus lines to provide a means of sending information from a subscriber of one bus line to the subscriber of another. The Gateway module recognizes from the receiver address whether a message is to be routed through the gateway or not (e.g., IKE, KOMBI).

Electronic Control Module Coding and Programming

The Snap-on® scan tool does not currently perform any coding or programming functions. The information below explains the differences between various types of BMW coding and programming and may be helpful in advance of a repair to more fully understand what is involved when electronic control modules are replaced.

C.1 Coding vs. Programming

Coding is the process of selecting and activating one program for a specific vehicle from a set of programs that the factory installed in the control module. This allows one control module to be used for different models, countries, and emission applications.

Programming is the process of taking a blank control module and then adding the correct vehicle program to memory. The programming process for BMW powertrain control modules may use one of the following types of programming methods:

- Older engine control modules (DME) with a removable PROM (purchased separately) and no flash technology
- Control modules with flash EEPROMS that can only be programmed at the factory, *not* by the factory scan tool
- Control modules with flashable EEPROMS, which are soldered in (non-removable)

NOTE:
Powertrain modules (DME/EGS) are either variant-coded or programmed. All other modules are centrally coded (ZCS).

C.2 Car and Key Memory Coding

First, it is important to note that *car and key memory* coding are not part of control module coding or programming. Car and key memory coding refer to customizing convenience and climate features to the owner's preferences. Available features vary with year and model (e.g., E38 and E39 key memory is not available prior to 9/98).

- **Car memory** programmable features function regardless of the key being used, such as pathway lighting (headlights staying on after shutdown) and central locking options.
- **Key memory** features function differently depending on the vehicle key being used. The vehicle key is identified during remote control door unlocking (function is inoperative during manual door unlocking), such as seat and mirror memory, automatic locking when driving, IHKA recirculation, and radio station settings.

NOTE:
E65/85 have a combined Car and Key Memory (CKM).

C.3 DME Variant Coding (Bosch Engine Control Modules)

The variant code is a 4-digit hexadecimal (alpha-numeric) code. The variant code is stored in the control module and activates the specific market-required functions of the control module. Variant codes can usually be transferred from the old DME to the new DME (providing that old DME has communication capability). The variant code can also be entered manually.

The factory scan tool downloads the variant code to the DME control module. When the download is completed, the specific vehicle information for a particular engine group is activated and the DME is ready for use.

C.4 Central Coding (ZCS)

ZCS is an acronym for the German words, "Zentraler Codierschlussel", meaning central coding key. With the introduction of the E31, the ZCS was used for the first time as an encoding key for replacement vehicle control modules. The ZCS is called a "key" because it automatically "unlocks" or "activates" the previously-installed program of a new control module or recodes a used control module to be compatible with a specific vehicle.

The ZCS is a unique 48-digit code that represents all model and equipment information about a vehicle. The ZCS code is created by the factory when the vehicle is assigned for a country and emission application and is used to encode all the installed control modules in the vehicle after assembly.

The ZCS is stored in one or two modules, which is retrieved by the factory scan tool during the process of coding a new control module. When installing a replacement ZCS-encodable control module, the factory tool searches for the location of the ZCS, copies it, and then downloads it to the new control module. Before the control module coding can work, the coding software checks the stored ZCS code, coding data, and module version for compatibility. If they do not agree, the coding program may update and issue a new ZCS.

C.5 Important Tips Regarding ZCS Coding

- If the modules that store the ZCS are replaced, the ZCS code must be manually entered. Examples of control modules that store the ZCS are the instrument cluster and the EWS.
- There is no limit to the number of times ZCS-encodable control modules can be coded.
- If a control module gets damaged, it automatically reverts to a default setting that may not function properly.

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