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Coding & Programming

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Coding & Programming

Model: All

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Distinguish between Coding & Programming
- Understand the importance of Coding & Programming
- Understand where data is stored in a Control Module
- Know the 5 (+1) reasons for programming a vehicle

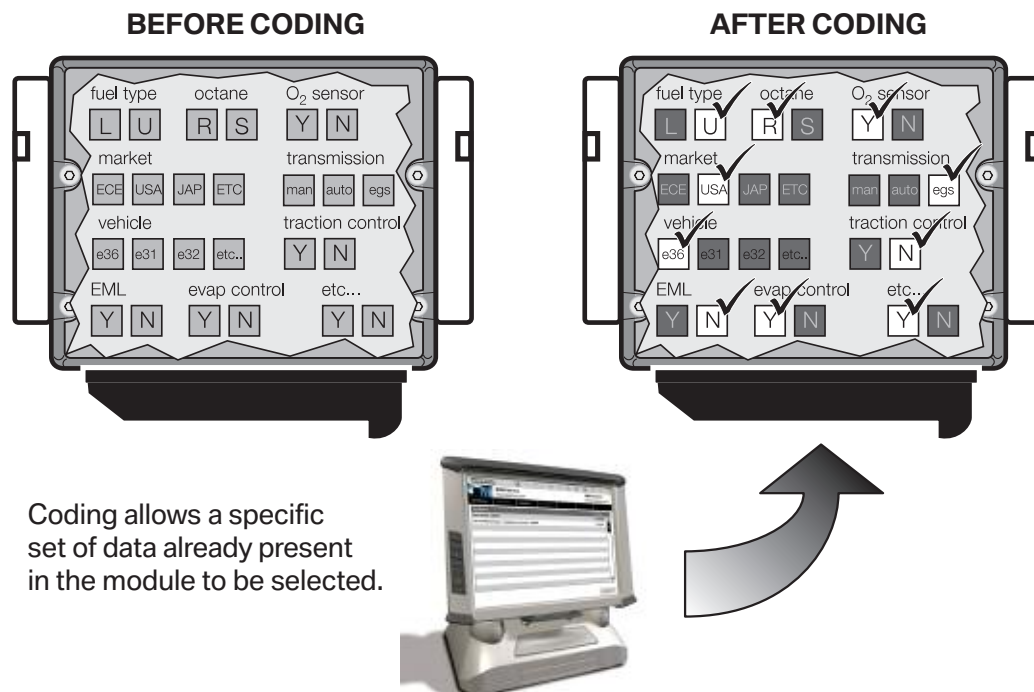
Fundamentals of Coding & Programming

What is Coding?

It is a process utilized by BMW, which groups system specific operating requirements (Data) together and then assigns a label/code to each of these groups of data. The various groups of data are all pre-loaded into system specific “codable” control modules, along with a basic set of operating instructions (Program).

Types of operating requirements:

- Nominal values of device input signals (0.25V to 2.5V, 5W - 25W, ...)
- Type of device input signal (PWM, square wave, analog ...)
- Operational parameters (device activation/deactivation time, ...)
- Market specific operations (O2 Sensors, Fuel Type, Emission Control, ...)
- Country Specific Regulations (U.S., Canada, Japan, UK, ECE, ...)
- Powertrain Configurations (Manual, Auto, Diesel, ...)



The procedure of assigning one specifically labeled group of data to the operating program of a specific control module/component is referred to as “coding”.

A “codable” control module has a basic operating program already installed along with several specific variations of operating data. The coding process allows a specific set of operating data to be assigned to the basic operating program of that module/component, with respect to its specific application.

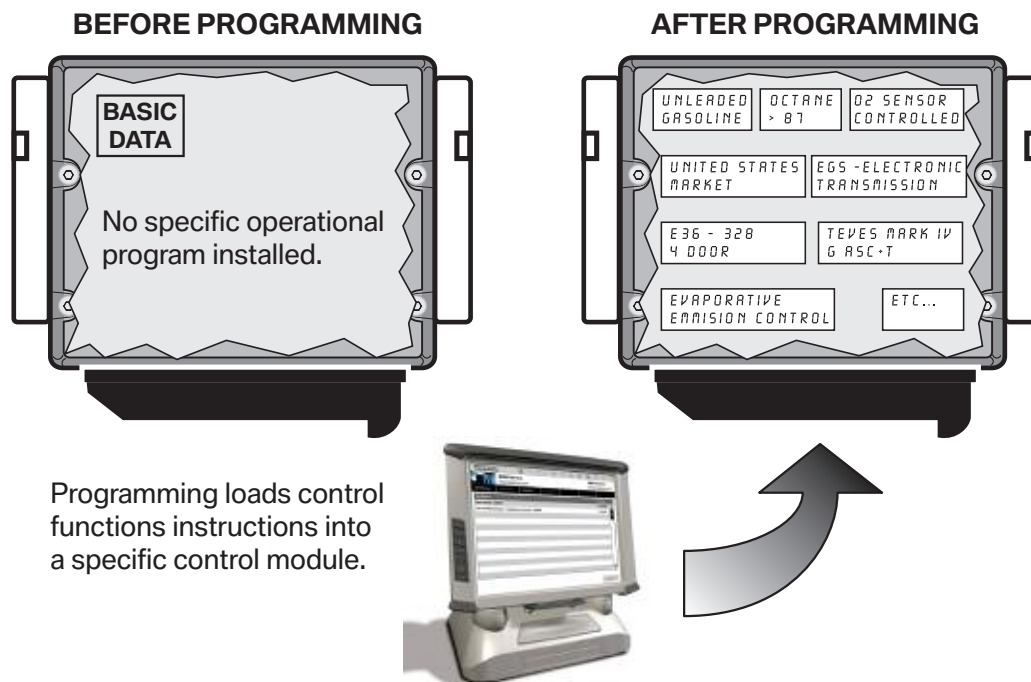
Coding can be performed for some systems/components:

- Selecting customer specific system operational settings from a list of available features (VKM).
- Automatically by selecting a specific coding process available via ISTA/P.
- By using a coded ground wire to a module.
- Determined at the factory.

Note: Codable control modules/components are system specific, which means that not all control modules are codable.

What is Programming?

It is a process utilized by BMW to load application/system specific operating instructions (Program) into a module/component which already has the systems operating requirements (Data) installed, plus it can be used as a means of updating data and operating instructions previously installed in a control module.



Basic programmable control modules have a pre-defined set of operating data already installed which allows the module to be fairly generic until a specific operational program is installed.

Programming of system control modules is performed using ISTA/P.

Note: Programmable control modules are system specific and not all control modules are programmable using workshop equipment like ISTA/P. The ability to program a module is limited to the number of times it has already been programmed and the hardware version of the control module itself.

What is the Purpose of Coding and Programming?

As a global manufacturer, BMW must design a large variety of control modules to meet numerous vehicle requirements pertaining to issues such as:

- Country Specific Regulations (U.S., Canada, Japan, UK, ECE, ...)
- Vehicle Equipment Level (Phone, Navigation, HiFi, IHKA, IHKR, ...)
- Vehicle Powertrain Configurations (Manual, Auto, ...)
- System Specific Operating Requirements (Nominal values, type of input signal, ...)

By using Coding and/or Programming, the large variety of control modules needed can be reduced to a smaller number of model specific hardware variations.

Codable control modules contain:

- A common operating program
- A large number/variety of specific operating data groups

In order to use this type of control module it must first be CODED to ensure that the operating data specific to that vehicle/model application is used by the operating program of the control module.

Programmable control modules contain:

- The required/specific operational data
- No operating program

In order to use this type of control module it must first be PROGRAMMED to ensure that the operating program specific to the vehicle/model application is used.

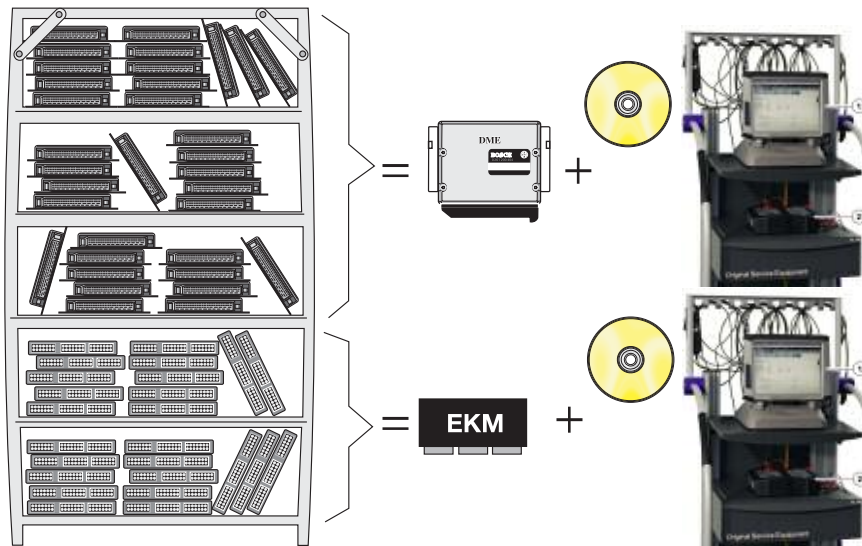
Prior to the availability of Coding and Programming in the workshop this task could only be performed at the factory.

Initially the factory installed Control Module(s) with a common operating program or data into vehicles and as these vehicles reached various points in the assembly process the control modules were updated with the required operating data or program specific to the application for that particular vehicle. Since replacement parts always need to be available, parts inventory needed to contain all variations of preprogrammed control modules installed in all varieties of vehicles that were manufactured. This was not a big problem in the early years, when the variety/quantity of models was smaller.

As the number of control modules and the complexity of the various systems installed into vehicles increased, the number of modules that needed to be stored in parts inventory began to increase as well. Eventually this led to the stocking of hundreds of different control modules that were either pre-programmed or pre-coded for a specific application and model, but only differed slightly in the way they were coded or programmed.

Pre-programmed and pre-coded control modules always needed to be available in the event a control module failed once the vehicle left the factory floor, since this was the only place programming & coding procedures could be performed. In order for repairs to be made quickly, dealers were required to maintain a stock of several varieties of control modules, since technicians could only remove the failed module and installed a new pre-programmed or pre-coded module into the vehicle.

As a result of having to maintain a very large inventory of pre-programmed and pre-coded control modules in parts inventory, it was decided to make coding and eventually programming available in BMW workshops.



The following advantages have occurred since programming and coding can be performed in the workshop:

- Fewer control module hardware versions are needed (only need basic control modules)
- Lower parts and inventory costs
- Able to update software in a control module without having to replace the module (Re-Code/ Re-Program to address service Measures)
- Ability to add special equipment features to existing control modules (DWA, Day Time Running Lights, ...)
- Customization of vehicle operation (Conversions, VKM, A/C, ...)

The means by which coding or programming information is provided to a control module varies and is determined by the vehicle, model year and type of module(s) installed.

BMW currently uses the following methods to perform Coding or Programming:

- Coding Plug
- DME variant Coding
- Coding Code
- Central Coding Key (ZCS) or Vehicle Order (VO)
- EPROM Programming
- Flash Programming
- Vehicle and Key Memory (VKM)

Where is Data Stored in a Control Module?

The control modules used in our vehicles store data/information on one of the following:

- EPROM (Electrically Programmable Read Only Memory)
- EEPROM (Electrically Erasable Programmable Read Only Memory)

in essence these devices are similar to the hard drive of the PC (**P**ersonal **C**omputer) that many of us use daily to store the images and documents/files of information.

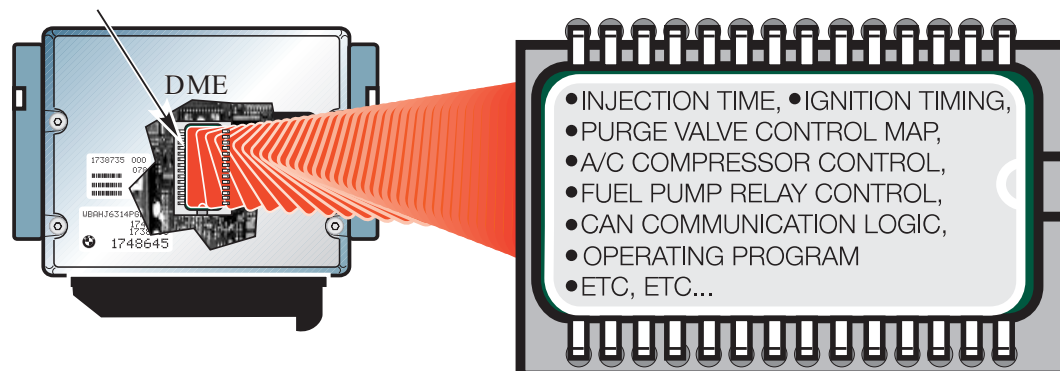
EPROM (Electrically Programmable Read Only Memory)

An EPROM is a computer memory chip that can be electrically programmed, however this chip cannot be erased using normal means.

In order to erase data that is stored on the chip it must be removed from the device and exposed to UV lighting for a specific time period. An EPROM has what is commonly called a “window” on the top portion of the chip usually located underneath a protective label, it is this area that must be exposed to UV light of a certain intensity for a specific time period in order to erase the information stored on it.

BMW does not currently utilize EPROMS on current vehicles.

EPROM IN CONTROL MODULE



EEPROM (Electrically Erasable Programmable Read Only Memory)

An EEPROM is a computer memory chip that can be electrically programmed and electrically erased, thereby not requiring the chip to be removed from the module or exposed to light. In general this chip is not easily removable from the device it is installed into (it is usually soldered in its place).

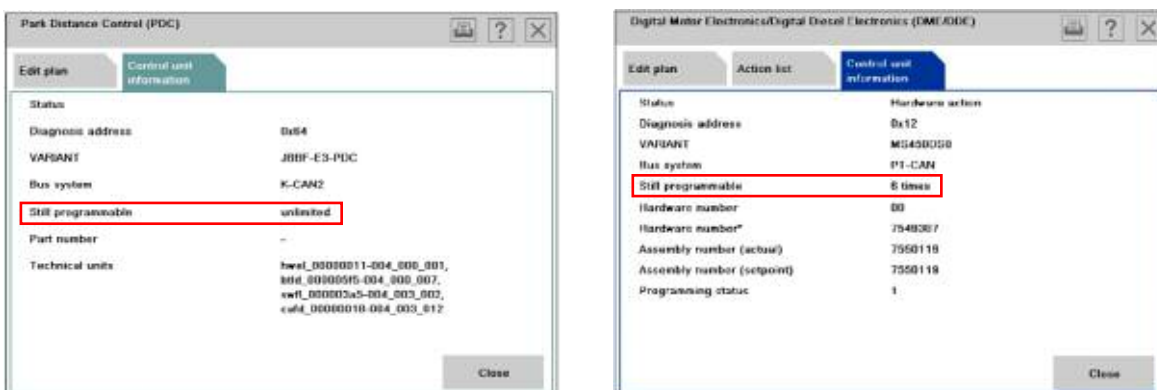
Since the entire process of programming and erasing is done electronically this device is commonly referred to as “**Flash Programmable**”.

During the programming process the following type of information may be loaded into the control module depending on the specific application or update that needs to be installed:

- Characteristic Maps (Ex. Ignition, Injection, Purge Control, DSC Regulation, ...)
- Control Constants/ Operational Data
- Operational Program
- Control Module Identification Information (Ex. Hardware Number, Program Number, Date of Modification, ...)

At this moment, there are modules with EEPROMS that can only be flash programmed (“**flashed**”), 14 times total and others that have no limit. For the ones that do, if the module has to be programmed a 15th time, the module has to be replaced.

Note: For more information on whether a control module can be programmed or not, please refer to the Control Unit Information tab in ISTA P.



What is needed to Code and Program?

In order to code or program a vehicle or control in the workshop, specific equipment and special software is required such as ISTA/P which must be connected to a network and have the most current version installed. Having the latest version will allow ISTA/P to update the required control modules to address customer concerns and implement service solutions.

Complete Software Update Programming Procedures (Five Pillars) + 1

There are constant improvements and enhancements to BMW products that are included with each new software release. However, it is not BMW's policy to automatically update vehicles with new software as it becomes available. This practice is time consuming, costly, and may change the functionality of one or more systems; in most cases, it offers no tangible benefit to the customer.

In situations where BMW identifies specific product issues, the fixes are integrated into the diagnostic test plans, and/or are announced via an SIB. If the applicable test plans have been completed, and the SIBs reviewed in TIS did not identify any fixes related to a software update, there is no reason to believe that the latest version of vehicle software will correct a customer's concern.

Before updating the vehicle's software, always verify that:

1. The latest available software release version has an Integration Level that is higher than the vehicle's current software Integration Level. The vehicle's current software Integration Level is shown when completing the Vehicle Test using ISTA or in the Software tab in SAM, which is located in DCSnet, after the current key data is read. The current software Integration Level will also display the corresponding Print Key Data printout.
2. The vehicle's current Integration Level is not already equal to or greater than the minimum Integration Level specified as needed in a corresponding SIB or repair procedure. Refer to SI B09 07 07 for a cross-reference between Integration level and Programming version.

Five Pillars for Programming a Vehicle

A vehicle must have its software updated if:

1. Programming was required after replacing a control module.
2. Programming was required, as outlined in an SIB, to address a specific product issue, Service Action or Recall; and the vehicle's current Integration Level is lower than what is specified as necessary.
3. A Programming Validation Code (GW Code) was provided at the end of a diagnostic test plan.
4. Programming was recommended through a PuMA contact.
5. Programming was recommended by the Regional Technical Engineer (RTE).

Lastly, a vehicle may also be programmed because of:

1. Software updates caused by a "customer pay" conversion or retrofit.

Note: For more information please refer to SI B01 03 06.

Vehicle Coding Information

Introduction

As part of an ongoing process to reduce the need for country, model and option specific control modules, BMW utilizes a multi digit vehicle coding structure referred to as a Central Coding Key (ZCS).

The Central Coding Key (ZCS) is a unique 37 digit code that contains specific model, country variation and individual equipment/option information for a vehicle.

| | |
|-----------|--------------------------|
| GM | 16430000P |
| SA | 0000422005009CC0U |
| VN | 000001E116K |

During the manufacturing process of a vehicle, the ZCS code is created to identify the specific vehicle being built and to properly code the control modules installed during the assembly process once the vehicle reaches the end of the line. To ensure that the ZCS code can be retrieved once the vehicle leaves the factory it is stored in two control modules, the cluster and the EWS.

ZCS is often referred to as a “key” since it is able to automatically “unlock” or “activate” specific functions of a new control module or can be used to recode a used control module to be compatible with the specific vehicle it has been installed into. With the introduction of the E31 the ZCS information was used for the first time as a coding key for replacement vehicle control modules, this ensured that the replacement modules would be coded to the required specification of the vehicle.

These codeable modules have no limit as to the number of times that they can be recoded.

ZCS Structure

The 37 digit structure of the ZCS is subdivided into three segments. The segments represent specific information about the vehicle.

Each segment ends with a checksum “digit”. A checksum is utilized by the coding software to detect unacceptable/erroneous manually entered coding information.

| | |
|-----------|--------------------------|
| GM | 16430000P |
| SA | 0000422005009CC0U |
| VN | 000001E116K |

The information/digits of the ZCS code reflects the options installed in the vehicle and should never be changed manually unless it is necessary for special recoding functions such as:

- Canadian market vehicle being moved to the US
- Retrofit installation of an accessory system (ie. alarm or satellite radio)

For extreme cases; If a modification needs to be made to the ZCS structure and there is no information available in a service bulletin then the Technical Hotline should be contacted for assistance by submitting a PUMA case, requesting a modified ZCS code.

Each portion of the ZCS provides specific information regarding that vehicle:

GM (Grundmerkmale) - Identifies the “Basic Features” of the vehicle and contains 9 digits that are used to describe:

- Vehicle type (R50, R52, R53 ...)
- Specific body style of the vehicle (Convertible, Coupe ...)
- Country specific coding identification (US, UK, ECE ...)
- Unique equipment that affects the basics of the vehicle (with sunroof, without sunroof, wheel size ...)
- Basic language variant (English, Spanish, German ...)

SA (Sonderausstattungs) - Identifies the “Special Equipment” of the vehicle and contains 17 digits that describe what features/functions are installed in the vehicle, such as:

- Power Windows or Manual windows
- Power Door Locks or Manual Door Locks
- Power Sunroof or Manual Sunroof
- Power Convertible Top or Manual Convertible Top
- Satellite Pre-wire

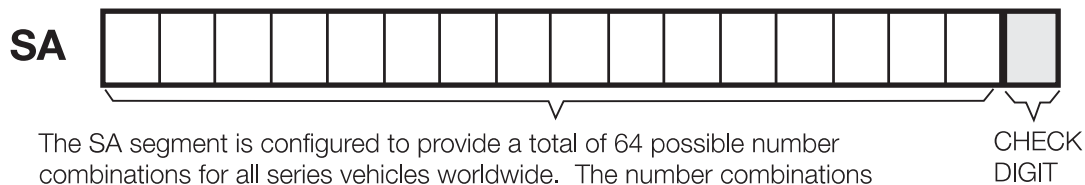
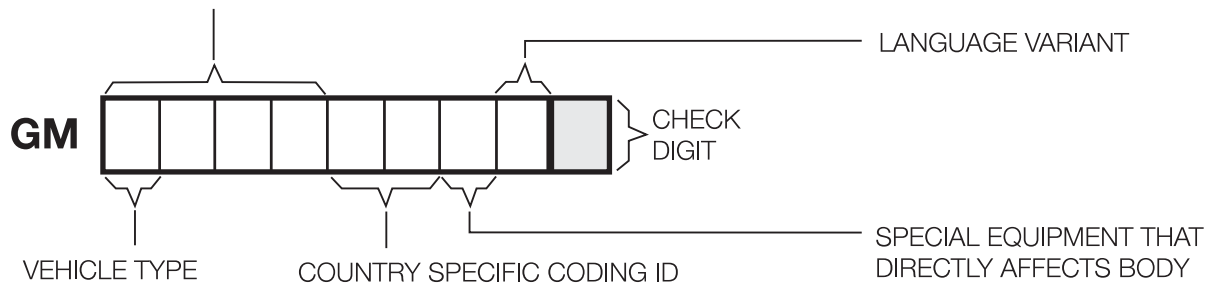
The SA segment is configured to provide a total of 64 possible number combinations (option groups) for all series vehicles worldwide. The information is modified whenever a new component/accessory is added to the vehicle via a retrofit coding procedure.

VN (Versionsnummer) - Identifies the “Version Number” of the vehicle and contains 11 digits that are used to describe:

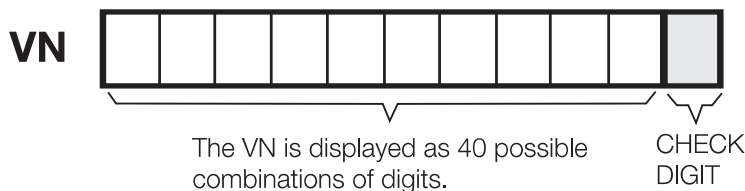
- Series specific coding data that are not reflected in the GM or SA segments. This includes, model year dependent data, software and hardware versions of the control modules installed, coding instructions, etc.

The VN is displayed as 40 possible combinations of digits. A deliberate change in the VN will result in erroneous coding data being used when recoding a module or coding a replacement module which will affect the proper operation of a control module(s) coded with an incorrect VIN.

FOUR DIGIT PORTION REPRESENTS VEHICLE BODY AND SPECIFIC BODY EQUIPMENT (COUPE, SEDAN, ROADSTER, SUNROOF, ETC.)
There are 4096 possible combinations of digits per model.



The SA segment is configured to provide a total of 64 possible number combinations for all series vehicles worldwide. The number combinations are special equipment option packages.



ZCS Stored Location in Vehicle

The ZCS is stored in the vehicle to simplify the coding procedures when a module needs to be recoded or a replacement module needs to be coded. Depending on the vehicle, the ZCS information is stored in the following locations:

| Vehicle | Model | Module | Vehicle | Model | Module |
|---------|--------------------------|---|---------|-------|------------------------|
| E31 | All | EKM | E39 | All | Instrument Cluster/EWS |
| E32 | All | Instrument Cluster | E38 | All | Instrument Cluster/EWS |
| E34 | All | Instrument Cluster | E46* | All | Instrument Cluster/LSZ |
| E36 | 318i/is 325i/is M3 | Instrument Cluster | E52 | All | Instrument Cluster/LSZ |
| E36 | 318ti Z3 | EWS II As of 9/98: Instrument Cluster/EWS | E53 | All | Instrument Cluster/LSZ |

* The E46 switched to a Vehicle Order (VO) data structure in 9/01.

The procedure to code control modules that utilize the ZCS information can be performed via ISTA/P. Always reference service bulletins for information regarding the latest coding version and any possible software errors.

When coding a ZCS codable control module the coding program automatically searches the stored location, based on the VIN, and codes the selected module according to the information provided in the ZCS code.

On later production vehicles the ZCS information began to be stored in two locations, referred to as redundant data storage, this insures that the information is always available in the event the primary device storing the data fails.

Note: On early production vehicles without redundant data storage, if the module being coded or recoded is the module that stores the ZCS information, then the vehicles ZCS information must be obtained from the label located on the vehicle or electronically accessed from the module and printed out then entered manually via the input screen on ISTA/P. For vehicles with redundant data storage the coding of the module storing the data is performed automatically using the information stored in the “back up” module.

Accessing ZCS Information Label

On earlier production vehicles the ZCS label is affixed to the vehicle in a specific location depending on the model:

- E36 - Under rear seat; center area or next to left sending unit of fuel tank.
- Z3 Roadster - In Trunk; under carpet on floor, forward of tool kit.
- E31/32/34 - In fuse box cover
- E38 - In E-Box cover



Note: As of 9/98 production the ZCS label was eliminated from the vehicle. Some older vehicles will have identification labels containing an AM segment, this information is not needed for coding or recoding a control module on that vehicle.

NOTES

Vehicle Order

In 9/01 the ZCS vehicle data structure on the E46 was replaced with what is referred to as the Vehicle Order (VO) or Fahrzeugauftrag (FA). The vehicle order structure is utilized on all new models introduced/produced as of 9/01, such as E65/66, E60, E63/64, E83, E85 etc. Models such as E36, E39, E52, and E53 produced after 9/01 continued to be manufactured using the ZCS structure until production of the model is complete.

Vehicle Order for E46 as of 9/01 Production:

| | | |
|---|----------------------|--|
| Vehicle identification number: KW17732 | E-Wort: | 521,522,534,550,639, 645,650,661,674,692, 818,823,832,845,853, 876,925,926,992,302, |
| Vehicle order: | HO-Wort: 633L, | Vehicle order and vehicle identifica- tion number are stored in |
| Model series: E46 | SA: | KOMBI |
| Type des. code: EV33 | 1CA,205,210,240,249, | |
| Time criterion: 0904 | 279,354,403,411,431, | |
| Paint code: 0A08 | 438,441,459,465,473, | |
| Upholstery code: N6SW | 488,494,495,502,520, | |
| Assbly. no.: | | |

Vehicle Order for New Models as of 9/01 Introduction:

| Select measures plan. | |
|-----------------------------|---|
| Date / time: | 10.11.2004 / 13:31 |
| Model series: | E60 |
| Vehicle ID number: | WBANA53584B848013 |
| Vehicle order: | E60_#1203*NA53%0475&LCBA\$1CA\$205\$248\$2RA \$302\$319\$354\$403\$415\$416\$430\$431\$438\$441 \$442\$459\$465\$473\$488\$494\$502\$534\$540\$563 \$605\$609\$620\$639\$645\$676\$694\$697\$785\$818 \$823\$850\$853\$876\$8SP\$925\$992-E110+K639+O111 +O112 |
| Vehicle data status: | E060-04-09-504 |
| Target data status: | E060-04-09-504 |

The vehicle order format contains information pertaining to the production of a specific vehicle such as:

Series Type - E46, E65, E60, etc.

Time Criterion - Identifies date the options/hardware equipment available for installation into the vehicle was standardized/"locked". This information does not refer to the production date of the vehicle. A problem with coding or programming may occur if a module or option based on a newer or older time criterion date is installed into the vehicle.

Model Code (Basic Type) - Base level from which the vehicle is "created/built".

Paint Code - Identifies the color of the vehicle at time of production.

Upholstery Code - Identifies the type of upholstery installed in the vehicle at time of production.

Assembly Number - Identifies the programmed part number for powertrain (Not used).

E-Wort - Identifies additions/options added to the vehicle that are not part of standard SA codes/options.

HO-Wort - Identifies options installed at Center/Dealer using 3 digit option code (Currently not used).

Installed Option/SA Codes - Listing of accessories & equipment options installed in the vehicle.

The information contained in the vehicle order is used to identify the module(s)/system(s) that are/should be installed in the vehicle and also what if any control modules need to be updated if a new system/option is added or removed to/from the vehicle to ensure proper compatibility with the devices installed in the vehicle. The information contained in the vehicle order such as installed options, is modified whenever a new component (module/system) is installed and coded to the vehicle. If the new component is not properly coded to the vehicle the SA listing is not updated and problems can be encountered whenever a measures plan for the vehicle is created, vehicle needs to be recoded or VKM/Individualization functions are to be modified.

A listing of the components that need to be updated is provided whenever a measures plan is generated.

Example: Information contained in the VO of an E60

| Select measures plan. | |
|------------------------------|--|
| Date / time: | 10.11.2004 / 13:31 |
| Model series: | E60 |
| Vehicle ID number: | WBANA53584B848013 |
| Vehicle order: | E60_#1203*NA53%0475&LCBA\$1CA\$205\$248\$2RA \$302\$318\$354\$403\$415\$416\$430\$431\$438\$441 \$442\$459\$465\$473\$488\$494\$502\$534\$540\$563 \$505\$609\$620\$638\$645\$676\$694\$697\$785\$818 \$823\$850\$853\$876\$8SP\$925\$992-E110+K639+O11 +O112 |
| Vehicle data status: | E060-04-09-504 |
| Target data status: | E060-04-09-504 |

Series Type: E60

Time Criterion: Identified as 1203 indicates the date (month/year) that the list of available options/hardware available for installation into the vehicle was standardized/"locked". Although the vehicle referenced was produced in 6/04 the time criterion of 1203 is still valid and indicates that no changes were made to the available option packages/hardware available for installation into that specific model since 1203.

Model Code: Identified as NA53 indicates the vehicle and engine type plus provides information pertaining to the country the vehicle was built for (i.e. LH or RH drive). If an automatic transmission is installed it will be considered an NA63, however the model code contained in the VO will always reflect the base level which is a manual transmission vehicle.

Paint Code: Identified as 0475 indicates the color of the vehicle at time of production.

Upholstery Code: Identified as LCBA indicates the type of upholstery installed in the vehicle at time of production.

**Installed Option/
SA Codes:** Listing of accessories & equipment options installed in the vehicle
 1CA - Selection COP relevant vehicles
 205 -Automatic transmission
 248 - Steering Wheel Heating
 2RA - LT/ALY wheels

Control Modules Flash (EEPROM) Programming

An EEPROM is an Electrically Erasable Programmable Read Only Memory chip that is soldered onto the circuit board of a control module. This signifies that programs & data stored on the chip can be electrically erased and replaced with new/ revised programs or data.

In order to erase the data on the chip a short duration low level voltage/charge is applied to a pin on the EEPROM and the stored data is erased, hence the name “Flash”. Once the data is erased new data is loaded.

By using a this technology, control modules have the ability to be updated a total of 13 times before they need to be replaced.

Theoretically an EEPROM can be erased and reprogrammed more than 13 times, BMW set the number to 13, since a point will be reached where the update being installed may no longer be compatible with the hardware of the installed module which could result in erroneous operation. If the program is not compatible with the hardware version of the module, the program used to determine the correct update for the module will indicate that the module will need to be replaced before the update can be performed.

The reference to Flash programming is a result of the technology used to erase the EEPROM prior to installing a new program and or data.

The utilization of EEPROMs started with Engine Management Systems and has expanded into other control modules.

Determination Process for DME EEPROM

ISTA/P is used to determine the correct replacement part numbers (Control Module or software update) to be installed.

For modules that utilize EEPROMs/Flash programming the determination process is done automatically as part of determining a measures plan.

Coding & Programming

Introduction

The intention of ISTA/P is to insure that whenever a module is updated or replaced it will still be compatible with all the other modules installed in the vehicle. Since all of the communication between the various modules installed in a vehicle is over a bus network structure, it is very important that all of the installed modules be able to communicate with each other without problems.

To ensure compatibility/seamless integration between control modules, ISTA/P reads out the part numbers of all the control modules installed in the vehicle as well as the software levels of the respective modules. The information from the various installed modules is then cross referenced against a “master reference list” to determine if a module(s) needs to be updated and how this update will effect the other installed modules. Once this cross reference process is started it can result in additional issues such as:

- If the software level in a selected module is updated will the hardware of the module still be able to function correctly.
- If the software to be installed is not going to be compatible with the installed hardware then the module will need to be replaced.
- If updated software is installed in the selected module will this have any impact on any other installed modules and will they need to have the software updated or will the hardware need to be updated in additional modules in order to install the revised software.

Example: *A desktop computer originally built with a Pentium I, 75 MHz processor using Windows 95 is not able to operate using Windows 2000. In order to operate with Windows 2000 this old desktop computer needs to be upgraded with new hardware. However, a desktop computer designed to operate with Windows 2000 can be updated to Windows XP without having to upgrade the hardware of the computer.*

All hardware devices that utilize software/programs to operate can only have the installed software updated a certain number of times before the operating capacity of the installed hardware is exceeded and no longer compatible, this results in the device no longer being able to function. In order for these devices to continue to operate the installed hardware/control modules will need to be updated, which is what happens in our vehicles or desktop computers over time.

Specific information pertaining to coding and programming with ISTA/P are provided in **SI B 09 05 01**.

Integration Levels

All new models produced as of the E65 have a minimum allowable software level, based on production date, which is referred to as an integration level or data status. The integration level defines the software level that all the control modules installed into a particular model, at time of production, must be at in order to ensure compatibility. Once an integration level for a specific production period is defined/“locked”, the modules installed in those vehicles can not be updated beyond that level.

The Integration level or data status for vehicles equipped with a most bus is provided in the “Status report” or “Measures plan” as shown below.

Vehicle data status: E060-04-09-503

Target data status: E060-04-09-555

If the vehicle data status and target data status are not the same, this indicates that some of the installed control modules need to be updated to bring the vehicle up to the latest level.

If the software levels were not locked it would be quite complex to track all software and hardware variations for all models through all production ranges. It would be extremely difficult to determine what software and hardware level is compatible with each module installed in a specific vehicle(s) and exactly what needs to be updated if one module is updated or replaced, therefore a limit or locked point must be define for specific production periods by model.

Example: *MY2002 vehicles can not be programmed with software that is assigned to MY2003 vehicles since the defined integration level for each Model Year is different. Similarly Windows 2000 can not be installed & operated on a computer originally developed to run with Windows 95.*

Information contained in this module is for reference as a user guide, more detailed information can be obtained from the respective Service Information Bulletins

SI B09 05 01 & SI B09 03 98.

NOTES

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