GENERAL INFORMATION

Basic Engine Measuring Techniques - Overview

BASIC MEASURING TECHNIQUES

BASIC ENGINE MEASUREMENTS

During the course of engine repairs some basic engine measurements are required to verify engine diagnosis as well as to complete proper repairs. These measurements are made by precision measuring tools such as micrometers, Vernier calipers, cylinder bore gauges and dial indicators.

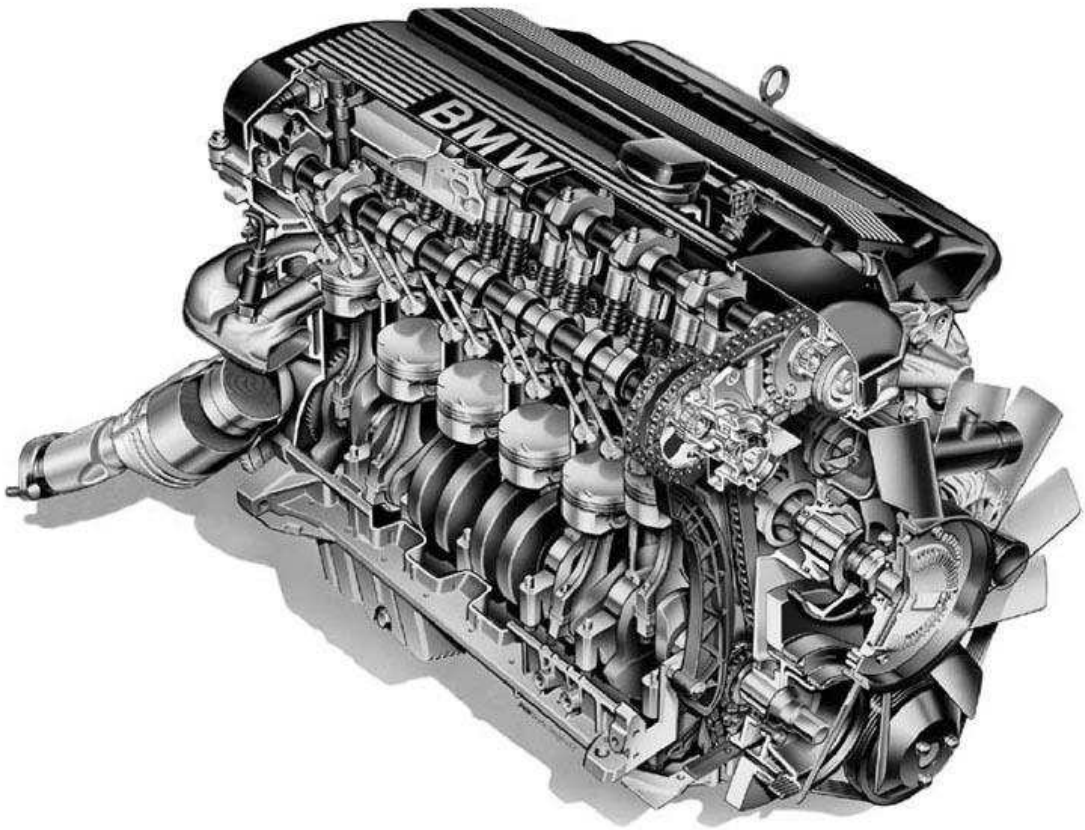


Fig. 1: Sectional View Of Engine
Courtesy of BMW OF NORTH AMERICA, INC.

Also, a working knowledge of the metric system is also a vital skill that is needed by the technician. All BMW engine measurements consist of metric specifications. Some of the routine engine measurements performed include:

- Valve Guide Wear (Tilt Angle K)

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- Cylinder Bore Measurements (Taper and Out-of-Round)
- Cylinder Head Warpage and Thickness
- Axial and Radial Endplay Measurements (Crankshaft/Camshaft etc).

Among all of the skills possessed by a modern technician, basic measuring techniques are perhaps the most overlooked and least used. This is why it is important to review these skills from time to time as a refresher.

Also, it is necessary to access technical data to obtain the proper specifications for these measurements. This course is designed to review measuring techniques to assist in engine diagnosis.

Vernier Measurement

The Vernier scale is used on various measuring tools such as the Vernier caliper and the Depth Gauge. The Vernier scale can be used with Fractional (US) and Metric systems. For the purposes of this training module we will always refer to the Metric Vernier scale.

The Vernier scale consists of a fixed scale and a sliding scale. The fixed scale is divided with graduations in 1 millimeter increments. The sliding scale has 10 graduations in increments of .5.

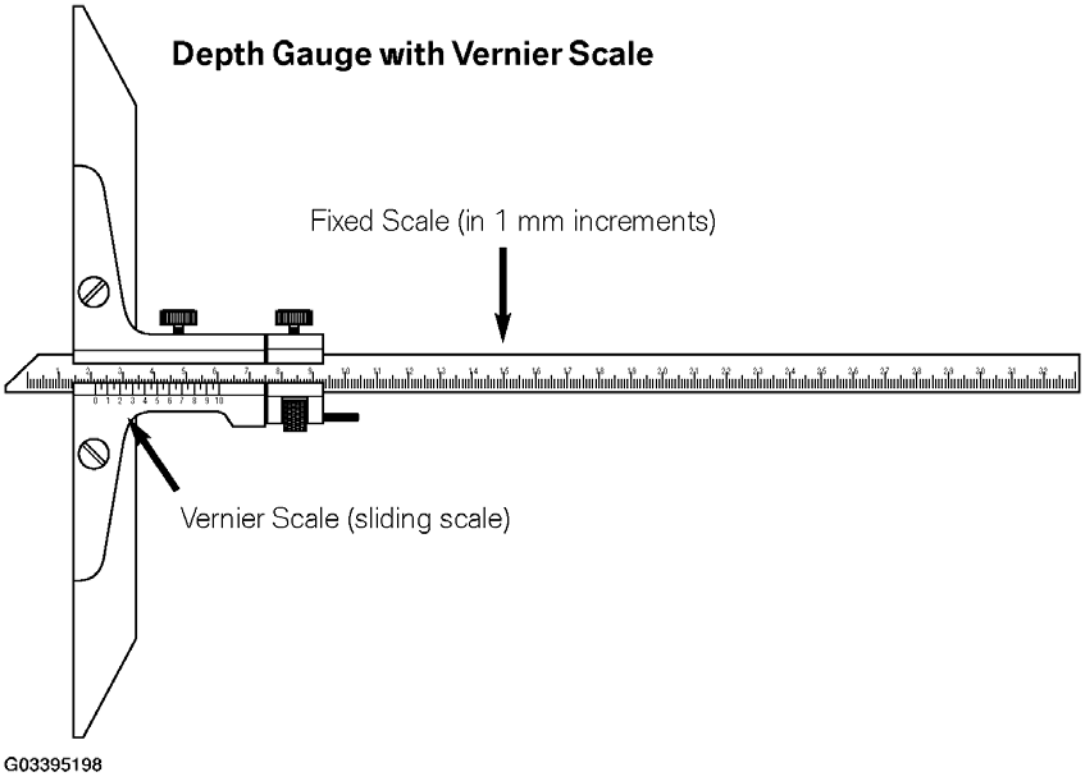


Fig. 2: Identifying Depth Gauge
Courtesy of BMW OF NORTH AMERICA, INC.

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In order to read a measurement, use the zero mark on the left end of the vernier scale to use as a guide to read a measurement on the fixed scale.

In the example shown at the right, the zero mark is resting between 26 and 27 mm. Therefore the base measurement is 26 mm.

Next, the decimal measurement must be taken. For this, find a line on the Vernier that most closely matches any line on the fixed scale.

Using the example drawing, the "4" on the Vernier scale is lining up directly with a line on the fixed scale.

Combining the previous reading with this reading, the result would be 26.4 mm.

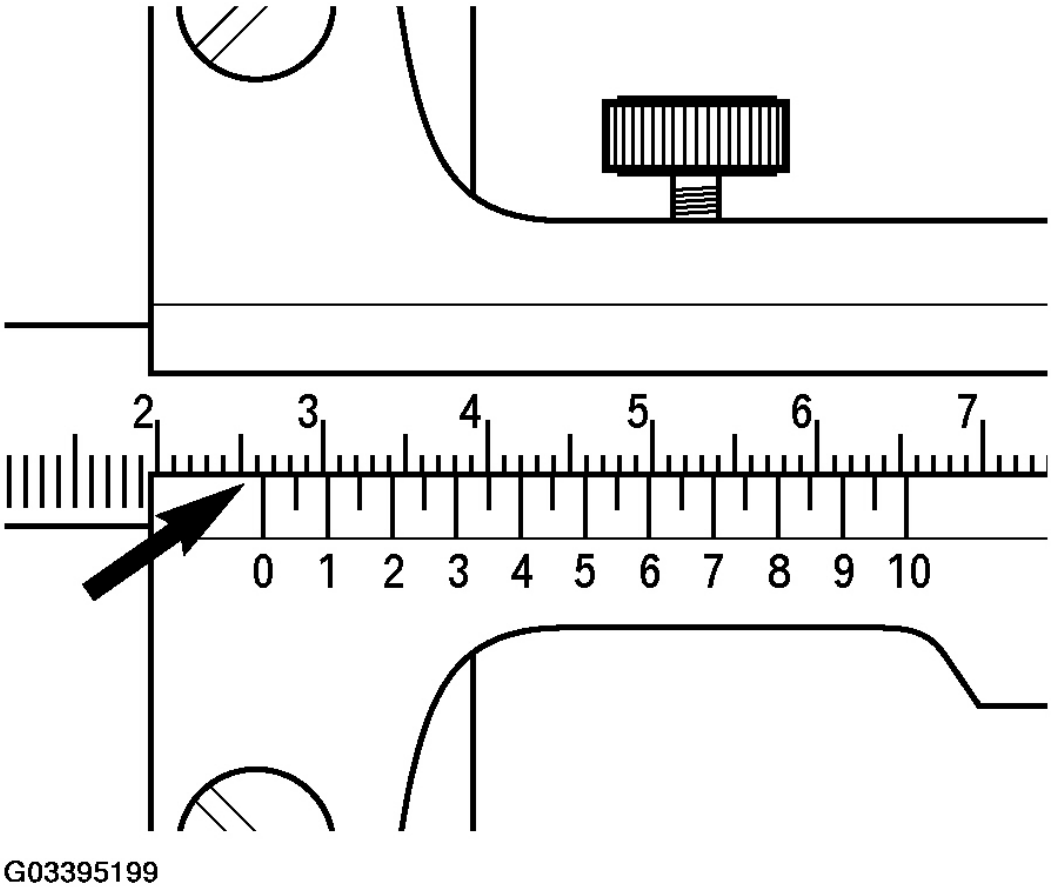


Fig. 3: Locating Vernier Scale Reading
Courtesy of BMW OF NORTH AMERICA, INC.

The designations on the Vernier scale are in increments of .5. For example, if a reading on the Vernier scale falls on the .5 (i.e. 2.5, 3.5 etc) designation this would indicate 5/100th's of a millimeter.

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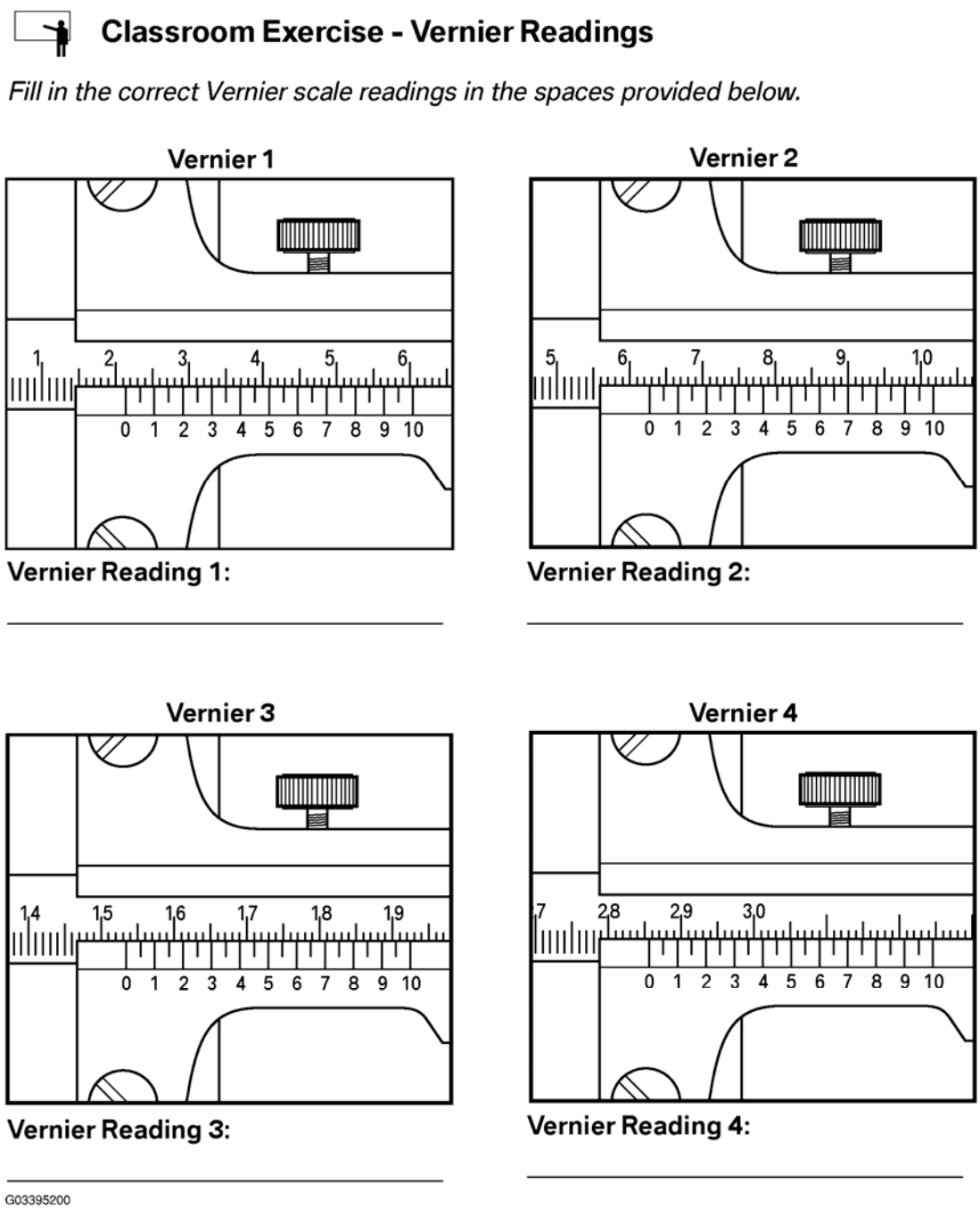


Fig. 4: Identifying Vernier Scale Reading
Courtesy of BMW OF NORTH AMERICA, INC.

Micrometer Measurements

Another valuable measuring tool is the micrometer, which can be used for measurements such as bearing journal diameter, cylinder head thickness, valve shim thickness and brake rotor thickness etc. Micrometers also come in configurations for inside measurements as well.

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The micrometer scale comes in both fractional and metric varieties. We will cover only the metric micrometer scale in this course.

First you must familiarize yourself with the construction of the micrometer in order to understand how measurements are made.

Metric Micrometer Construction

The micrometer is constructed of a few basic parts. The actual item to be measured is placed between the anvil and the spindle. The micrometer can be adjusted to the approximate size using the thimble. The thimble should only be used for the coarse adjustment. In order to make the actual measurement, the micrometer should only be turned using the ratchet (a.k.a. the friction stop). Do not attempt to make a measurement using the thimble. This will give an inaccurate measurement and ultimately damage the micrometer.

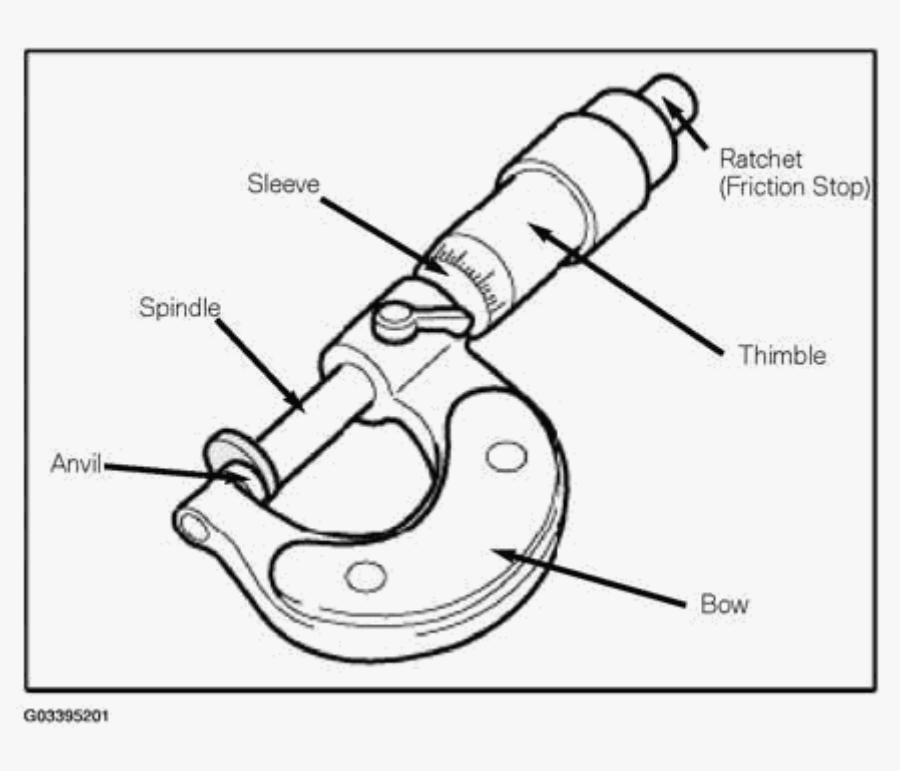


Fig. 5: Identifying Micrometer
Courtesy of BMW OF NORTH AMERICA, INC.

Micrometers are available in various sizes for outside as well as inside measurements. The more common variation is the outside micrometer. They are usually available in 25 millimeter increments such as 0-25 mm, 25-50 mm, 50-75 mm etc..

The metric micrometer can measure in increments of one hundredth of a millimeter (.01mm). One hundredth of a millimeter is equal to 0.0003937 inch which is less than one thousandth of an inch.

The measurement area of the micrometer consists of the sleeve scale and the thimble scale. The sleeve scale is used to read whole and half millimeters. The thimble scale (which rotates) reads in hundredths (.01) of a

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millimeter from zero to fifty. Two complete revolutions of the thimble equals one millimeter.

On the sleeve scale, each scale mark above the center line indicates whole millimeters. Below the center line, half of a millimeter (or .5mm) increments are indicated.

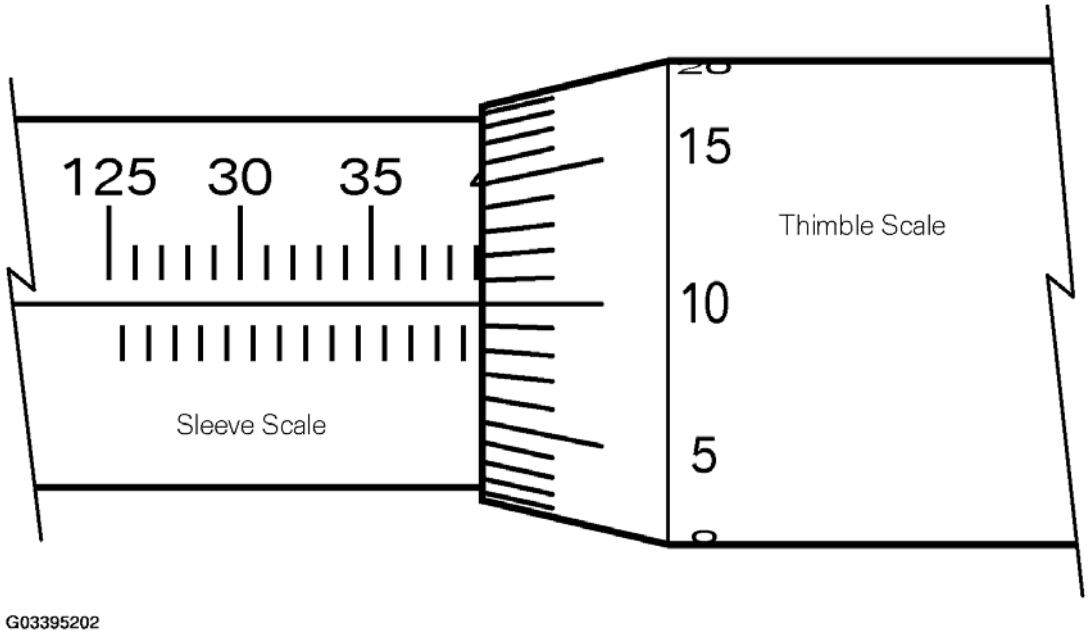


Fig. 6: Identifying Micrometer Reading
Courtesy of BMW OF NORTH AMERICA, INC.

Using the example shown above, the micrometer is a 125-150mm micrometer. To read this micrometer, first take the basic reading from the sleeve scale. The thimble is past the 139 mm mark. Therefore the reading is a least 139 mm. Next, look at the thimble scale and note the reading on the centerline. The "10" on the thimble scale is lined up with the centerline. This indicates a reading of .10 mm. If you add the two readings; 139 + .10 = 139.10 mm.

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Classroom Exercises - Micrometer Measurements

Fill in the correct micrometer readings in the spaces provided below.

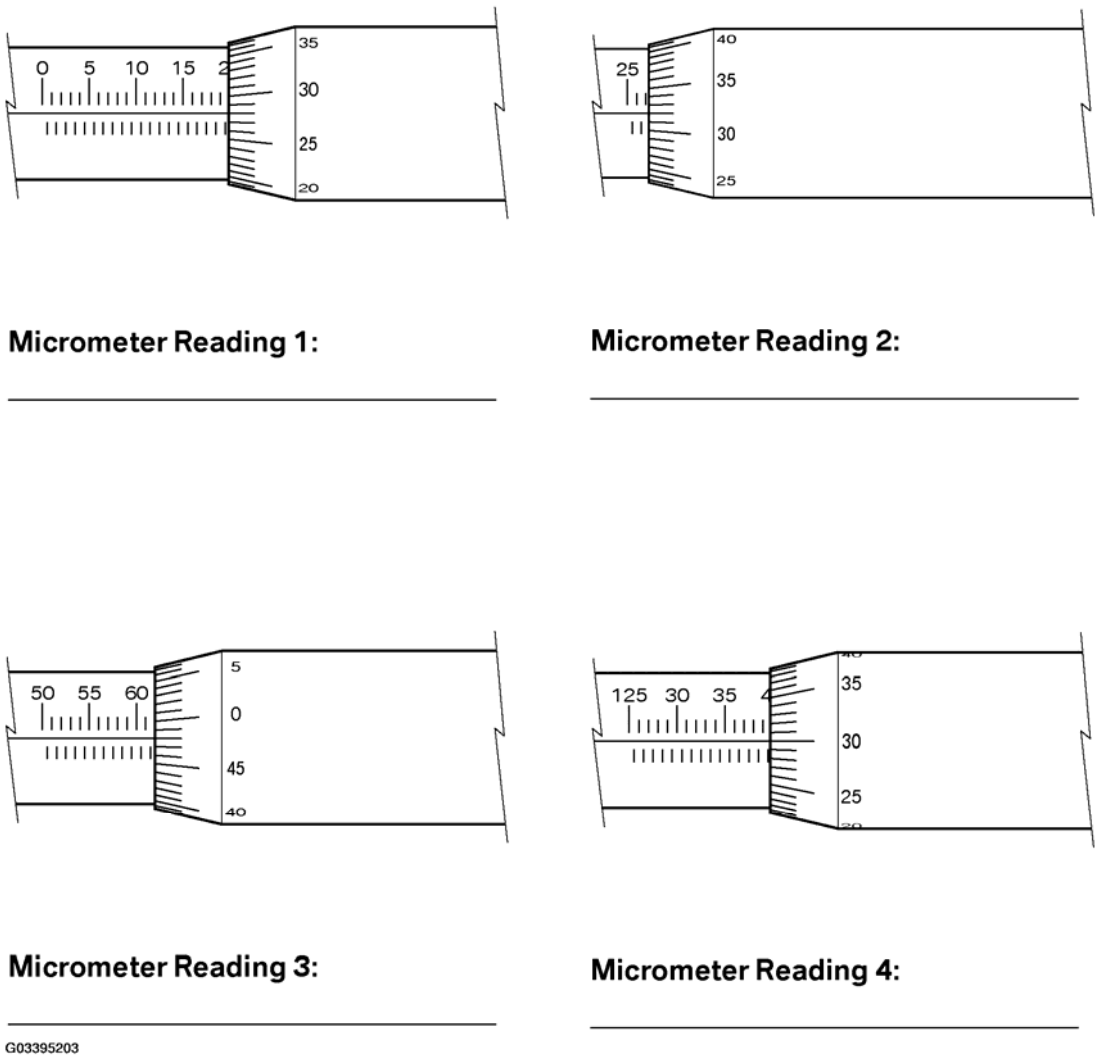


Fig. 7: Identifying Correct Micrometer Reading
Courtesy of BMW OF NORTH AMERICA, INC.

Dial Indicator Measurements

The dial indicator is used to measure the travel or movement of a specific item. It can also be used to measure axial and radial runout. In engine measurement applications, the dial indicator can be used to measure valve guide wear, axial movement of the crankshaft (thrust), and runout of flywheels and harmonic balancers.

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First, it is important to familiarize yourself with Dial Indicator construction. The face of the dial indicator consists of a moveable bezel which is also attached to the large measuring scale. This allows the tool to be brought to the "zero point" when needed.

The main measuring device is the contact point. The contact point (1) is placed against the object to be measured. Usually, the contact point is rounded or has a ball bearing. This allows for a more accurate measurement.

The measuring face of the dial indicator consists of 2 scales. The smaller scale is for the "coarse" measurement which is in graduations of 1 millimeter. One revolution of the small scale is 10 millimeters.

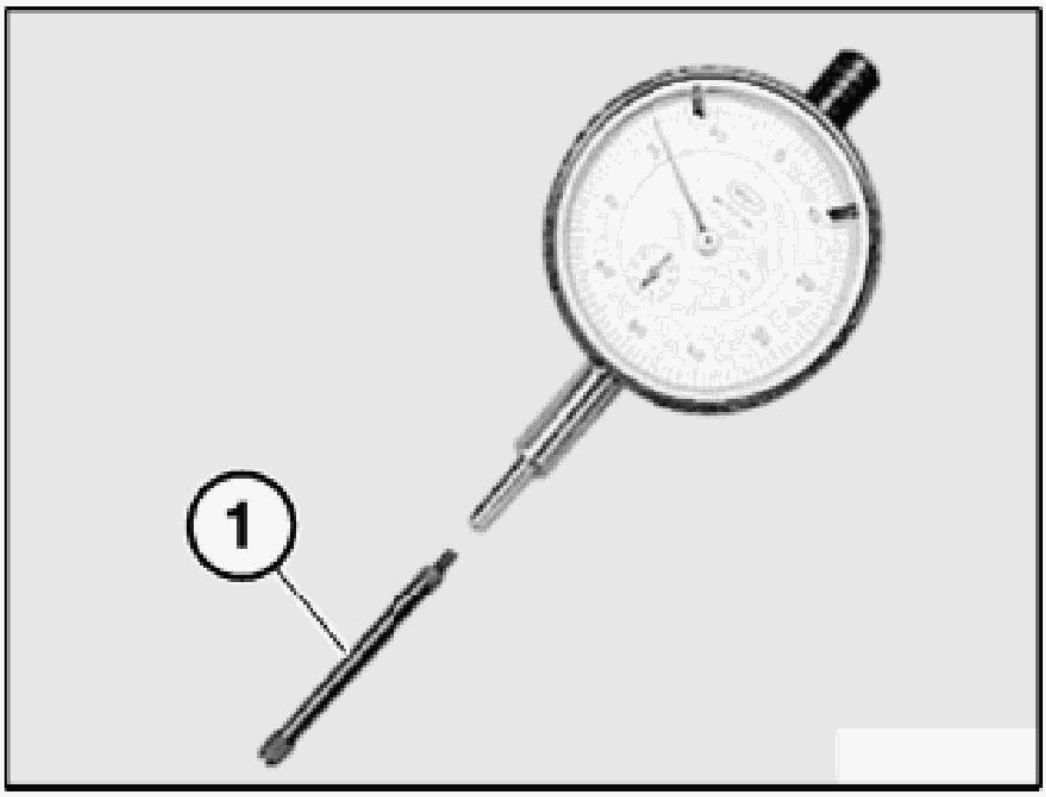


Fig. 8: Identifying Dial Indicator
Courtesy of BMW OF NORTH AMERICA, INC.

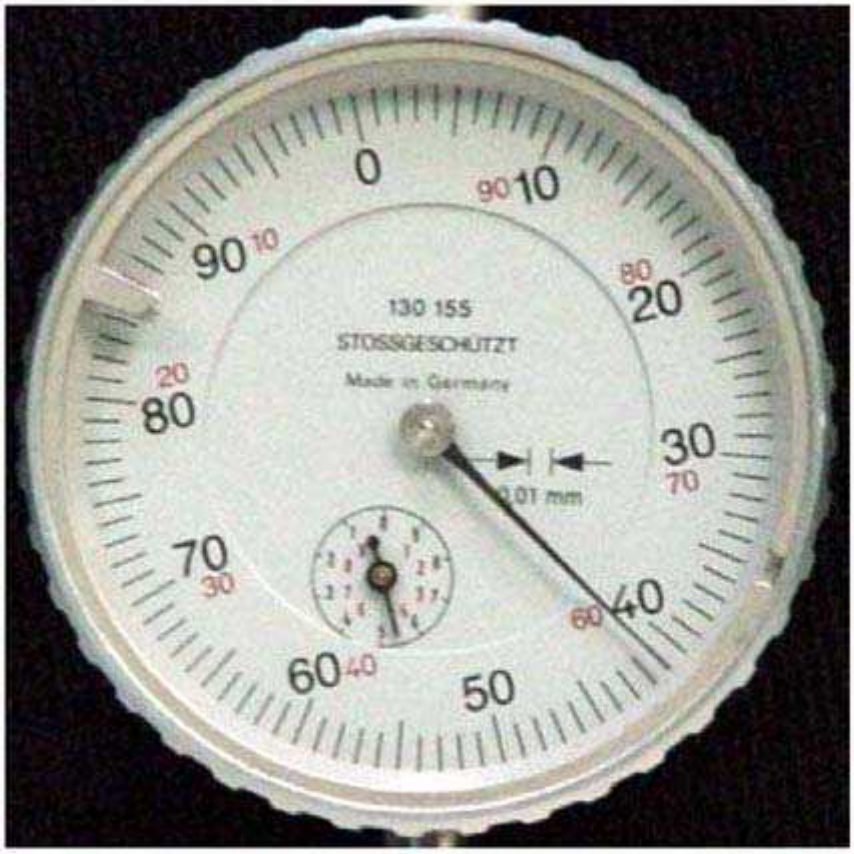
The large scale is in graduations of .01 millimeter and the scale goes from zero to one hundred. Therefore, one revolution of the large scale is one millimeter.

The dial indicator also needs to be held in place when taking a measurement. This requires a stand or base. Depending upon the application, these stands can be a clamp type, magnetic or a threaded base.

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When taking a measurement, place the contact point on the object to be measured. The dial indicator must be pre-loaded slightly to prevent the measurement from bottoming out.

When reading the scale, be sure to "zero" the dial indicator first. If the readings to be taken are less than 1 millimeter, you do not need to use the small scale. If the readings are larger than 1 millimeter, be sure to factor the small scale into your measurement.



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Fig. 9: Identifying Dial Indicator Reading
Courtesy of BMW OF NORTH AMERICA, INC.

Examples Of Dial Indicator Measurements

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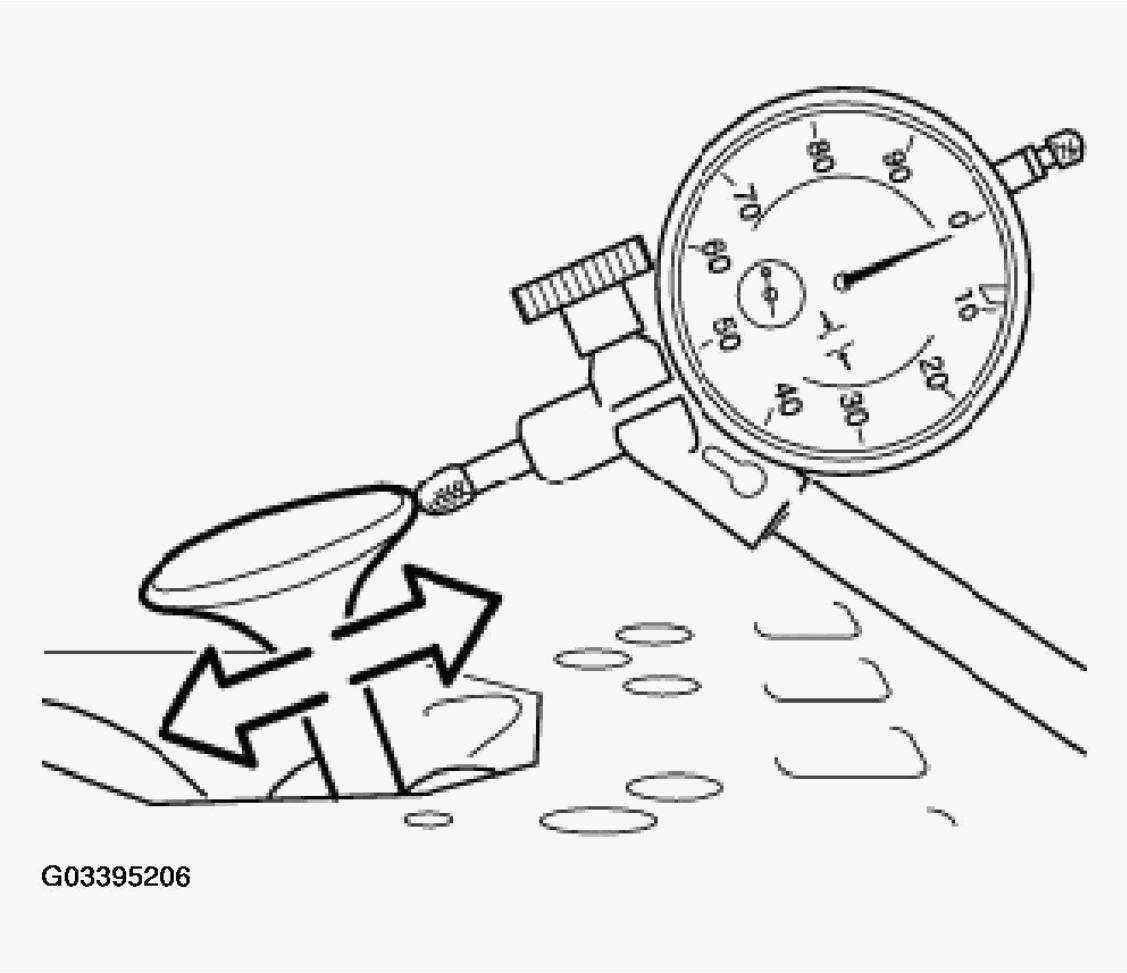


Fig. 10: Measuring Valve Guide Wear - Tilt Angle "K" Using Dial Indicator
Courtesy of BMW OF NORTH AMERICA, INC.

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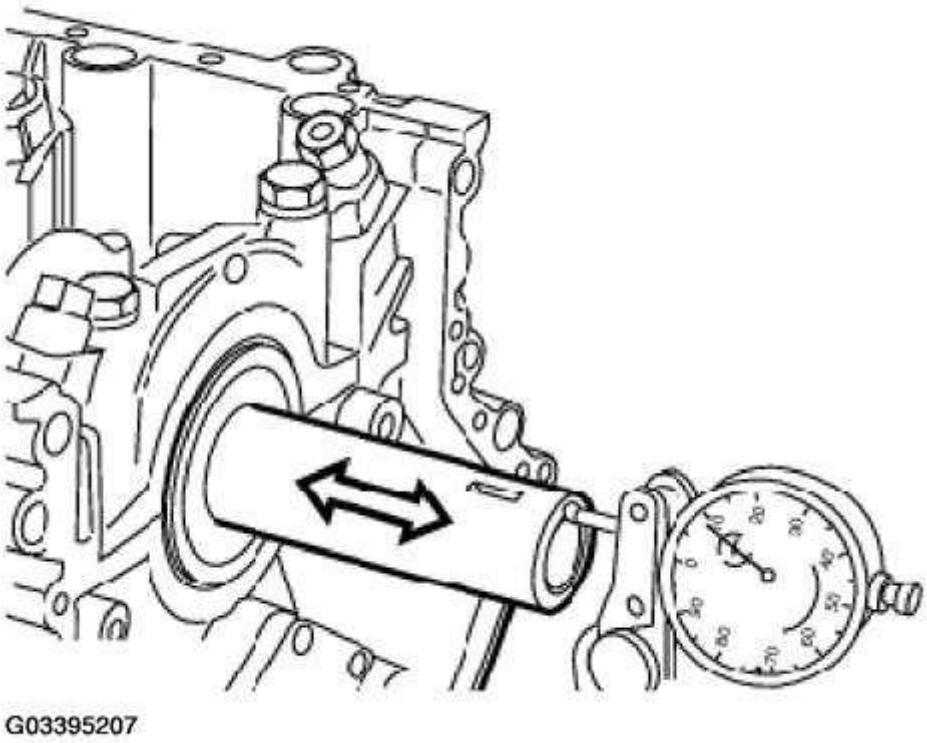
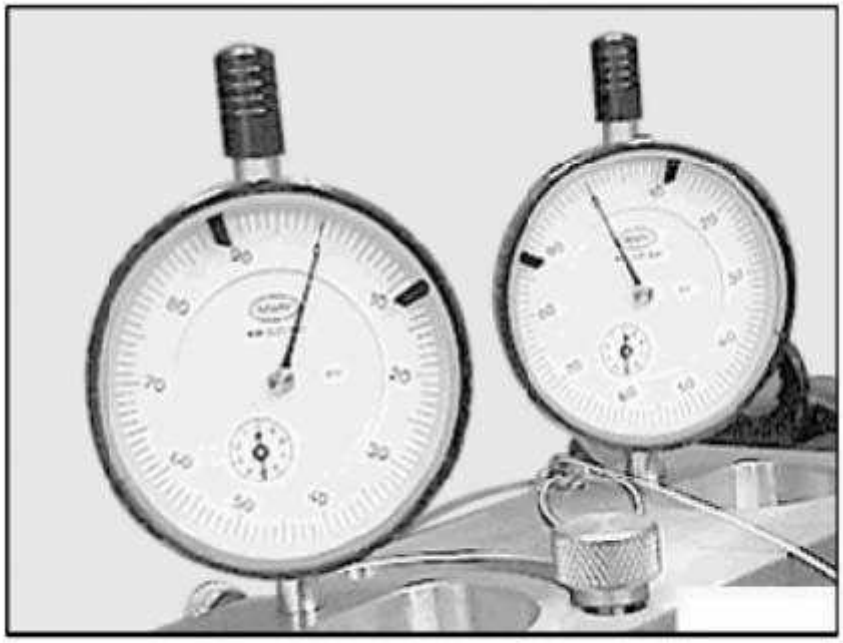


Fig. 11: Measuring Crankshaft Endplay - Axial Using Dial Indicator
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Fig. 12: Measuring S62 Engine - Basic Throttle Setting Using Dial Indicator
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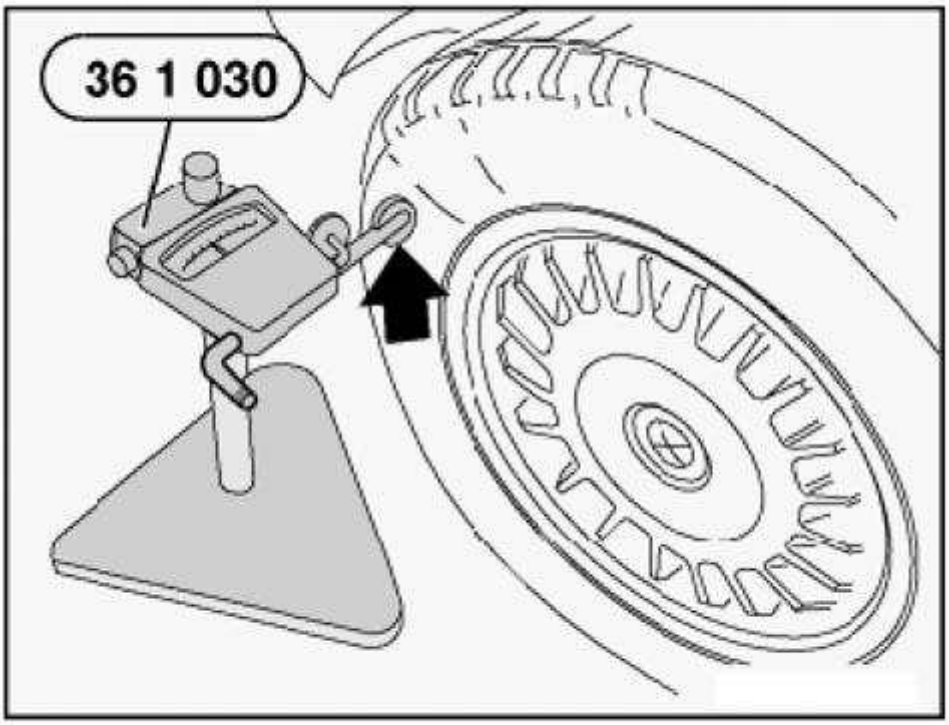


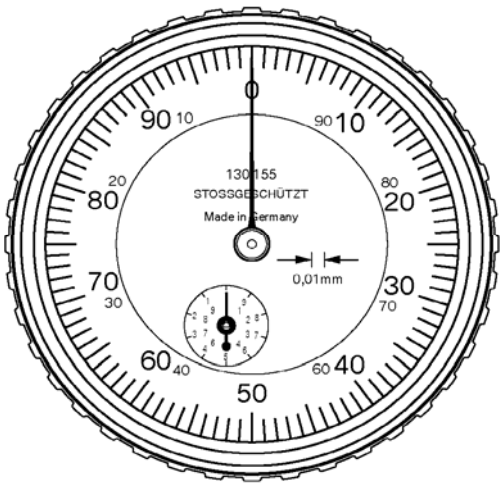
Fig. 13: Measuring Wheel Runout - Axial Using Special Tool
Courtesy of BMW OF NORTH AMERICA, INC.

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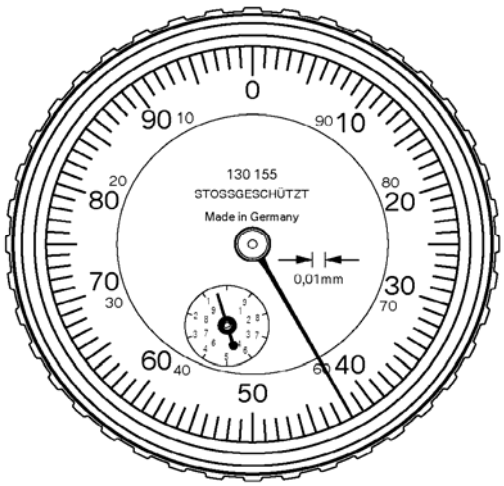
Classroom Exercise - Dial Indicator Measurements

Compare the dial indicator readings, and determine the total travel. Record your results below in the spaces provided.

Dial indicator A

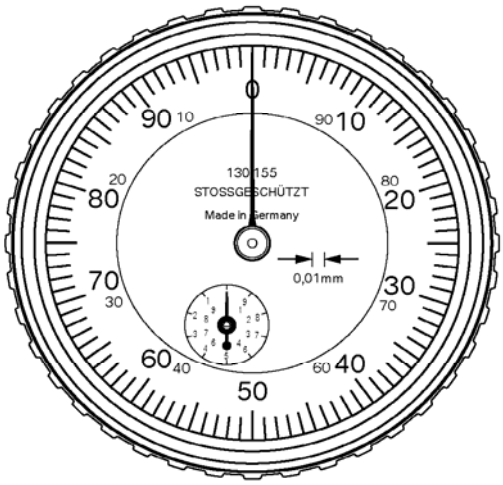


Dial indicator B

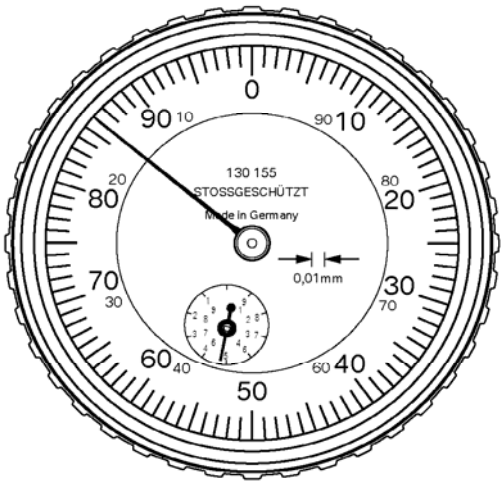


What is the difference (total travel) between dial indicator A and dial indicator B?

Dial indicator C



Dial indicator D



What is the difference (total travel) between dial indicator C and dial indicator D?

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Fig. 14: Identifying Correct Dial Indicator Reading
Courtesy of BMW OF NORTH AMERICA, INC.

ADDITIONAL ENGINE MEASUREMENTS

During engine repair procedures it is sometimes necessary to assess engine wear to make determinations on

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parts replacement. Also, some engine measurements are needed to verify a previous diagnosis.

For example, a cylinder leakdown test could indicate a cylinder sealing concern. Once the engine is disassembled, it would be necessary to verify this condition by checking the piston and piston ring condition. If OK, the next step would be to determine the condition of the cylinder bore. At this point, the cylinders should be checked for taper (conicity) and for out-of-round. The correct measurements could mean the difference between just replacing the rings and/or pistons or replacing the engine block. This is why it is necessary to make accurate measurements when needed.

Some of the other routine engine measurements include:

- Cylinder head warpage
- Cylinder head thickness (on some applications)
- Piston rings - end gap and axial clearance
- Cylinder bore - including out-of-round and taper

Cylinder Head Measurement

If a repair requires removal of the cylinder head, a few basic measurements can be performed to save time and unnecessary machine shop costs. If an engine has been overheated or has an internal or external fluid leakage (coolant/oil), it is a good idea to check the cylinder head for warpage.

This can be done by using a commercially available machinists straight edge and a feeler gauge. by sliding the feeler gauge under the straight edge in various locations, it can determine if there are any low spots or warpage. Usually, the specification is about .05 mm.

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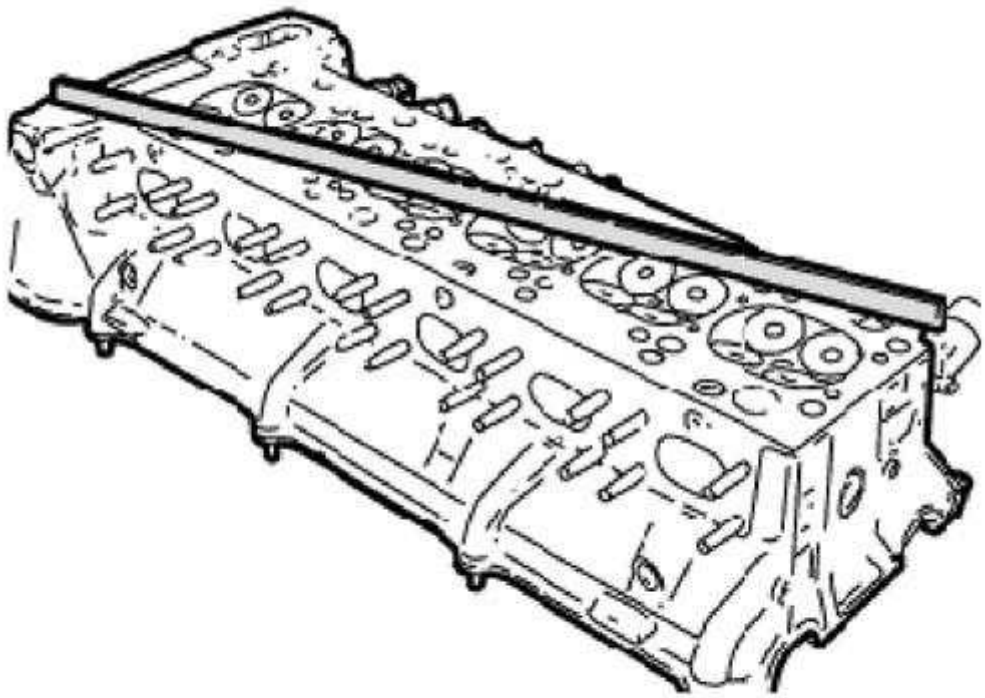


Fig. 15: Identifying Cylinder Head
Courtesy of BMW OF NORTH AMERICA, INC.

Also, check to see if the cylinder head has a specification for machining limit. If so, it may be possible to have the cylinder head re-surfaced. Depending on the amount of material removed during the machining process, it may be necessary to install a thicker head gasket. There are some "service" head gaskets available through the part s department.

The cylinder head can be checked for minimum thickness. This is done using a micrometer or a vernier caliper. This is not possible on all engines, the example shown is a 6-cylinder (M52TU/M54).

If the minimum thickness is not met, the head will need to be replaced.

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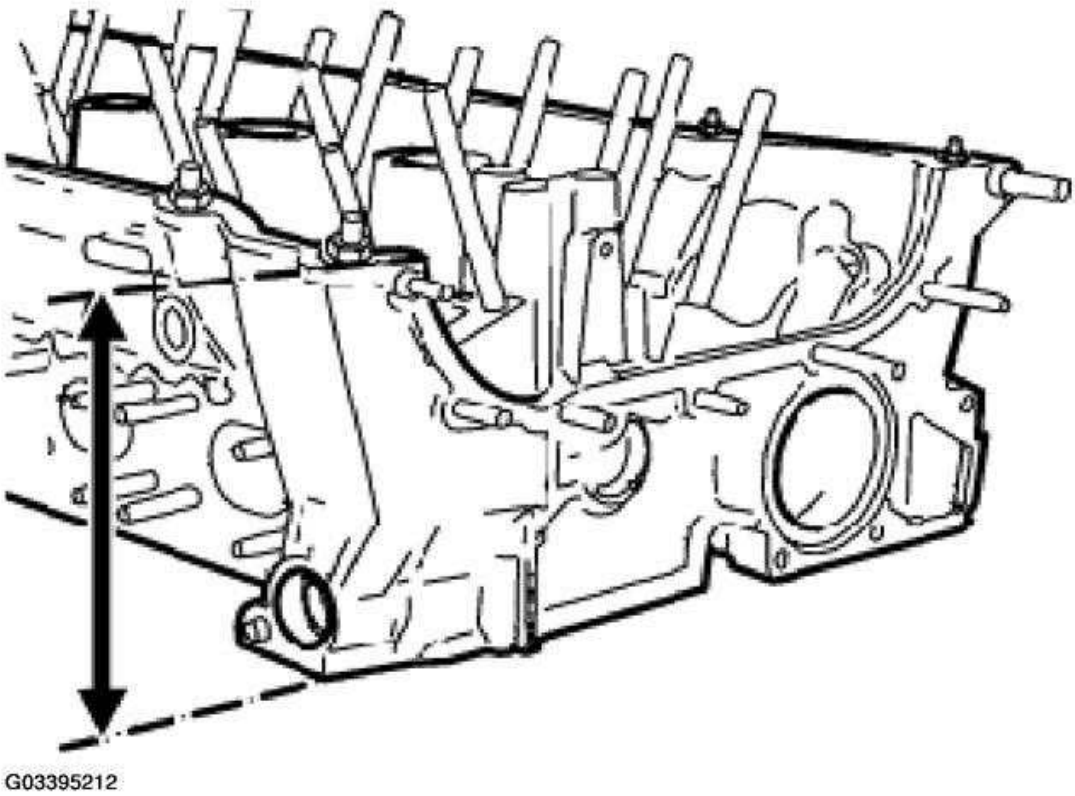


Fig. 16: Measuring Thickness Of Cylinder Head
Courtesy of BMW OF NORTH AMERICA, INC.

Piston Measurements

When replacing pistons and/or piston rings, there are some basic measurements that need to be made. When fitting a piston to a cylinder bore, the piston diameter should be checked to ensure a proper fit.

The piston diameter is measured using a micrometer. The measurement is taken at a specified point (A) which is 90 degrees from the piston pin axis. Each engine has a specific location to measure piston diameter. For example, the illustration below shows measuring Point A. The specification for this engine (N62) is 18 mm. So the piston diameter is measured 18 mm from the bottom of the piston skirt.

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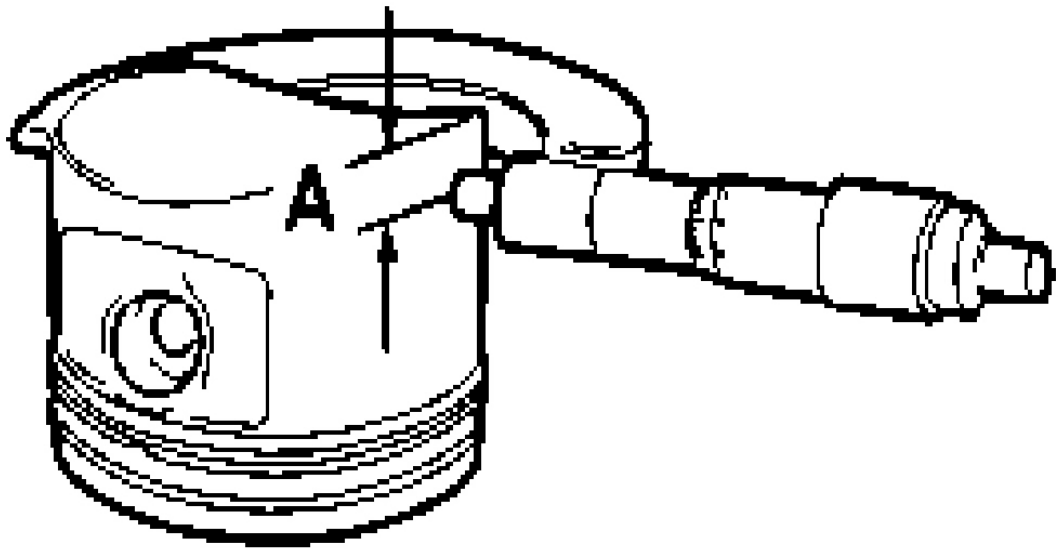


Fig. 17: Measuring Piston Diameter Using Micrometer
Courtesy of BMW OF NORTH AMERICA, INC.

The piston diameter, when subtracted from the cylinder bore equals the cylinder wall to piston clearance. If the clearance measurement obtained is not correct, re-check your readings.

Piston Ring Measurements

There are some important specifications to check when installing piston rings. One of the measurements in axial clearance. Axial clearance is the distance between the piston ring and ring land. This prevents the rings from binding in the ring land at operating temperature. Axial clearance is measured using a feeler gauge.

Also the piston ring end gap has to be checked. This measurement is checked using a feeler gauge.

This clearance is critical in order to prevent the end gaps from contacting each other when the engine is at operating temp.

When installing the piston rings, always stagger the end gaps as per the repair instructions.

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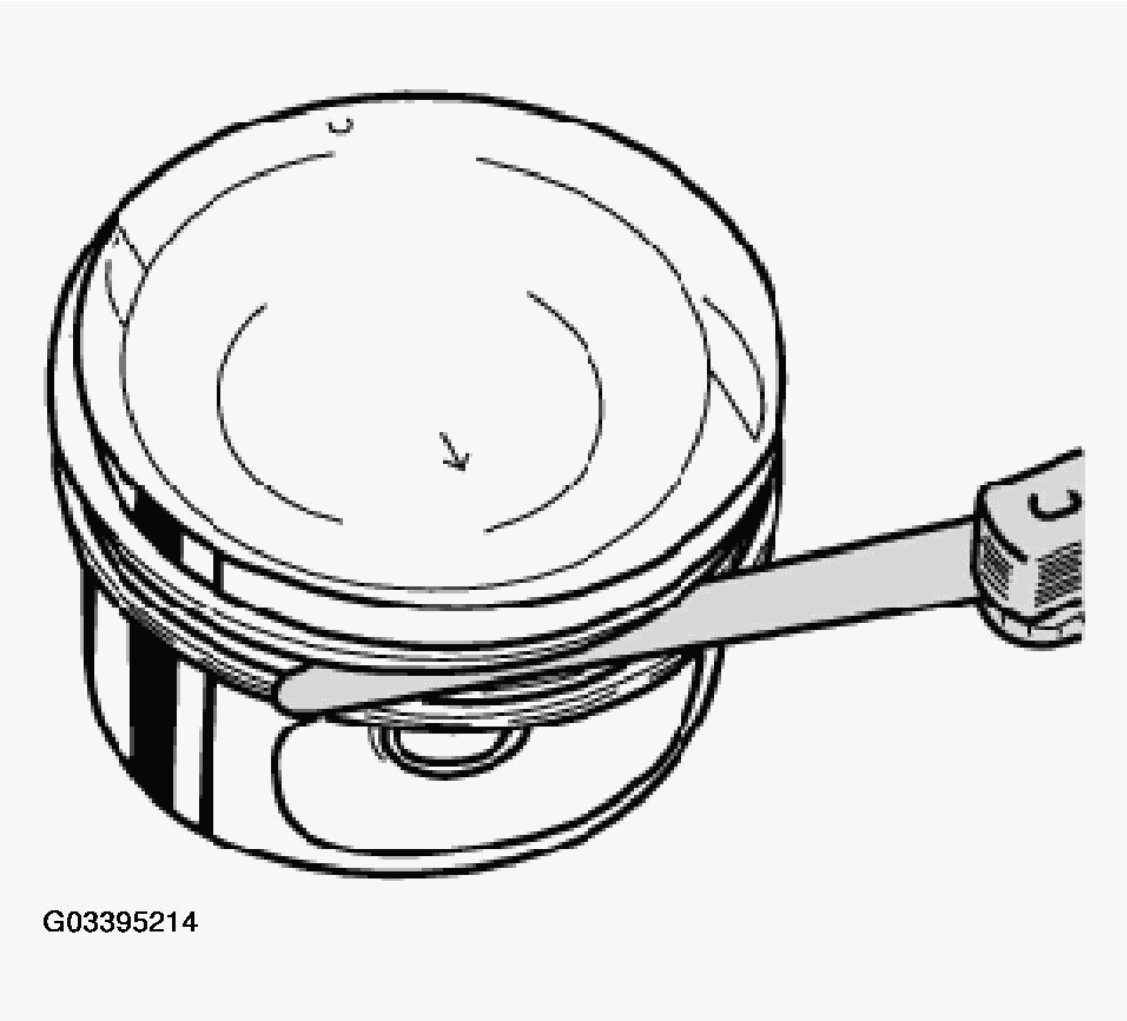
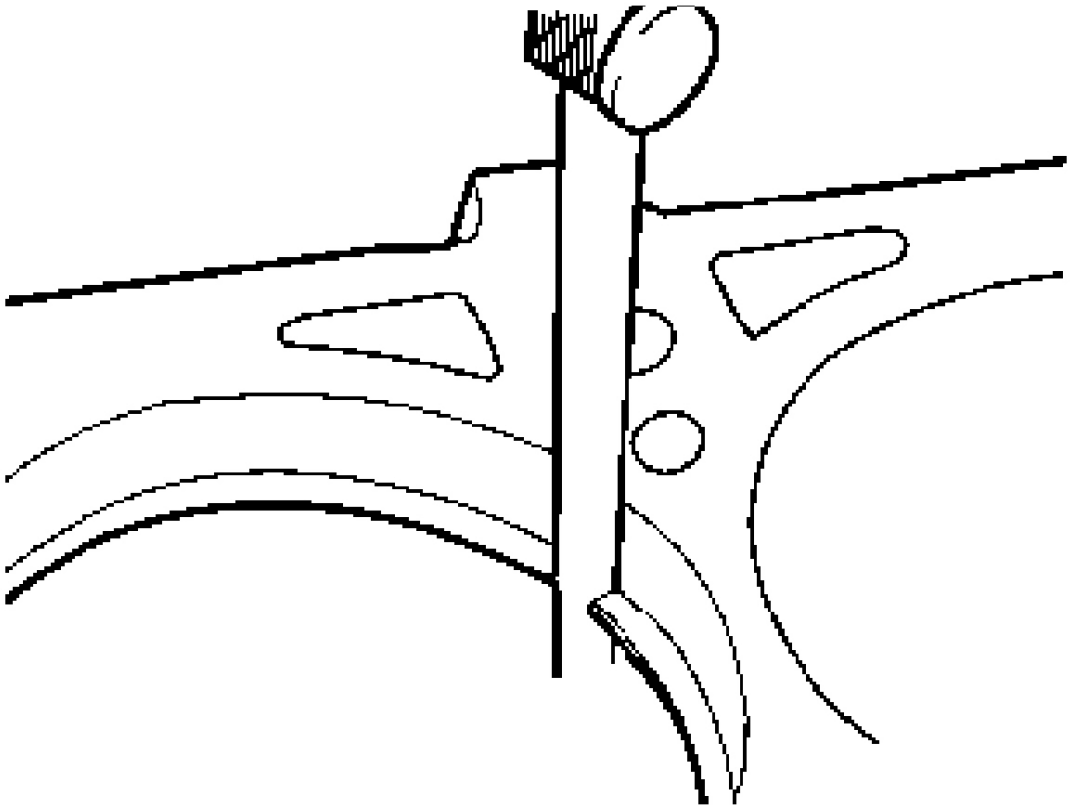


Fig. 18: Measuring Piston Ring Gap Using Feeler Gauge
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Fig. 19: Measuring Piston Ring End Gap Using Feeler Gauge
Courtesy of BMW OF NORTH AMERICA, INC.

Cylinder Bore

In order for the cylinder bore to be considered acceptable, it must not be excessively tapered or out-of-round. Once the cylinder has been checked for obvious damage and the surface finish is OK, the integrity of the bores must be verified. If cylinder wear is suspected, it must be checked using the proper cylinder bore gauge.

Each cylinder must be checked at three position in the bore - top, middle and bottom. Also there must be two opposing dimensions that should be checked. The difference between the top and bottom measurements will indicate the taper of the bore. The opposing dimensions will indicate the out-of-round specification.

If these measurements are out of specification, the cylinder bore must be re-finished or overbored. New pistons and rings must be fitted as well.

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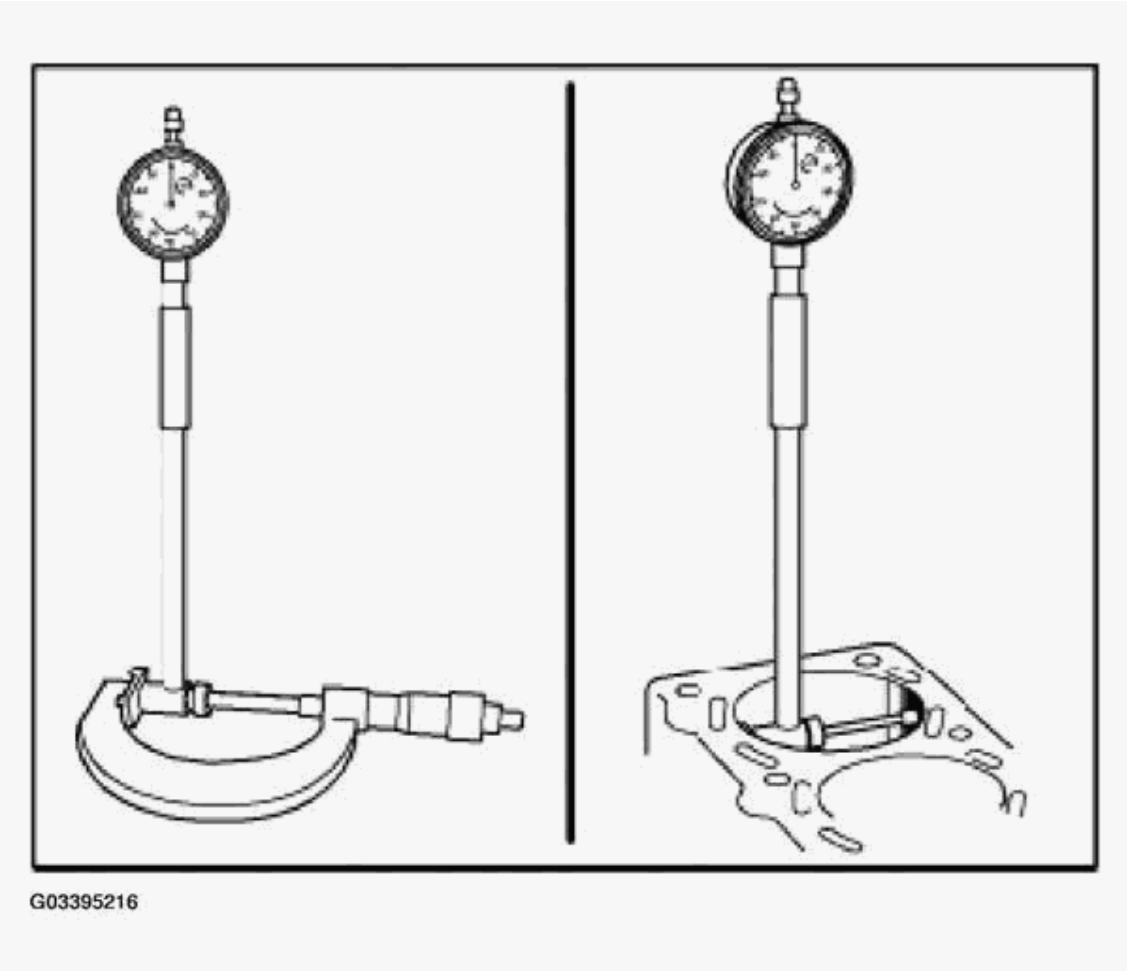


Fig. 20: Checking Cylinder Bore Using Cylinder Bore Gauge
Courtesy of BMW OF NORTH AMERICA, INC.

METRIC SYSTEM

The unit of length, and the basis for all other metric units of measurement is the meter. The meter (1 meter), as a point of reference, is slightly longer that a yard (39.37 inches).

The divisions of a meter are hundredths and thousandths. One hundredth of a meter is called a centimeter, and is equal to .3937 inch or about half the diameter of a nickel.

One thousandth of a meter is called a millimeter. The small marks between the centimeter increments are each one millimeter, or one tenth of a centimeter. And as a point of reference, a standard paper clip is about one millimeter thick.

Metric System Denominations

Throughout the metric system, common to all units of measurement, are prefixes which designate multiples or fractions of the unit.

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For automotive applications, the most common prefixes are centi; designating one-hundredth; milli; for one thousandth and kilo- for one thousand.

There are letters uniformly used throughout the system to label the divisions or multiples of each unit of measurement. The letter "m" represents milli, "c' is for centi and "k" is for kilo. These are then combined with the letter representing the unit of measurement.

For example, mm is millimeter, cm is centimeter and km is kilometer. The same applies to liter which is the unit of volume and gram which is the unit of weight.

One kilogram is equal to one thousand grams which is equal to 2.2 pounds. All metric measurements are directly related. For example, one thousand cubic centimeters, or 10cm x 10cm x 10cm of water weighs one kilogram. The volume of those one thousand cc's is one liter.

Metric Reference Chart

METRIC REFERENCE CHART

Weight			
1 kilogram	= 1 kg	= 1000 grams	= 1000 g
1 hectogram	= 1 hg	= 100 grams	= 100 g
1 dekagram	= 1 dag	= 10 grams	= 10 g
1 gram	= 1g		
1 decigram	= 1dg	= .1 gram	= 0.1 g
1 centigram	= 1 cg	= 0.01 gram	= 0.01 g
1 milligram	= 1 mg	= 0.001 gram	= 0.001 g
Length			
1 kilometer	= 1 km	= 1000 meters	= 1000 m
1 hectometer	= 1 hm	= 100 meters	= 100 m
1 dekameter	= 1 dam	= 10 meters	= 10 m
1 meter	= 1m		
1 decimeter	= 1dm	= .1 meter	= .1 m
1 centimeter	= 1 cm	= 0.01 meter	= 0.01 m
1 millimeter	= 1 mm	= 0.001 meter	= 0.001 m
Volume			
1 kiloliter	= 1 kl	= 1000 liters	= 1000 l
1 hectoliter	= 1 hl	= 100 liters	= 100 l
1 dekaliter	= 1 dal	= 10 liters	= 10 l
1 liter	= 1l		
1 deciliter	= 1dl	= .1 liter	= .1 l
1 centiliter	= 1 cl	= 0.01 liter	= 0.01 l
1 milliliter	= 1 ml	= 0.001 liter	= 0.001 l

Metric System Conversion Charts

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METRIC SYSTEM CONVERSION CHARTS

Linear Measure to Metric	Linear Measure (Metric) to English
1 inch = 2.54 cm	1 mm = 0.03937 inch
12 inches = 1 foot = 30.48 cm	1 cm = 0.39 inch
3 feet = 1 yard = 0.91 m	1 m = 39.37 inch
5.5 yards = 1 rod = 5.03 m	1 km = 0.62 miles
5280 feet = 1 mile = 1.61 km	-
Square Measure to Metric	**Square Measure (Metric) to English**
1 in^2 = 6.45 cm^2	1 mm^2 = 0.002 in^2
144 in^2 = 1 ft 2 = 0.09 m^2	1 cm^2 = 0.16 in^2
9 ft^2 = 1 yd^2 = 0.84 m^2	1 m^2 = 1549 in^2
640 acres = 1mi^2 = 2.59 km^2	1 km^2 = 0.39 mi^2 = 247.10 acres
Cubic Measure to Metric	**Cubic Measure (Metric) to English**
1 in^3 = 16.39 cm^3	1 mm^3 = 0.000061 in^3
1728 in^3 = 1 yd^3 = 0.76 m^3	1 cm^3 = 0.061 in^3
27ft^3 = 1 yd^3 = 0.76 m^3	1 m^3 = 35.32 ft^3
	1 km^3 = 0.24 mi^3
Liquid Measure to Metric	**Liquid Measure (Metric) to English**
1.81 in^3 = 1 fluid oz. = 30 ml	1 ml = 0.03 fluid oz = 0.061 in^3
1 pint = 0.47	l 1000 cm^3 = 1 l = 61.02 in^3 = 1.06 qt
57.75 in^3 = 1 quart = 0.95 l	1 ft^3 water = 62.5 lb
231 in^3 = 1 gal = 3.79 l = 0.0038 m^3	
1 ft^3 = 7.48 gal = 28.35 l	
Weights to Metric	**Weight (Metric) to English**
1 0z = 28.35 g	1 g = 0.035 oz
1 lb = 453.59 g	1 kg = 2.20 lb
1 lb = 0.45 kg	1 metric ton = 1000 kg = 1.102 tons = 2205 lb
1 ton = .91 metric ton	
Temperature to Metric	**Temperature to Fahrenheit**
F = 9/5C +32	C = 5/9 (F-32)

Pressure Conversion Chart

PRESSURE CONVERSION CHART

Bar	kPa	psi	in.Hg.
6.0	600	87.0	
5.9	590	85.5	
5.8	580	84.0	
5.7	570	82.5	

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5.6	560	81.0	
5.5	550	79.0	
5.4	540	78.5	
5.3	530	77.0	
5.2	520	75.5	
5.1	510	73.5	
5.0	500	72.5	
4.9	490	71.0	
4.8	480	69.5	
4.7	470	68.0	
4.6	460	66.5	
4.5	450	65.5	
4.4	440	64.0	
4.3	430	62.5	
4.2	420	61.0	
4.1	410	59.5	
4.0	400	58.0	
3.9	390	56.5	
3.8	380	55.0	
3.7	370	53.5	
3.6	360	52.0	
3.5	350	51.0	
3.4	340	49.5	
3.3	330	48.0	
3.2	320	46.5	
3.1	310	45.0	
3.0	300	43.5	
2.9	290	42.0	
2.8	280	40.5	
2.7	270	39.0	
2.6	260	37.5	
2.5	250	36.5	
2.4	240	35.0	
2.3	230	33.5	
2.2	220	32.0	
2.1	210	30.5	
2.0	200	29.0	
1.9	190	27.5	
1.8	180	26.0	
1.7	170	24.5	
1.6	160	23.0	
1.5			

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	150	22.0	
1.4	140	20.5	
1.3	130	19.0	
1.2	120	17.5	35.90
1.1	110	16.0	32.91
1.0	100	14.5	29.92
0.9	90	13.0	26.93
0.8	80	11.5	23.94
0.7	70	10.0	20.94
0.6	60	9.0	17.95
0.5	50	7.5	14.96
0.4	40	6.0	11.97
0.3	30	4.5	8.98
0.2	20	3.0	5.98
0.1	10	1.5	2.99
0.0	0	0.0	0.0

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GENERAL INFORMATION

BMW Universal Bluetooth - Overview - All Models

BMW UNIVERSAL BLUETOOTH™

INTRODUCTION

The BMW Universal Bluetooth™ HandsFree System (ULF) utilizes Bluetooth™ wireless technology to enable a wireless connection to be established between a Bluetooth™ enabled mobile phone and the ULF Control Module installed in the vehicle. The combination of these components results in a new generation of in-vehicle phone system.

The ULF Control Module forms an interface that allows a mobile phone with the embedded Bluetooth™ wireless technology feature to be wirelessly integrated into the vehicle. For the first time BMW is introducing a new generation hands-free telephone system kit that provides the customer with the option of using various Bluetooth™ enabled mobile phones (a list of recommended phones is available from your BMW Center).

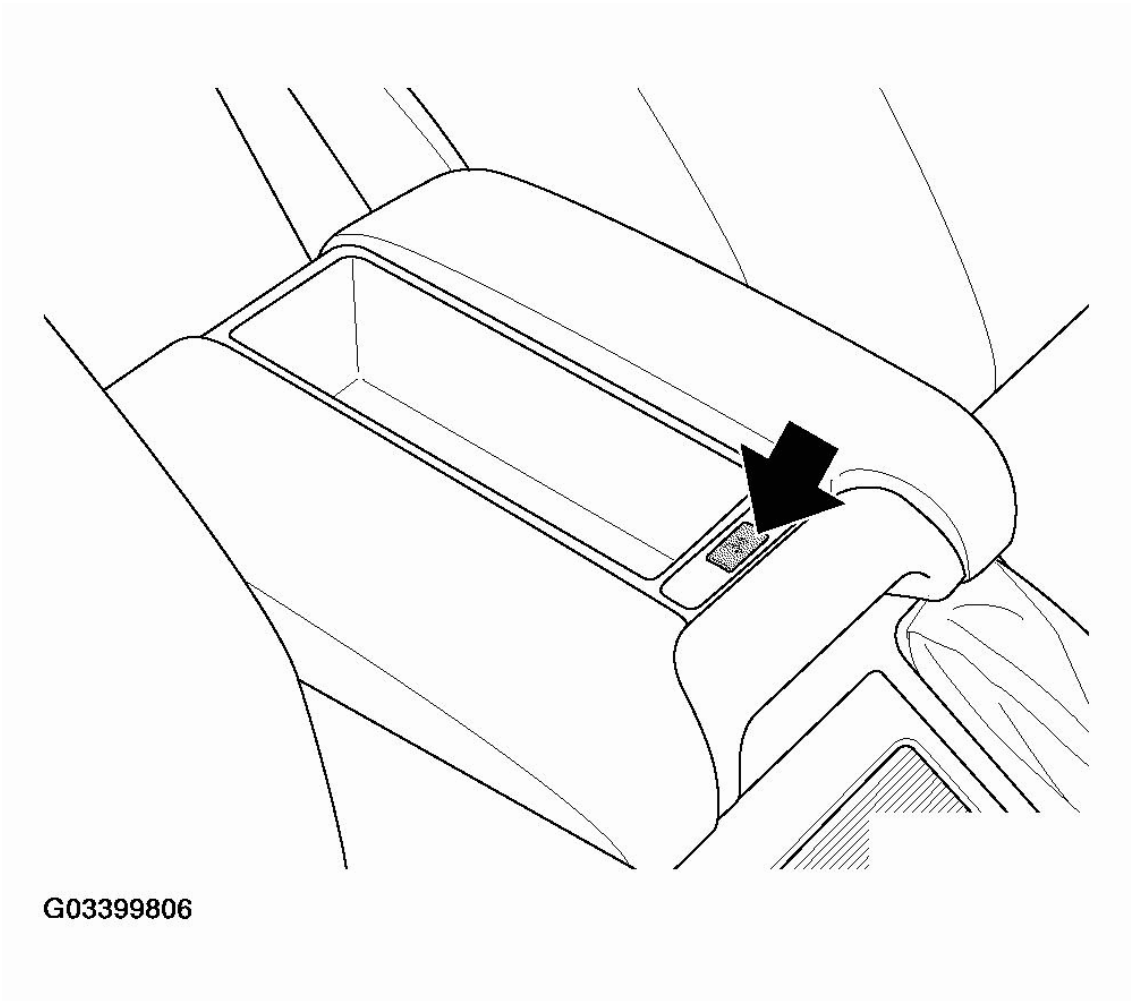


Fig. 1: Identifying Oddment Tray Button

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Courtesy of BMW OF NORTH AMERICA, INC.

WHAT IS BLUETOOTH™

The name Bluetooth™ is derived from the Danish King Harald Bluetooth who lived in the 10th century. He was well known for his ability to unify his kingdom and today lends his name to a wireless technology standard that can connect/unify various electronic devices that are Bluetooth™ enabled and located within a short range (approx. 10 m or 32.8 ft) of each other.

Bluetooth™ wireless technology is a short-range radio frequency technology standard that allows several devices to communicate with each other simultaneously. The standard indicates that up to seven simultaneous connections can be established and maintained at one time, as long as the connected devices are within a range of 10 m (32.8 ft).

NOTE: The ULF system will allow four phones to be paired to the system at a time and only allow one phone to be connected at a time.



Fig. 2: Bluetooth Network Area Description
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Communication/Security

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The system uses the license-free, global Industrial Scientific Medical band (ISM) at 2.45 GHz. This frequency range from 2.402 GHz to 2.480 GHz is subdivided into 79 channels with a 1 MHz bandwidth.

Signals transmitted through the airways can be scrambled and unscrambled to enhance communication security. With Bluetooth™ technology, communication frequencies are changed 1600 times per second to reduce the risk of interference or interception of the transmitted signal. The relatively small operating range of approx. 10 m (32.8 ft) also enhances the security of this technology, since tampering with the transmitted data is only possible when inside the 10 m (32.8 ft) wireless "network".

To further enhance the security of this short-range wireless network the ULF system requires a pairing procedure to be carried out for each device that will be introduced into the network. As part of this procedure a required passkey must be entered once (during the initial pairing procedure) to establish a secure connection between the phone and the ULF Control Module.

Data and Voice

Bluetooth™ was developed for the transmission of both voice as well as data. A bandwidth of approx. 1 MB/s is available for this purpose.

Bluetooth™ Enabled Phones

Ideally all phones that are Bluetooth™ enabled should work with the ULF system, however not all phones utilize the same profiles and therefore may not be recognized by the ULF System. A list of recommended Bluetooth™ enabled phones is available from your BMW Center.

ADVANTAGES OF THE ULF SYSTEM

- Once a phone is paired to the system it will be able to automatically connect to the Bluetooth™ wireless network of the vehicle, the next time it is introduced into the vehicle and the vehicle ignition is on.
- Up to four different Bluetooth™ phones can be paired to the system at one time, although only one phone can be wirelessly connected at any time.
- The phone does not need to be inserted into a phone specific cradle in order to be integrated into the vehicle.
- The phone can remain in a briefcase, purse, glove box, etc.; as long as it is turned on and located within the interior of the vehicle.
- The MFL buttons on the steering wheel can be utilized to place or receive a call, to scroll the phone book and select a number or activate voice recognition in order to dial a number via voice command.
- A voice recognition system is integrated into the ULF control module and can be activated by depressing the send/receive ™ button.
- The communications protocol of Bluetooth™ wireless technology is standardized irrespective of the manufacturer, this therefore allows various mobile telephones that utilize Bluetooth™ wireless technology and a recognized profile to be connected to the ULF System.

System Overview

A ULF system consists of a control module, microphone, Bluetooth™ antenna, a standalone pairing

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(send/receive) button, or eject box with a coin tray insert.

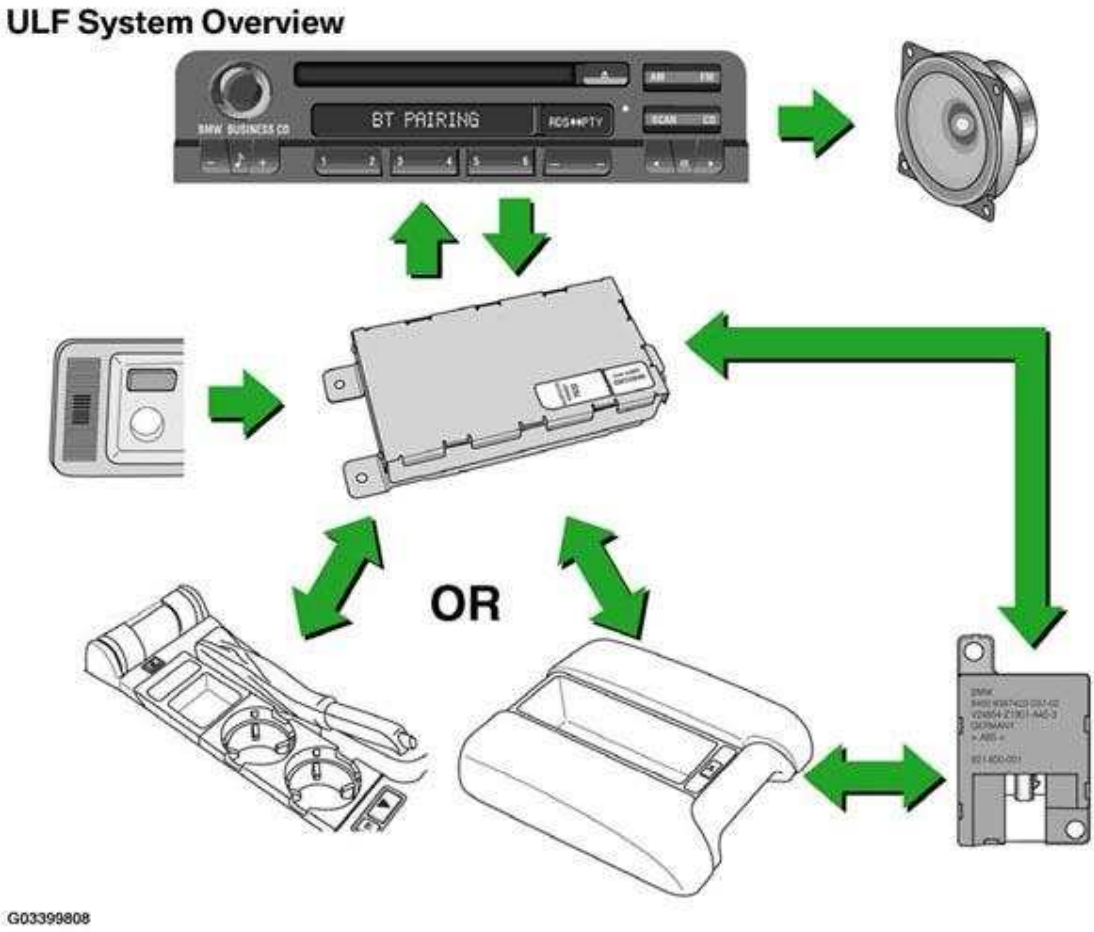


Fig. 3: ULF Control Module System Components
Courtesy of BMW OF NORTH AMERICA, INC.

ULF Control Module

The ULF module forms the interface between the Bluetooth™ mobile phone and the electronic system in the vehicle. The mobile phone with the embedded Bluetooth™ wireless technology is the transceiver, this requires that the phone be activated, paired and present within the vehicle network in order to place or receive a call in the vehicle.

Oddment Tray

The oddment tray, which is connected to the ULF control module via the vehicles wiring harness, serves the purpose of:

Housing the send/receive ™ or pairing button, which must be depressed to activate the pairing procedure between the phone and the control module.

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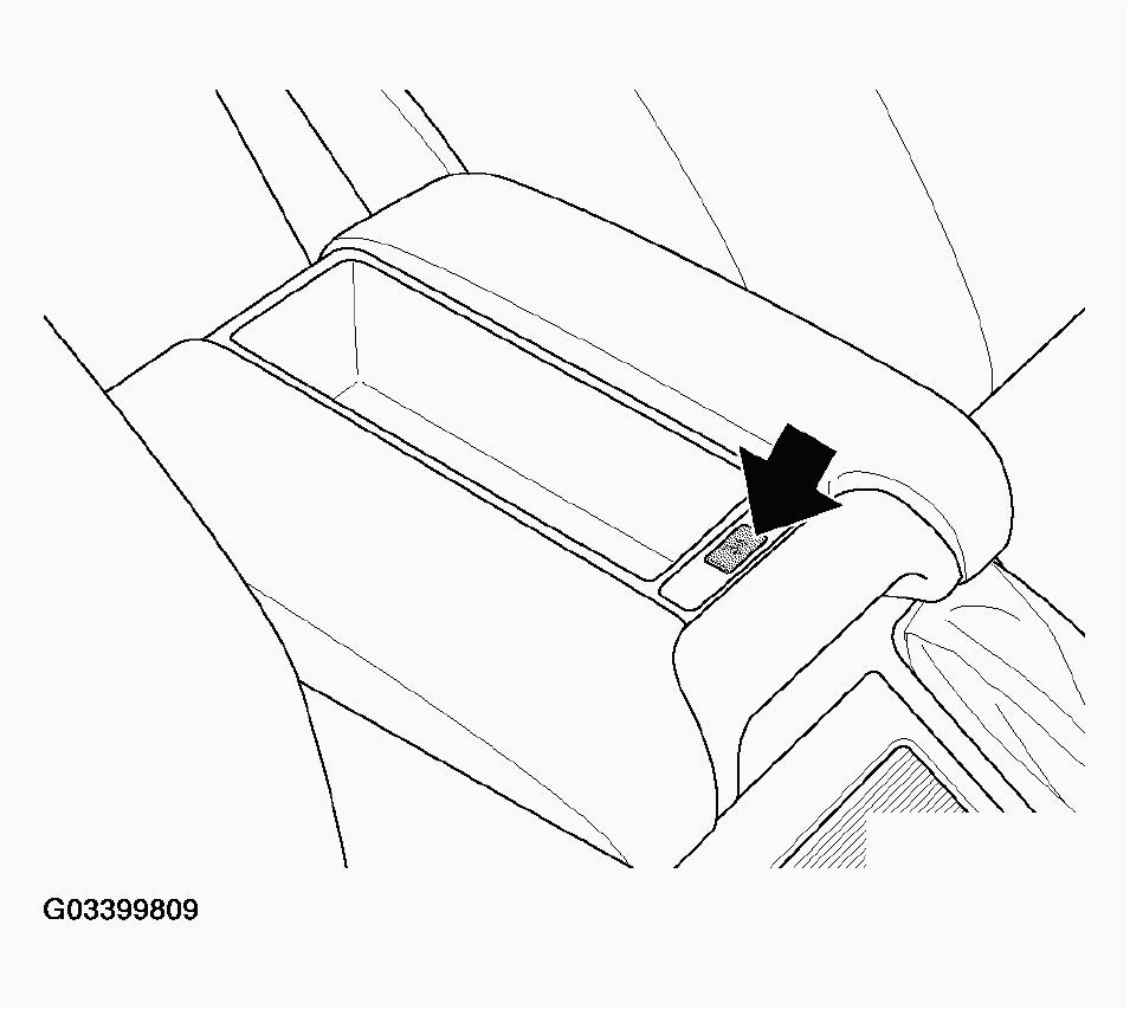


Fig. 4: Identifying Oddment Tray Button
Courtesy of BMW OF NORTH AMERICA, INC.

Pairing Button

A stand-alone send/receive ™ or pairing button is supplied for the 3 Series in order to retain the cup holders. The button provides the same function as the send/receive ™ button on the steering wheel, plus is the button that must be depressed to activate the pairing procedure between the phone and the control module.

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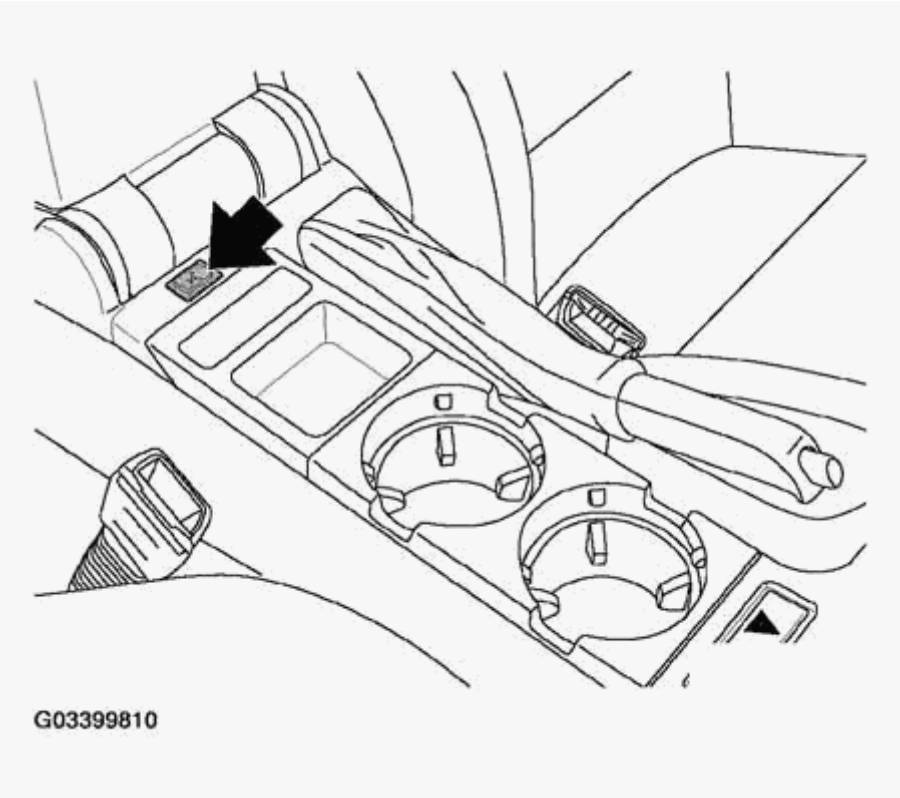


Fig. 5: Identifying Pairing Button
Courtesy of BMW OF NORTH AMERICA, INC.

Bluetooth™ Antenna

The Bluetooth™ antenna operates on a frequency of 2.45 GHZ and is installed in the interior compartment of the vehicle. This antenna provides the wireless interface between the Bluetooth™ enabled phone and the ULF Control Module.

SYSTEM OPERATION

Initial Operation

Prior to using the system for the first time, the Bluetooth™ mobile phone that is to be used must be paired with the ULF control module. This pairing procedure is necessary in order to assign the digital code of the mobile phone to the ULF control module installed in the vehicle. The pairing procedure is only required when a new phone is introduced to the ULF system for the very first time or the list of paired devices is cleared form the memory of the ULF module, it does not need to be performed every time the phone is used with the system.

After pairing, the mobile phone is recognized automatically by the ULF control module within 45 seconds after it is introduced into the vehicle and the ignition is turned on.

NOTE: Depending on the mobile phone manufacturer, particular care must be taken prior to initial operation to ensure that no headset is coupled with the mobile phone. Various devices may interpret the ULF control module as a headset and

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request deactivation of the headset. Please refer to the operating instructions of the mobile phone for detailed information.

Pairing Procedure

The pairing procedure that must be initiated through the phone will differ corresponding to the different menu configurations of the various Bluetooth™ mobile phones on the market. The user's manual of the phone manufacturer should always be referenced for specific steps on how to activate the Bluetooth™ feature and to pair/link devices.

The following steps are generalized steps that should help in activating the Bluetooth™ function of most phones:

In Vehicle:

1. Depress the send /receive (pairing) button located in the center console, for at least 1 second prior to switching on the ignition and continue to hold the button down for approximately 2-3 seconds after the ignition is turned on.
2. Release the button.

NOTE: The send/receive (pairing) button in 5 Series and X5 SAV is located on the oddment tray assembly in the center console.

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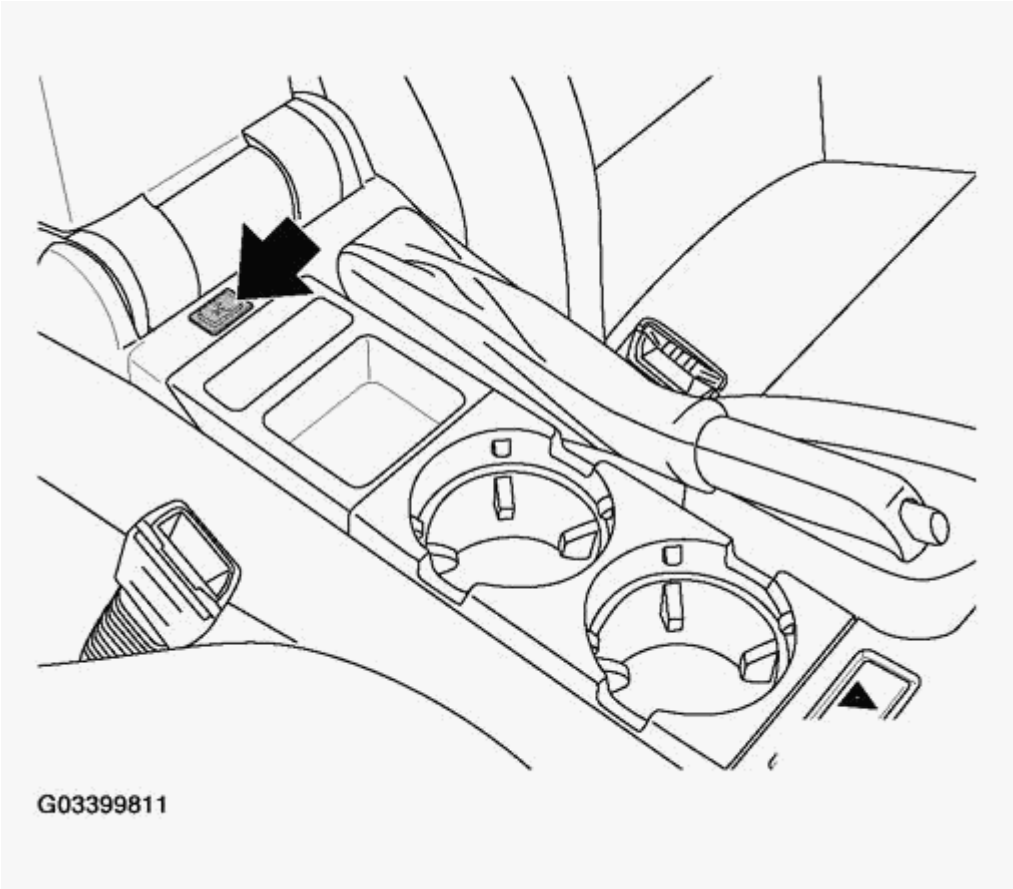


Fig. 6: Identifying Send /Receive (Pairing) Button Location (1 Of 2)
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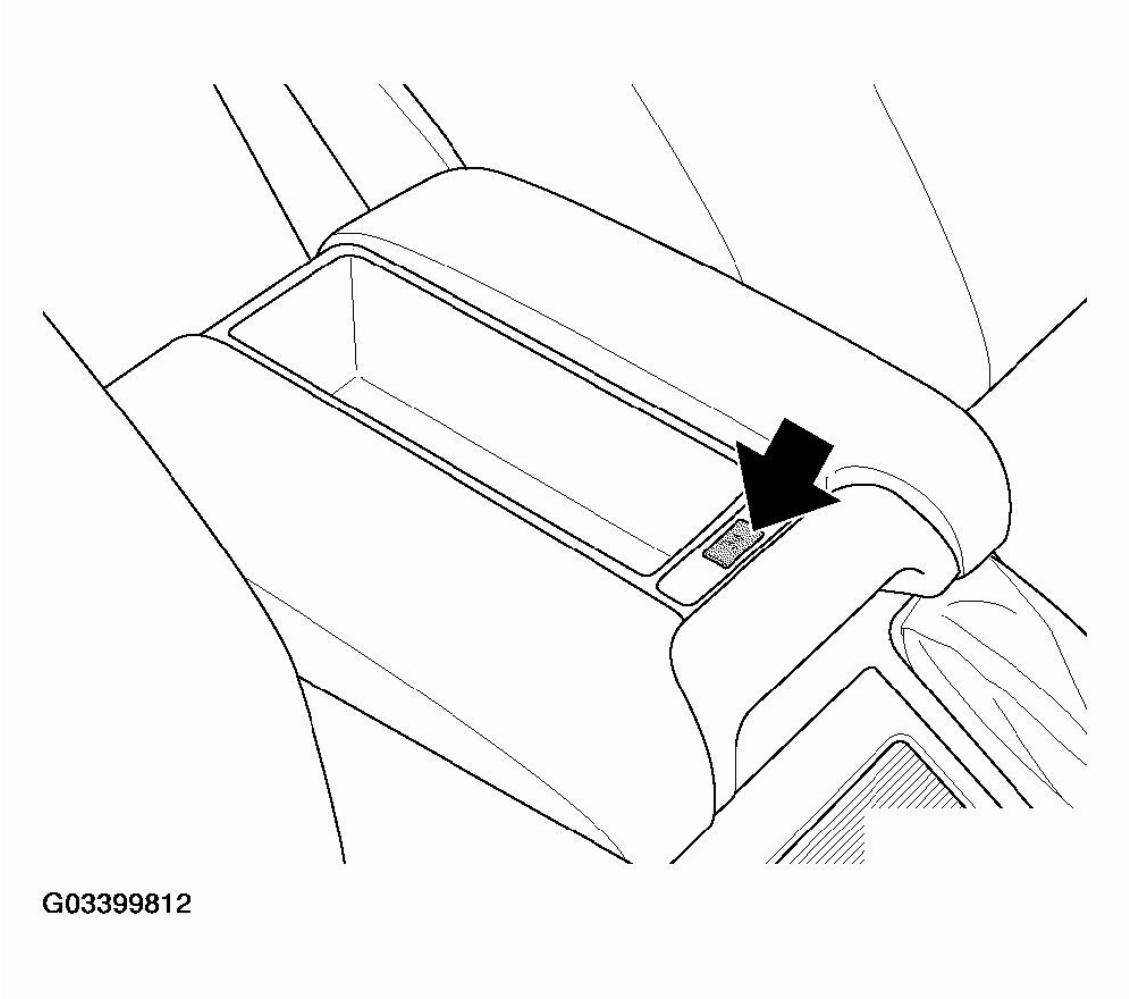


Fig. 7: Identifying Send /Receive (Pairing) Button Location (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

3. Shortly after releasing the button on the Radio or Display Screen, the following message should be displayed:
   a. Display Screen:

      "Bluetooth Pairing" displayed.

      Green, Yellow and Red LEDs on the right side of the unit are flashing which indicates that the ULF is waiting for a signal from the Bluetooth™ device to be paired.

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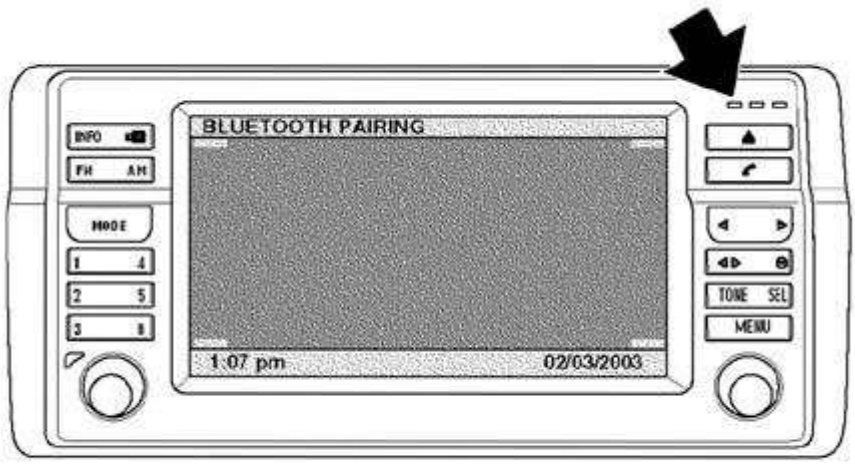


Fig. 8: Identifying Releasing Button On Radio
Courtesy of BMW OF NORTH AMERICA, INC.

b. Radio Display (5 Series and X5 SAV):

"Bluetooth Pairing" Display Which Indicates That The Ulf Is Searching For Available Bluetooth™ Devices. Green, Yellow And Red Leds On The Right Side Of The Unit Are Flashing Which Indicates That The Ulf Is Waiting For A Signal From The Bluetooth™ Device To Be Paired.

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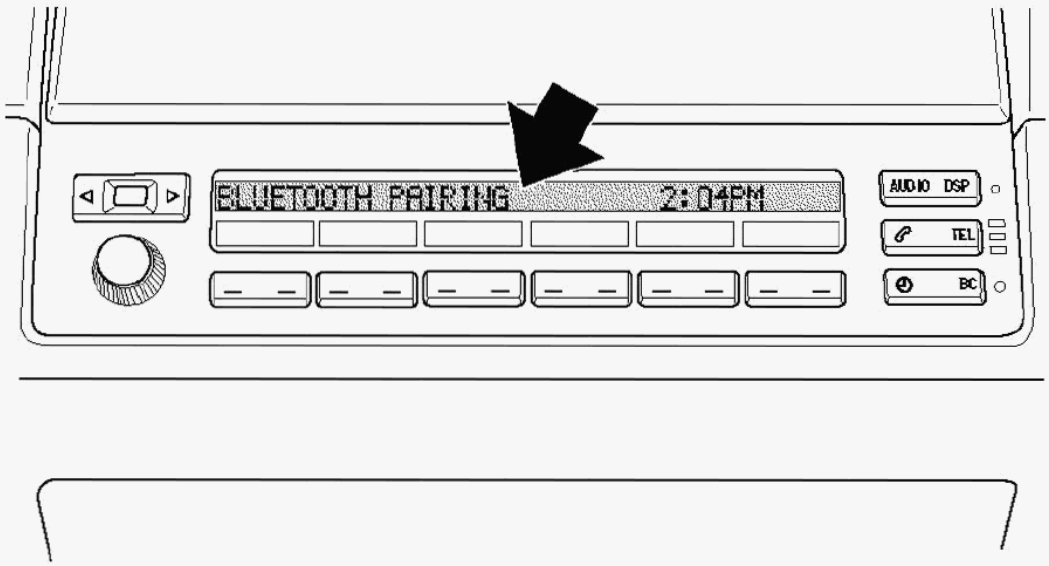


Fig. 9: Bluetooth Pairing Display
Courtesy of BMW OF NORTH AMERICA, INC.

c. Radio Display (3 Series with CD or Cassette):

"BT Pairing" display which indicates that the ULF is searching for available Bluetooth™ devices.

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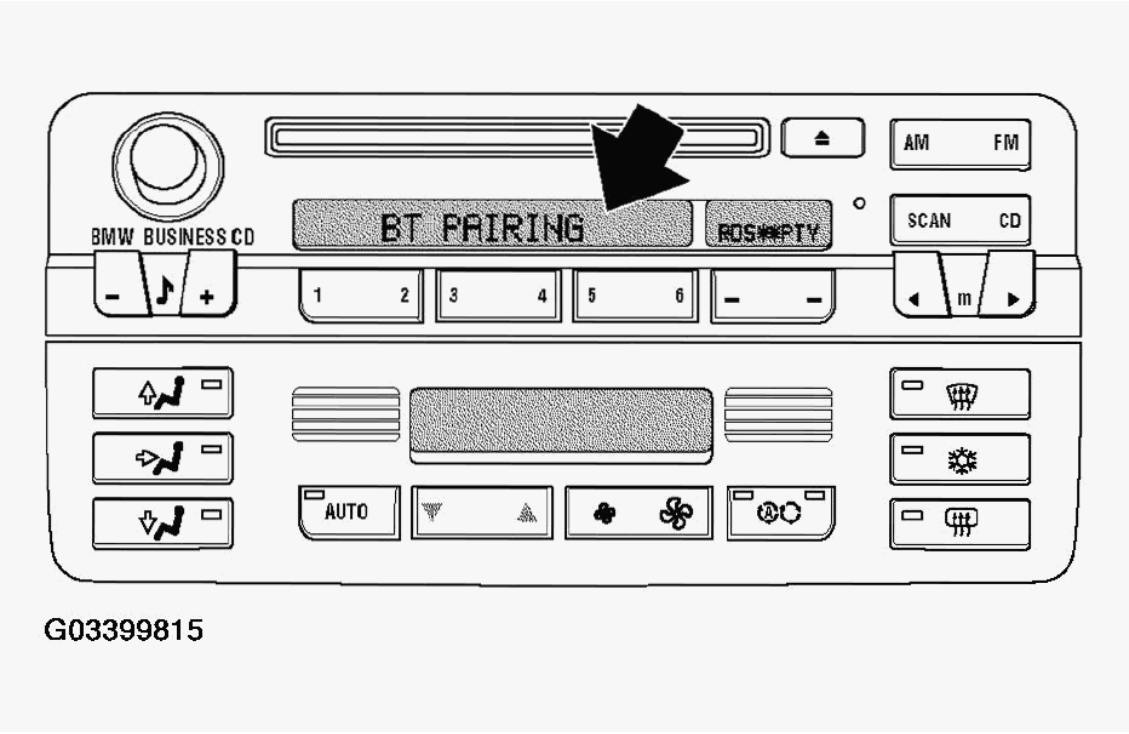


Fig. 10: BT Pairing Display
Courtesy of BMW OF NORTH AMERICA, INC.

4. Activate the search function of the phone as indicated below.

ON PHONE:

1. Locate the connection/settings menu and select Bluetooth™.
2. Select the response that will activate the Bluetooth™ feature of the phone.
3. Next select a menu option that will allow you to "Discover" or "Search" for active Bluetooth™ devices.
4. If the phone identifies/finds a device (named "BMW" followed by 5 digits) select it and follow the indicated steps to complete the pairing process.
5. Once the phone is successfully paired to the device cycle the vehicle ignition switch off and back on and the devices should wirelessly connect within 30 seconds. When the connection is established the phone will display a connection symbol.

The following steps are an example of the pairing procedure that must be initiated to pair the Sony Ericsson T68i phone to the ULF Control Module.

1. Press the menu button.
2. Select "Connect".
3. Select option 3: "Bluetooth".
4. Select option 4: "Options".
5. Select option 1: "Operation mode" and set to "On" or "Automatic".
6. Go back one step by pressing the red phone button several times.

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7. Select option 3: "Discover".
8. Mobile phone display shows 'Searching'
9. Select "BMW ....." in upcoming list.
10. Select option 1: "Add to paired".
11. Enter the password (= ULF passkey) located on ULF Control Module that is in the rear of the vehicle or on the Passkey Reference Card.
    - Mobile phone display shows 'BMW ..... Pairing'
    - Mobile phone display shows 'Pairing Successful'
    - Display screen shows 'Pairing succeeded' for 3 seconds
12. Enter device name or accept the name that is automatically displayed.
13. Mobile phone display shows "Added to paired devices".
14. Exit menu by pressing the red phone/NO button.
15. Once the phone is successfully paired to the device cycle the ignition switch off and back on.
16. The devices should wirelessly connect within 30 seconds. The connection is established when the phone displays the symbols indicated, on the right side of the screen.

NOTE: Shortly after turning on the ignition and the Bluetooth™ connection is identified, the phone may display a message asking if the connection should be established/accepted. The connection authorization request will always occur unless the setting on the phone is modified to allow automatic connection every time, please refer to the user's manual of the phone to determine how to change this setting.

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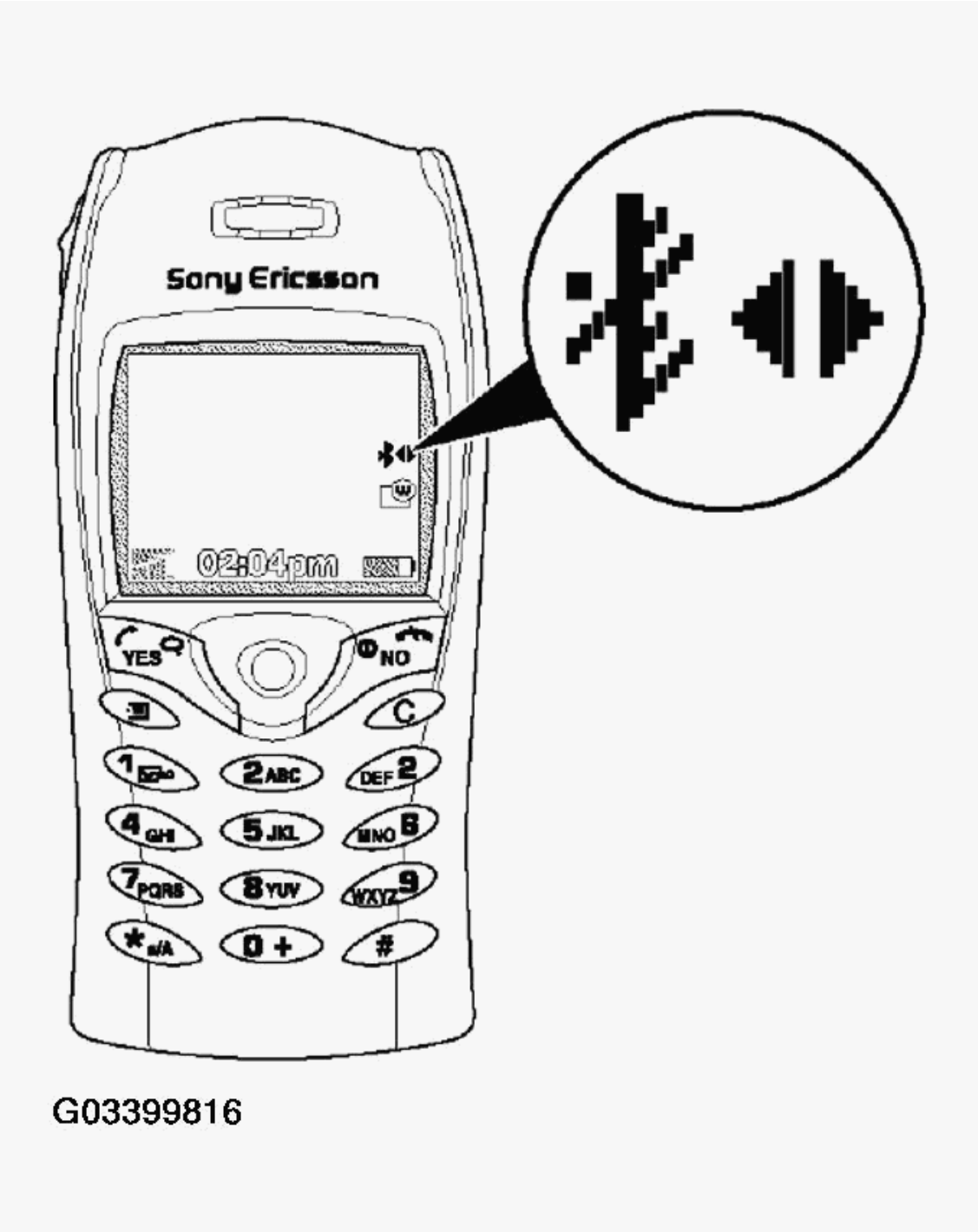


Fig. 11: Locating Connection/Settings Menu On Phone
Courtesy of BMW OF NORTH AMERICA, INC.

System Functions

The mobile phone must always be activated, paired and present within the Bluetooth™ network in order to place or receive a call through the vehicle.

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Indicator Lamps

The indicator lamps show the following:

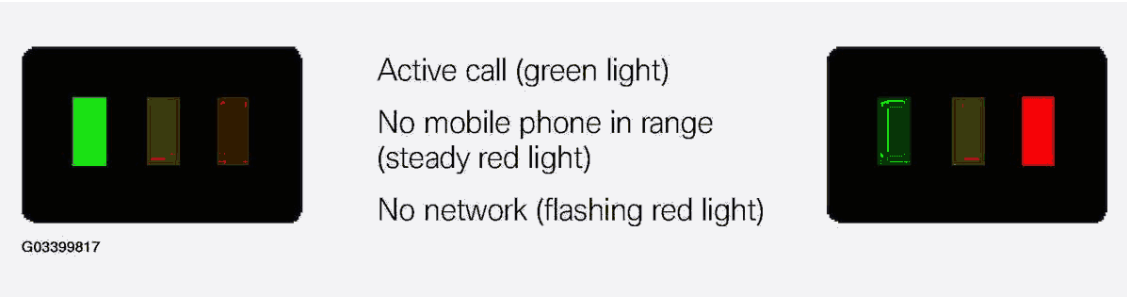


Fig. 12: Identifying Indicator Lamps
Courtesy of BMW OF NORTH AMERICA, INC.

Active call (green light).

No mobile phone in range (steady red light).

No network (flashing red light).

Adopting Telephone Book

Depending on the type of Bluetooth™ mobile phone, the telephone book is either transferred automatically (ex. Nokia 6310, Sony Ericsson T68i) or manually (depending on software version of phone) by the user to the ULF control module. The address book is stored temporarily for the purpose of accessing/displaying stored phonebook information using the steering wheel controls or telephone menu selections available on the display screen or some radio displays.

If a manual transfer of the address book must be made, the ULF must be in setup mode for manual transfer. The corresponding data can then be transferred. If phonebook data is modified while the phone is wirelessly connected to the vehicle the changes will not be displayed in the vehicle if the phonebook is scrolled via the steering wheel or display screen, changes will only be transferred the next time the ignition is cycled.

Placing a Call

A call can be placed in several different ways:

1. Using the keypad or address book of the mobile phone and depressing the send button on the phone.

   NOTE: Some phones may ask if the call is to remain within the phone. Refer to the users manual of the phone for specific instructions on disabling this feature.

2. Depressing the R/T button on the steering wheel, then scrolling (using the ™ or ™ buttons) through the address book of the phone that is linked to the ULF, until the desired number is displayed on the radio or display screen and then depressing the send/receive ™ button on the steering wheel or center console to

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place the call.

3. Depressing the ™ button on the steering wheel until an audible "beep" is heard through the vehicle speakers, at this point a call can be placed by using the following voice commands:
   - "Dial number" or "Dial phone":
   - After the system asks for a number say the number.

     Example: "123 456 7890"; the system will repeat the number requested once you stop speaking momentarily, the number may also be displayed depending on the vehicle and equipment/accessories installed.

   - "Dial":

     NOTE: Once the dial command is given the number will be displayed on the dis play screen or radio; plus it will always be displayed on the mobile phone after a call is placed.

4. Briefly depressing the ™ button on the steering wheel will redial the last number dialed.

For more information on using voice commands refer to the " Owner's Manual for Voice Input System. The Convenient Alternative to Manual Control" (P/N 84 11 027 942)

Receiving/Accepting a Call

The call ringer in the Bluetooth™ mobile phone is audible when an incoming call signal is received. At the same time, the signal is sent via the Bluetooth™ interface in the mobile phone to the Bluetooth™ antenna in the vehicle. The ULF receives the incoming ring/call signal via the Bluetooth™ antenna and mutes the radio. The incoming ring/tone signal is then also transmitted to the vehicle speakers.

The following options are available for accepting a call:

3 Series without Display Screen:

- Press send/receive ™ button on MFL (Steering Wheel).
- Press send/receive ™ button in the center console.
- Press send/receive key on mobile phone.

5 Series and X5 SAV without Display Screen:

- Press send/receive ™ button on MFL (Steering Wheel).
- Press send/receive key on radio.
- Press send/receive ™ button on the oddment tray (Center Console).
- Press send/receive key on mobile phone.

Vehicles with Display Screen:

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- Press send/receive ™ button on MFL (Steering Wheel).
- Press send/receive ™ button on the oddment tray (Center Console).
- Select the green phone symbol on the Display Screen.
- Press send/receive key on mobile phone.

Conducting a Call

If the call is accepted by pressing the send/receive key ™ on the Radio (5 series and X5 SAV), Display Screen, steering wheel or center console, it will be conducted via the hands free microphone and vehicle speakers.

If a call is accepted by pressing the send/receive key on the mobile phone, the reaction will depend on the type of handset. In the majority of cases, however, the question appears:

"Do you wish to use the mobile phone?"

Please refer to the operating instructions of the mobile phone for a detailed description of the operating procedure of the phone.

The hands-free function is activated after pressing the send/receive key. The incoming call is encoded (scrambled) via the Bluetooth™ interface in the mobile phone and sent to the Bluetooth™ antenna in the vehicle. The call is received by the ULF control module and output via the radio to the audio speakers.

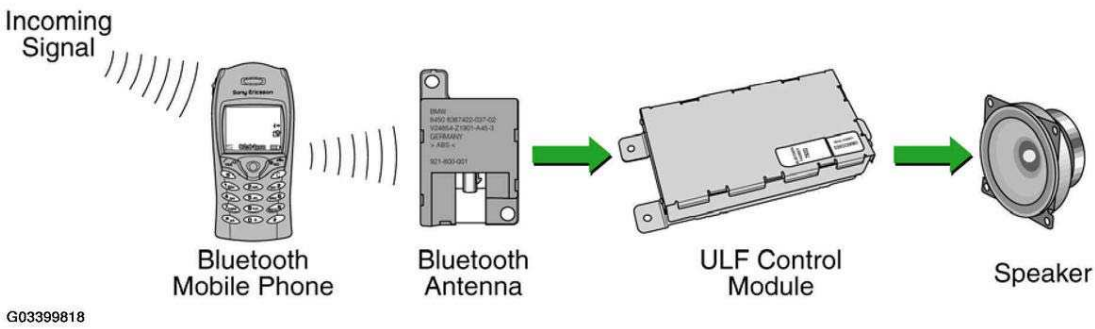


Fig. 13: Identifying Call Components (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Since the ULF system provides a digital full-duplex hands-free operation, it is possible to simultaneously speak and listen to calls. An echo cancellation function prevents feedback when speaking into the microphone. The microphone audio signal is sent via a hardwire connection to the ULF control module. In the ULF module the received audio signal is scrambled via the Bluetooth™ module and transferred via the Bluetooth™ antenna to the mobile phone. The mobile phone then transmits the call via the phone antenna.

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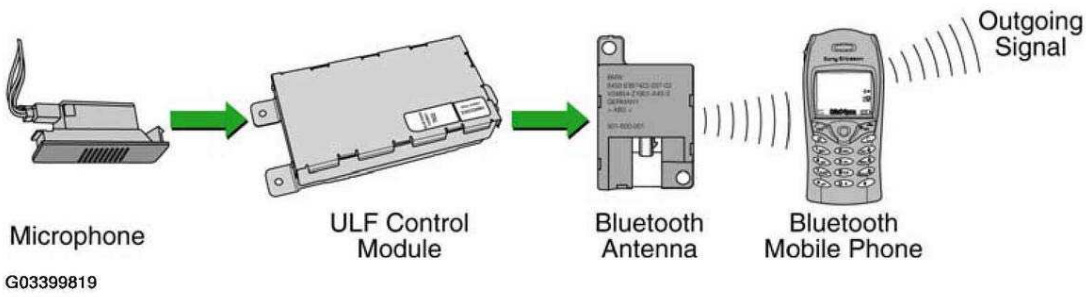


Fig. 14: Identifying Call Components (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Ending a Call

The following options are available for ending a call:

3 Series without Display Screen:

- Press send/receive ™ button on MFL (Steering Wheel).
- Press send/receive ™ button in the center console.
- Press send/receive key on mobile phone.

5 Series and X5 SAV without Display Screen:

- Press send/receive ™ button on MFL (Steering Wheel).
- Press send/receive key on radio.
- Press send/receive ™ button on the oddment tray (Center Console).
- Press send/receive key on mobile phone.

Vehicles with Display Screen:

- Press send/receive ™ button on MFL (Steering Wheel).
- Press send/receive ™ button on the oddment tray (Center Console).
- Select the green phone symbol on the Display Screen.
- Press send/receive key on mobile phone.

Transfer Active Call From Phone to ULF

If a call is received or placed via the handset, it can be transferred into the vehicle once the phone is within the active Bluetooth™ network of the vehicle.

Call transfer procedure:

1. Ignition must be on.

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2. Bluetooth™ connection must be established.
3. Briefly depress the send/receive ™ button located in the center console.

NOTE: Some phones may automatically display a statement asking the user if the active call should be transferred to the ULF system shortly after the Bluetooth™ connection is established. If the request is acknowledged the call is automatically transferred into the vehicle/ULF system without having to depress the send/receive button.

Transfer Active Call from ULF to Phone

If you are currently in an active call and you need to leave the vehicle the call can be transferred into the handset in several ways.

1. Ignition is turned off and you walk away from the vehicle. Once outside the 10 m (32.8 ft) range a message may be displayed on the phone asking if the current call should be maintained or ended, by maintaining the call it will be transferred to the handset.
2. Depending on the model of phone being used the call can be transferred to the handset by manually disconnecting from the Bluetooth™ network via the connections menu or selecting a transfer function in the settings menu of the phone (refer to the user's manual of the phone for more information).

Linking Several Bluetooth™ Mobile Phones

Up to four Bluetooth™ mobile phones can be paired one after the other to the ULF control module. The pairing operation corresponds to the procedure described above.

The handset paired last has the highest priority. The telephone paired first will drop out of the list if a fifth Bluetooth™ mobile phone is paired.

NOTE: For incoming and outgoing calls, only the user connected first to the system can speak via the hands-free facility.

If two users enter the network or connection range simultaneously, only the user with the highest priority (the user last paired during the initial pairing procedure) will be able to use the hands-free function for incoming & outgoing calls. If the highest priority phone is turned off the phone with the next highest priority will be connected.

Deleting Devices

The paired Bluetooth™ mobile phones can only be deleted as a single group from the ULF control module.

The pairing procedure must first be activated, and then the send/receive ™ button on the installed eject-box or the pairing button located at the rear of the center console must again be depressed for an additional 10 seconds after the "Bluetooth Pairing" message is displayed on the radio in order to clear the list of paired devices from the control module and the message "paired devices deleted" is displayed.

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TECHNICAL INFORMATION

Not only does the Universal Bluetooth™ Hands-Free System offer a means to wirelessly integrate a mobile phone into the vehicle, it also can be diagnosed using the DISplus or GT1.

The control module should always be coded to the specific vehicle that it is installed into to ensure optimum system performance. Coding of the module can be done using the DISplus or GT1 with CD33 or higher installed.

The ULF control module contains several controllers that provide the following functions:

1. Bluetooth™ Control Circuit:

   The Bluetooth™ control circuit is physically connected to the Bluetooth™ antenna. It establishes the connection between the Bluetooth™ mobile phone and the vehicle, de-scrambles the incoming call/signal from the phone, scrambles the outgoing signal from the microphone for transmission to the phone, plus controls all communication to paired Bluetooth™ devices.

2. Hands-free Control Circuit:

   The hands-free control circuit in the ULF controls the input/output of audio frequency signals in hands-free mode. The hands-free mode is designed for full-duplex transmission. This means the user can listen and speak simultaneously. Voice transmission takes place via a microphone located in the interior of the vehicle.

   Pressing and holding the send/receive ™ button until an audible beep is heard will activate the integrated voice recognition system and place the system into a hands-free mode.

3. Audio Output Control:

   The incoming signal from the Bluetooth™ phone is processed, sent through the radio and to the speakers.

4. Audio Input Control:

   The outgoing audio received from the vehicle microphone is processed and transmitted to the Bluetooth™ phone.

5. I/K-Bus Interface:

   The interface in the ULF control module for the I/K-bus controls the procedure for transmitting and receiving data telegrams via the I/K-bus in connection with other components on the bus.

6. Power Module:

   The power module in the ULF control module regulates the voltage supply and monitors system shutdown in the event of an under voltage situation in the vehicle.

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SYSTEM OVERVIEW

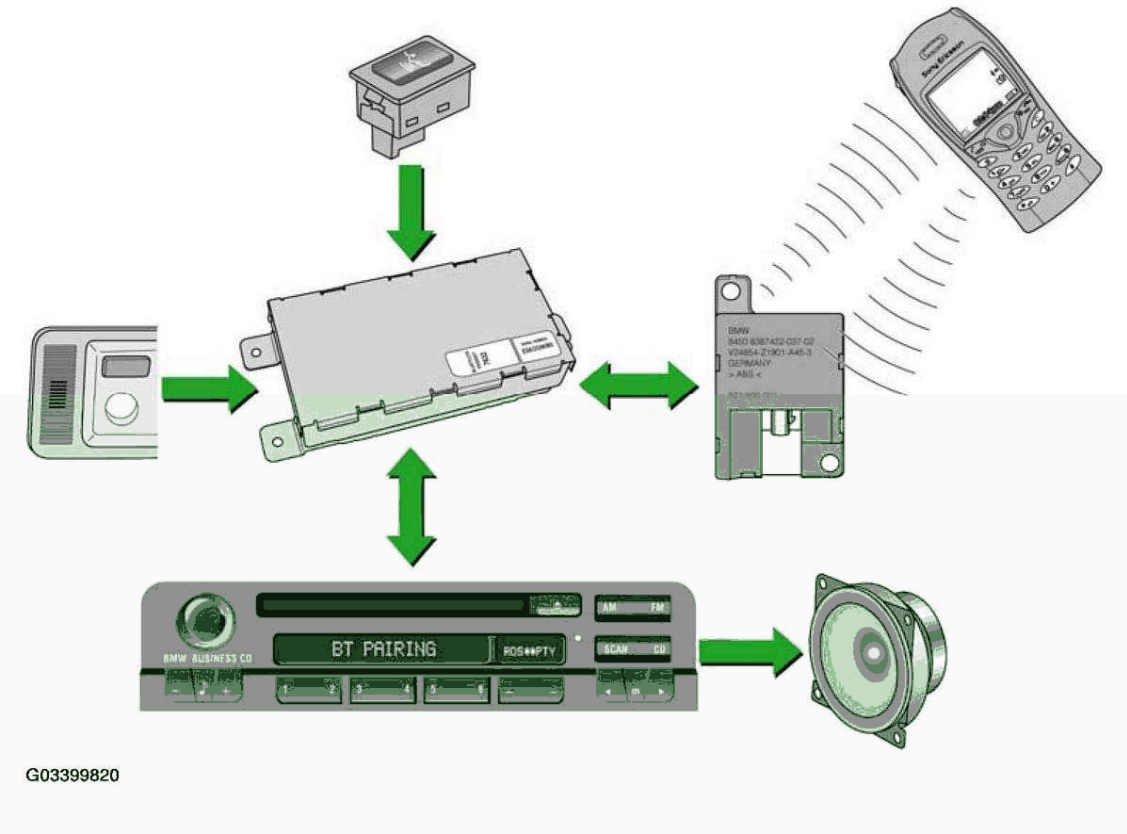


Fig. 15: Identifying Power Module System Components
Courtesy of BMW OF NORTH AMERICA, INC.

Voice Recognition

The voice recognition for the this system is integrated into the ULF Control Module and utilizes the same voice commands as those used with the TEMIC Voice Recognition Module used with the CPT8000 phone system. The "Owner's Manual for the Voice Input System" P/N 84 11 0 027 942 should be referenced for more detailed information regarding voice command features.

Coding ULF Control Module to Vehicle

After installing the ULF Kit, the vehicle should be re-coded with DISPlus/GT1 SW 33 or higher, using the "Retrofit" path to ensure that the system works properly with the systems currently installed in the vehicle. The recoding is done automatically when using the following "retrofit" procedure:

Example for coding E46 with ULF installed:

- Connect DIS or GT1 to vehicle (with SW 33 or higher installed).
- Turn on ignition.
- Select "Coding ZCS".

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- Series: "E46 Series".
- Path: "2 Retrofit".
- System: "ULF Universal charging and Handsfree facility".
- Follow the on screen requests to activate the coding procedure.

Function Test

Upon completion of the recoding, verify that the BMW Universal Bluetooth™ HandsFree System is working correctly by going through the following action steps. After completing each step ensure that the desired result is obtained:

FUNCTION TEST

Action	Response
Pair phone to vehicle (refer to section for pairing instructions).	Phone and or Radio/MID/Board Computer should display statement indicating Pairing succeeded.
Turn on radio and initiate a call using voice recognition commands by depressing/holding the Voice recognition button on steering wheel until an audible beep is heard.	Radio should mute and an audible beep is heard through vehicle speakers.
Say "Dial number".	System states "Please speak the number".
Say phone number to be dialed ex"1234567890".	System states "1234567890".
If number is correct say "Dial"	Call is placed and number being dialed is displayed on phone as well as on Radio/MID/Board Computer.

TROUBLESHOOTING

TROUBLESHOOTING

Situation	Correction
No audio output through vehicle speakers.	Check SES module jumper plug.
Radio does not mute after placing a call.	Check connections at rear of radio for Tel On and Tel Mute signal. Verify that connectors and pins are properly seated.
Audio quality in vehicle may not sound very good.	Recode ULF Control Module.™ **NOTE:** **Audio quality in vehicle or at person being contacted, is dependent on the quality and signal strength of the wireless service provider in the area traveled.**
Customer complains that the person being contacted hears a "Buzzing" noise, at times during their conversation or on voice mail message that he/she has left.	Intermittently a "Buzzing" noise is noticeable to the person being called from the vehicle. The "Buzzing" noise is a result of the GSM signal being feedback through the microphone, this usually occurs if the GSM phone is located too close to the microphone.

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	The customer should change the location of where the phone is placed/stored.
Driver is told that the person being contacted complains that there is an echo/reverberation in the audio; person can hear his/her voice back through the phone.	Audio volume in vehicle during a call may be a bit to loud, causing the other person to hear his/her voice coming back through the phone.
A second call is received while in a call, and call cannot be accepted using MFL controls.	Use handset to expect second call and place previous called on hold. Call waiting is functional only via the handset.
The radio audio does not come back immediately if the "other" person hangs up first.	It takes approximately 15 seconds for the ULF system to recognize that the call was terminated from outside the vehicle. If the call is terminated from outside the vehicle first, the driver can depress the button on the steering wheel to terminate the call from the vehicle and un-mute the radio quicker.
Customer is not able to pair phone to system, not able to locate ULF passkey/password reference card.	The "Bluetooth™ Passkey" is identified on the label of the ULF Control Module located in the rear of the vehicle.™ The "Bluetooth™ Passkey" for the installed control module can be obtained by connecting the DISPlus or GT1and accessing the diagnostics for the ULF system:- select "Diagnostic requests" - select "Bluetooth code".
Intermittently a popping noise is audible through the vehicles speaker and there is no Bluetooth™ wireless communication established between the ULF module and the phone.	Vehicle and /or ULF Control Module are not correctly coded.™ Recode module and vehicle (refer to **CODING ULF CONTROL MODULE TO VEHICLE**).
E46 Only: After installation of ULF system the speedometer and odometer do not work.	Remove pin 7 & 8 from the 54-pin connector going to the ULF Control Module. .

CONNECTOR PIN ASSIGNMENTS

The 54-pin connector of the ULF Control Module utilizes the following pins on X01185

PINS DESCRIPTION

PIN	Description
1	Microphone +
11	Cradle On/Enable
15	I-Bus
17	KL 30
19	Microphone -
21	Microphone Shield
22	Hook
27	Programming
28	Programming
32	Cradle Key +

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33	Telephone On
34	Telephone On (pin 33)
35	KL R (Ignition)
36	KL 31 (Ground)
43	Programming
44	Programming
45	Programming
51	Telephone Mute
52	KL 58g (illumination)

The following pins on X4545 are utilized when the eject box is connected

PINS DESCRIPTION

PIN	Description
1	Cradle Key +
2	KL 31
3	58G
5	KL 30
13	Cradle On/Enable

NOTE: The pairing button used on the E46 only utilizes pin 1, 2 & 3 of X4545

ULF Wiring Schematic for the E53 with Boardmonitor

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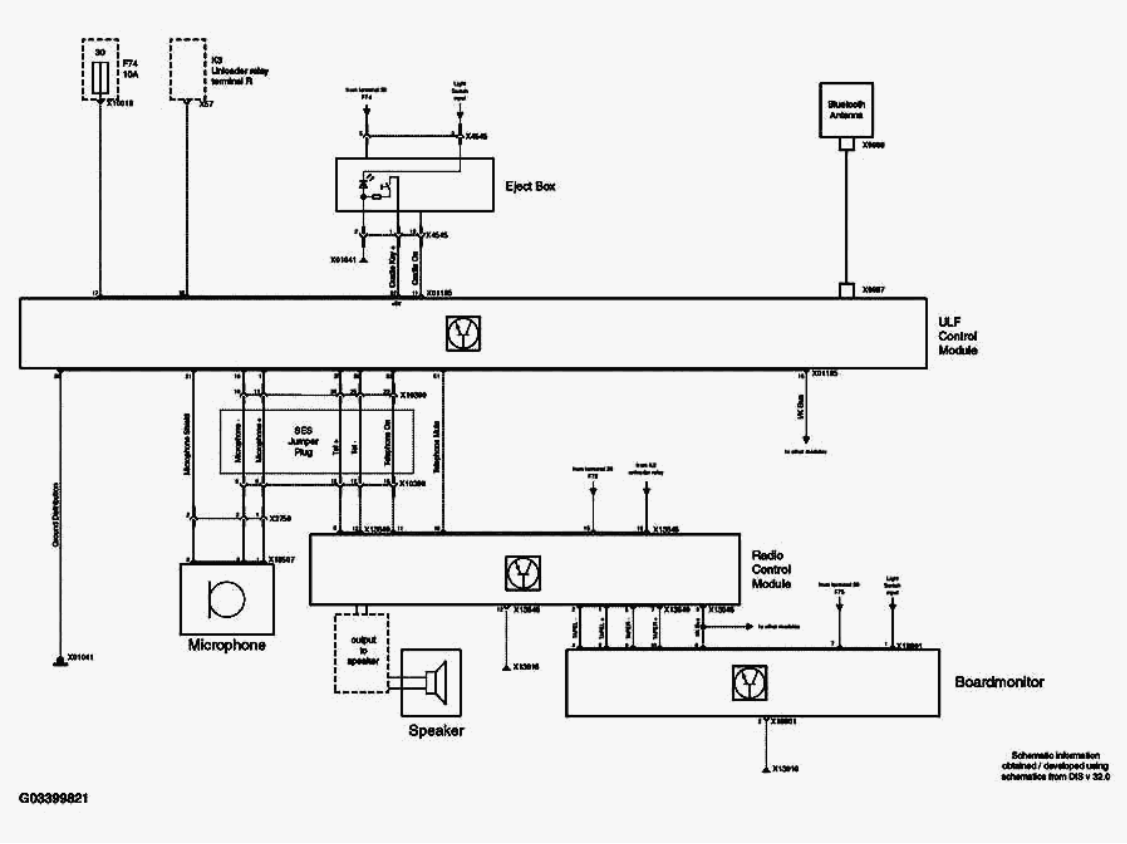


Fig. 16: ULF Wiring Schematic For E53 With Boardmonitor
Courtesy of BMW OF NORTH AMERICA, INC.

ULF Wiring Schematic for the E53 with Multi Information Display

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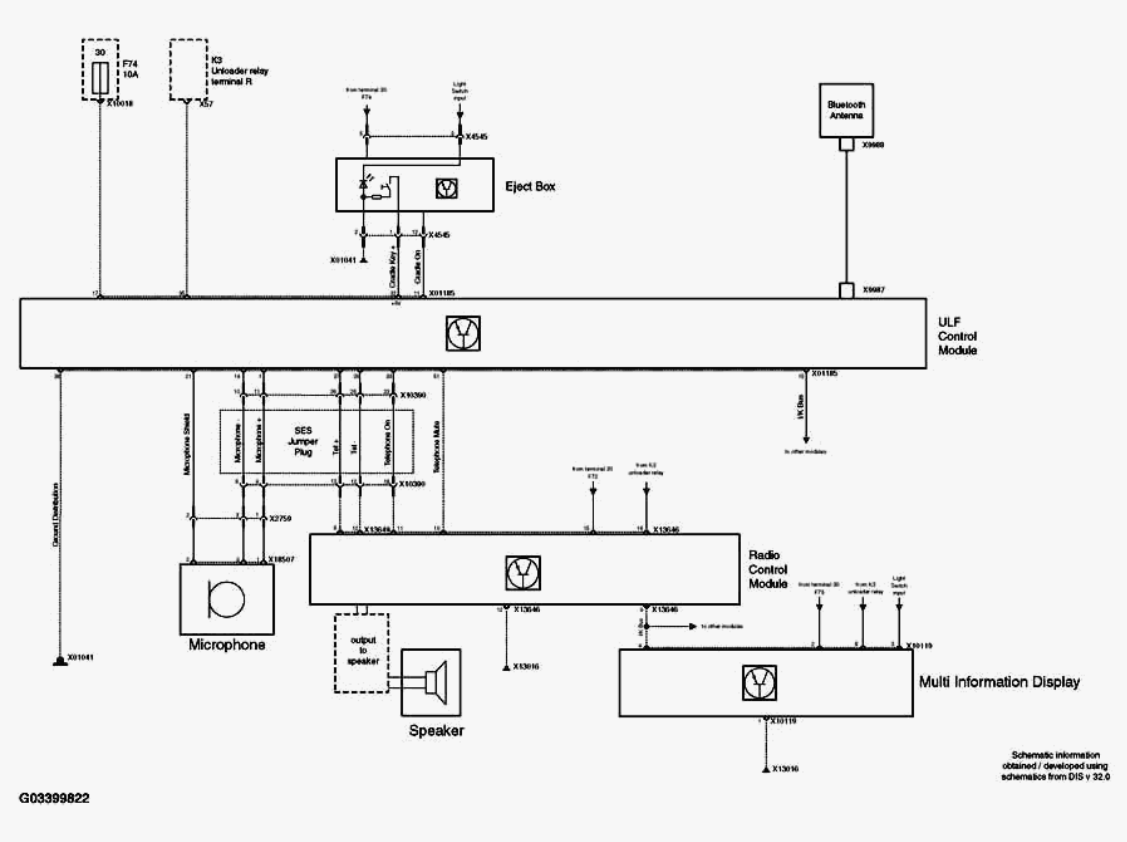


Fig. 17: ULF Wiring Schematic For E53 With MULTI Information Display
Courtesy of BMW OF NORTH AMERICA, INC.

ULF Wiring Schematic for the E39 with Boardmonitor

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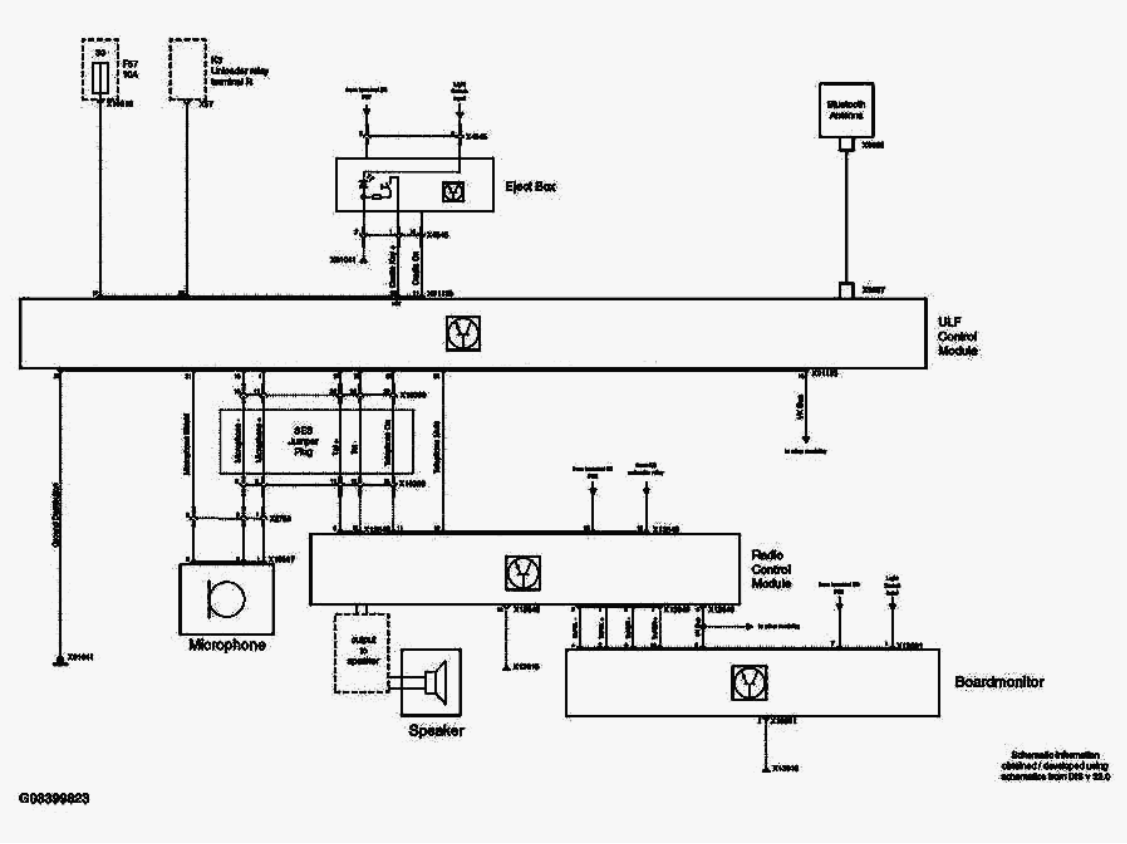


Fig. 18: ULF Wiring Schematic For E39 With Boardmonitor
Courtesy of BMW OF NORTH AMERICA, INC.

ULF Wiring Schematic for the E39 with Multi Information Display

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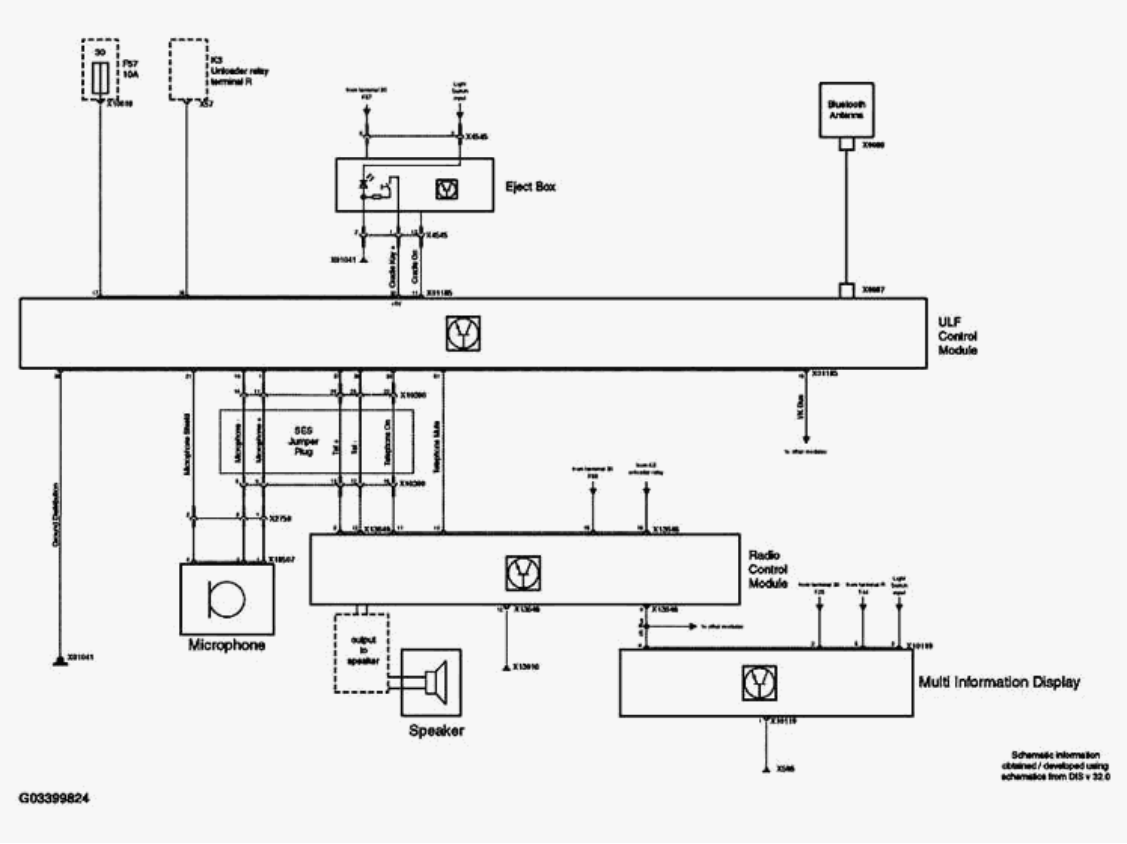


Fig. 19: ULF Wiring Schematic For E39 With Multi Information Display
Courtesy of BMW OF NORTH AMERICA, INC.

ULF Wiring Schematic for the E46 with Boardmonitor

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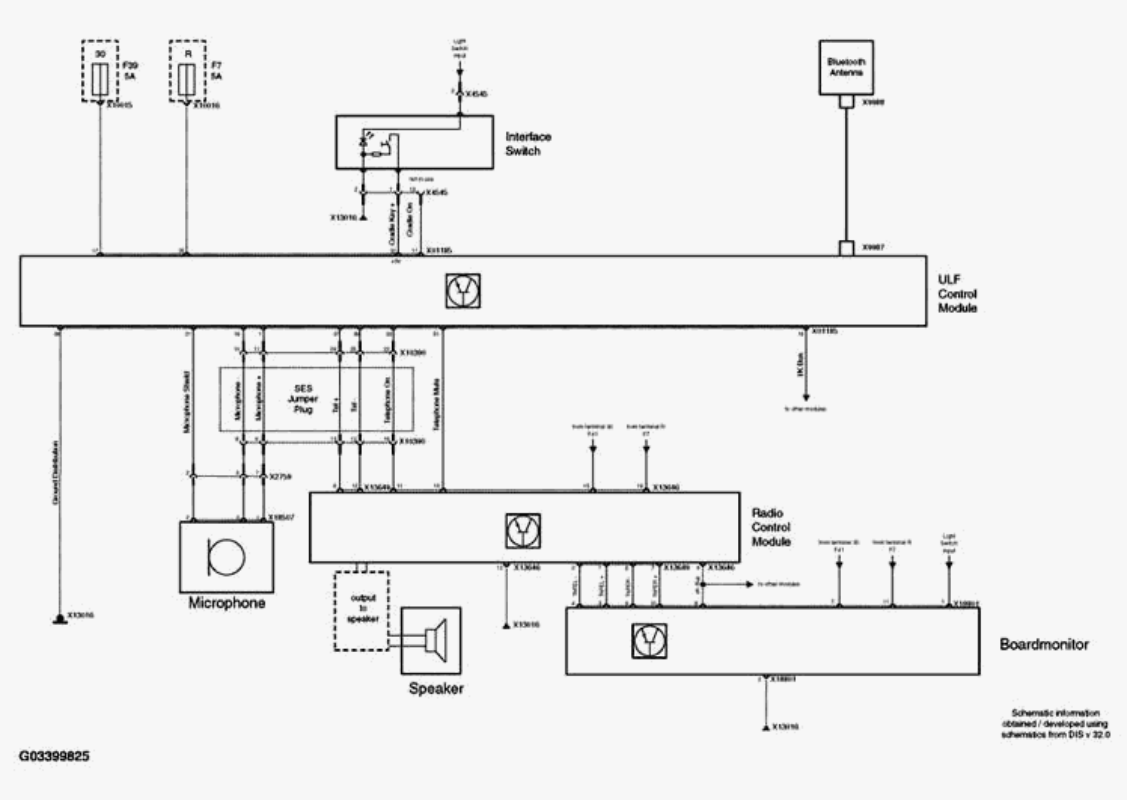


Fig. 20: ULF Wiring Schematic For E46 With Boardmonitor
Courtesy of BMW OF NORTH AMERICA, INC.

ULF Wiring Schematic for the E46 without the Boardmonitor

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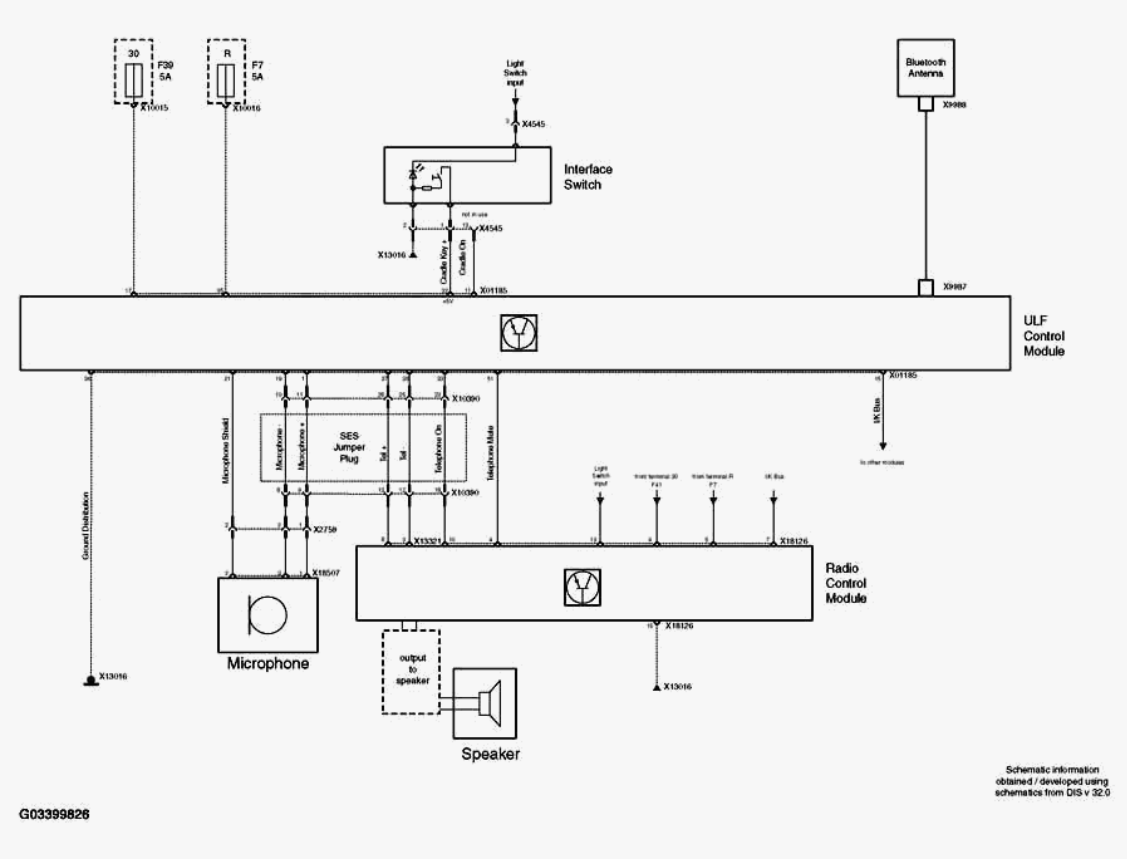


Fig. 21: ULF Wiring Schematic For E46 Without Boardmonitor
Courtesy of BMW OF NORTH AMERICA, INC.

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GENERAL INFORMATION

Breakout Boxes & Connectors - Overview

BREAKOUT BOXES AND CONNECTORS

Model: All

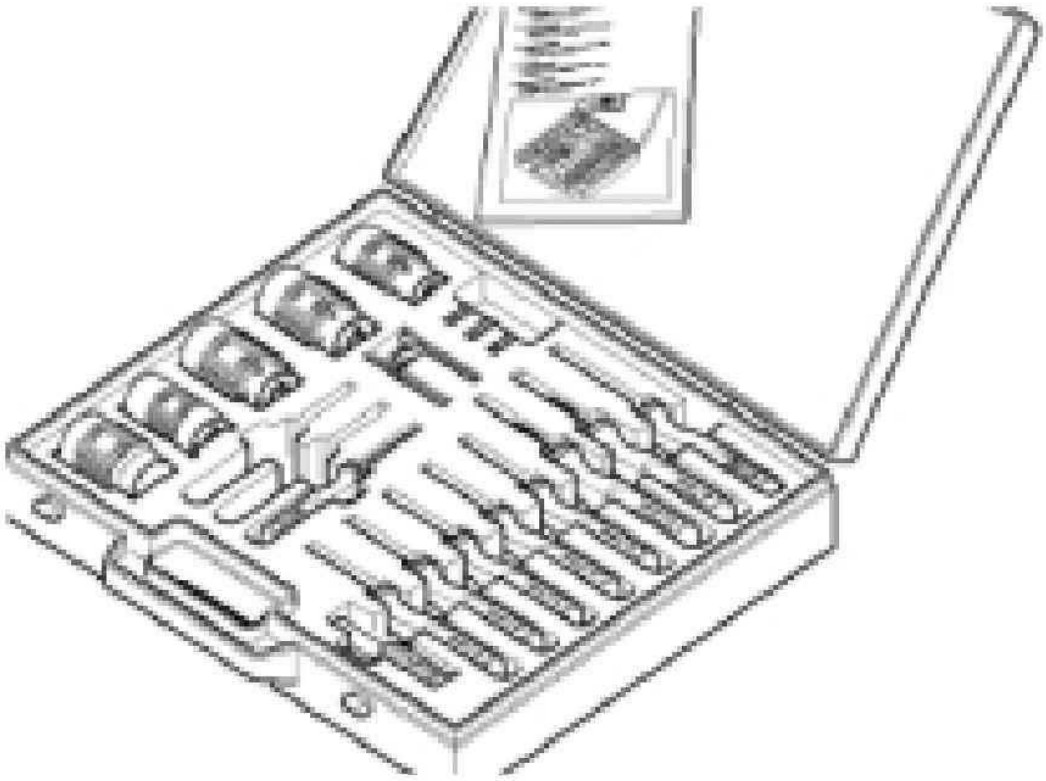
Production Date: All

CONNECTOR CONTACT KIT

Connector Contact Removal Kit

The connector contact removal kit provides tools for the disassembly of connectors. Proper use of these tools enable the technician to access wiring connectors for repairs equal to factory quality.

Always refer to the latest appropriate articles for up to date information regarding new tools.



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Fig. 1: Identifying Connector Contact Removal Kit
Courtesy of BMW OF NORTH AMERICA, INC.

Current P/N 88 88 6 611 150.

The Connector Contact Removal Kit is used for:

- Releasing round plug housings.
- Releasing relay carriers.
- Pressing out contacts.
- Pulling out indicator lamps.

Socket and Spring Contacts

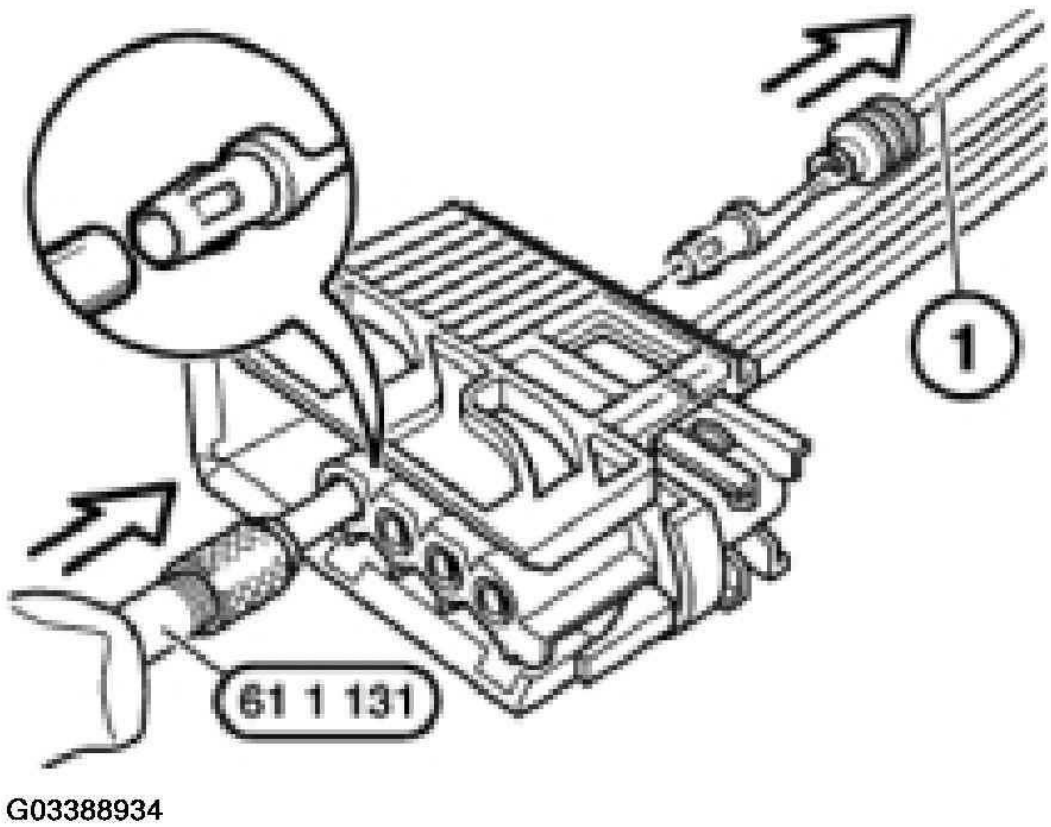


Fig. 2: Identifying Spring Contacts
Courtesy of BMW OF NORTH AMERICA, INC.

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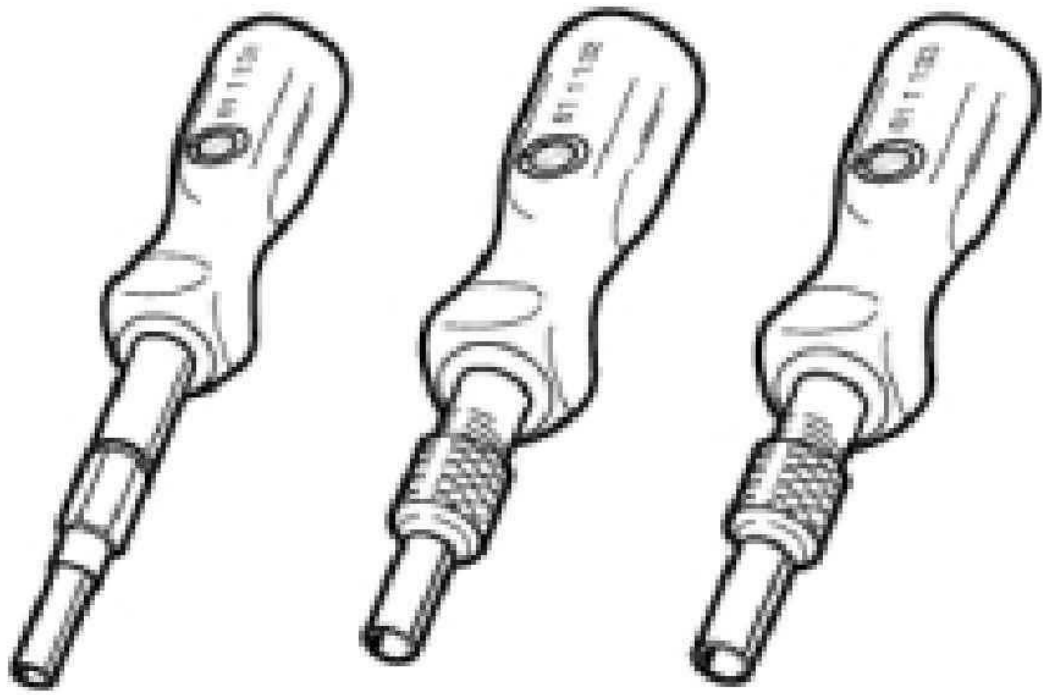


Fig. 3: View Of Socket Types
Courtesy of BMW OF NORTH AMERICA, INC.

Socket and Spring contacts compress the springs while the connector is pushed from the housing.

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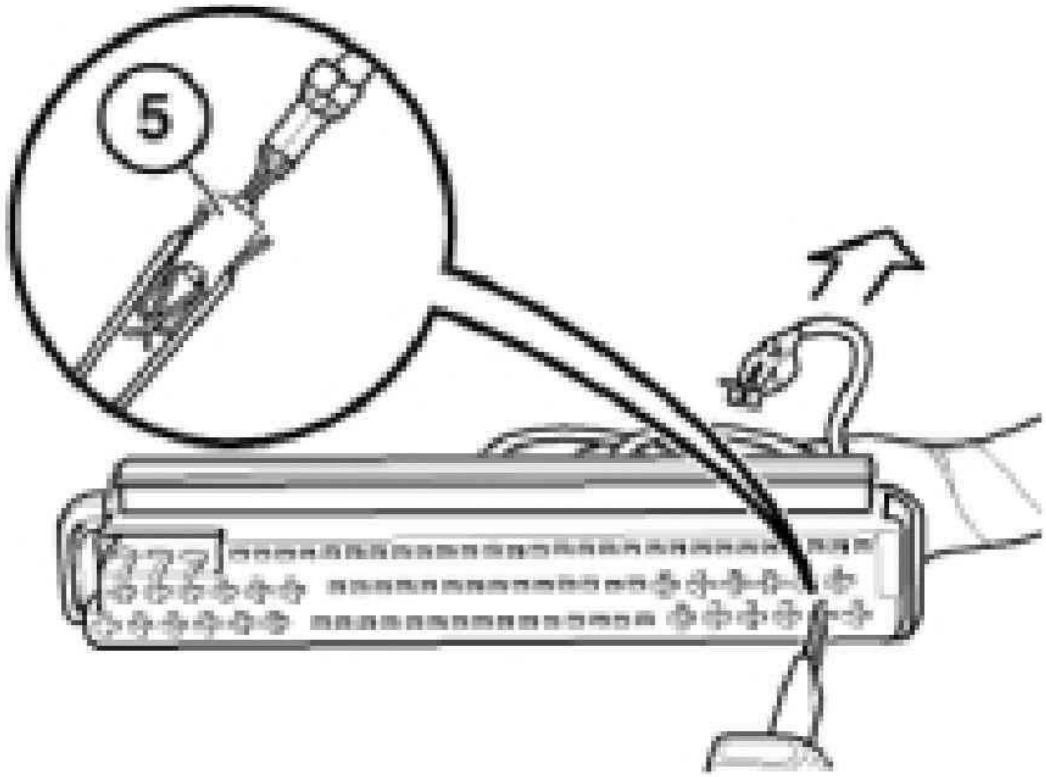


Fig. 4: Identifying Different Sockets
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 5: View Of Socket And Spring Contacts
Courtesy of BMW OF NORTH AMERICA, INC.

Flat spring contacts depress the spring allowing the connector to be pushed or gently pulled from the connector housing.

Instrument Cluster Illumination Bulb Holder Removal Socket

The backlighting illumination bulbs are removed from the cluster by placing square head of the socket on the bulb holder and turning 90° counter clockwise.

The bulb removal socket is used on all instrument clusters.

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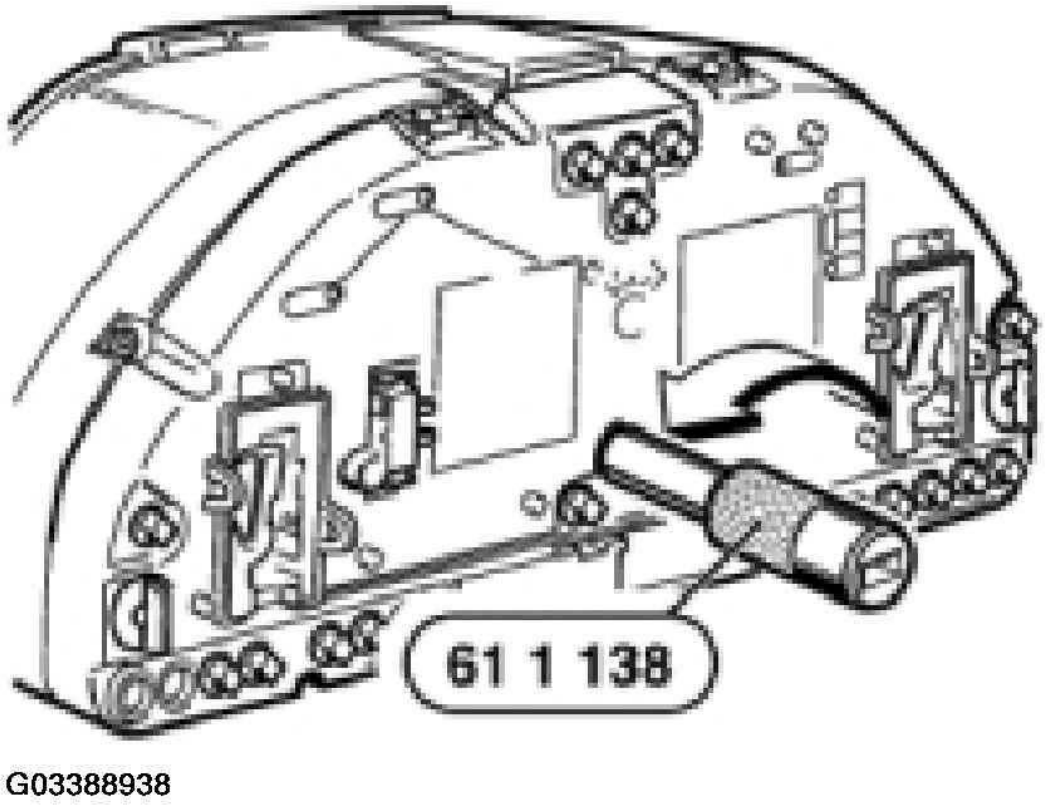


Fig. 6: Identifying Instrument Cluster Illumination Bulb Holder Removal Socket
Courtesy of BMW OF NORTH AMERICA, INC.

Relay Holder Disengaging Tool

This tool allows the relay holder (2) to disengage the relay connector (1).

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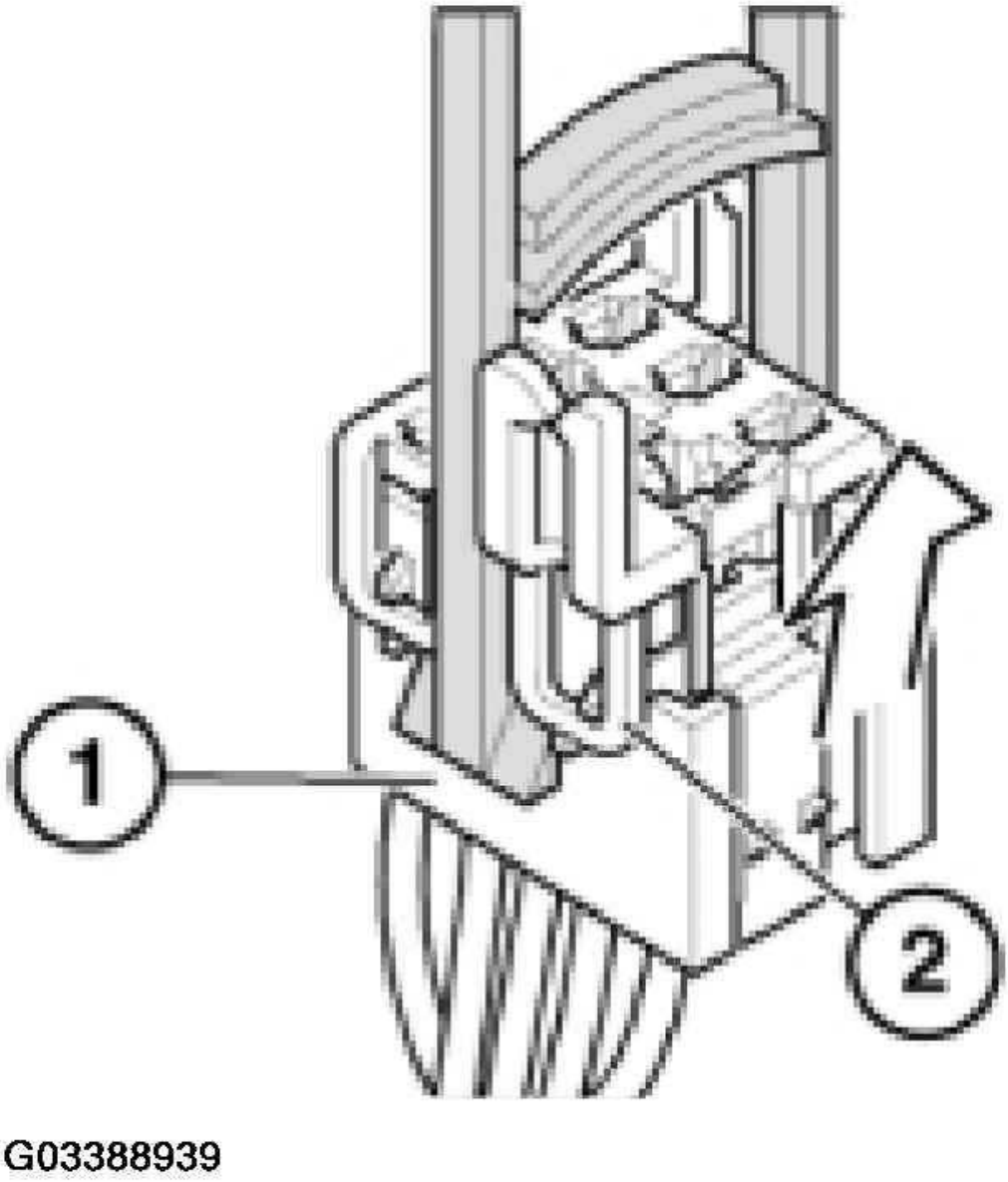


Fig. 7: Identifying Relay Holder Disengaging Tool
Courtesy of BMW OF NORTH AMERICA, INC.

Circular Connector Lock Disengager

These tools unlock the circular connector housings allowing the individual connectors to be removed.

The various sizes are reflected in the part numbers:

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4 pin = 61 1 141.

7 pin = 61 1 142.

10 pin = 61 1 145.

12 pin = 61 1 143.

25 Pin = 61 1 144.

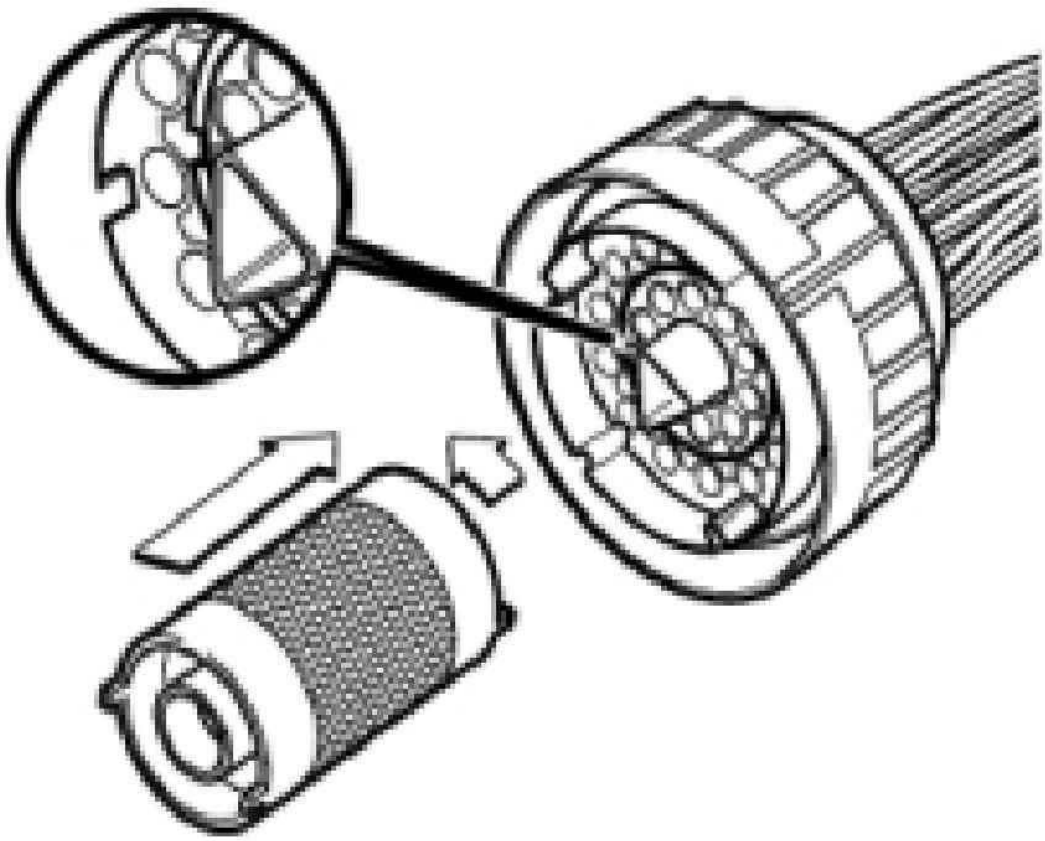


Fig. 8: Identifying Circular Connector Lock Disengager (1 Of 4)
Courtesy of BMW OF NORTH AMERICA, INC.

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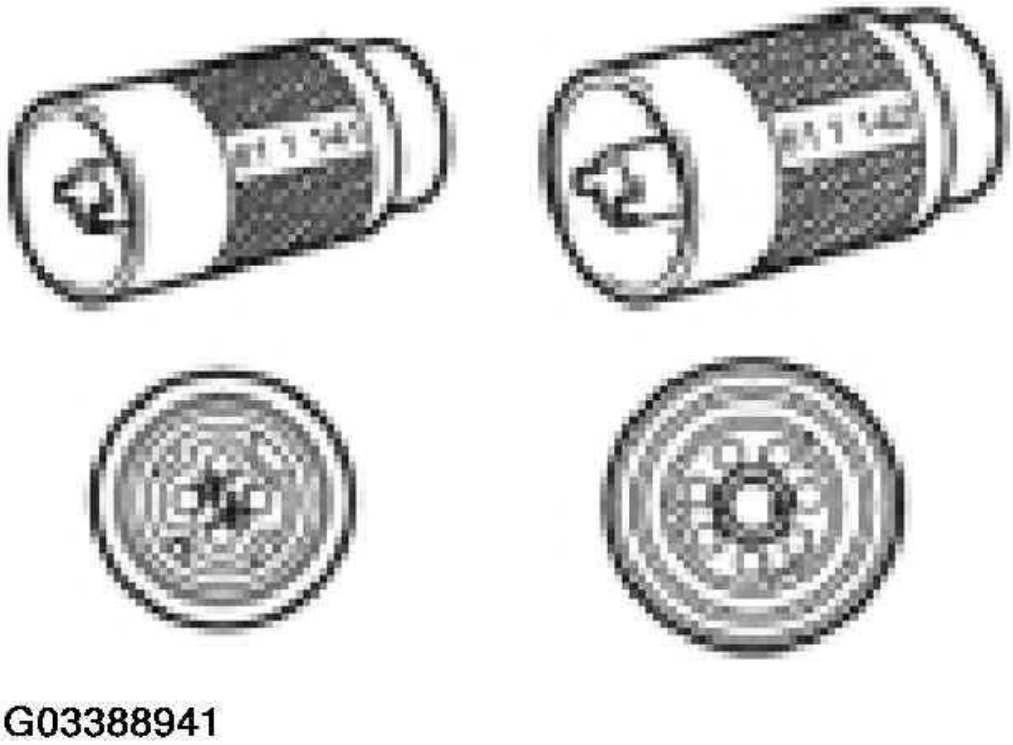


Fig. 9: Identifying Circular Connector Lock Disengager (2 Of 4)
Courtesy of BMW OF NORTH AMERICA, INC.

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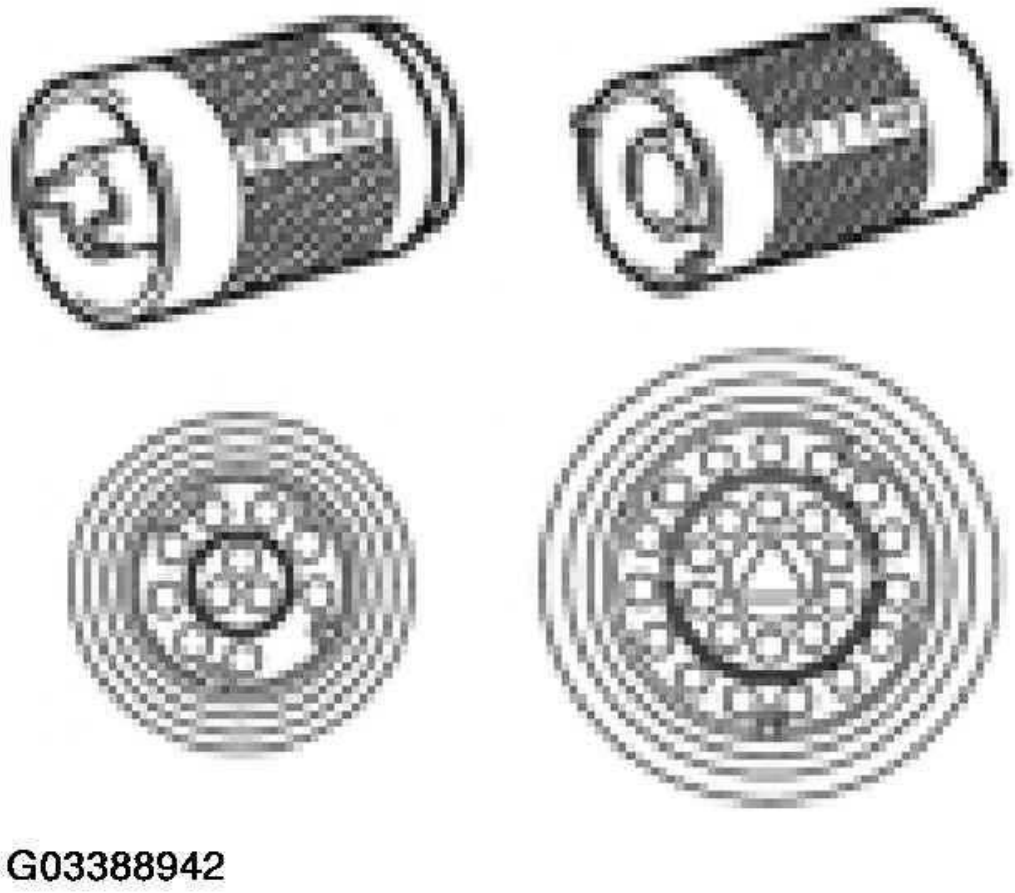


Fig. 10: Identifying Circular Connector Lock Disengager (3 Of 4)
Courtesy of BMW OF NORTH AMERICA, INC.

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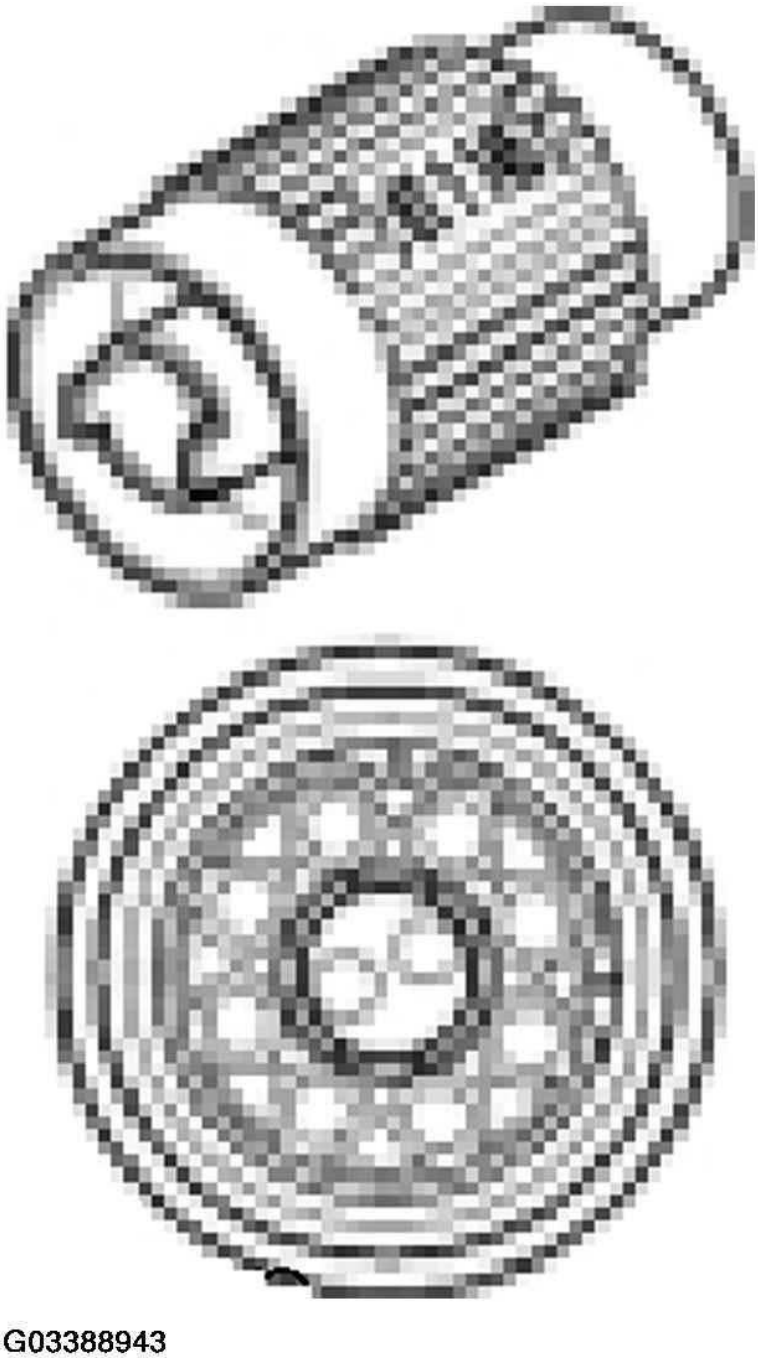


Fig. 11: Identifying Circular Connector Lock Disengager (4 Of 4)
Courtesy of BMW OF NORTH AMERICA, INC.

BMW PLUG SYSTEM ABBREVIATIONS

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BMW PLUG SYSTEM ABBREVIATIONS

D 1.5/2.5	Round contacts of 1.5mm or 2.5mm diameter
MDK 3 Plus	Miniature double flat spring contact
JPT ELA	Junior Power Timer flat spring contacts with strand sealing
DFK ELA	Double flat spring contacts with strand sealing
Elo	Electronic contacts with and without strand sealing Manufacturer: Siemens
Elo	Power Electronic contacts for heavy loads with and without strand sealing Manufacturer: Siemens
MQS	Micro Quadlock System electronic contacts with and without strand sealing Manufacturer: AMP
MPQ	Micro Power Quadlock electronic contacts for heavy loads with and without strand sealing Manufacturer: AMP

PLUG SYSTEM D1.5/D2.5

Circular Plug 7--8 Pin System D2.5

- Pull off the rubber boot (1).
- Push the retaining lugs (2) of the inner connector section 3 inward carefully to disengage the lock notch.
- Push the inner connector section (3) in the direction of the arrow in the illustration until the retaining lugs (2) are in the recessed notch (4) and use the appropriate sized spring contact tool and remove the connector from the housing.

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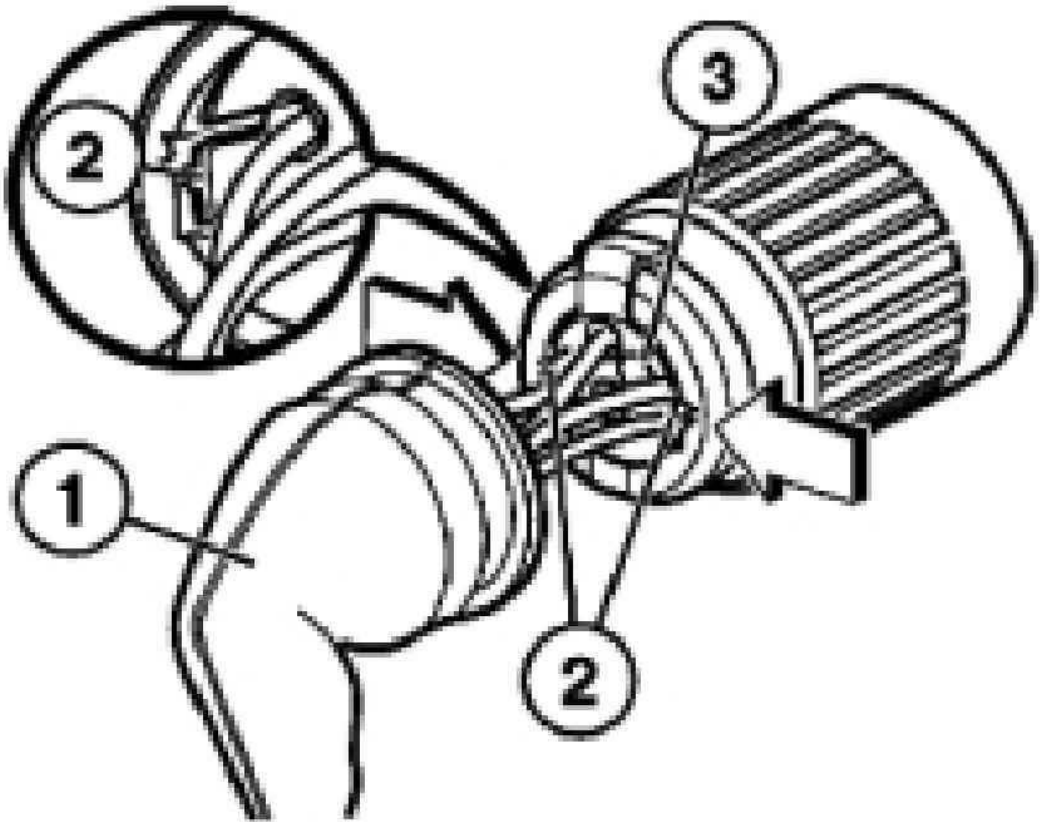


Fig. 12: Identifying Inner Connector Retaining Lugs
Courtesy of BMW OF NORTH AMERICA, INC.

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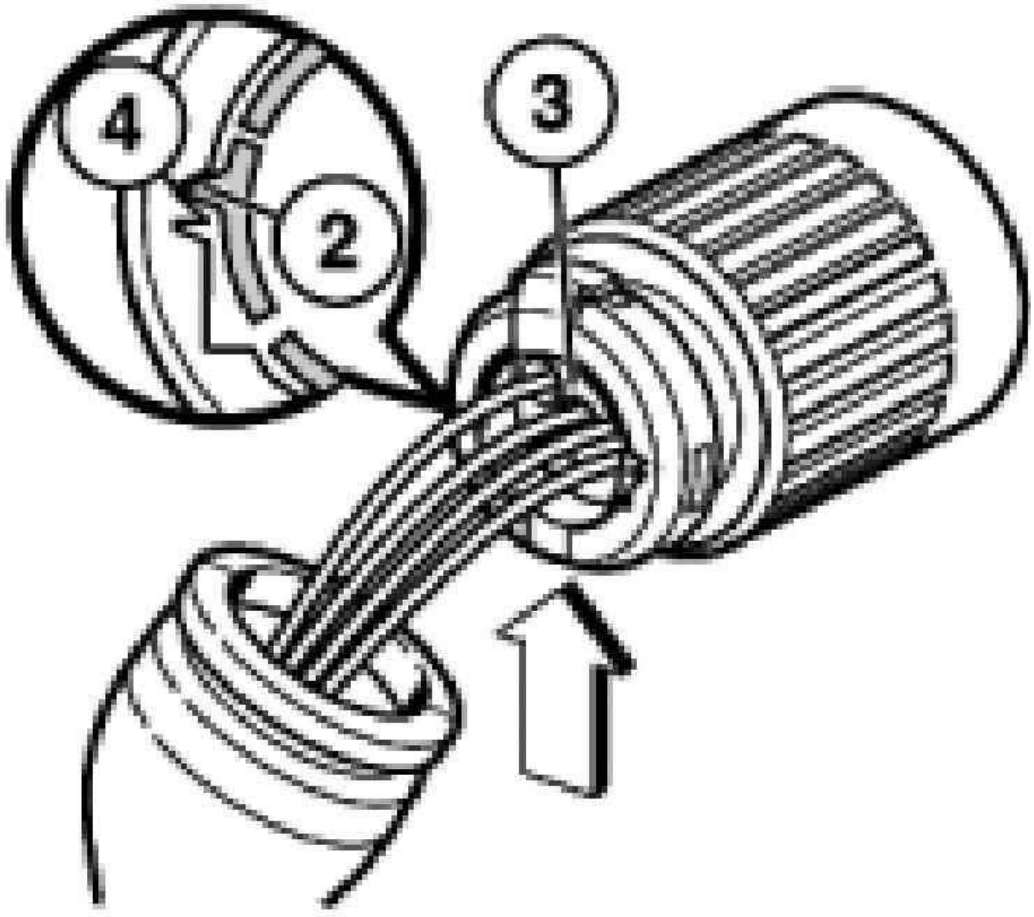


Fig. 13: Locating Recessed Notch In Inner Connector
Courtesy of BMW OF NORTH AMERICA, INC.

Circular plug 13 Pin System D2.5

- Carefully pull off the rubber grommet (1).
- Pull the lock retainers (2) outward (direction of arrows) to allow the lock notch to disengage.
- Pull the inner section (3) upward as shown in the illustration until the lock notches (4) are in the released position of the lock retainers (5) and use the appropriate size spring contact and remove the connector from the housing.

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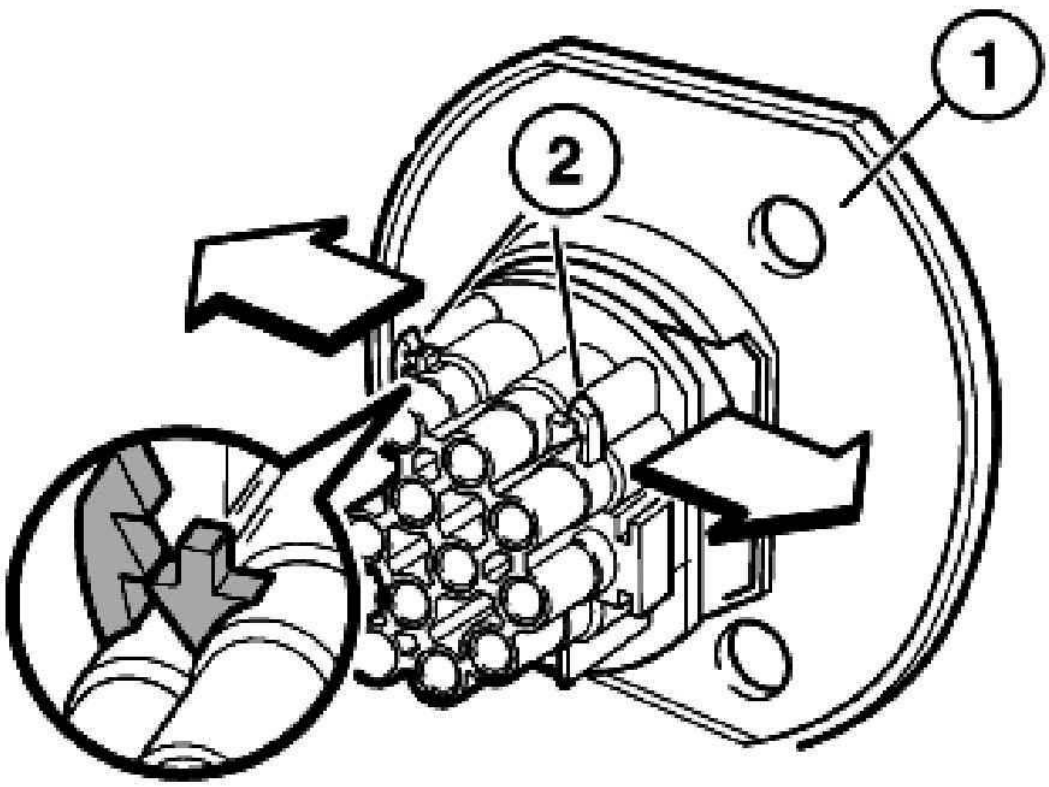


Fig. 14: Locating Circular Plug Lock Retainers
Courtesy of BMW OF NORTH AMERICA, INC.

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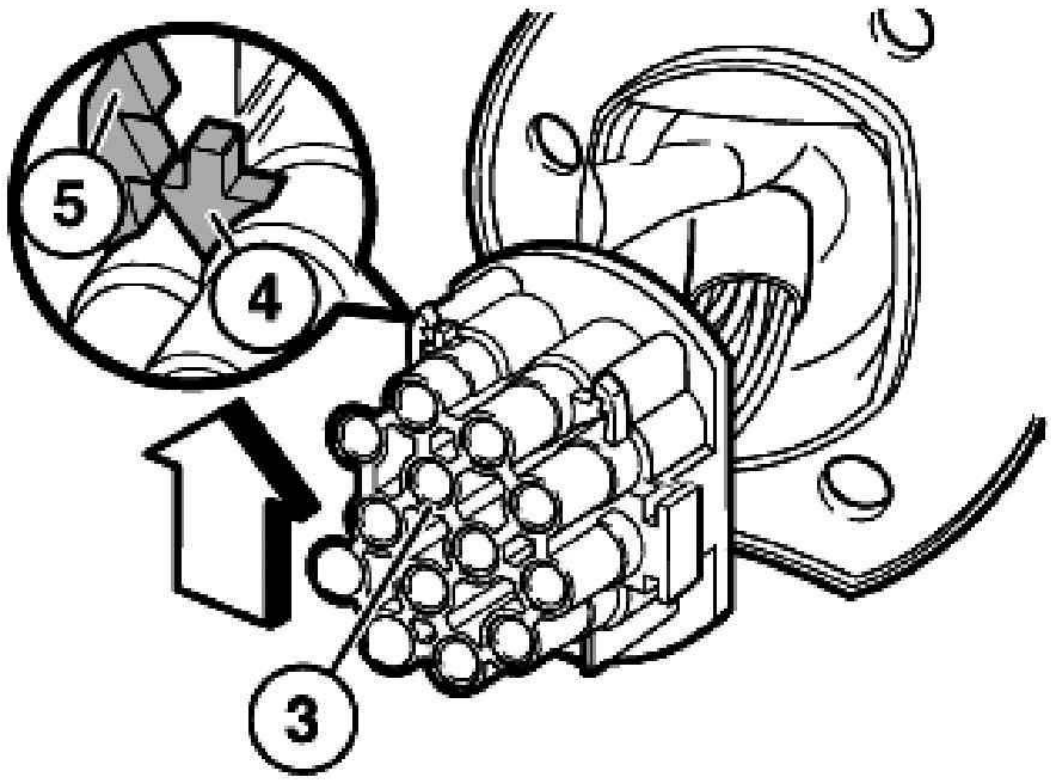


Fig. 15: View Of Lock Notch In Circular Plug
Courtesy of BMW OF NORTH AMERICA, INC.

Circular Plug 20 Pin System D2.5

- With the boot pulled back, press the lock tabs (1) of the inner connector section (2) inward.
- Simultaneously, rotate the inner connection section (2) counter clockwise to allow the lock tabs (1) to engage in the unlocked position and use the appropriate sized spring contact and remove connector from the housing.

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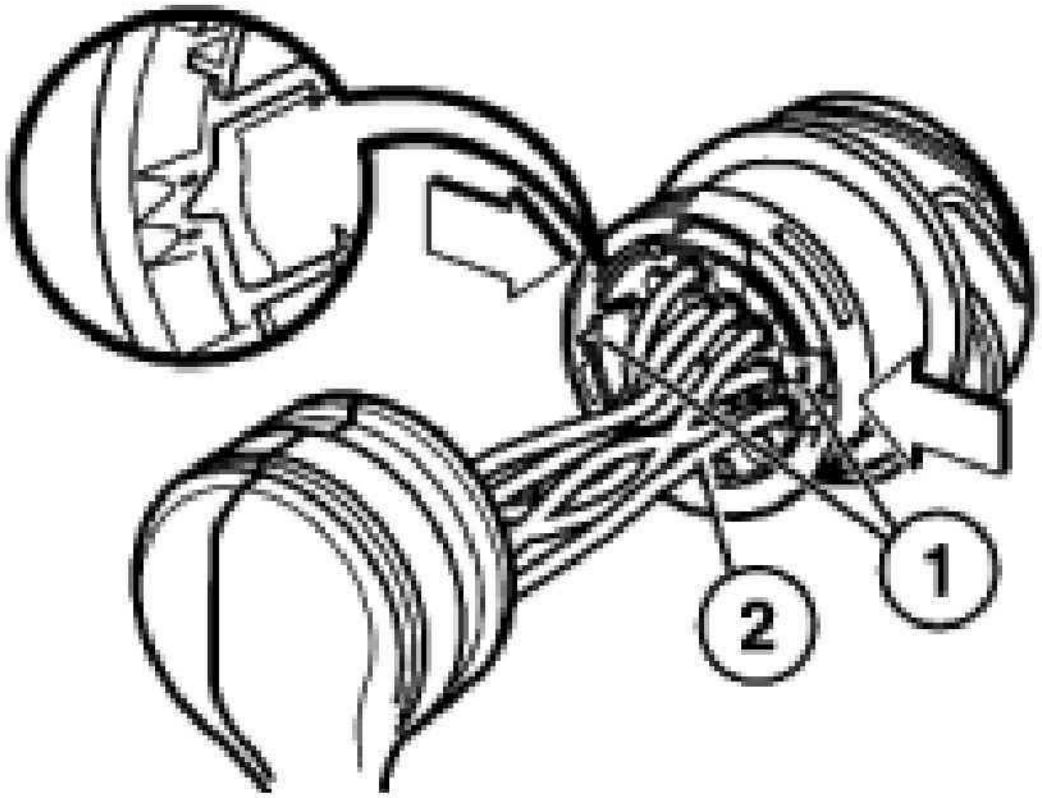


Fig. 16: Identifying Circular Plug Lock Tabs
Courtesy of BMW OF NORTH AMERICA, INC.

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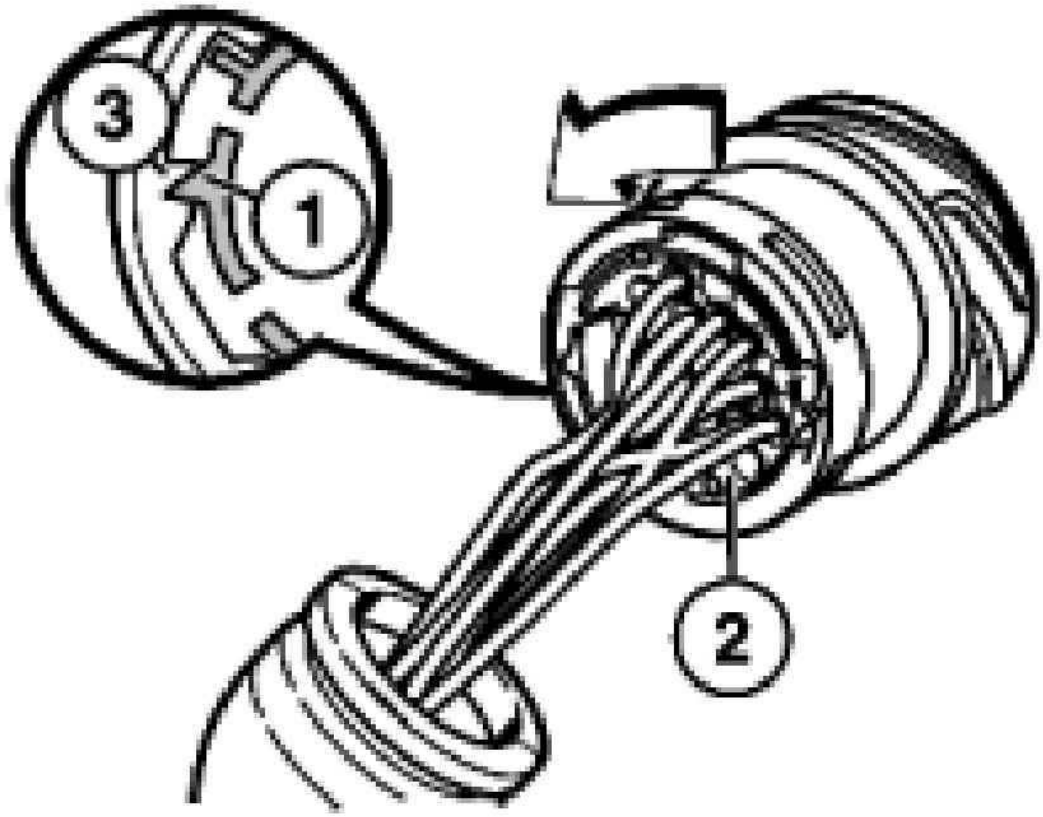


Fig. 17: View Of Inner Connection Of Circular
Courtesy of BMW OF NORTH AMERICA, INC.

Circular Plug 4-7-10-12-25 Pin System D1.5/D2.5

- Insert the appropriate unlocking tool (determined by the number of pins) into the connector.
- The connector is unlocked when the lock tab (3) is in the unlocked position (1). The connector is locked when the lock tab (3) is in the locked position (2).
- Use the appropriate sized spring contact and remove connector from the housing.

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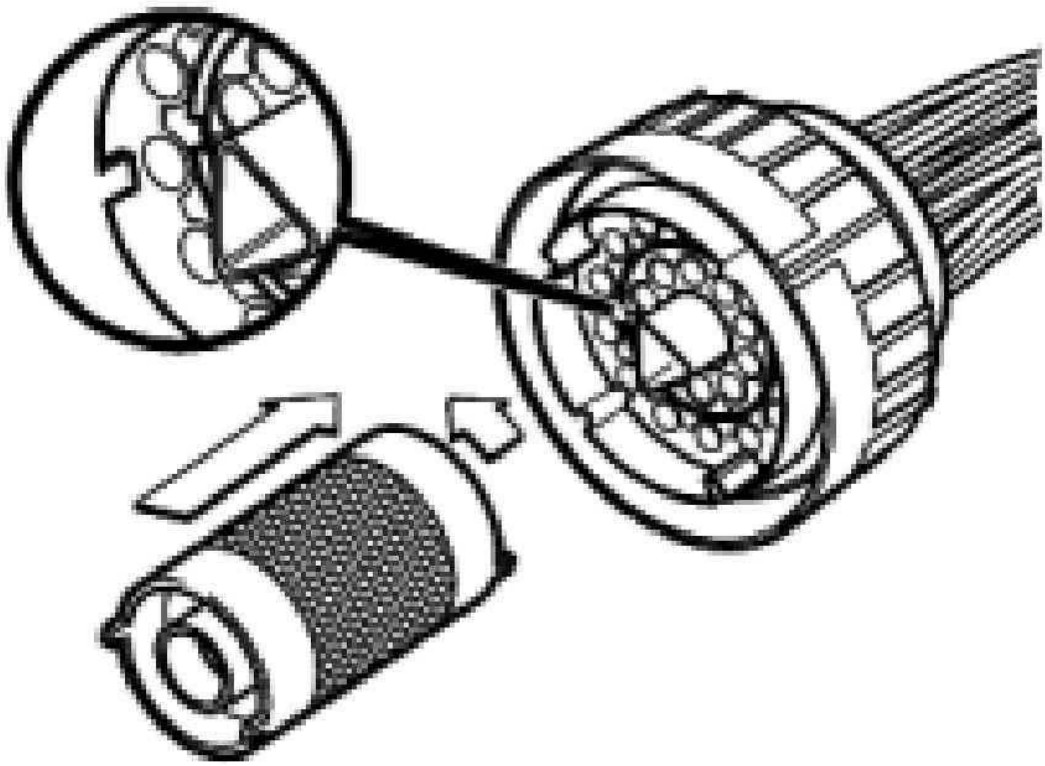


Fig. 18: View Of Circular Plug And Special Tool
Courtesy of BMW OF NORTH AMERICA, INC.

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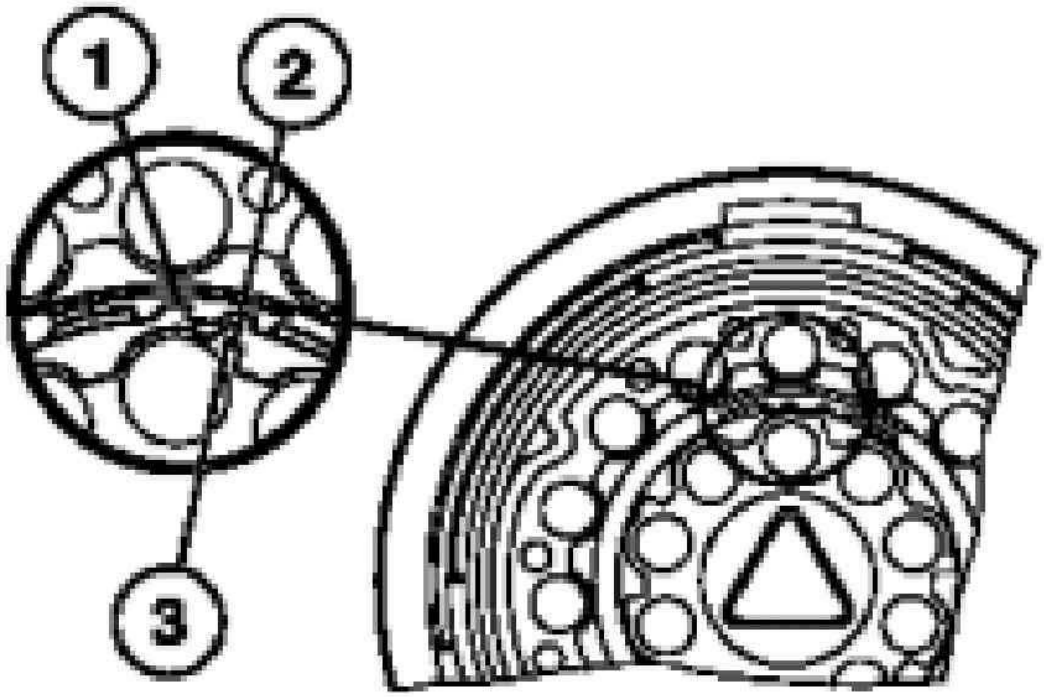


Fig. 19: Identifying Lock Tab Of Circular Plug
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 15 Pin System D2.5

- Pull the outer connector section (1) slightly outward in the area of lock tabs (2).
- Simultaneously, slide the inner connector section (3) in the direction of the arrow to the unlocked position.
- Use the appropriate sized spring contact and remove connector from housing.

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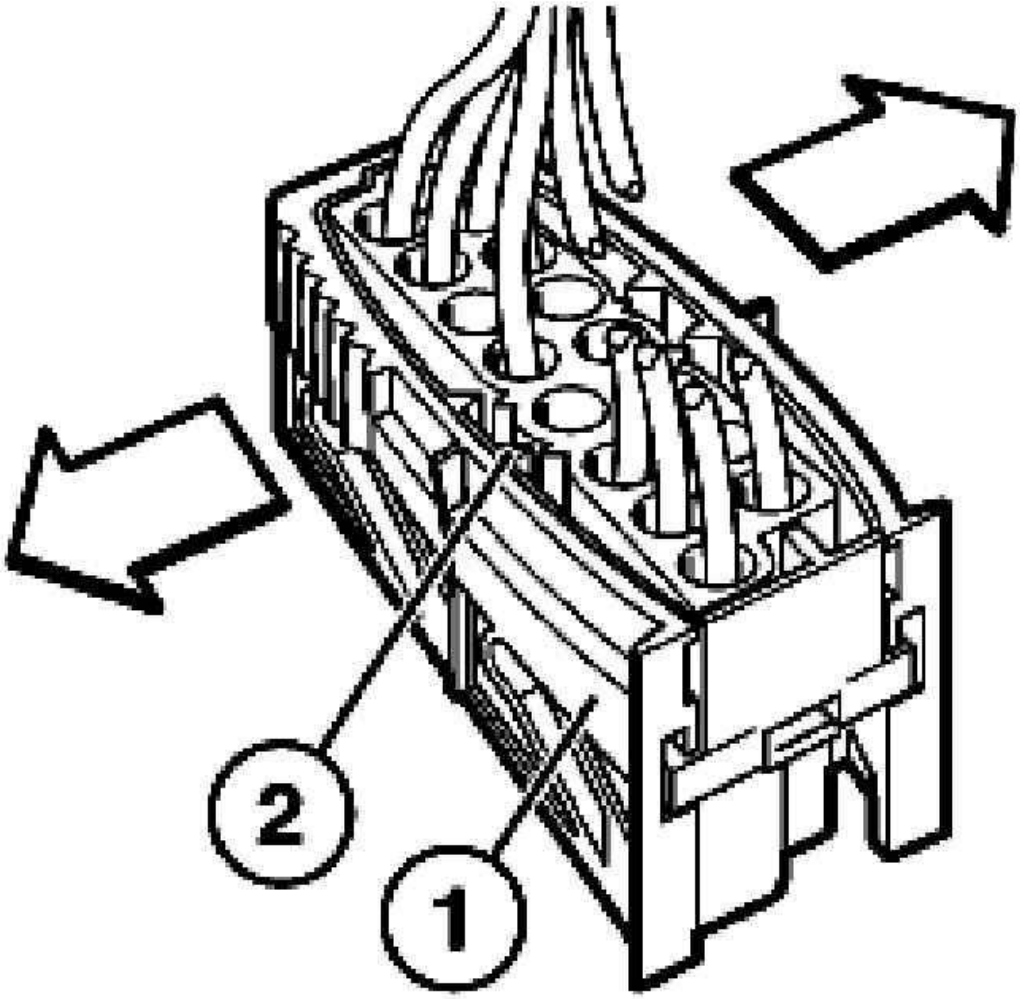


Fig. 20: Identifying In-Line Plug Lock Tabs
Courtesy of BMW OF NORTH AMERICA, INC.

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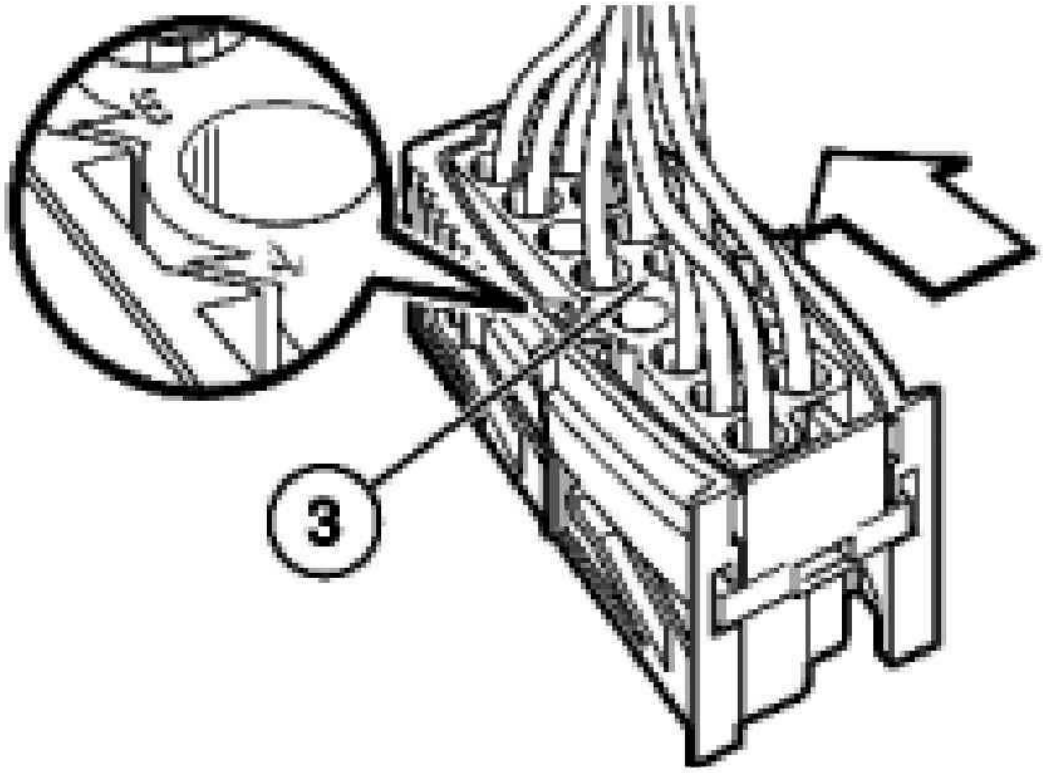


Fig. 21: Locating In-Line Plug Inner Connector Section
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 8-, 12 Pin System D2.5

- Slide the upper section (1) and the lower section (2) of the connector in opposite directions to unlock the connector.
- Using special tool **61 1 132** press the spring latch down and pull the connector (3) from the housing.

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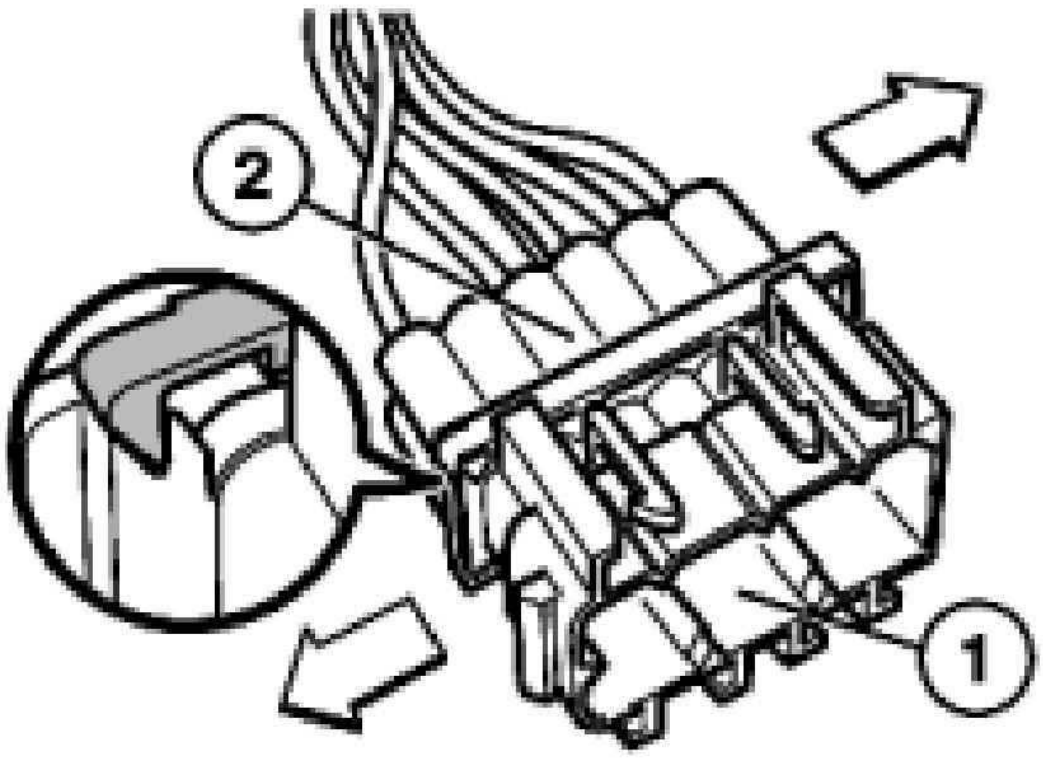


Fig. 22: Separating In-Line Plug Lower And Upper Sections
Courtesy of BMW OF NORTH AMERICA, INC.

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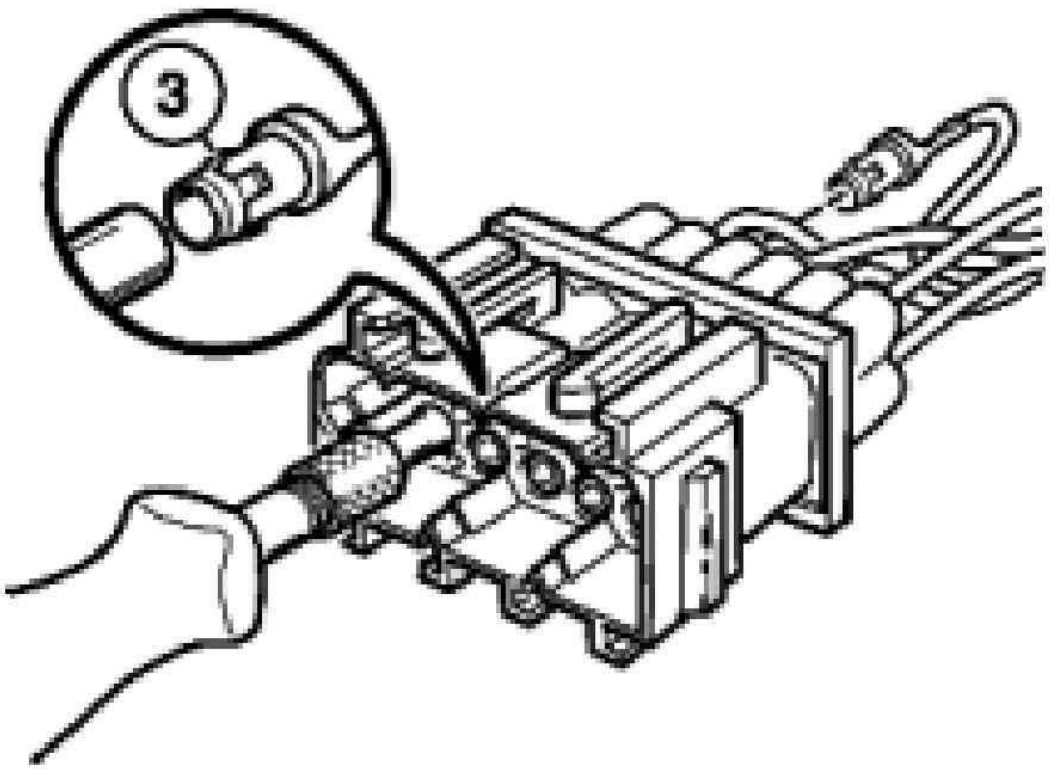


Fig. 23: View Of In-Line Plug Connector
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 20 Pin System D2.5

- Pull locking slide (1) completely out of connector (2).
- Using special tool **61 1 132** press the spring latch down and pull the connector from the housing.

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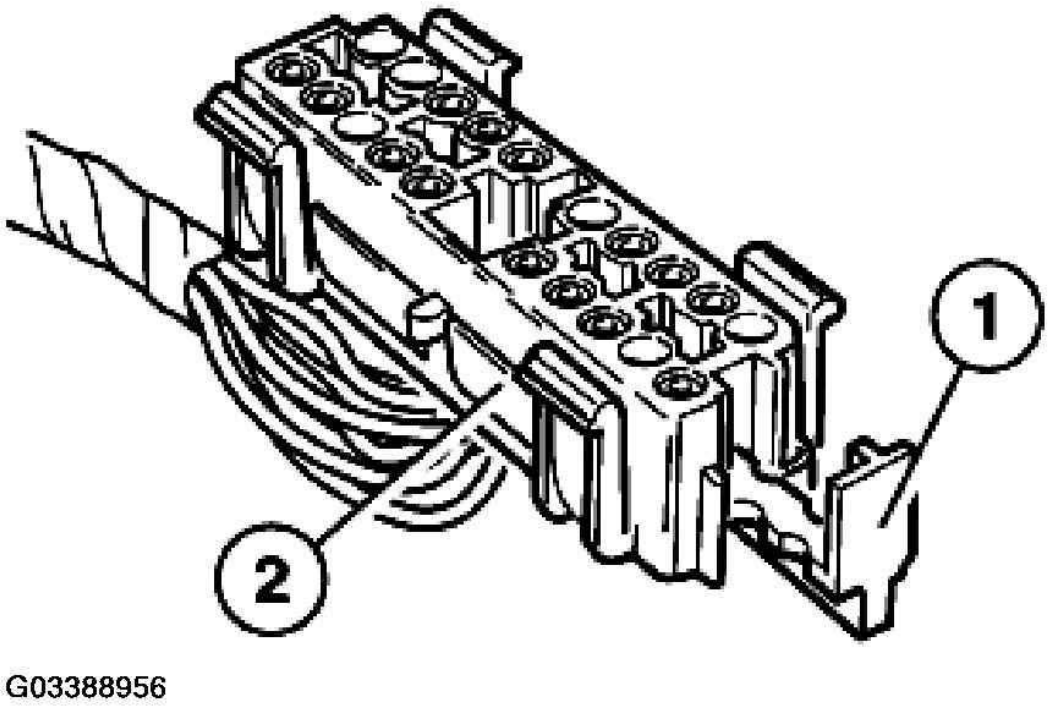


Fig. 24: Removing Locking Slide From Connector
Courtesy of BMW OF NORTH AMERICA, INC.

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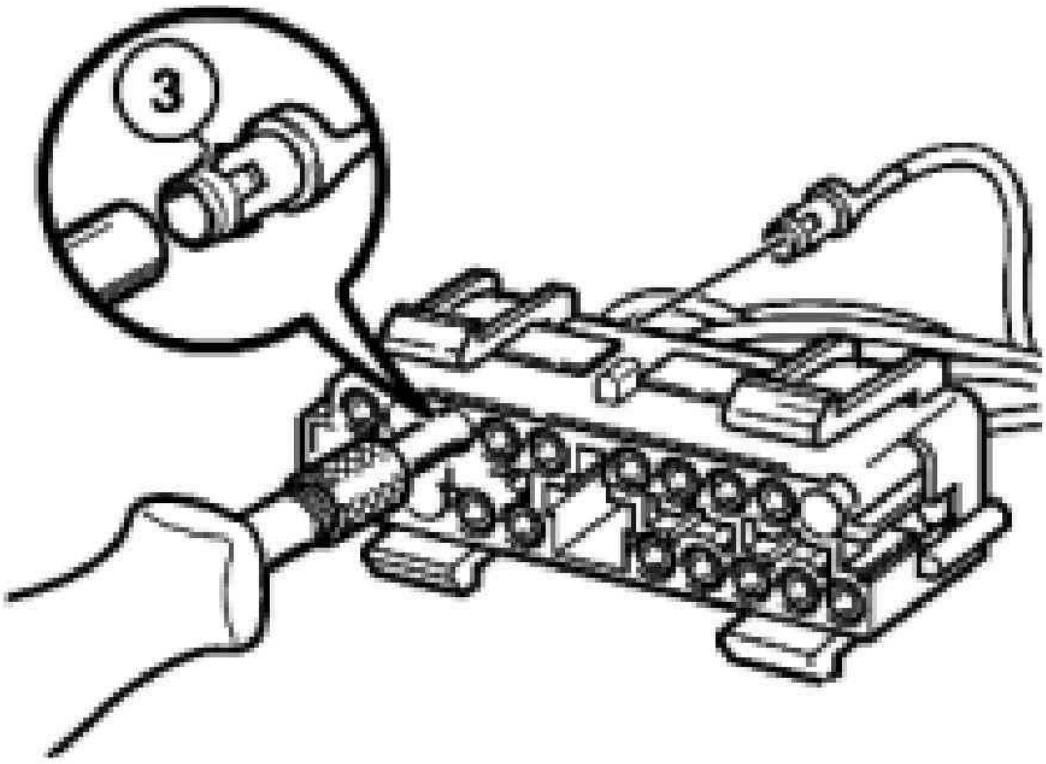


Fig. 25: View Of In-Line Plug Connector
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 30 Pin System D2.5

- Pull the outer section (1) slightly outward in the area of lock tabs (2).
- Simultaneously, slide the inner connector section (3) in the direction of the arrow to the unlocked position.
- Use the appropriate sized spring contact and remove connector from housing.

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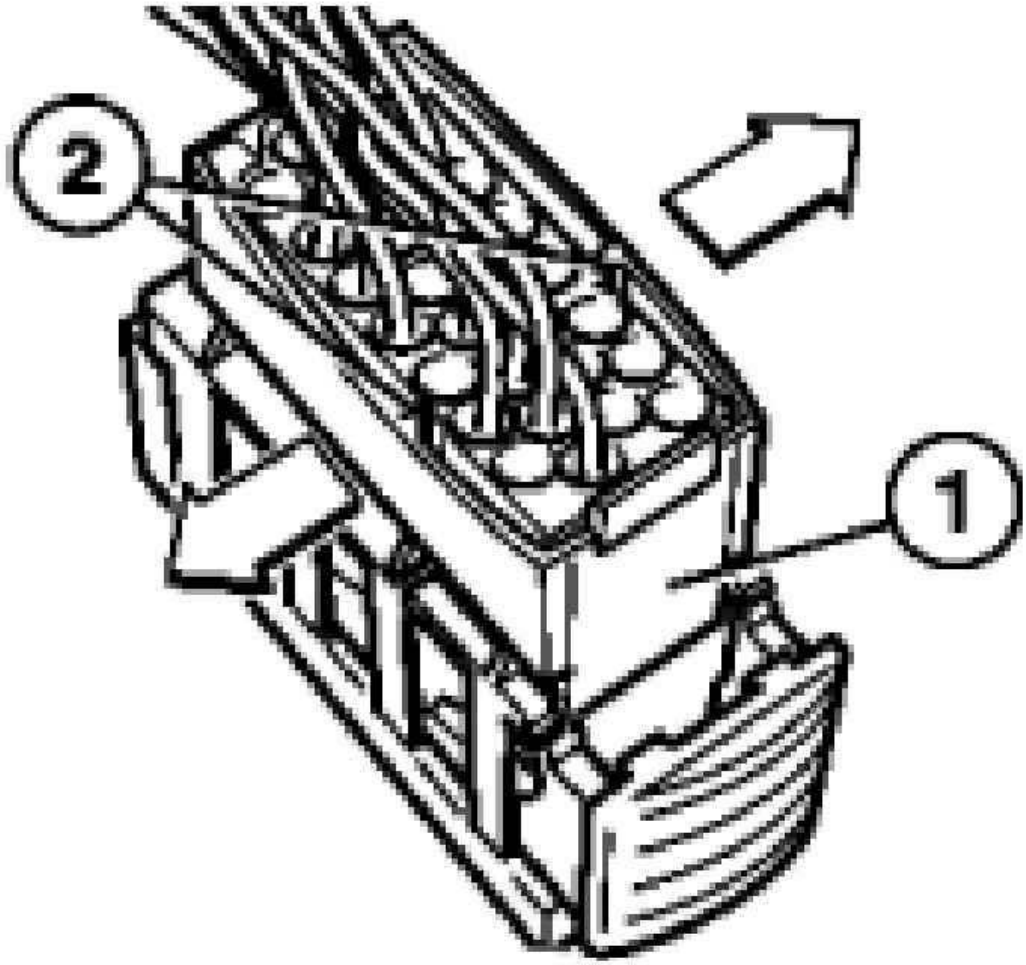


Fig. 26: Identifying In-Line Plug Outer Section
Courtesy of BMW OF NORTH AMERICA, INC.

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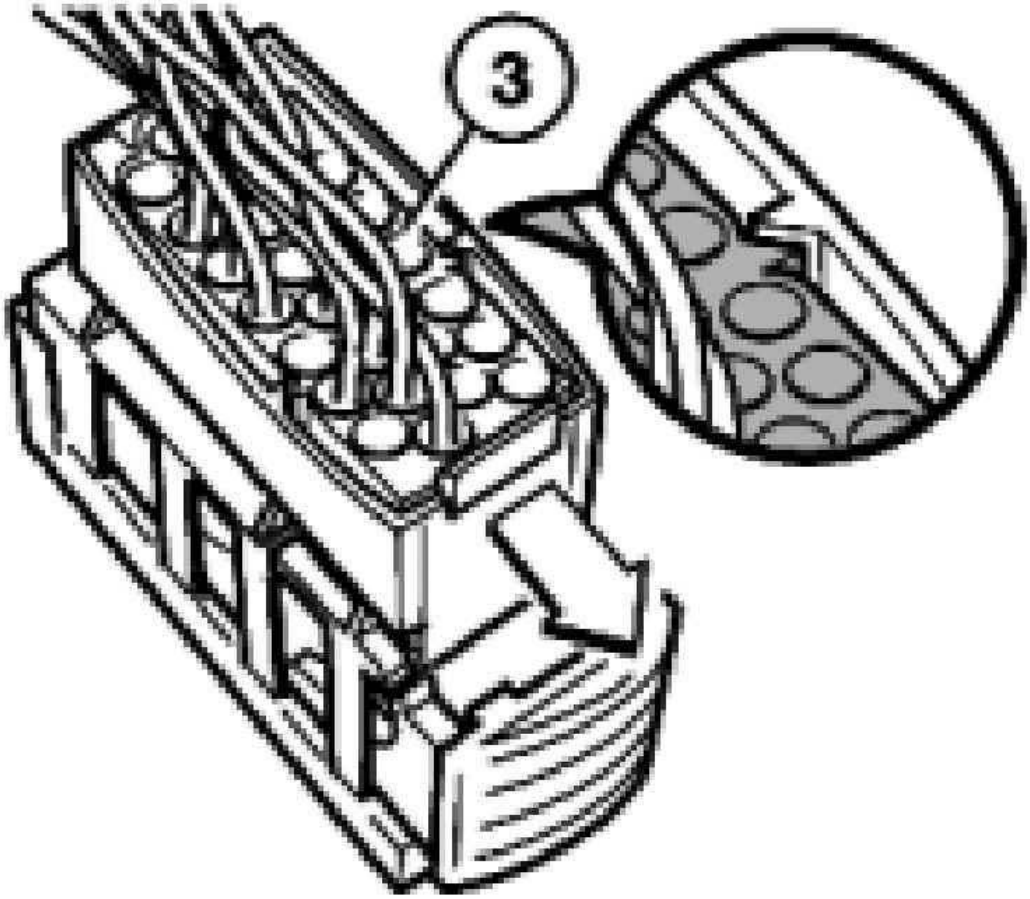


Fig. 27: View Of Inner Section Of In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

PLUG SYSTEM JPT/MDK/DFK

In-line plug 2 Pin System JPT ELA

- Press lock (1) in direction of arrow and slide plug forward.
- Press lock (1) downward and slide out to one side.
- Unlock contact with special tool **61 1 136** and pull out cable (2) and contact towards rear.

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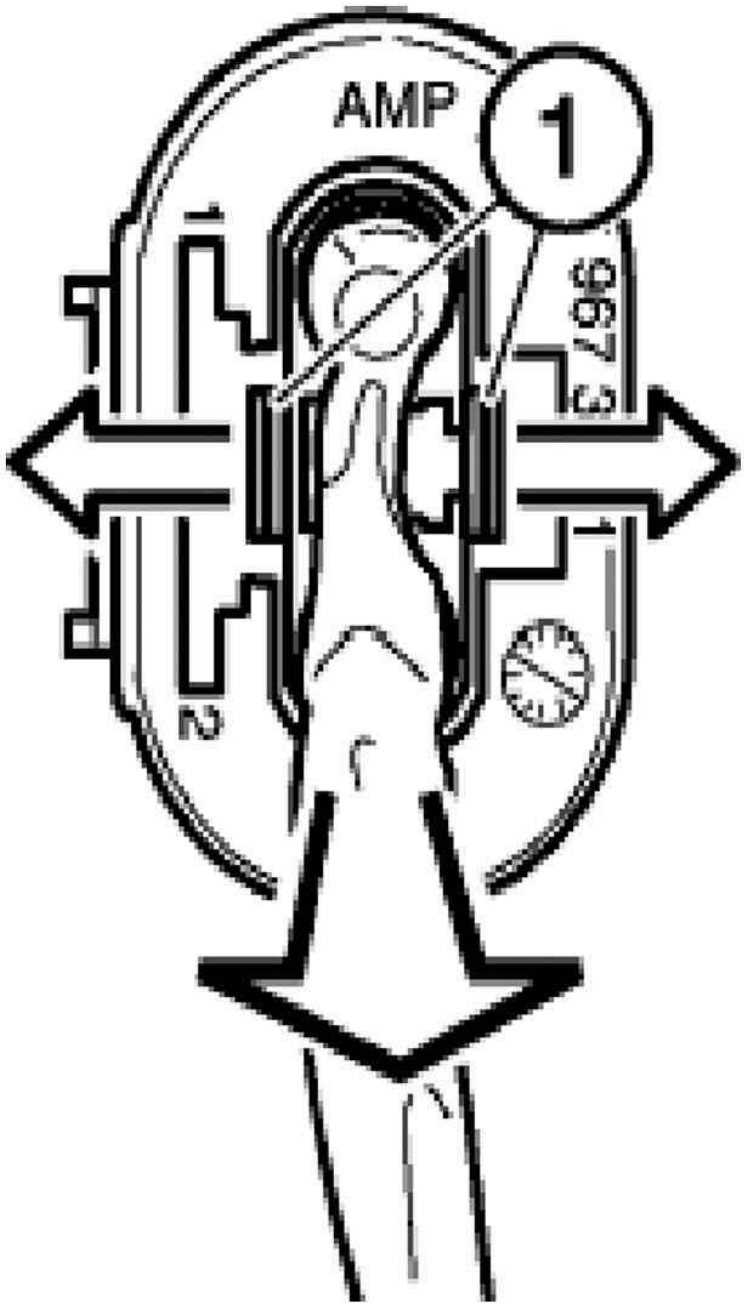


Fig. 28: Locating Lock For In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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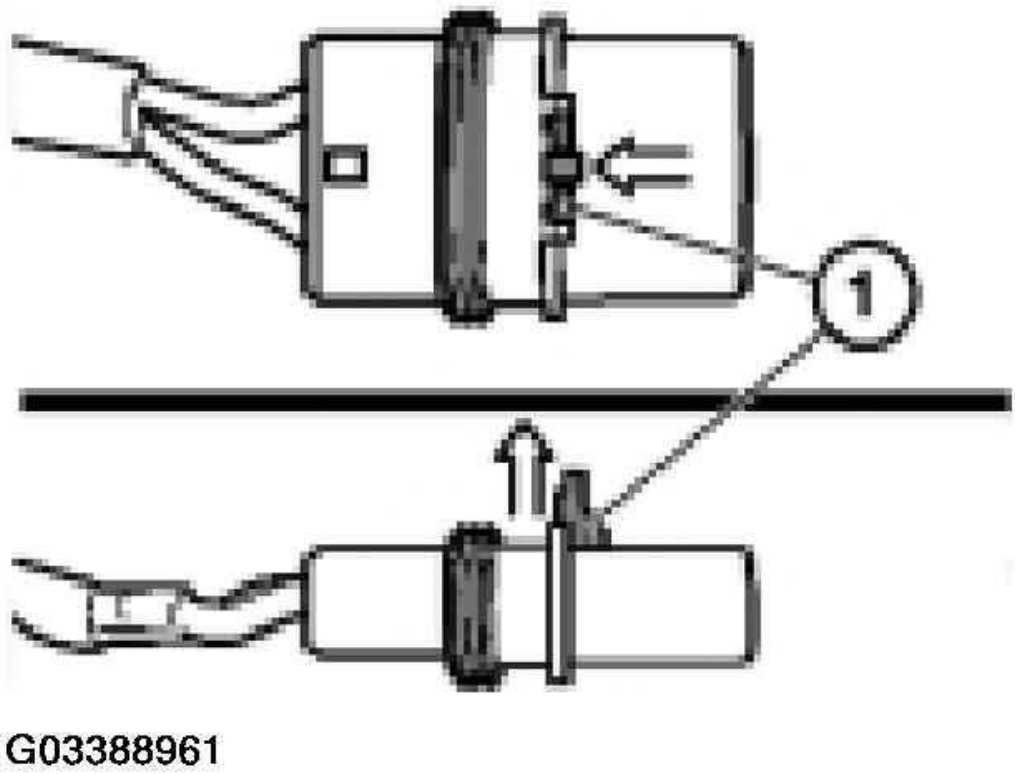


Fig. 29: View Of In-Line Plug Lock
Courtesy of BMW OF NORTH AMERICA, INC.

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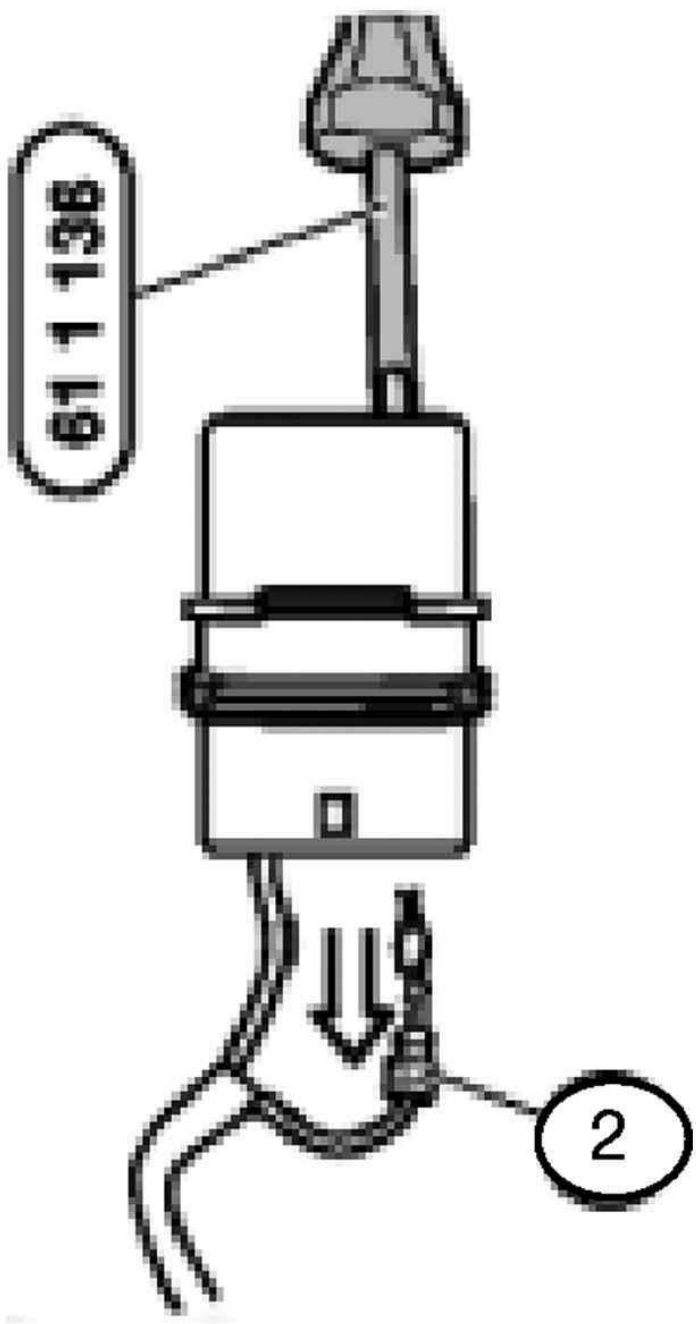


Fig. 30: Removing In-Line Plug Contact Using Special Tool
Courtesy of BMW OF NORTH AMERICA, INC.

In-line plug 2 Pin System MDK 3 plus 2.8

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- Unlock lock (1) on outside at arrester hook and slide out lock (1) side.
- Unlock contact with special tool **61 1 136** and pull out cable (2) and contact towards rear.

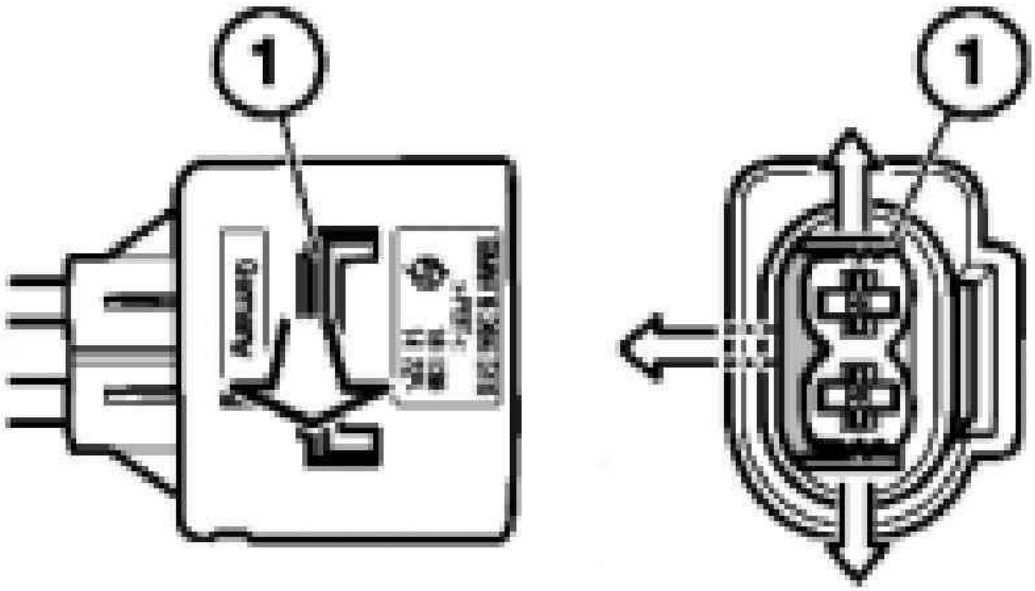


Fig. 31: View Of Lock On In-Line Plug Arrester Hook
Courtesy of BMW OF NORTH AMERICA, INC.

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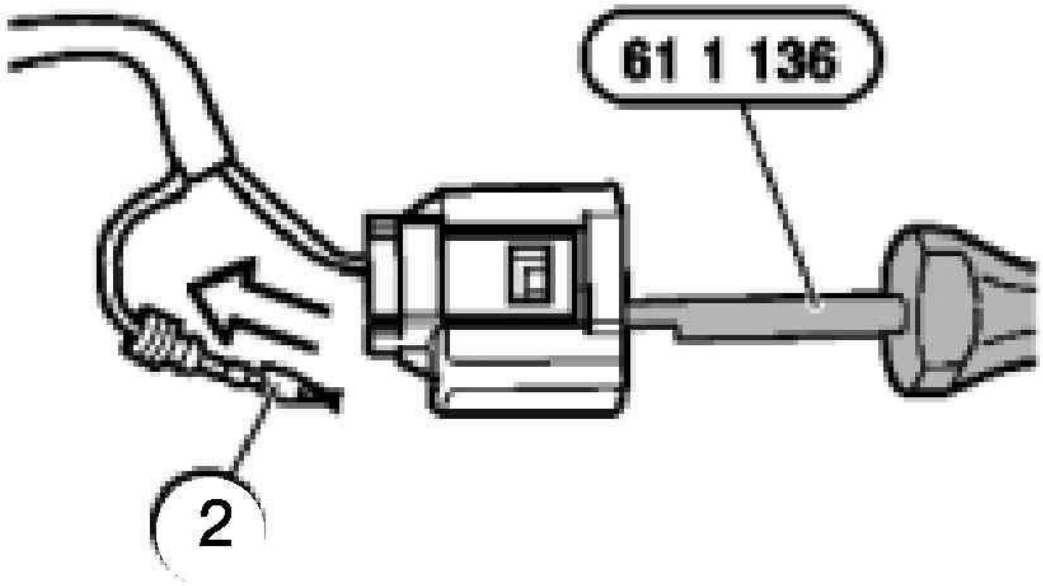


Fig. 32: Identifying In-Line Plug And Special Tool
Courtesy of BMW OF NORTH AMERICA, INC.

In-line plug 4 Pin System DFK ELA

- Press arrester hook in direction of arrow and remove lock (1).
- Unlock contact with special tool **61 1 136** and pull cable and contact out towards rear.

Installation Instructions:

- If necessary, slide lock must also be unlocked with screw driver.

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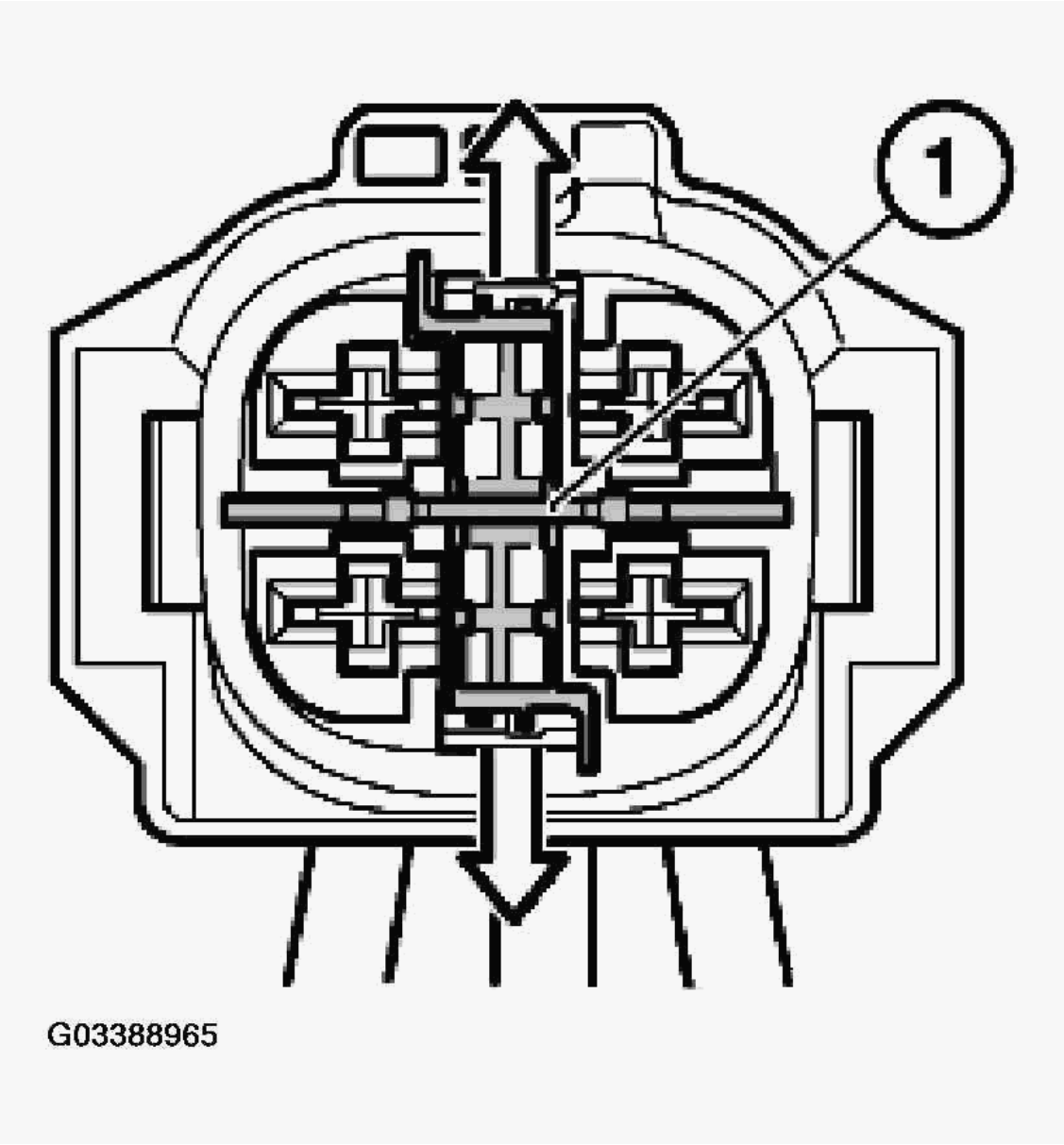


Fig. 33: Locating Lock In Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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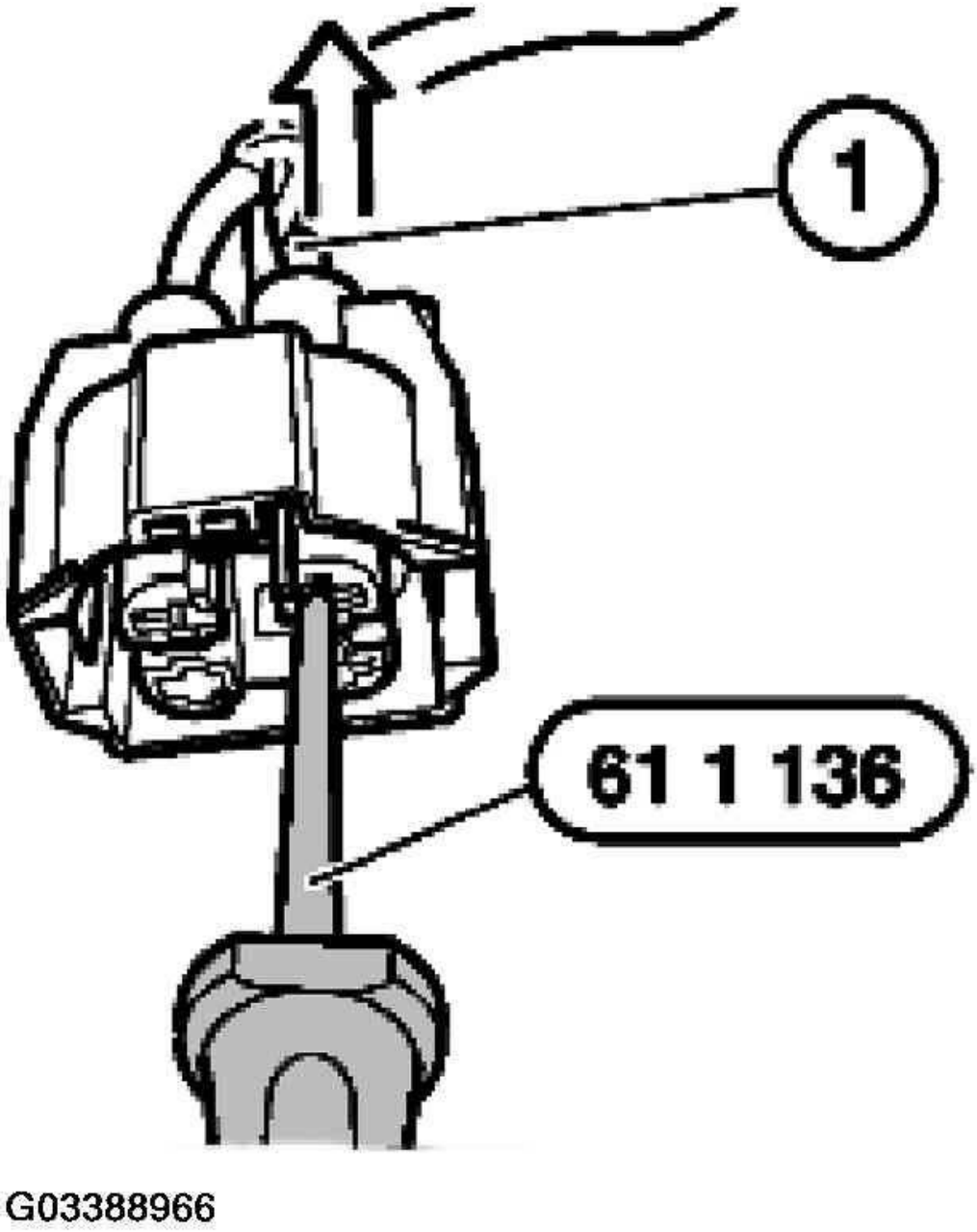


Fig. 34: Unlocking With Special Tool (61 1 136)
Courtesy of BMW OF NORTH AMERICA, INC.

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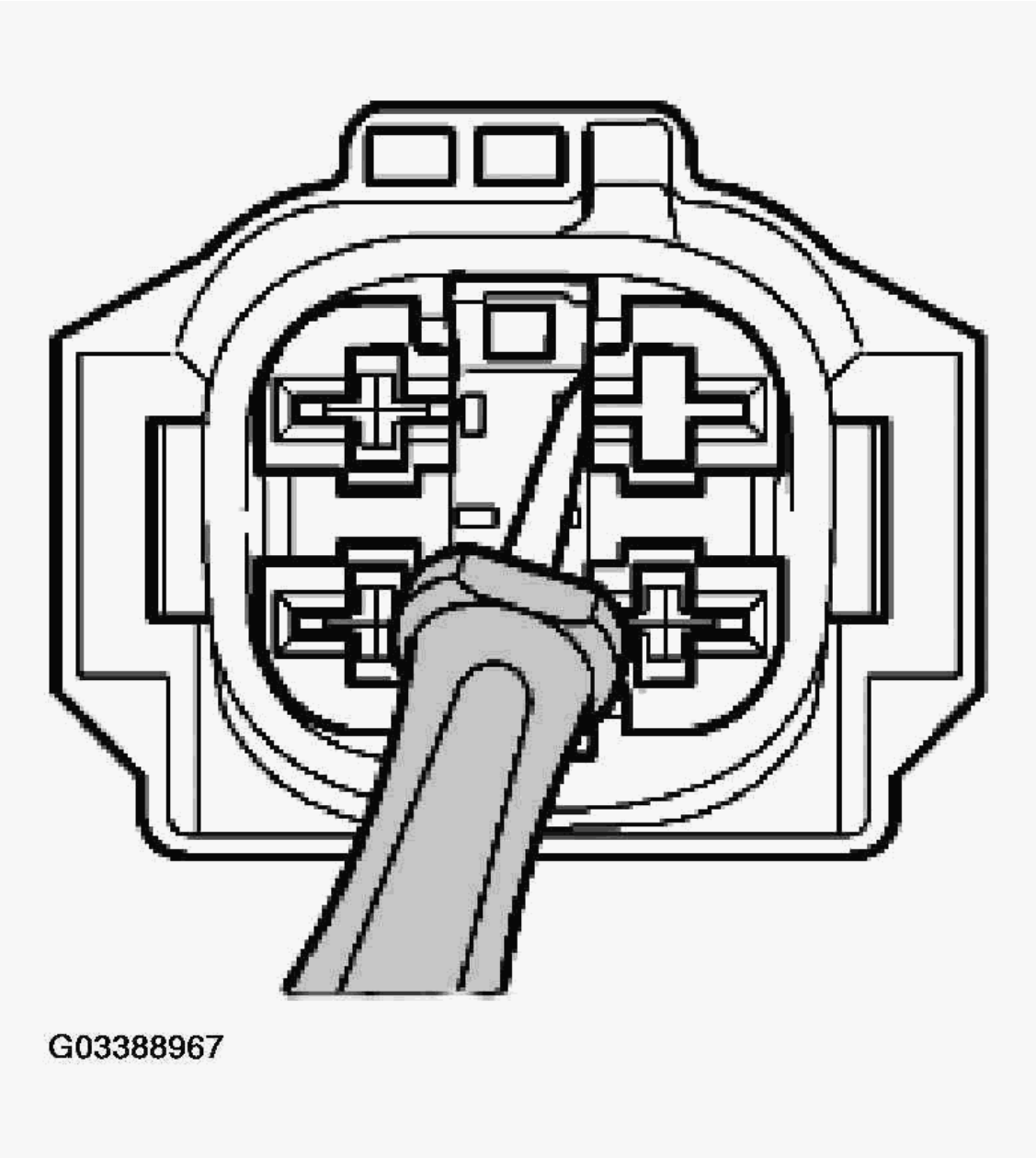


Fig. 35: View Of Slide Lock In Plug
Courtesy of BMW OF NORTH AMERICA, INC.

PLUG SYSTEM ELO/ELO POWER

In-line Plug 3-,6 Pin System Elo-Power 2.8

- Press unlocking hook (1) in direction of arrow and disengage. Then unlock locking hook (2) and remove lock.
- Press down arrestor hook (3) with screwdriver and pull out cable with contact towards rear.

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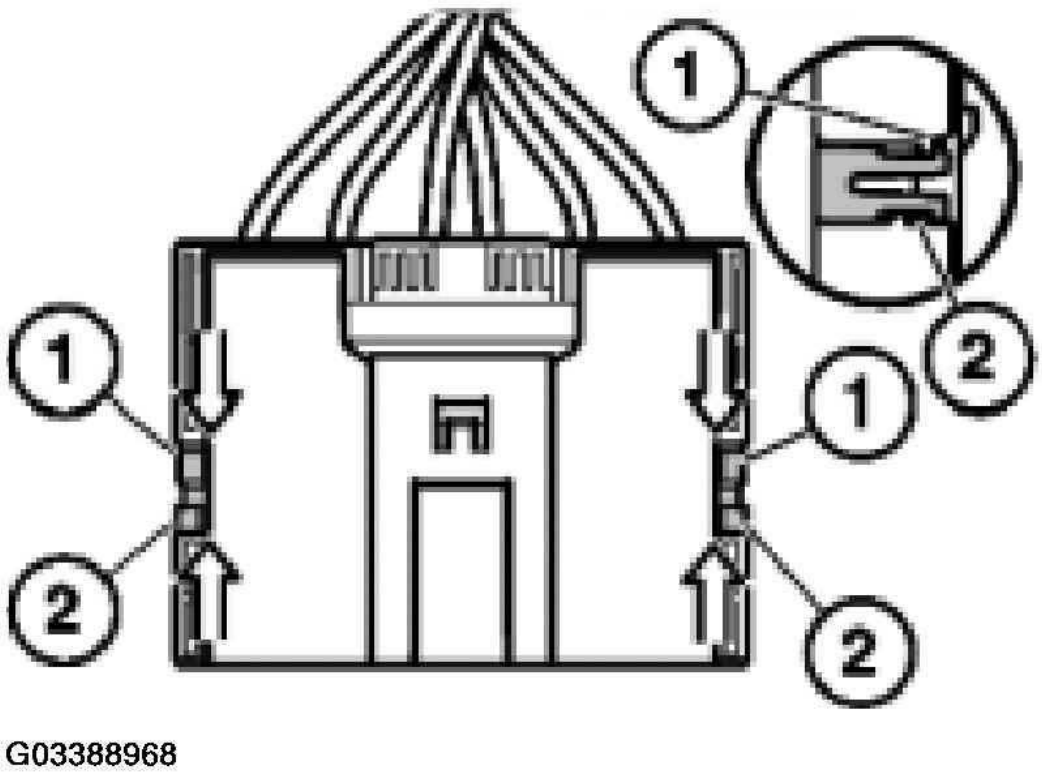


Fig. 36: Identifying Hook On In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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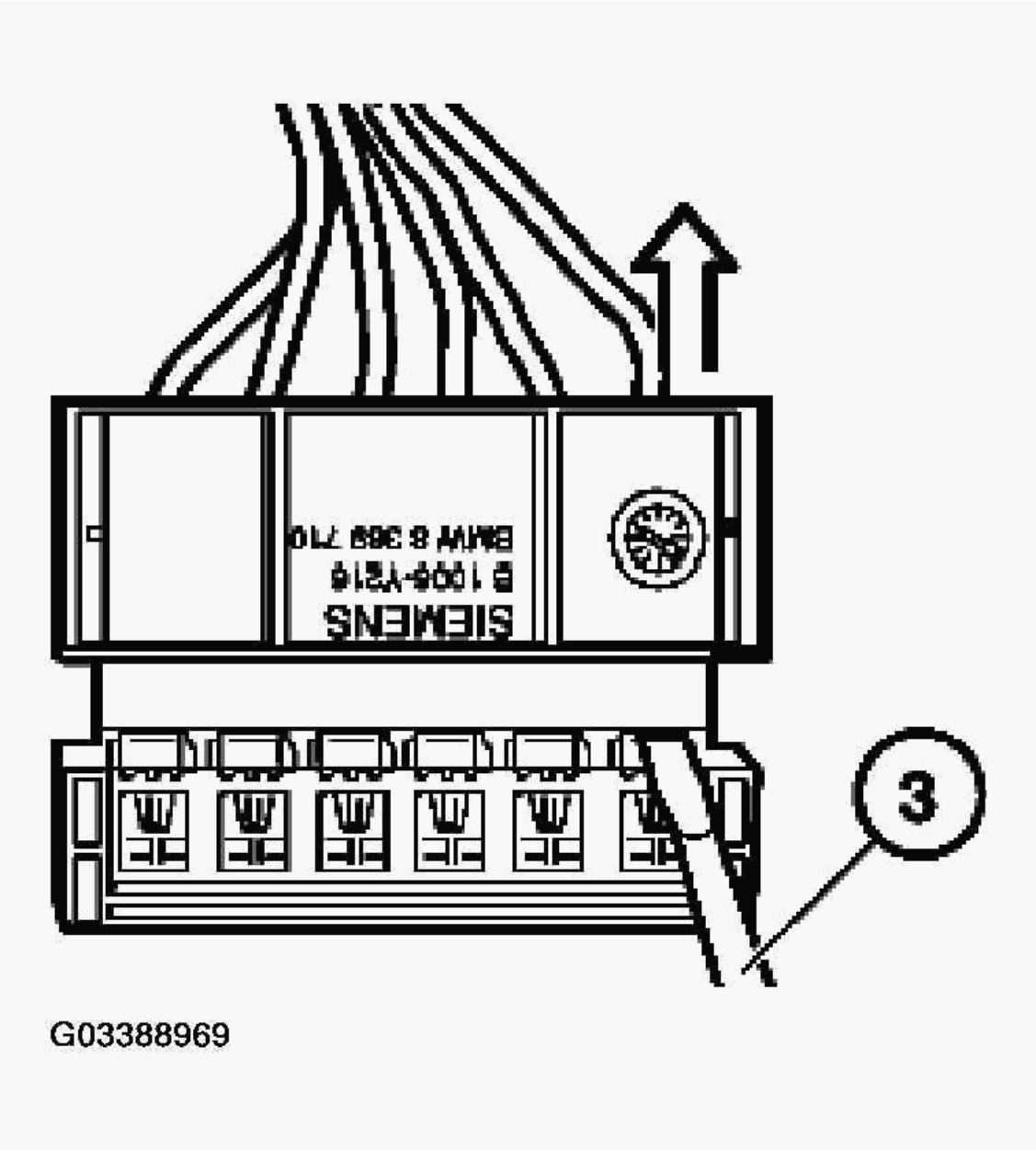


Fig. 37: View Of In-Line Plug Arrester Hook
Courtesy of BMW OF NORTH AMERICA, INC.

In-line plug 4-,10 Pin System Elo

- Slide connector lock (1) off of main connector body.
- Push the lock tab of the connector being removed down (3) with pin or small screwdriver in the primary lock slot (4) and pull the wire out (5) to the secondary lock position (6).
- Push the lock tab down again in the secondary lock position and remove wire completely.

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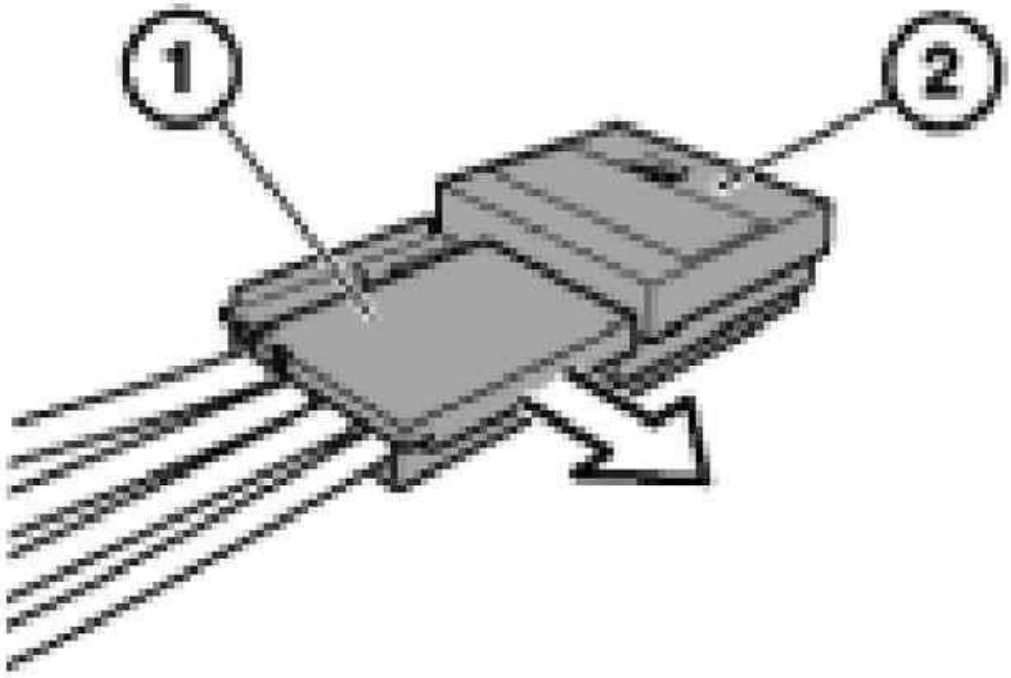


Fig. 38: Locating Connector Lock For In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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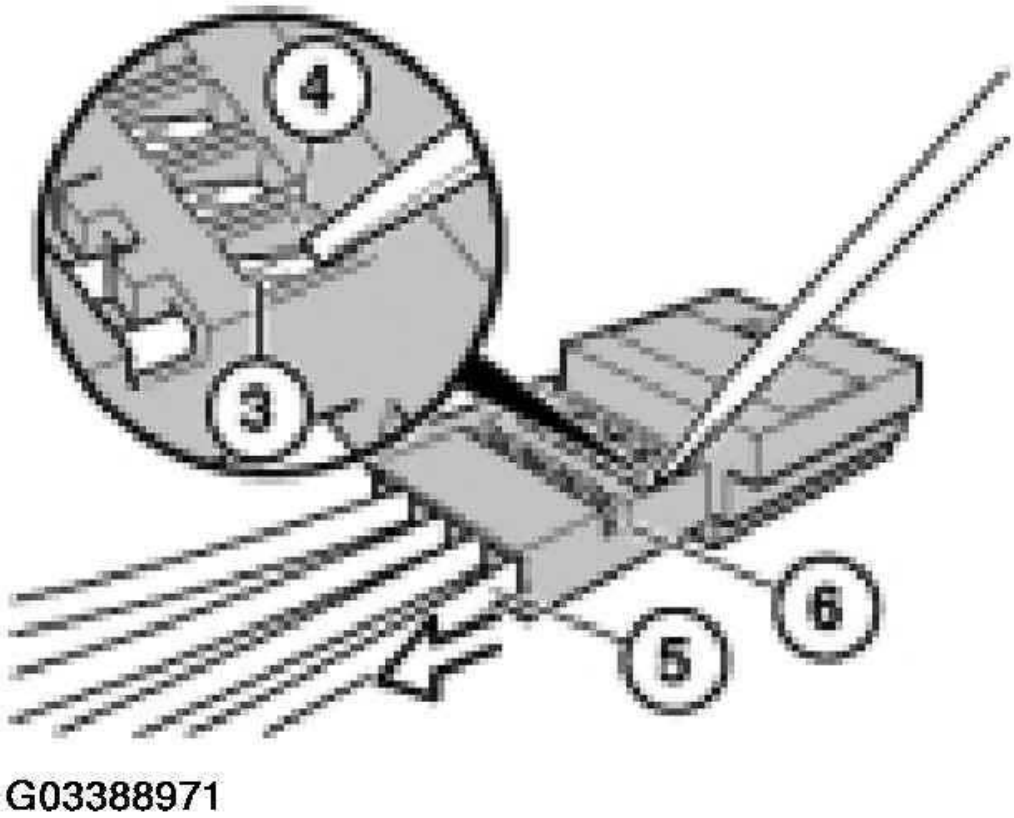


Fig. 39: Identifying In-Line Plug Lock Tab
Courtesy of BMW OF NORTH AMERICA, INC.

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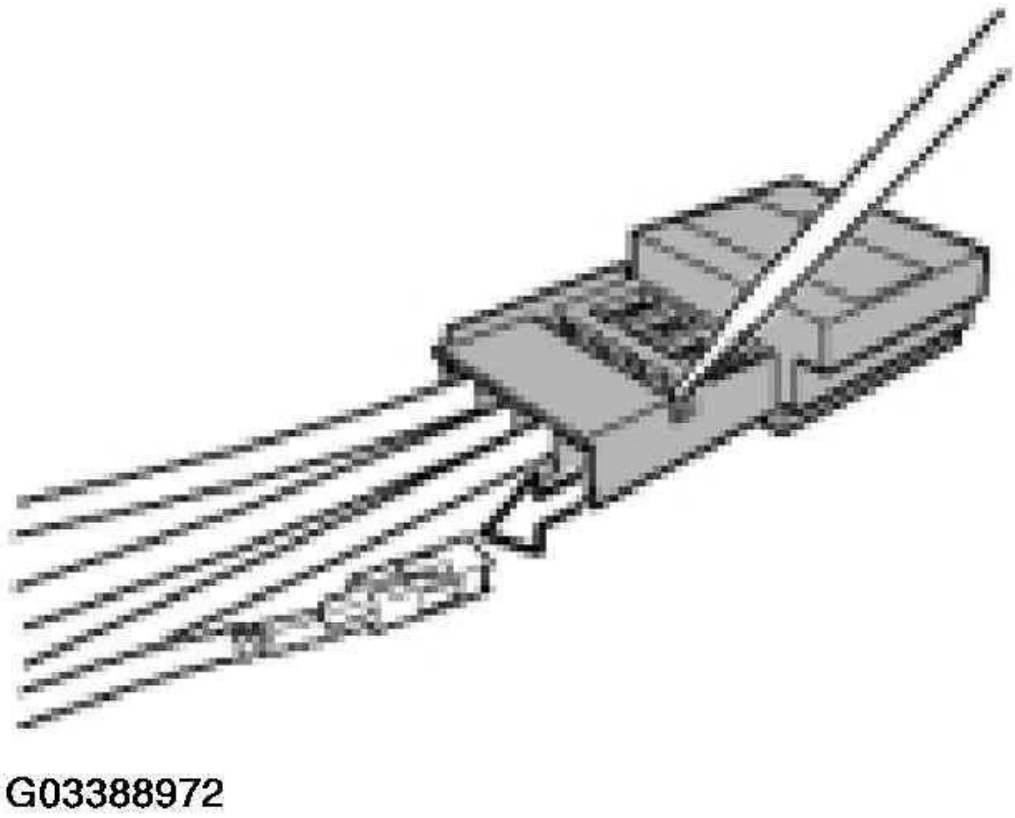


Fig. 40: View Of In-Line Plug 4-, 10 Pin System Elo
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 6-,50 Pin System Elo

- Unlock lock (**Fig. 41**).
- Unfasten cable clip (**Fig. 42**).
- Slide connector lock (1) off of main connector body (2) (**Fig. 43**).
- Push the connector plate (3) out of connector shell using a small screwdriver through hole on end of connector body (**Fig. 44**).
- Push the lock tab of the connector being removed down (6) with pin or small screw driver in the primary lock slot (7) and pull the wire out to the secondary lock position (8) (**Fig. 45**).
- Push the lock tab down again in the secondary lock position and remove wire completely (**Fig. 46**).

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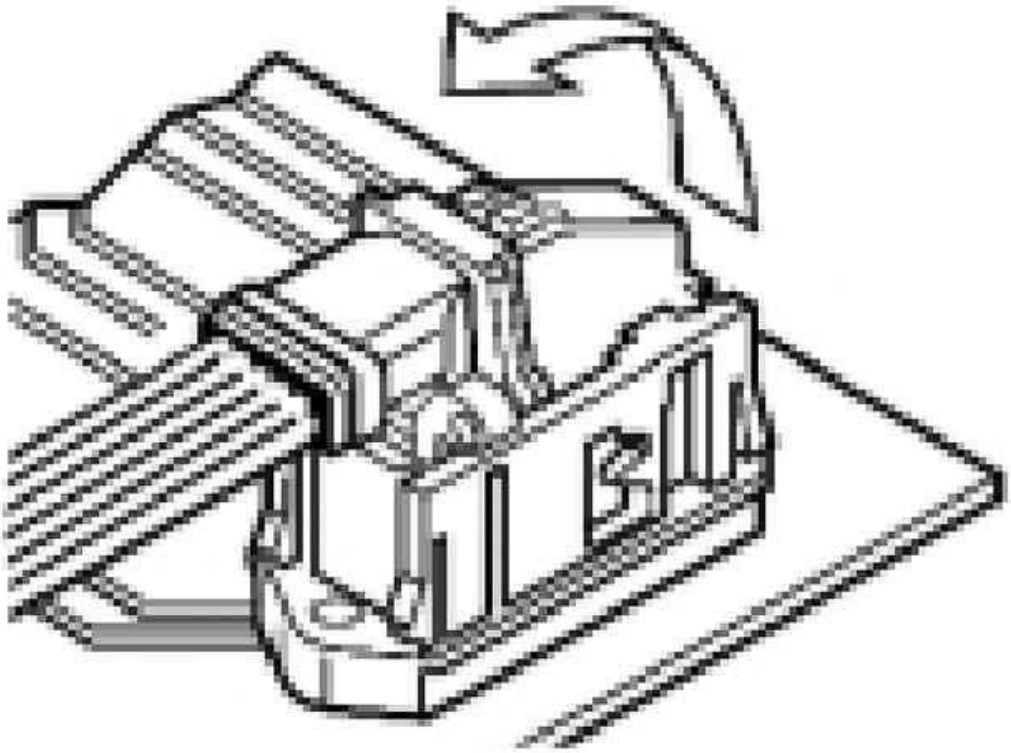


Fig. 41: Identifying Lock On In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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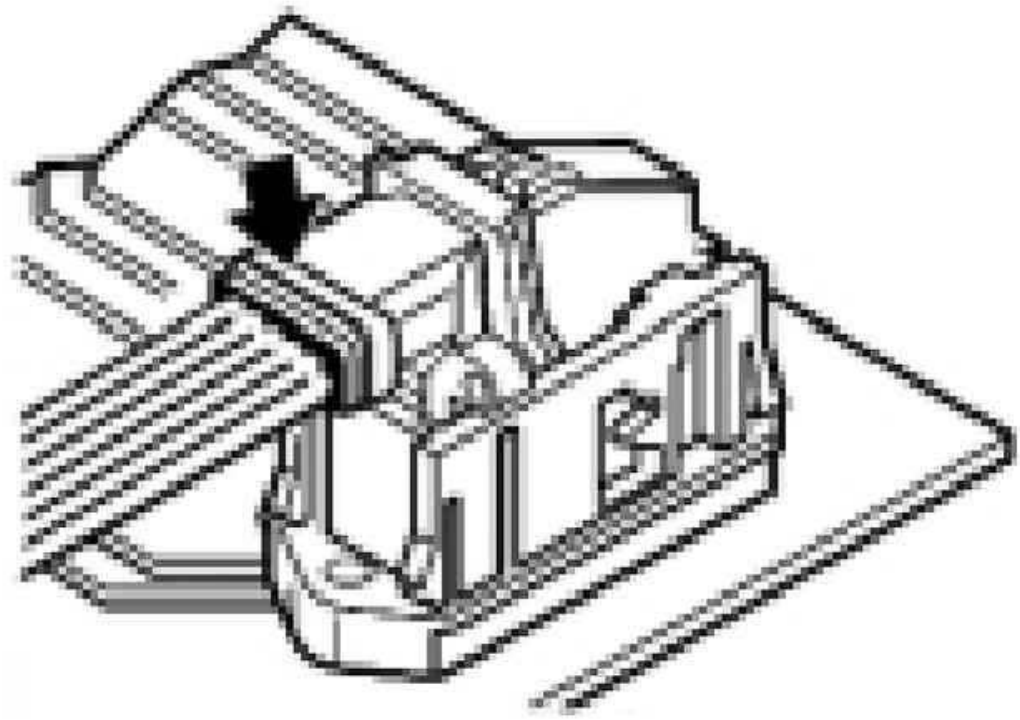


Fig. 42: View Of Clip On In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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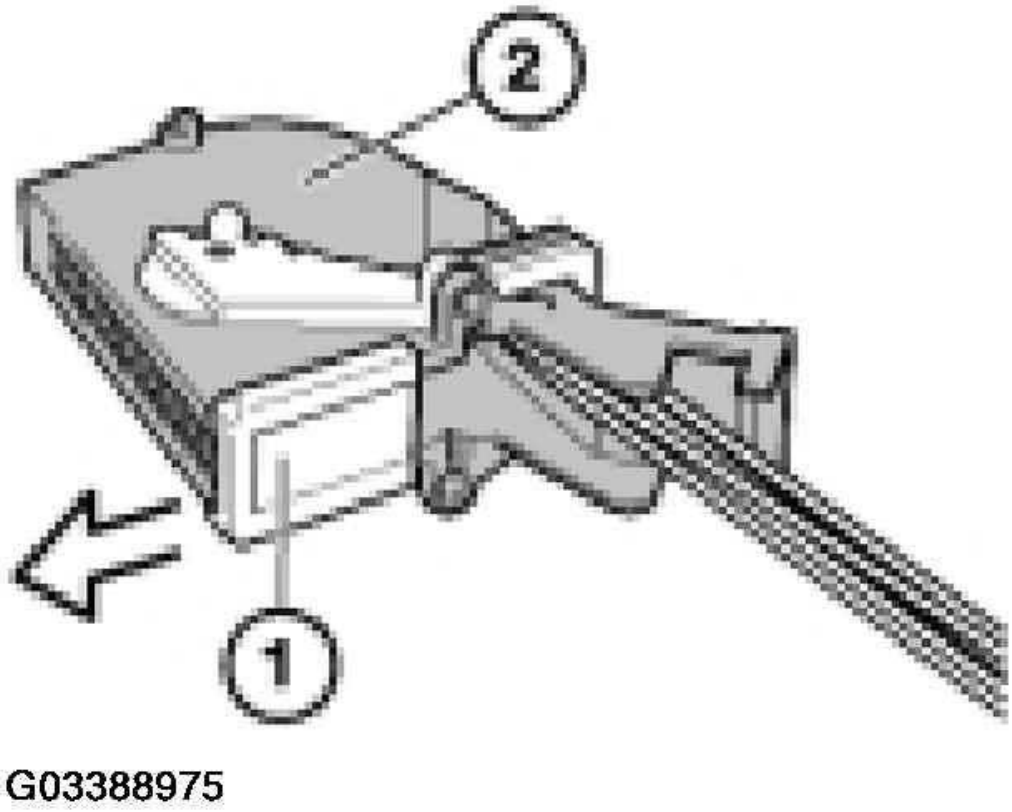


Fig. 43: Removing Connector Lock From In-Line
Courtesy of BMW OF NORTH AMERICA, INC.

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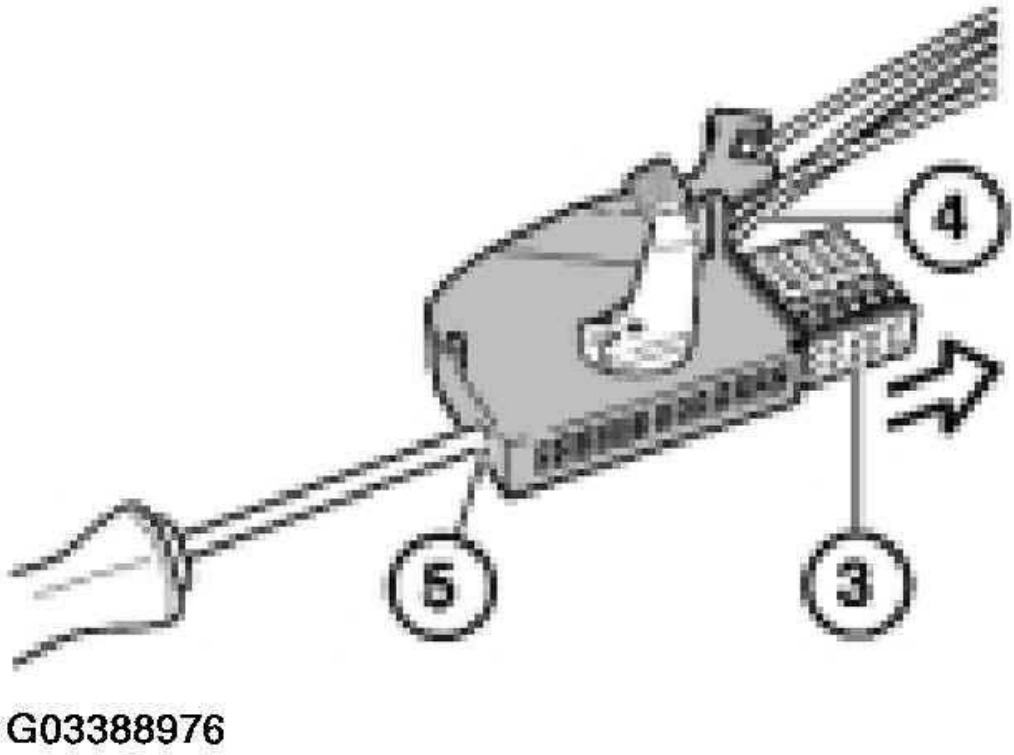


Fig. 44: Removing Connector Plate From In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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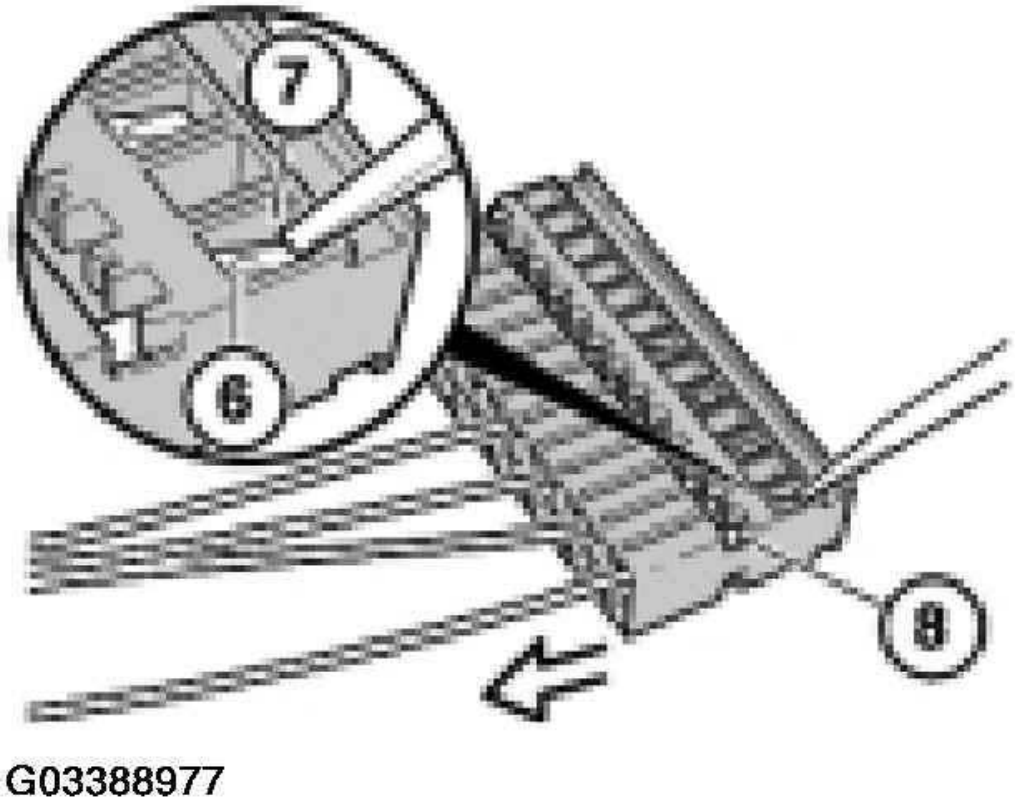


Fig. 45: Removing Wire From Secondary Lock Position
Courtesy of BMW OF NORTH AMERICA, INC.

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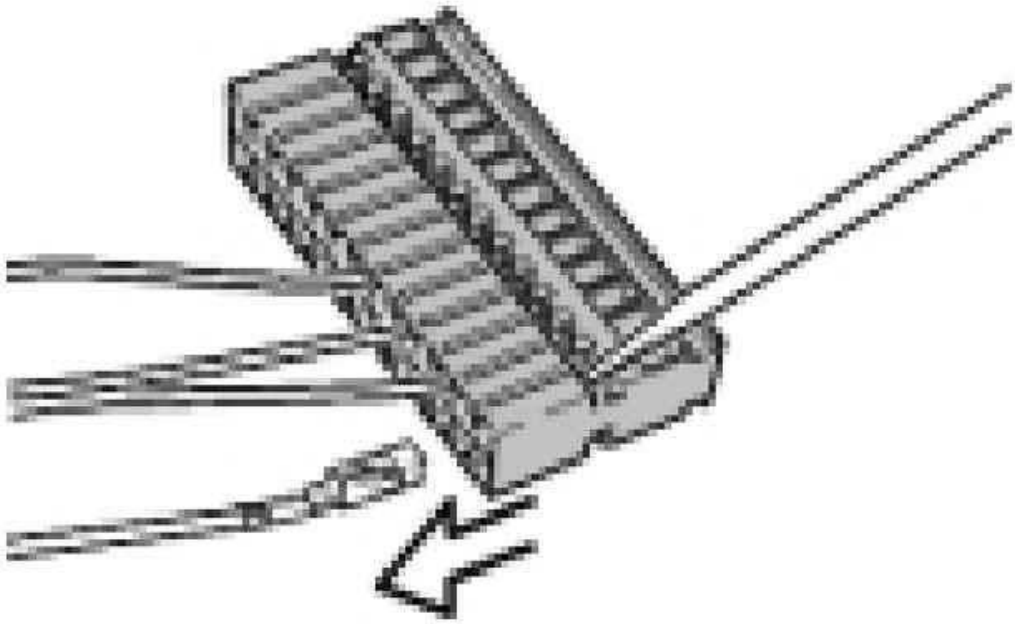


Fig. 46: Removing Wire Using Screwdriver
Courtesy of BMW OF NORTH AMERICA, INC.

PLUG SYSTEM MQS/MPQ

In-line Plug 6-,8 Pin System MQS

- Press lock (1) in direction of arrow and slide plug forward.
- Press locking hook (2) downward and slide lock (1) out.
- Press down arrester hook (3) with screwdriver and pull out cable with contact towards rear.

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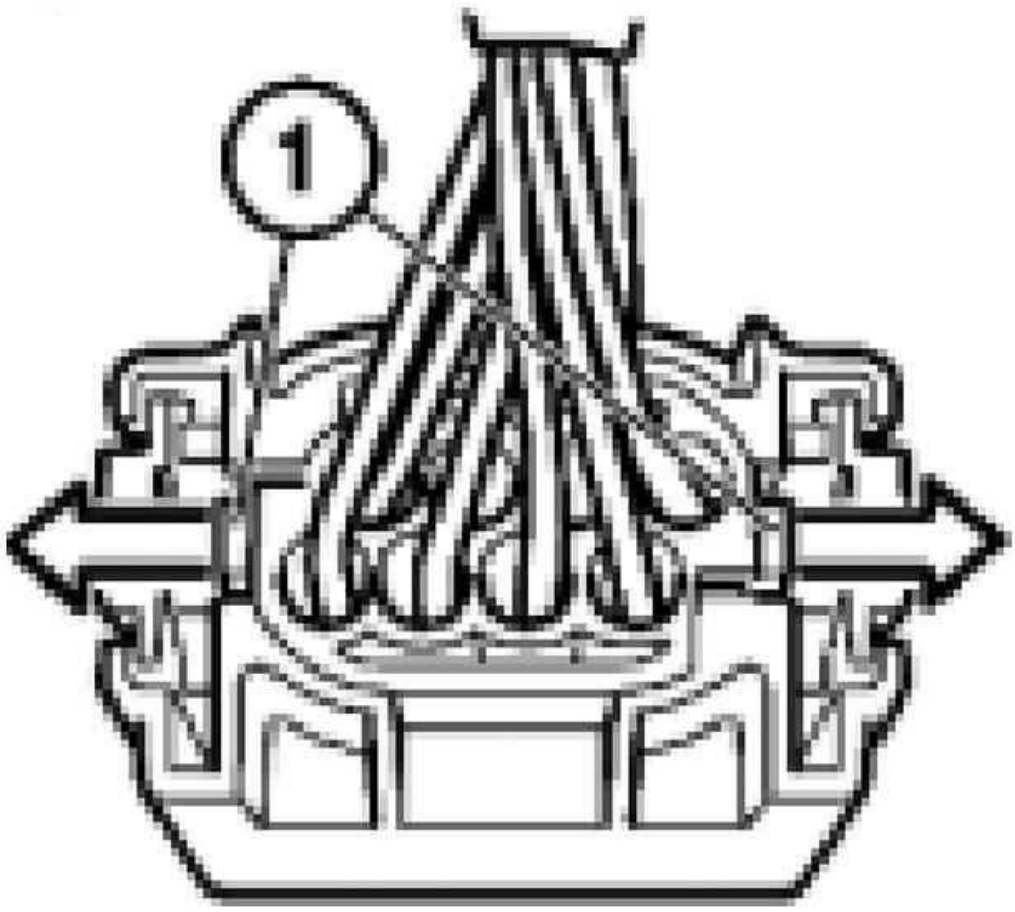


Fig. 47: View Of In-Line Plug Lock
Courtesy of BMW OF NORTH AMERICA, INC.

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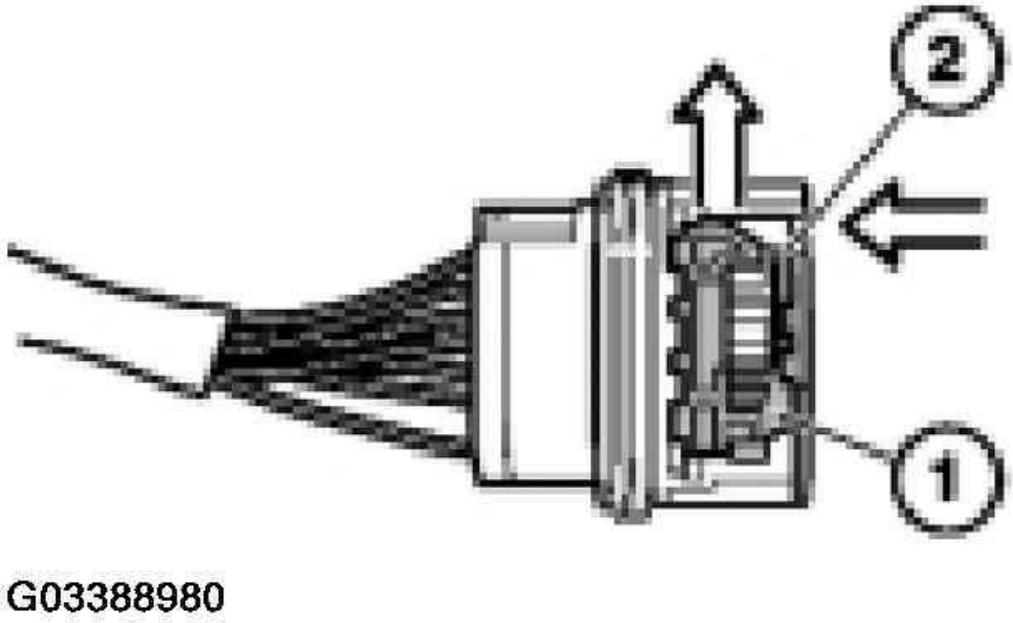


Fig. 48: Identifying In-Line Plug Locking Hook
Courtesy of BMW OF NORTH AMERICA, INC.

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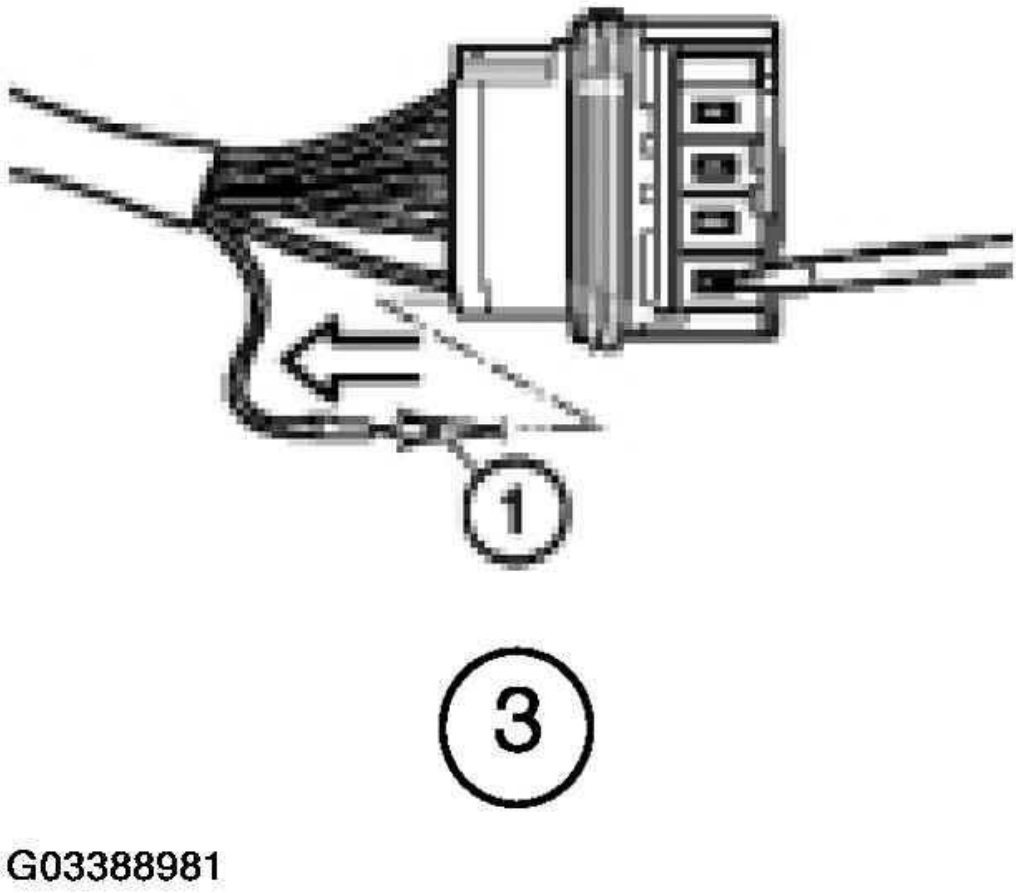


Fig. 49: Removing Cable From In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 2 Pin System MPQ 2.8

- Press catch on outside in direction of arrow and remove towards top.
- Press down arrestor hook (1) with screwdriver and pull out cable and contact (2) towards rear.

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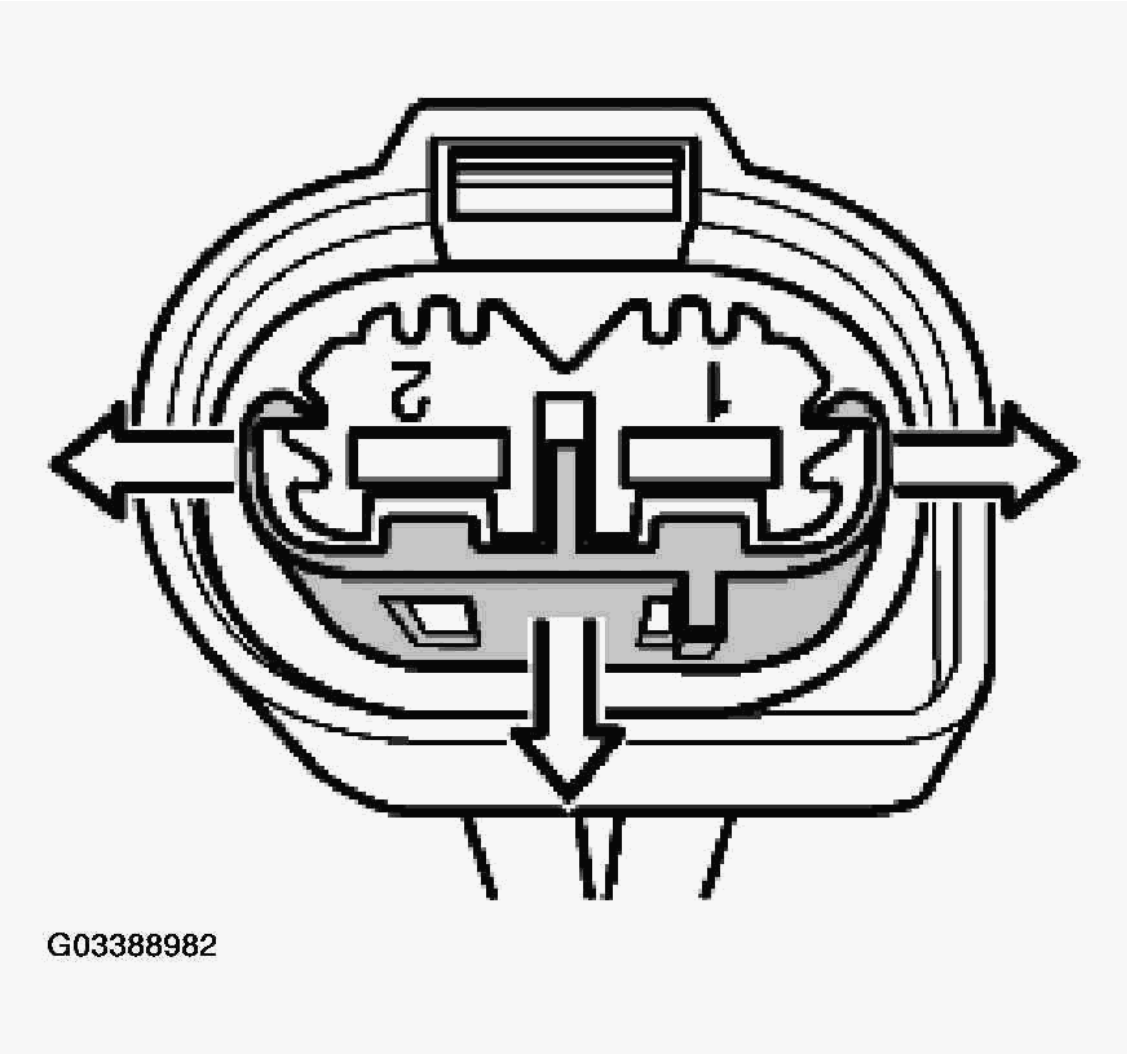


Fig. 50: Identifying Catch On In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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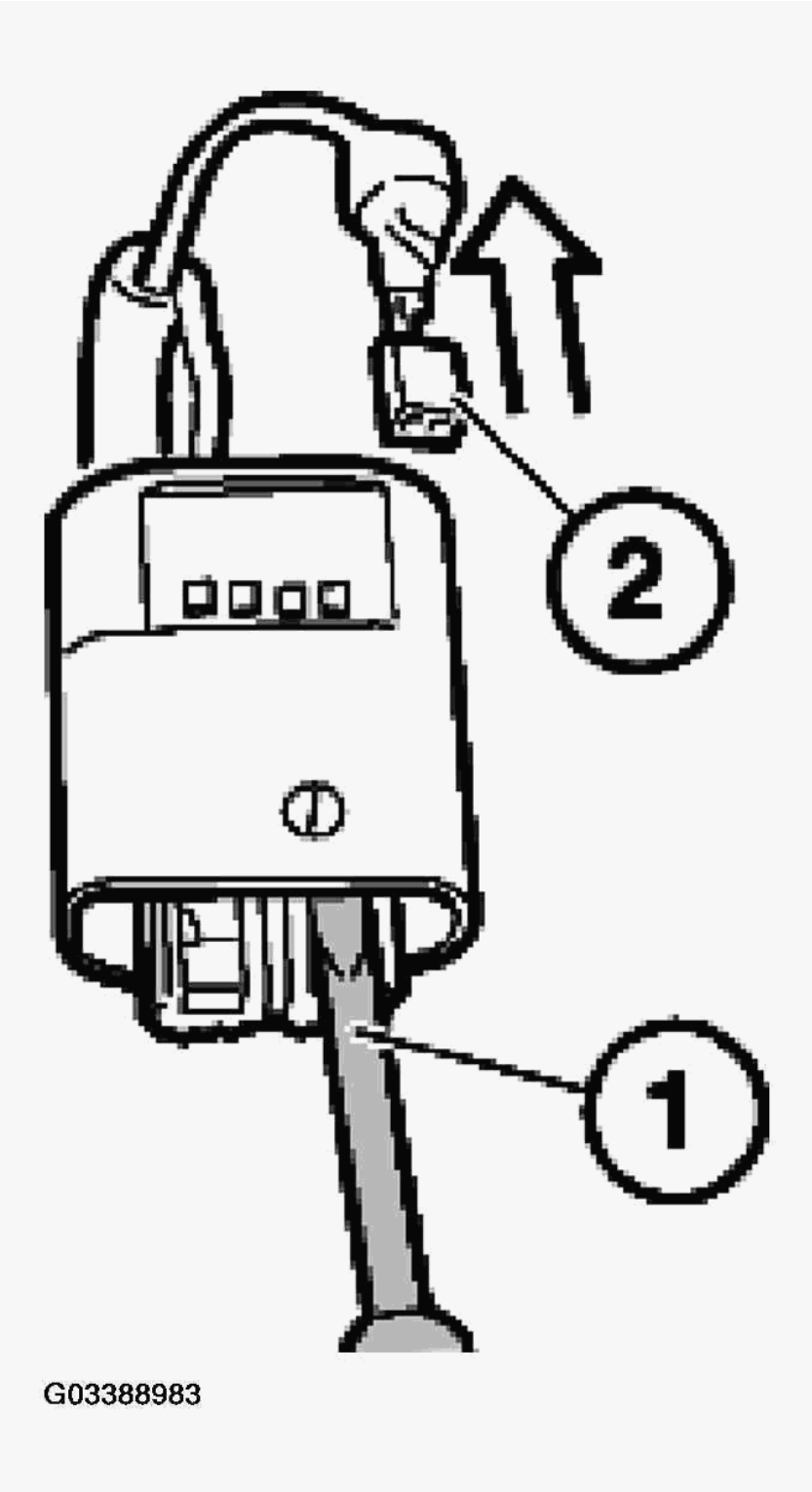


Fig. 51: Removing Cable And Contact From In-Line Plug
Courtesy of BMW OF NORTH AMERICA, INC.

Control Unit Plug 25-, 35-, 55-,83-,88 Pin

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- Remove phillips head screws (1) from connector. Gently pivot the connector plate (2) with seal (3) out of the connector shell.
- Remove seal (3) and pull connector plate lock (4) out of locked position.
- Using the appropriate sized spring contact and remove connector (5) from housing.

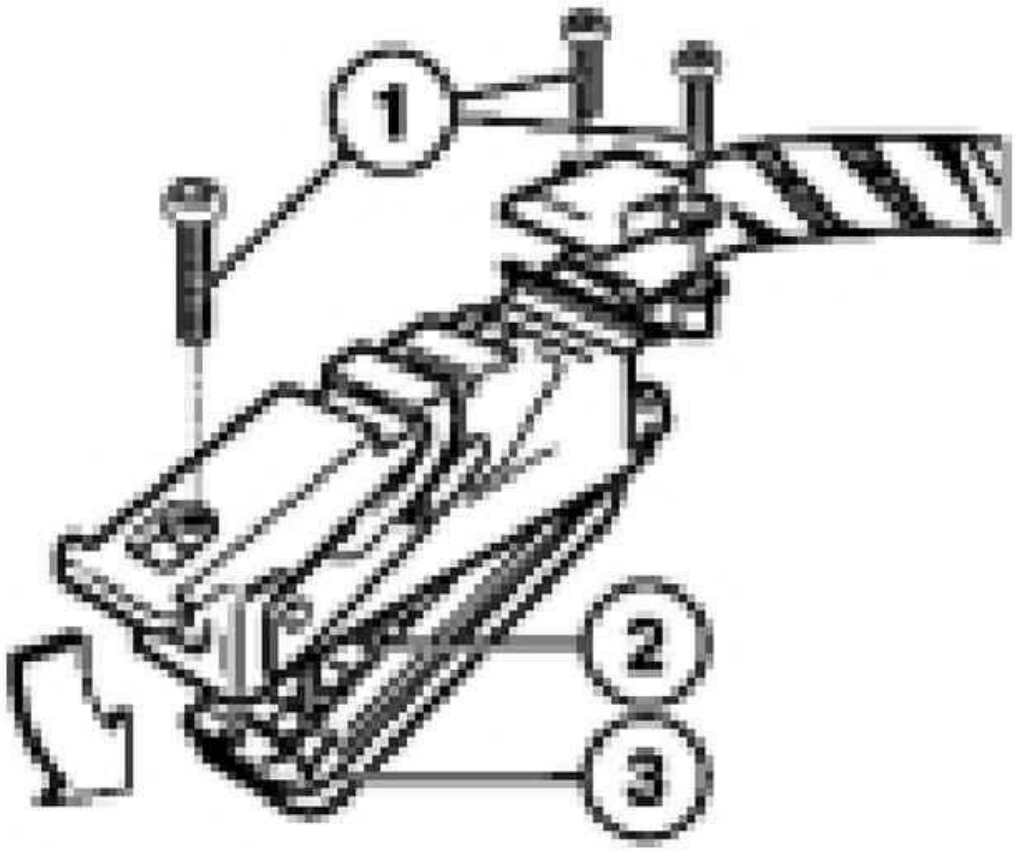


Fig. 52: Identifying Control Unit Plug Retaining Screws
Courtesy of BMW OF NORTH AMERICA, INC.

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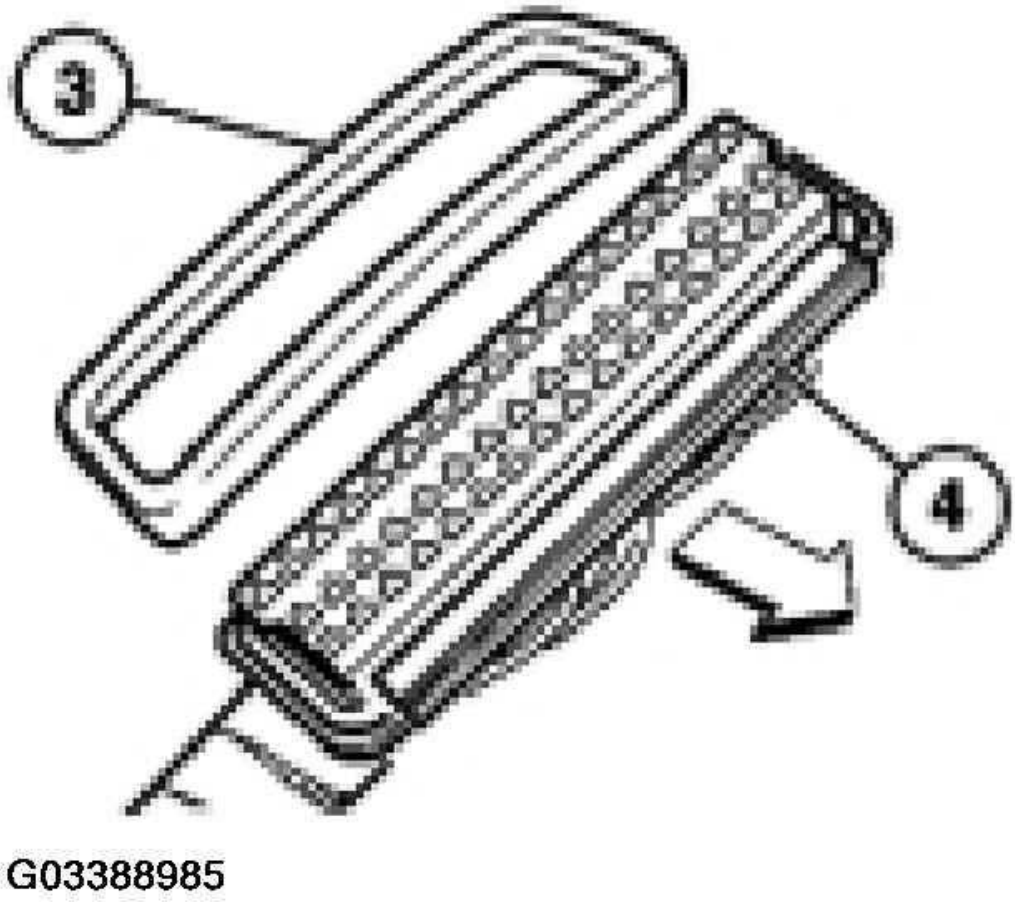


Fig. 53: View Of Control Unit Plug Seal
Courtesy of BMW OF NORTH AMERICA, INC.

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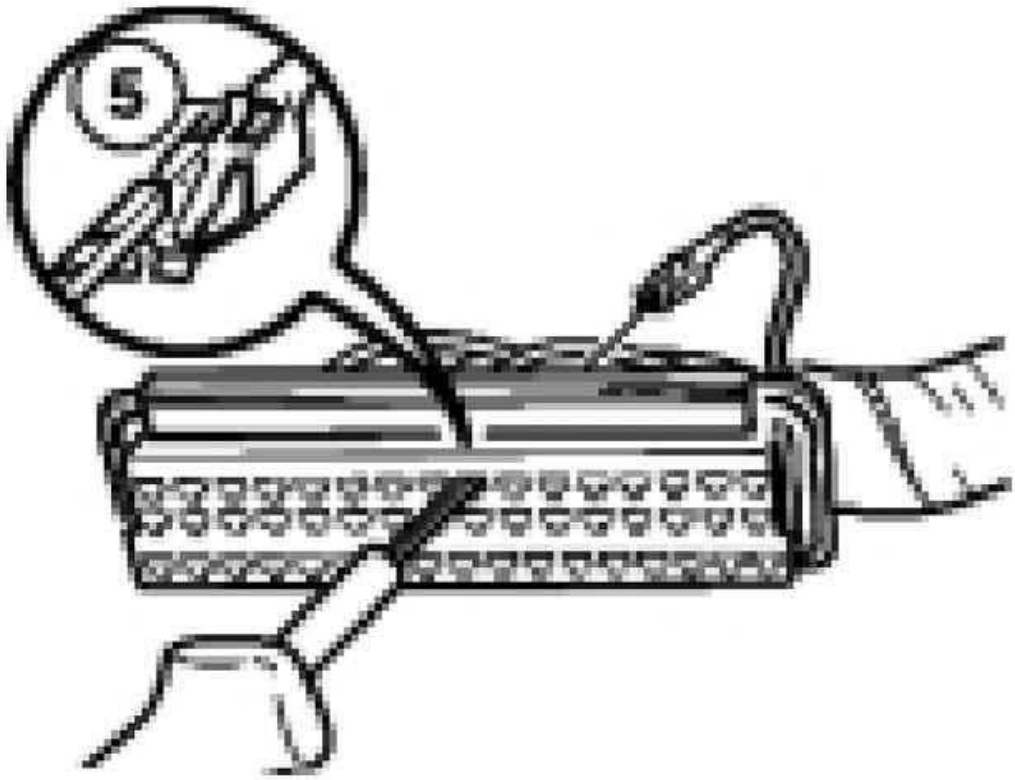


Fig. 54: Removing Connector From Control Unit Plug
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 24 Pin Hybrid System MQS/MPQ

Manufactured by AMP : The following contact types without strand sealing can be fitted in the plug housings:

MQS (Micro Quadlock System).

MPQ, width 2.8 mm (Micro Power Quadlock).

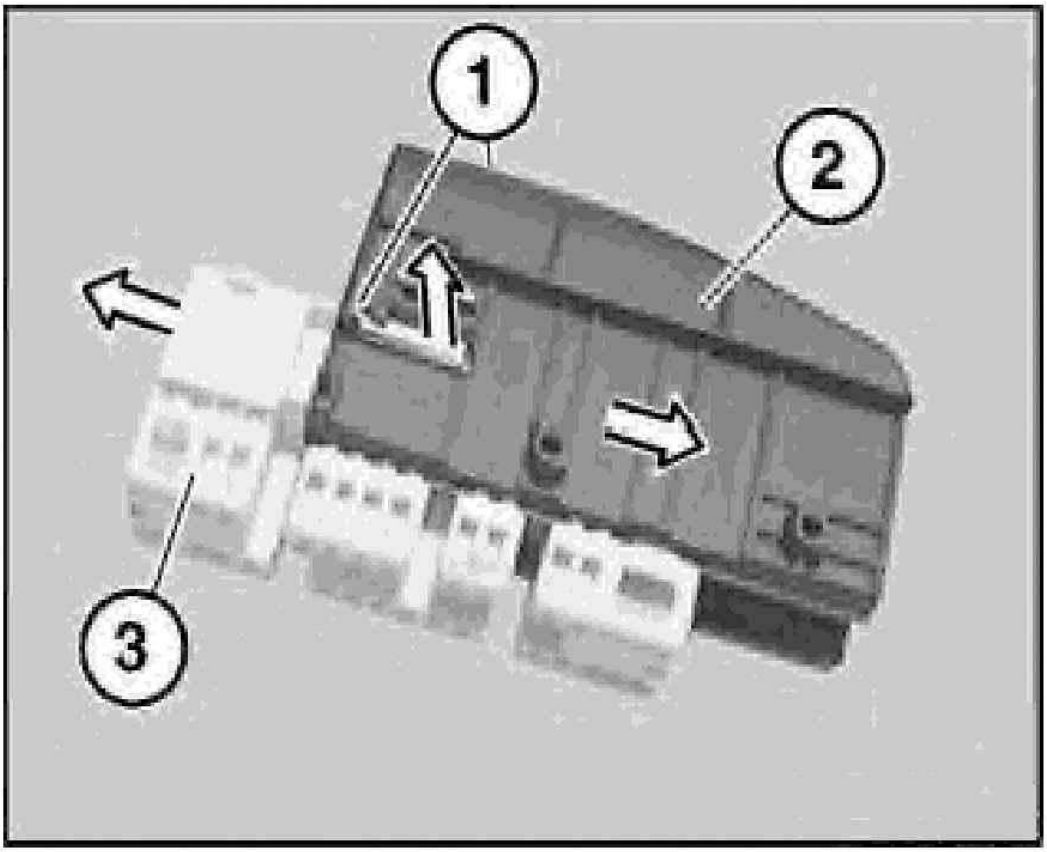
MPQ, width 5.2 mm (Micro Power Quadlock).

Socket Housing

- Press locks (1) on cap (2) upwards on both sides.
- Detach cap from contact carrier (3).

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NOTE: Detaching the cap releases the secondary lock of the socket contacts.

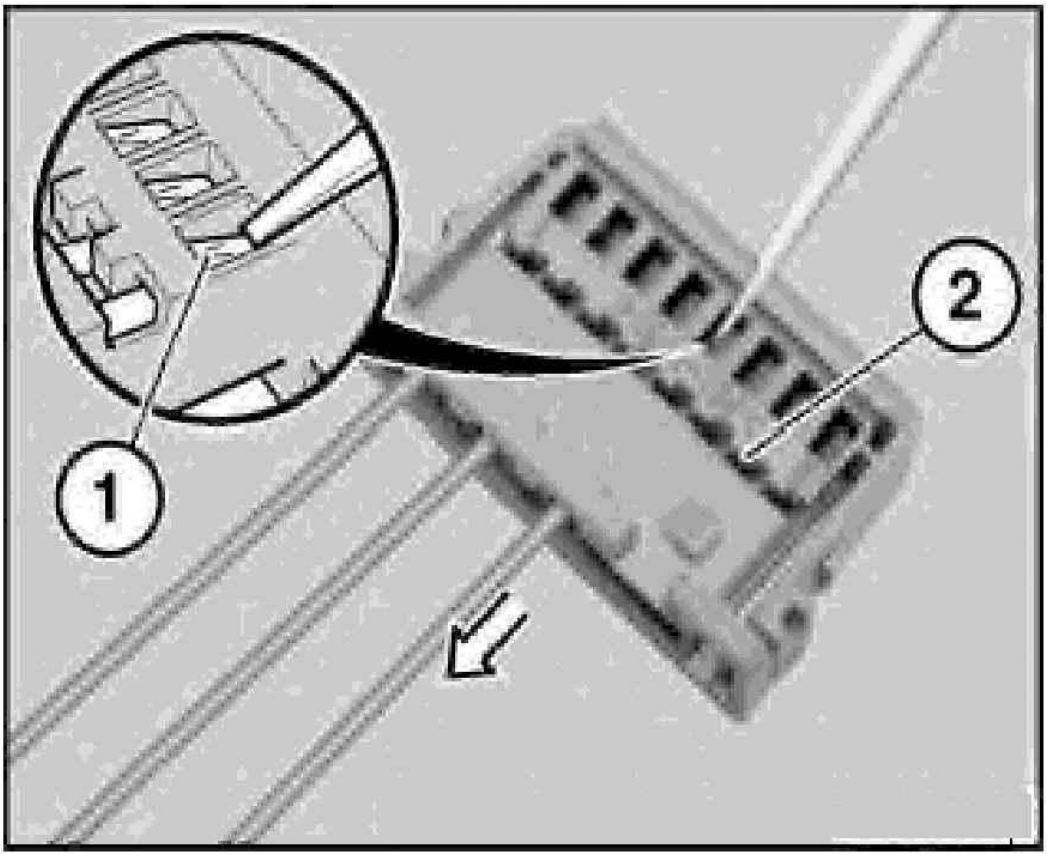


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Fig. 55: Removing Cap From Contact Carrier
Courtesy of BMW OF NORTH AMERICA, INC.

- Hold down retaining hook (1) of socket contact carrier with a small screwdriver.
- Pull wire with socket contact in direction of arrow as far as secondary lock (2). (**Fig. 56**)
- Hold down retaining hook in secondary lock (1) again and pull cable with socket contact (2) completely out of contact carrier (3). (**Fig. 57**)

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Fig. 56: View Of Retaining Hook In Secondary Lock
Courtesy of BMW OF NORTH AMERICA, INC.

Pin Housing

- Press locks (1) on cap (2) upwards on both sides.
- Detach cap from housing carrier (3)(**Fig. 58**).

NOTE: Detaching the cap releases the secondary locks of the pin contacts in the contact carriers.

- Pull contact carrier (1) out of housing carrier (2) (**Fig. 59**).
- The pin contacts are pulled of a contact carrier as described under "Socket Housing".

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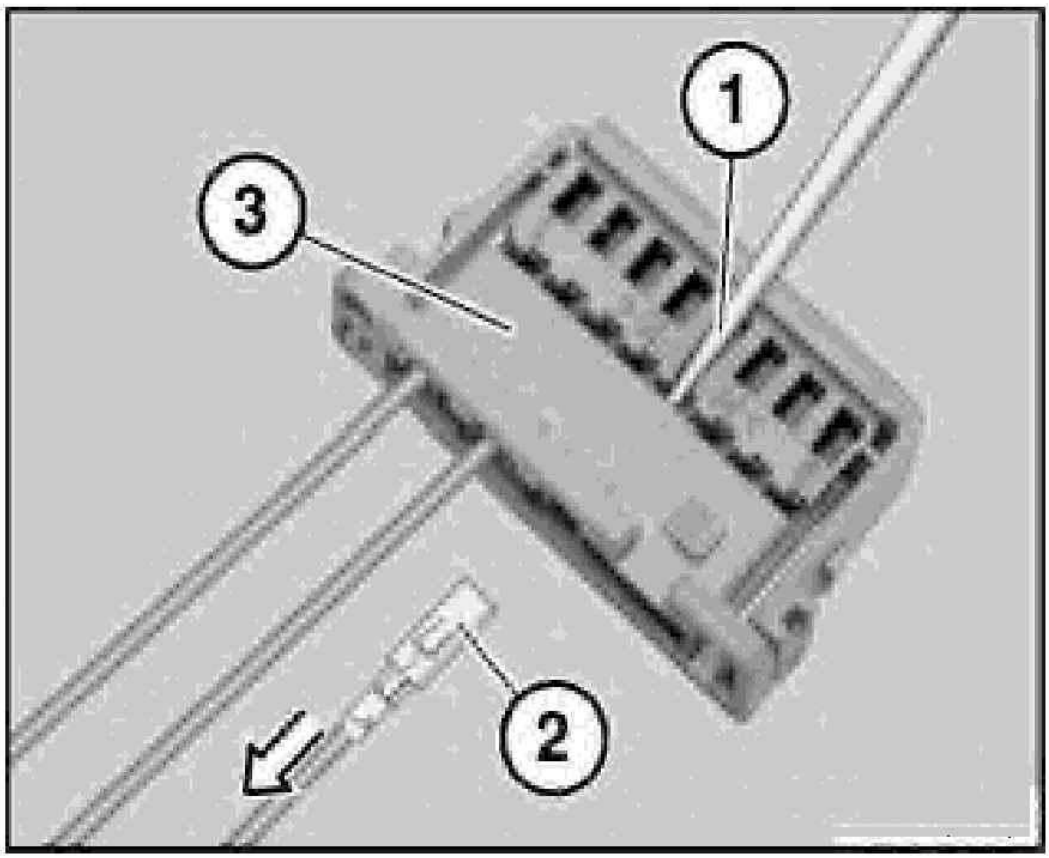
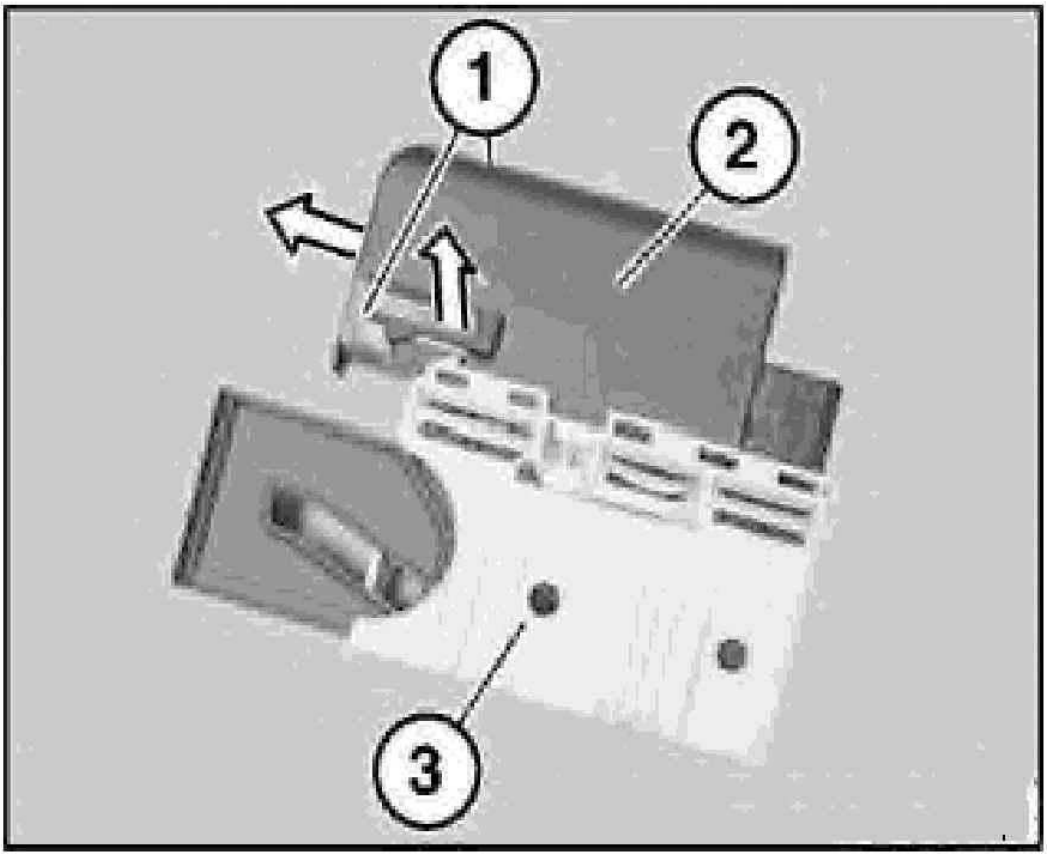


Fig. 57: Identifying Pin Housing Locks
Courtesy of BMW OF NORTH AMERICA, INC.

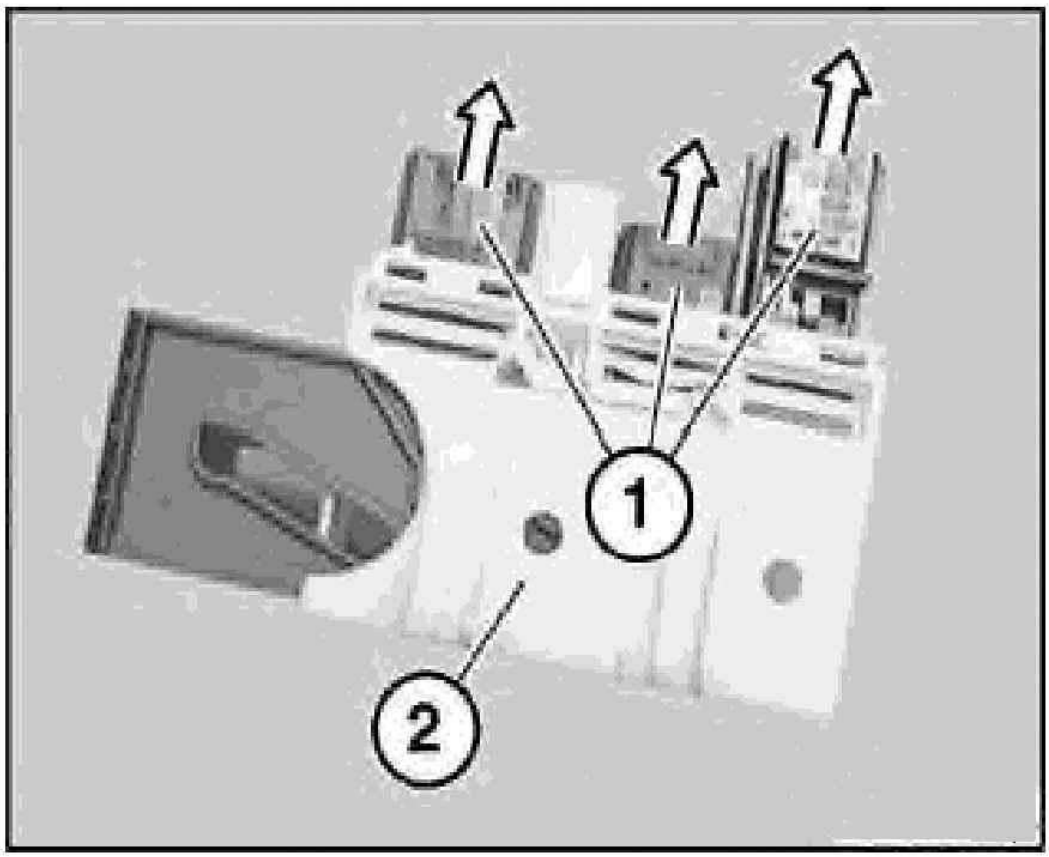
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Fig. 58: Removing Cap From Pin Housing
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 59: Removing Contact Carrier From Housing
Courtesy of BMW OF NORTH AMERICA, INC.

Socket Housing 42-,43 Pin Hybrid Systems MQS/MPQ

Manufactured by AMP: The following contact types without strand sealing can be fitted in the socket housings:

MQS (Micro Quadlock System).

MPQ, width 2.8 mm (Micro Power Quadlock).

MPQ, width 5.2 mm (Micro Power Quadlock).

- Open secondary locks (1) on socket housing.
- Press back retaining hook of MQS contacts (2) with special tool 61 1 134 and pull out cable with contact.
- Press back retaining hook of MPQ contacts (3) with screwdriver or similar tool and pull out cable with

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contact.

Installation:

- Bend open retaining hook of contacts gently before inserting into plug housing.
- To install contacts, observe cavity numbers on reverse side of socket housing.

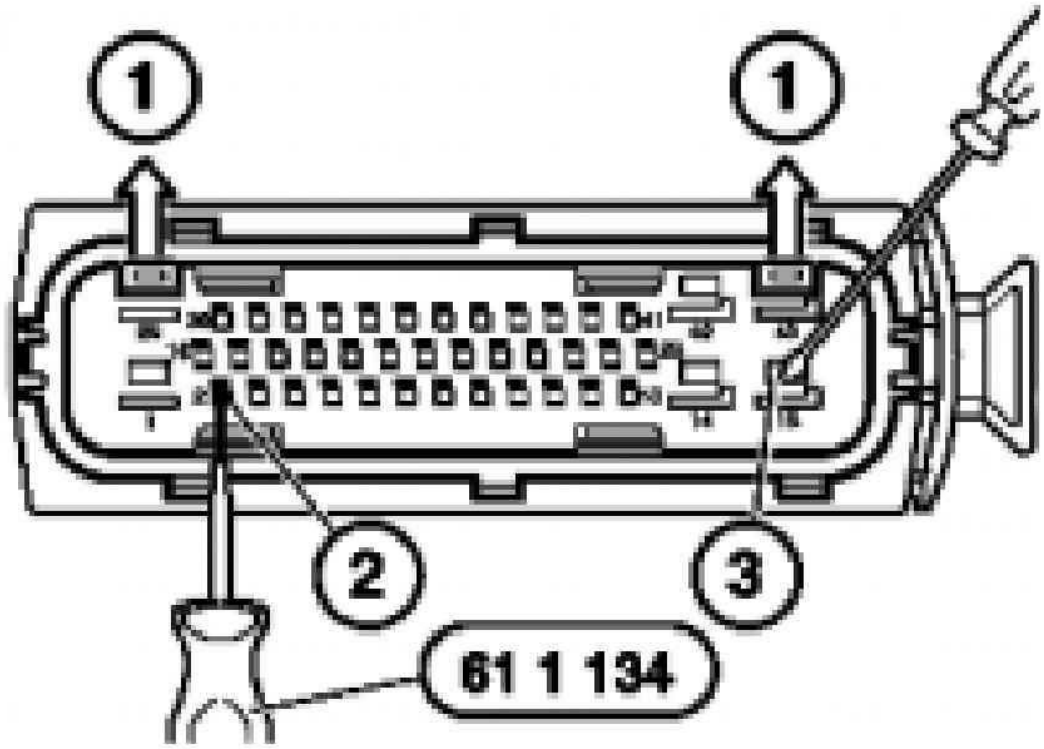
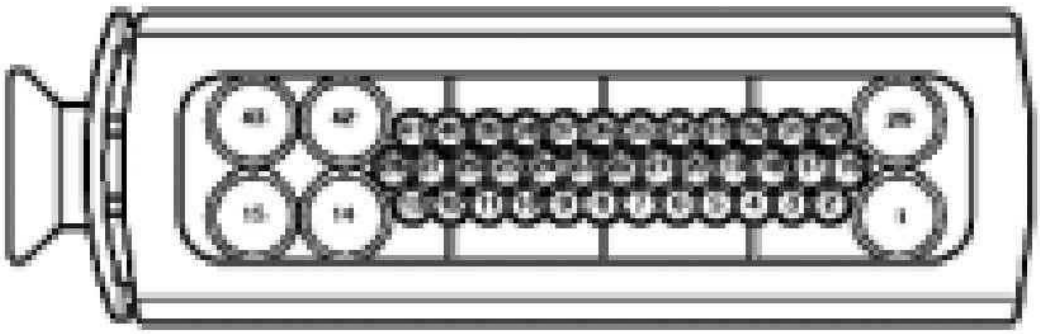


Fig. 60: Identifying MQS Contact Retaining Hook
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 61: Identifying Cavity Numbers On Socket Housing
Courtesy of BMW OF NORTH AMERICA, INC.

Socket Housing 2x27-, 2x27 Pin Hybrid System MQS/MPQ, Elo/Elo Power

Manufactured by Amp: The following contact types without strand sealing can be fitted in the socket housings:

MQS (Micro Quadlock System).

MQS, width 2.8 mm (Micro Power Quadlock).

MPQ, width 5.2 mm (Micro Power Quadlock).

Manufactured by Siemens: The following contact types without strand sealing can be fitted in the socket housings:

Elo (electronic contact).

Elo-Power 2.8 mm wide (electronic contact for heavy loads).

Elo-Power 5.2 mm wide (electronic contact for heavy loads).

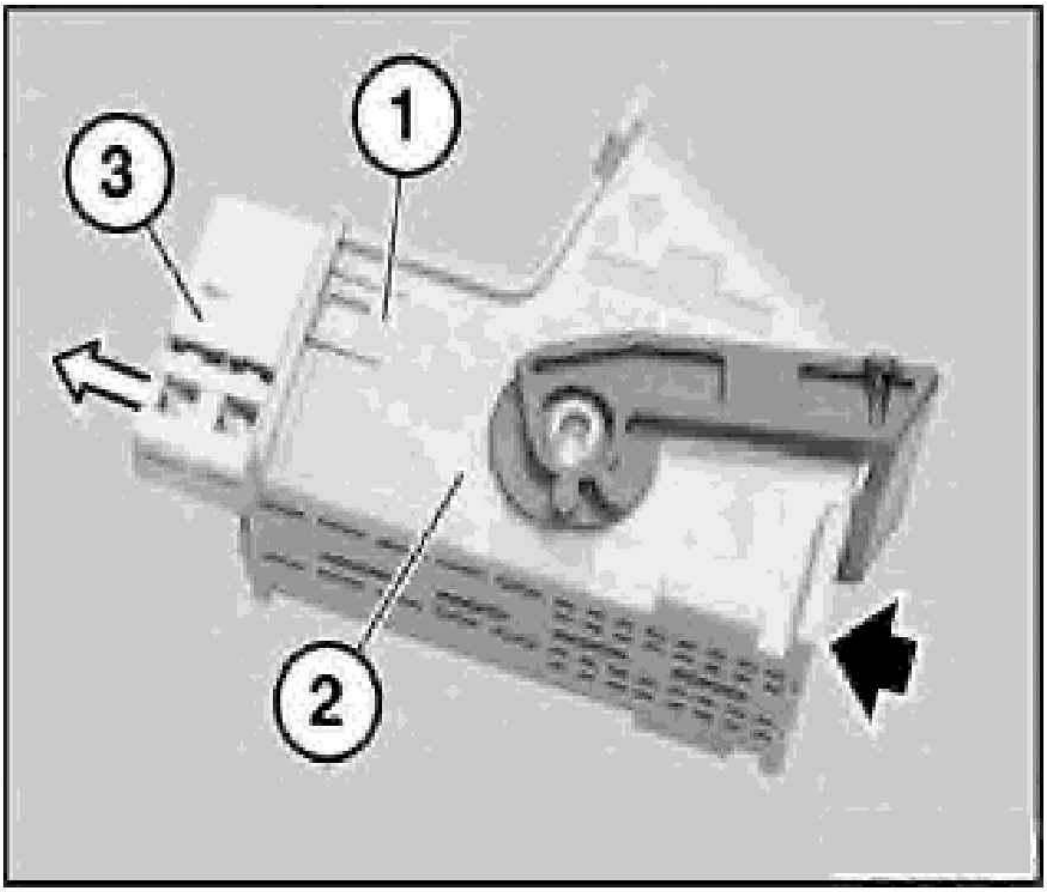
- Raise lock (1) on housing (2).
- Push contact carrier (3) from rear out of housing.

NOTE: The second carrier is pushed out in the same way.

Pushing out the contact carrier releases the secondary locks of the secondary contacts.

Procedure for removing contacts are same as for other Elo/Elo-Power Systems, refer to the appropriate article.

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Fig. 62: Removing Contact Carrier From Rear Housing
Courtesy of BMW OF NORTH AMERICA, INC.

In-line Plug 30 Pin Hybrid System MQS/MPQ

Manufactured by AMP: The following contact types without strand sealing can be fitted in the plug housings:

MQS (Micro Quadlock System).

MPQ, width 2.8 mm (Micro Power Quadlock).

MPQ, width 5.2 mm (Micro Power Quadlock).

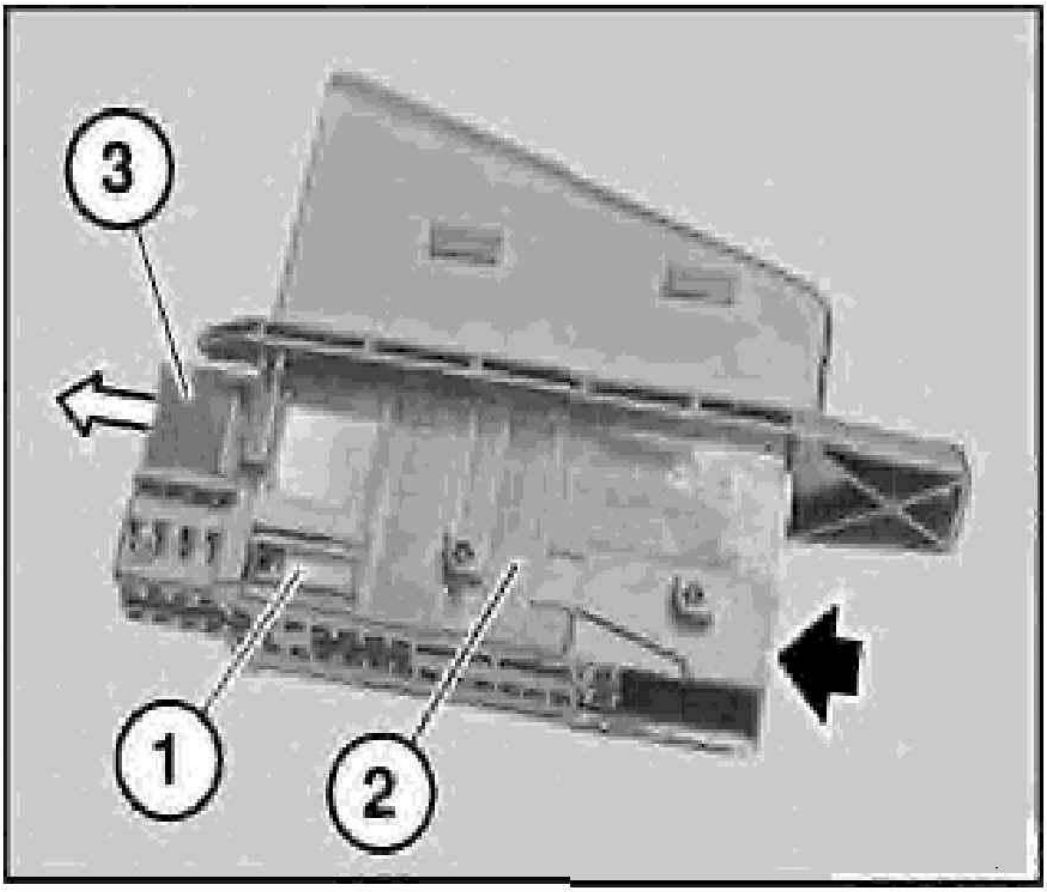
Socket Housing

- Raise lock (1) on housing (2).

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- Push contact carrier (3) from rear out of housing (2).

NOTE: Pushing out the contact carrier releases the secondary locks of the socket contacts. Procedure for removing contacts are same as for other Elo/Elo-Power Systems, refer to the appropriate article.



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Fig. 63: Removing Contact Carrier From Rear Out Of Housing
Courtesy of BMW OF NORTH AMERICA, INC.

Pin Housing

- Contact 1-13 and 19-27.
- Raise locking slide (1) on both sides (2) of housing and detach.

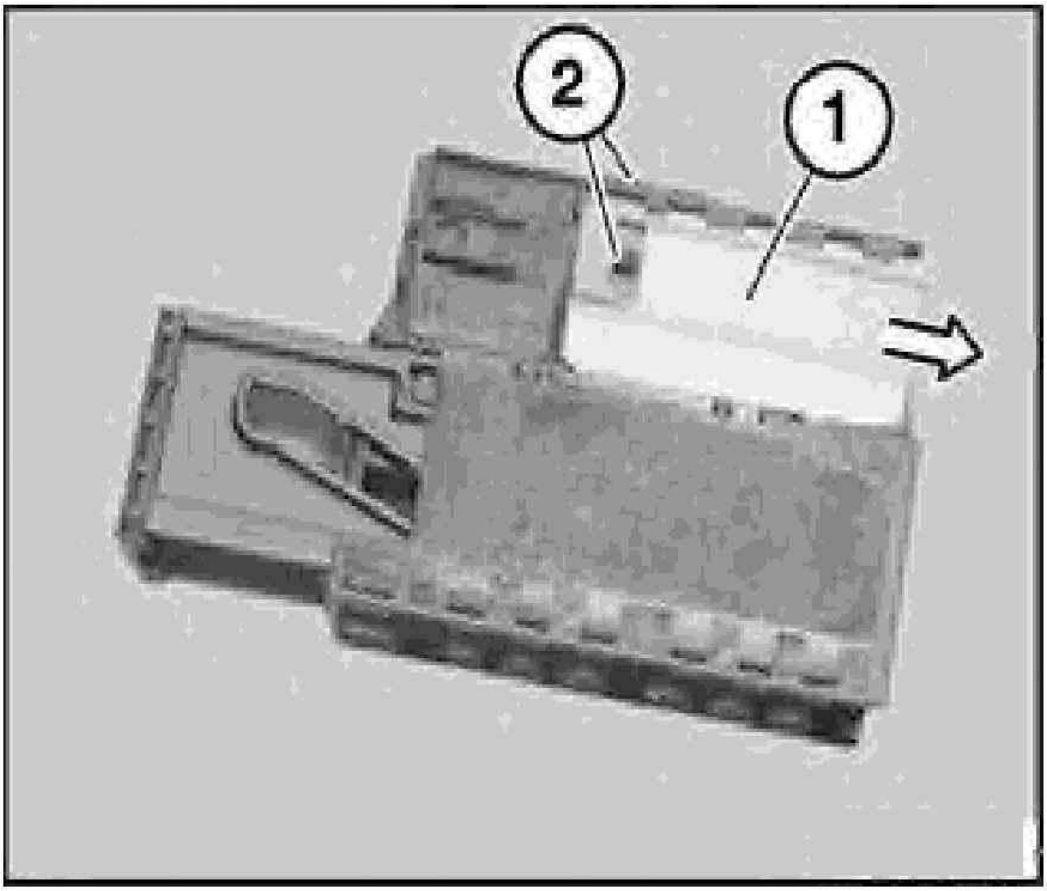
NOTE: Detaching the locking slide releases the secondary locks of the pin

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contacts.

- Contacts 14-18 and 28-30.
- Pull slide (1) outward completely.
- Raise lock (2) on housing.
- Pull contact carrier out of housing.

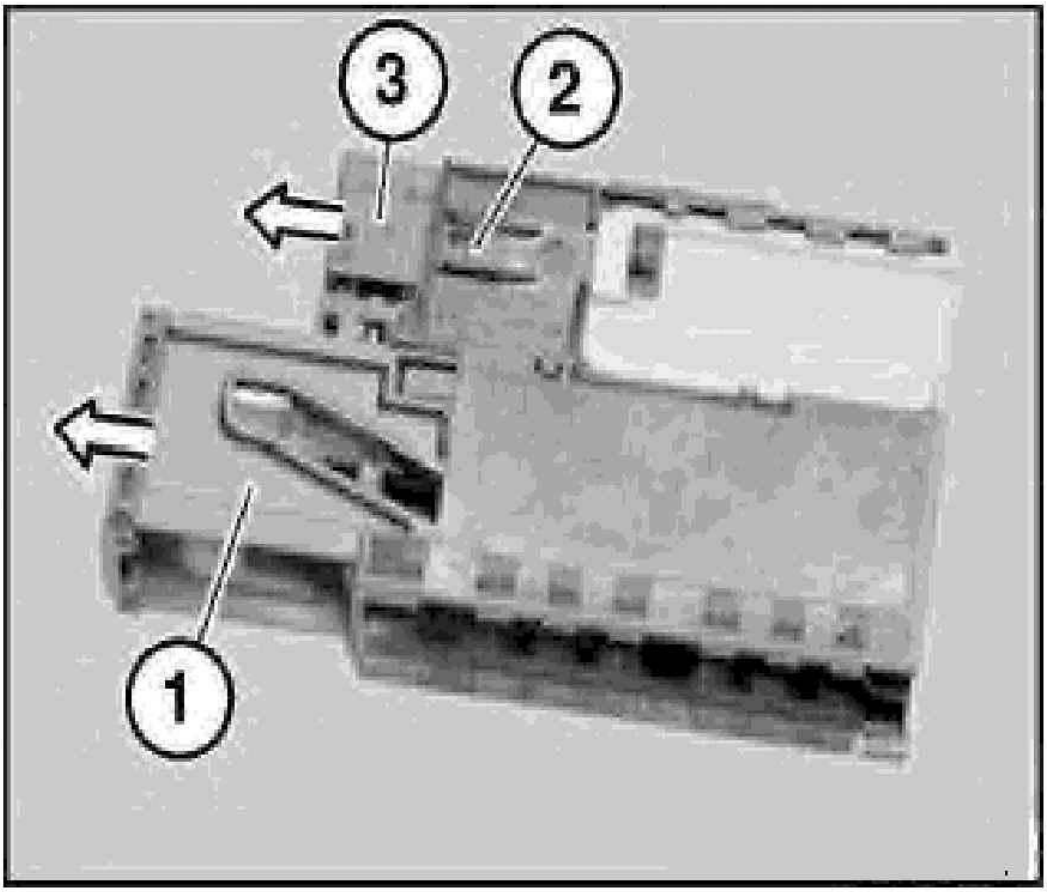
NOTE: Pulling out the contact carrier releases the secondary locks of the pin contacts.



G03388996

Fig. 64: Identifying Pin Housing Slide
Courtesy of BMW OF NORTH AMERICA, INC.

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G03388997

Fig. 65: Removing Pin Housing Contact Carrier
Courtesy of BMW OF NORTH AMERICA, INC.

Socket Housing 5-, 8 Pin System MQS/MPQ

Manufactured by AMP: The following contact types without strand sealing can be fitted in the socket housings:

MQS (Micro Quadlock System).

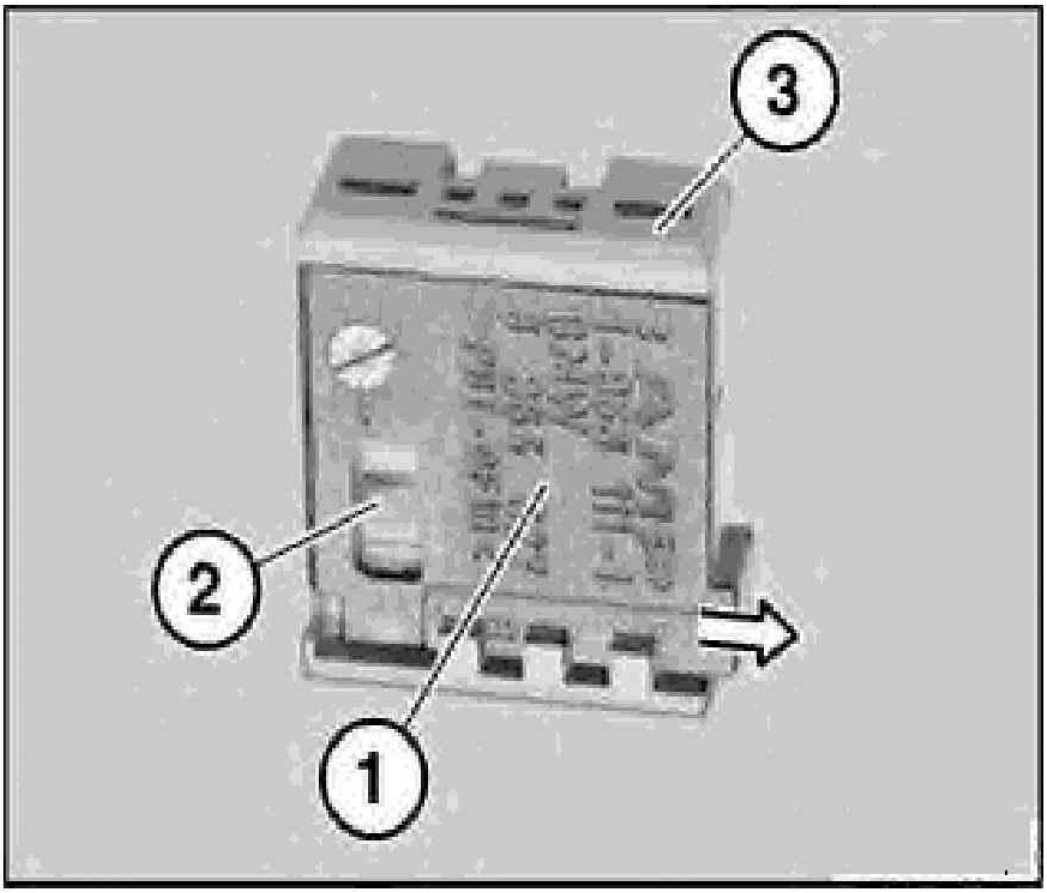
MPQ, width 2.8 mm (Micro Power Quadlock).

MPQ, width 5.2 mm (Micro Power Quadlock).

Socket housing 5 pin (Hybrid System MQS/MPQ)

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- Raise fastener (1) (slide) by way of retaining lug (2) and detach from contact carrier (3).



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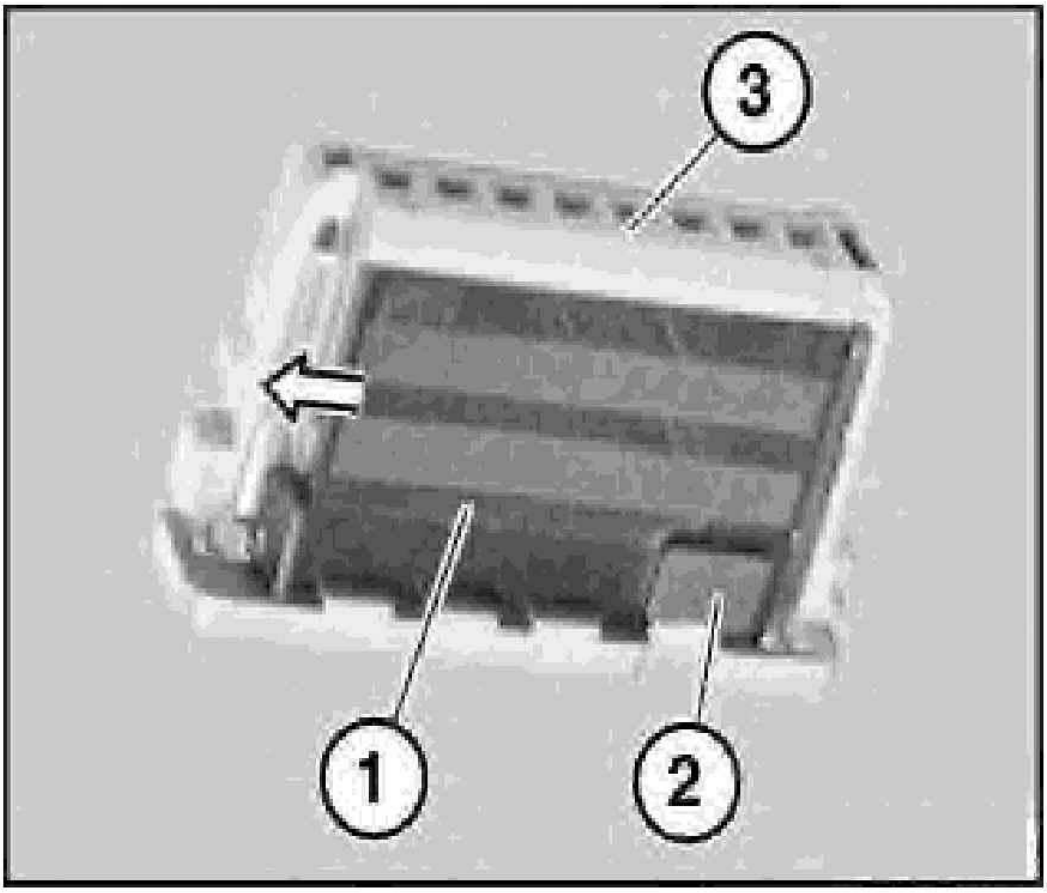
Fig. 66: Identifying Socket Housing Fastener
Courtesy of BMW OF NORTH AMERICA, INC.

Socket Housing 8 Pin (MQS)

- Raise fastener (1) (slide) by way of retaining lug (2) and detach from contact carrier (3).

Procedure for removing contacts are same as for other Elo/Elo-Power Systems, refer to the appropriate article.

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Fig. 67: Identifying Socket Housing 8 Pin (MQS)
Courtesy of BMW OF NORTH AMERICA, INC.

Socket Housing (Radio Plug) Hybrid system MQS/MPS

Manufactured by AMP: The following contact types without strand sealing can be fitted in the plug housings:

MQS (Micro Quadlock System).

MPQ, width 2.8 mm (Micro Power Quadlock).

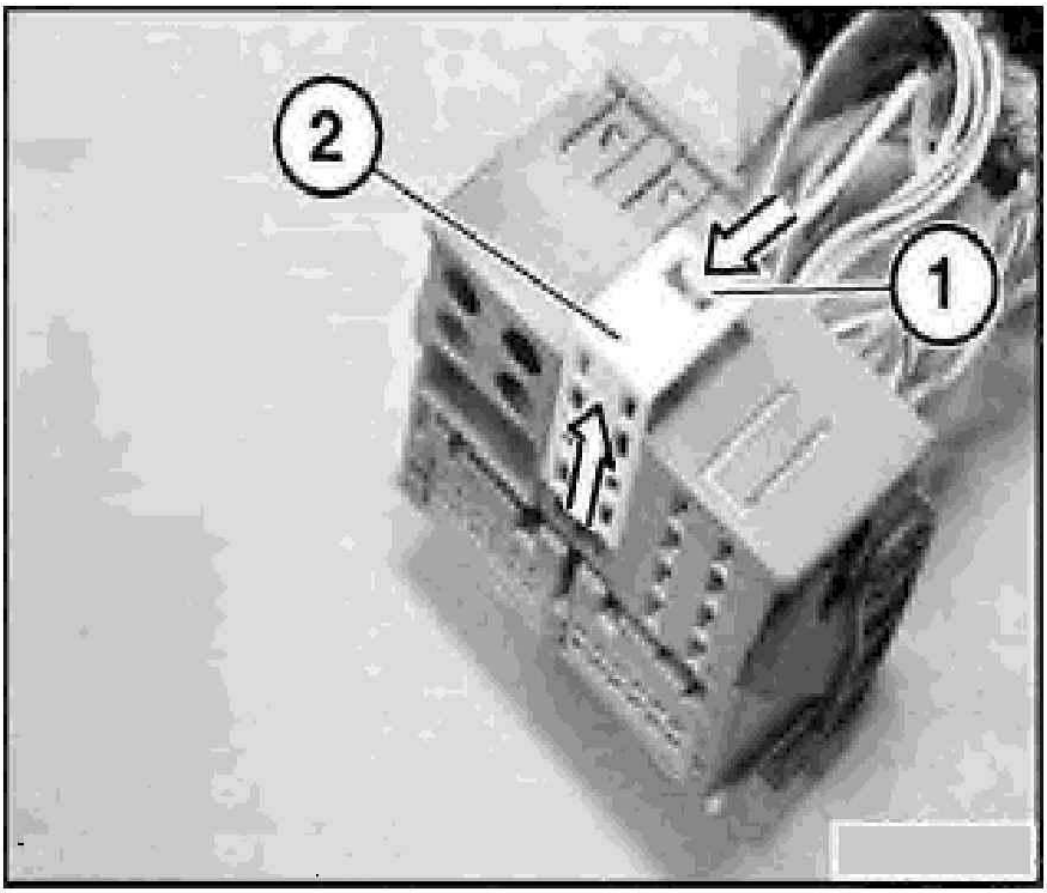
MPQ, width 5.2 mm (Micro Power Quadlock).

Removing MPQ contacts from radio plug:

- Press lock (1) in direction of arrow, detach secondary lock (2) from radio plug.

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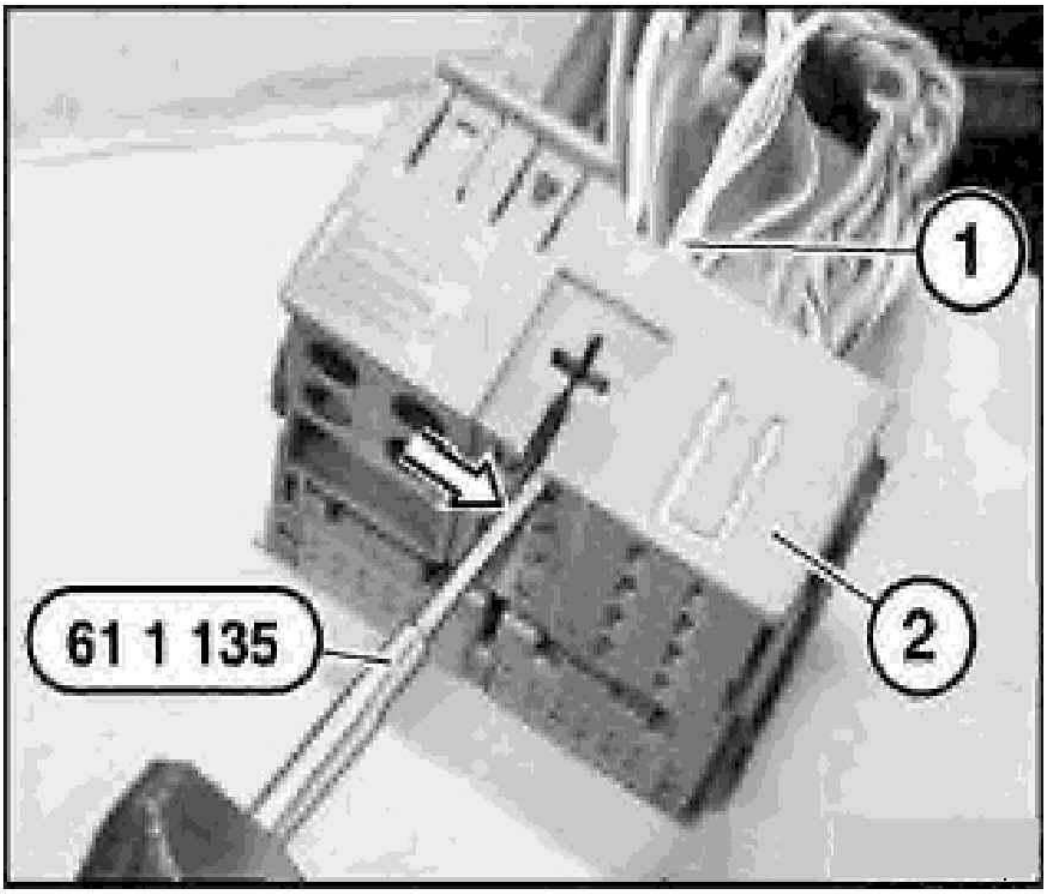
- Feed special tool 61 1 135 past side of contact.
- Press special tool 61 1 135 in direction of arrow.
- Pull wire (1) with socket contact out of radio plug (2).



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Fig. 68: Locating Radio Plug Lock
Courtesy of BMW OF NORTH AMERICA, INC.

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G03389001

Fig. 69: Identifying Special Tool In Radio Plug
Courtesy of BMW OF NORTH AMERICA, INC.

Removing MQS contacts from carrier

- Press lock (1) in direction of arrow and pull housing (2) out of radio plug (**Fig. 70**).
- Press lock (1) in direction of arrow. Pull contact carrier (2) out of housing (**Fig. 71**).

NOTE: When the contact carrier is pulled out, the secondary locks of the socket contacts are raised. Procedure for removing contacts are same as for other Elo/Elo-Power Systems, refer to the appropriate article.

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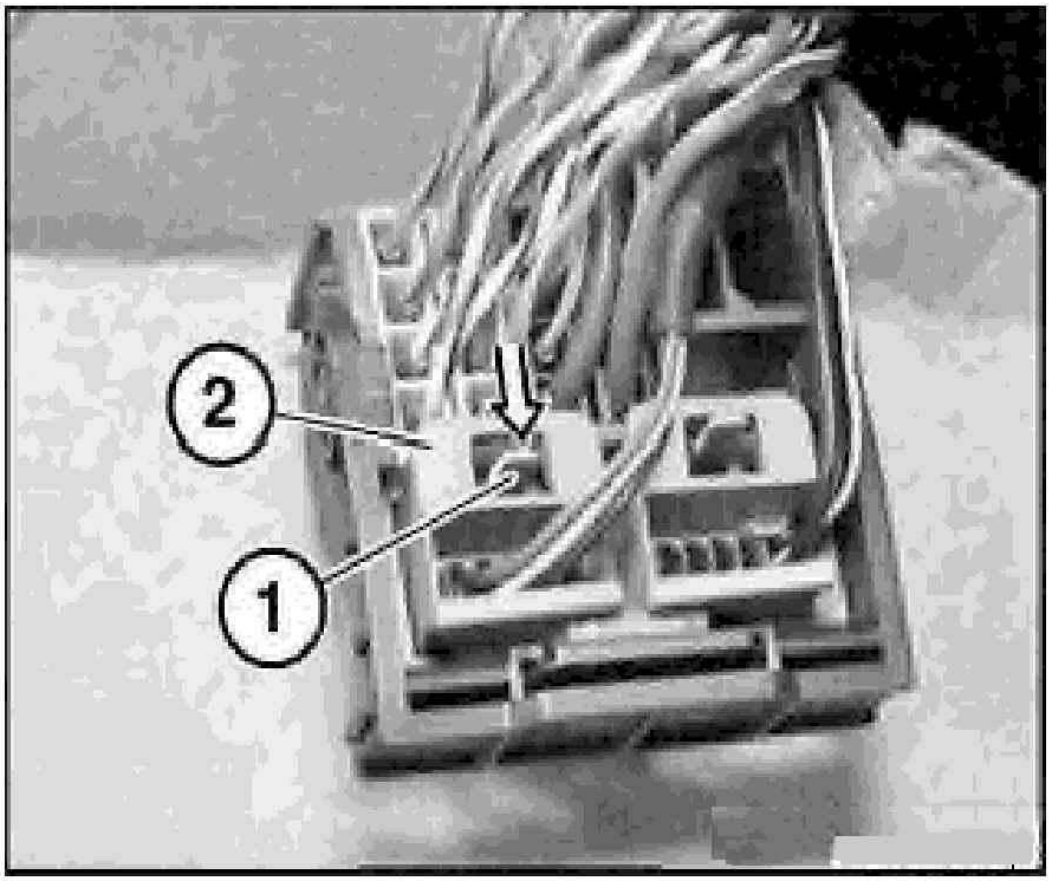
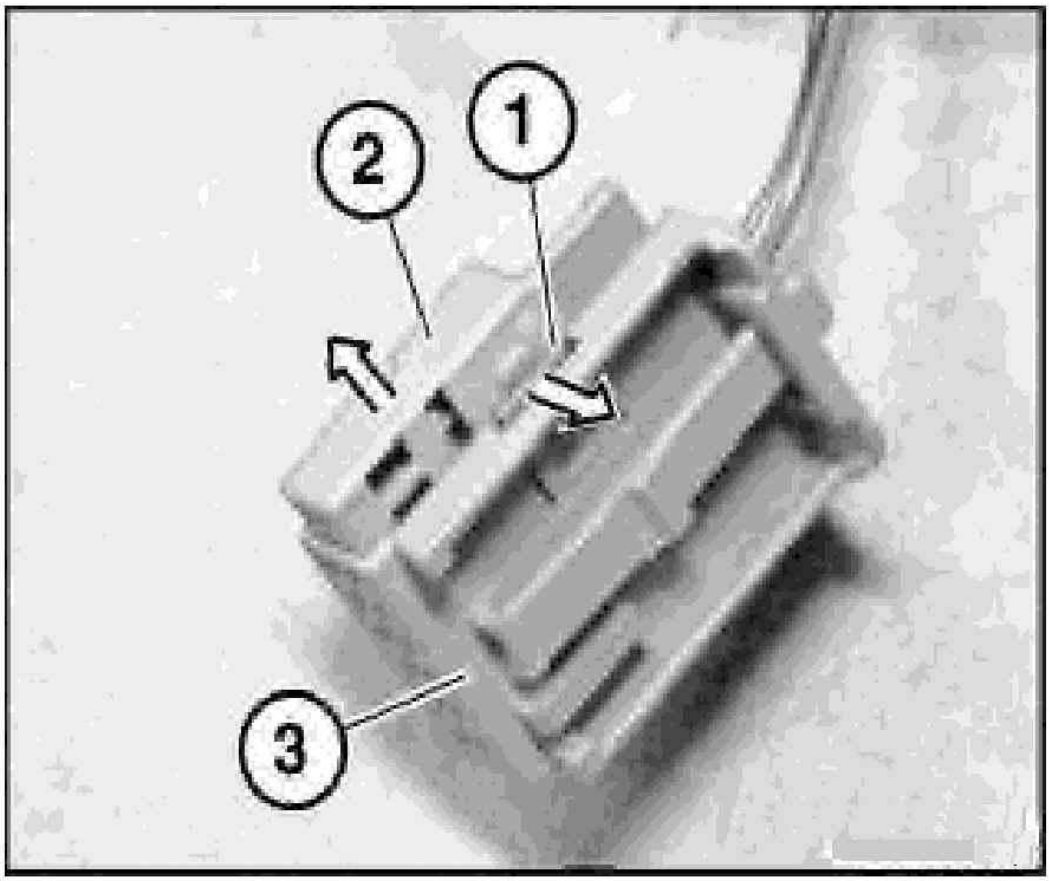


Fig. 70: Removing Housing From Radio Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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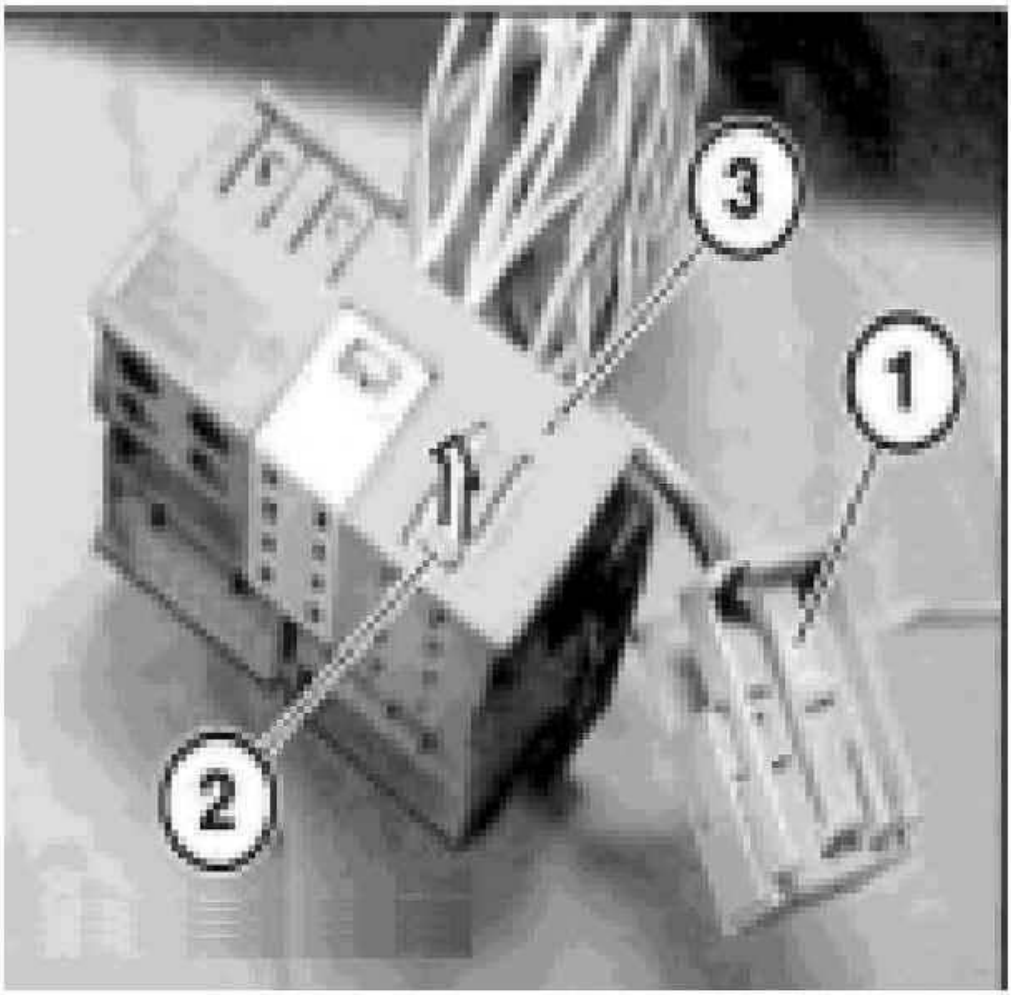
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Fig. 71: Removing Contact Carrier Out Of Housing
Courtesy of BMW OF NORTH AMERICA, INC.

Removing MPQ contacts from contact carrier

- Remove contact carrier (1) with MQS contacts from radio plug. Raise lock (2) on radio plug. Pull contact carrier (3) out of radio plug (**Fig. 72**).
- Press lock (1) in direction of arrow. Pull secondary lock (2) in direction of arrow completely out of contact carrier (3) (**Fig. 73**).
- Press special tool 61 1 135 on inside of contact into contact carrier (2). Pull wire with socket contact (1) out of contact carrier (2) (**Fig. 74**).

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Fig. 72: Removing MPQ Contacts From Contact Carrier
Courtesy of BMW OF NORTH AMERICA, INC.

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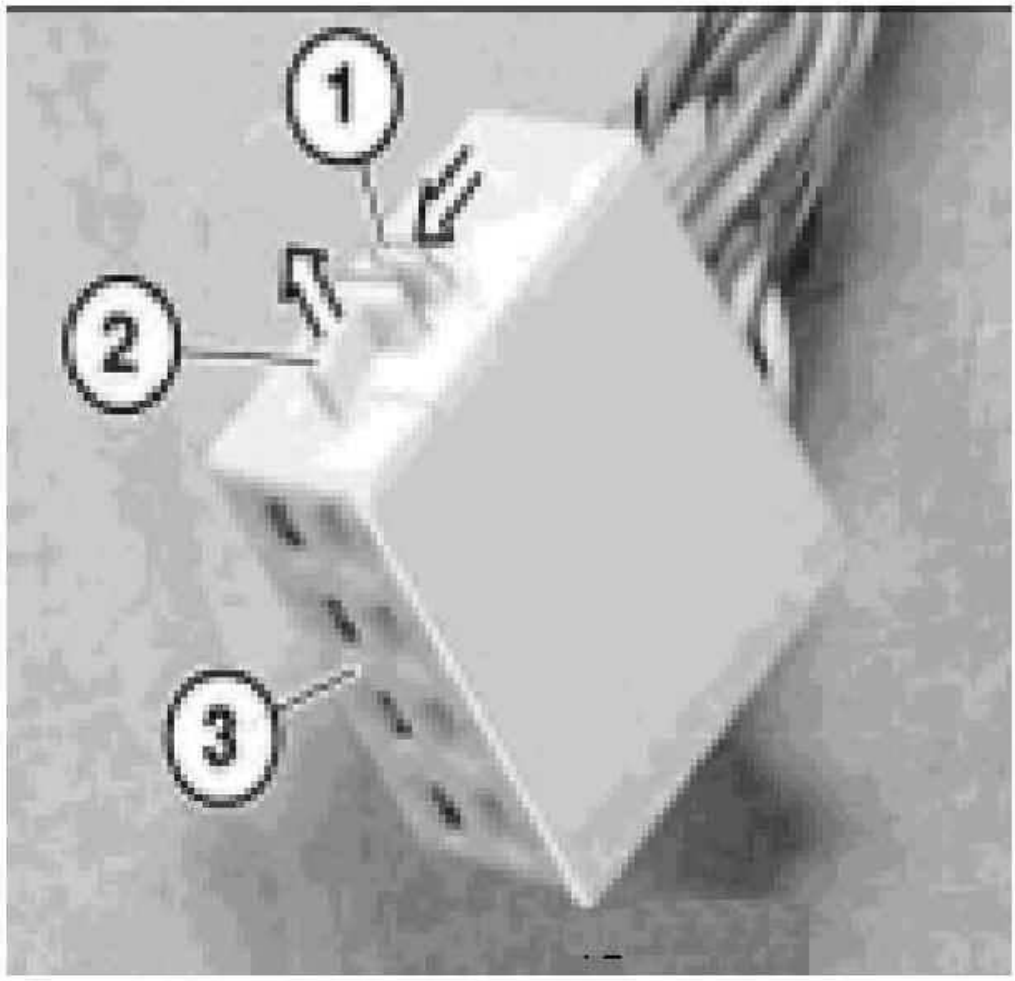


Fig. 73: Removing Secondary Lock From Contact Carrier
Courtesy of BMW OF NORTH AMERICA, INC.

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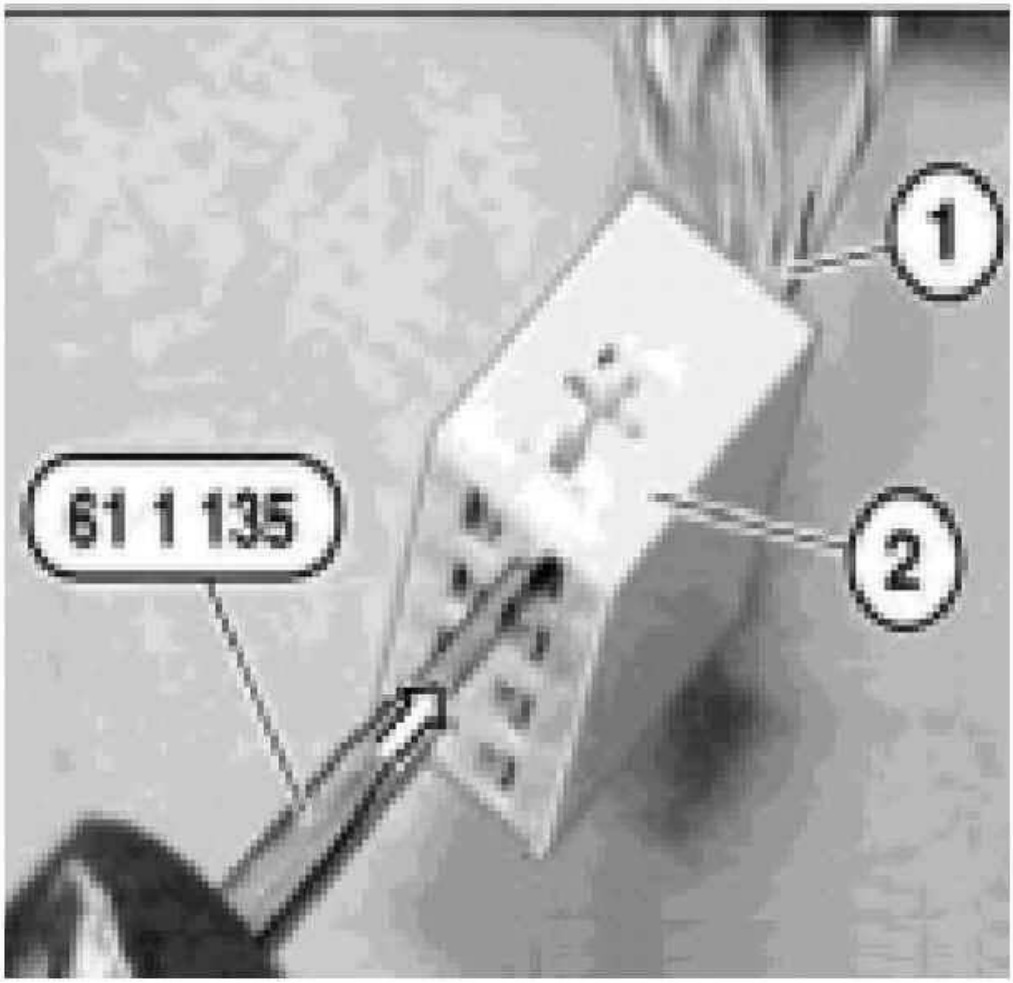


Fig. 74: Removing Socket Contact From Contact Carrier
Courtesy of BMW OF NORTH AMERICA, INC.

MISCELLANEOUS CONNECTORS

Fuse Strip

- Pull appropriate fuse from fuse strip (1).**Note: Mark fuse rating and position for reinstallment.**
- Pull locking slide (2) out of fuse strip until stop is felt.
- Using special tool **61 1 136** or **61 1 137** press the spring latch down (3) and pull the connector from the housing.

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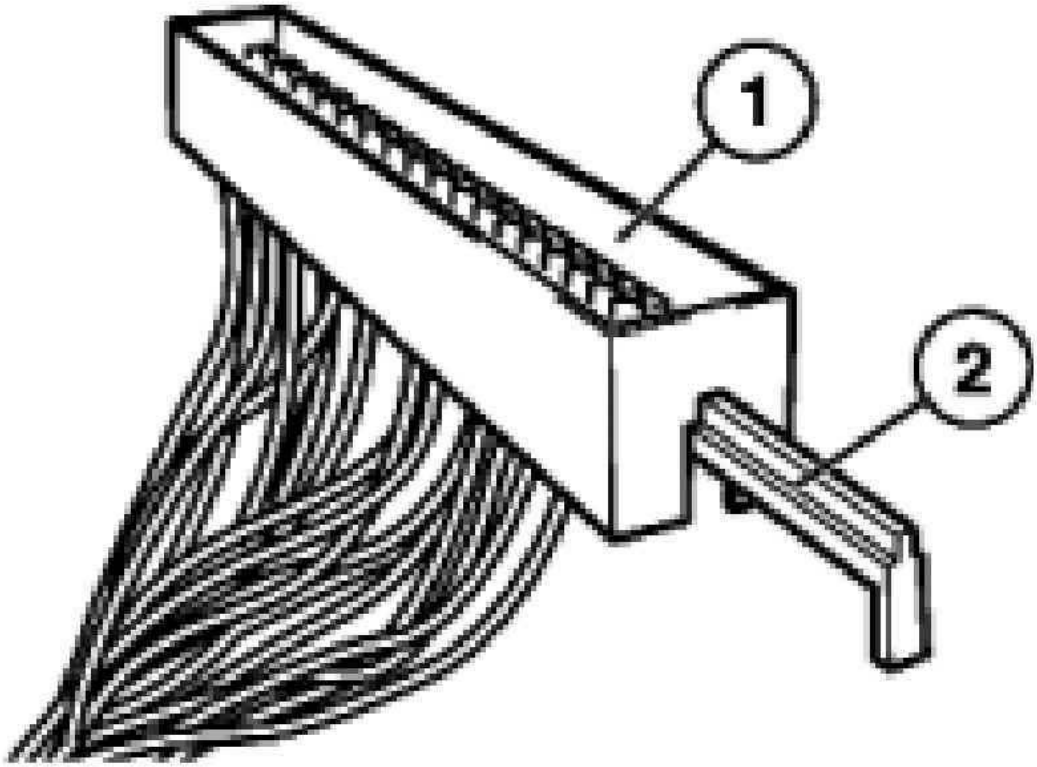


Fig. 75: Removing Locking Slide From Fuse Strip
Courtesy of BMW OF NORTH AMERICA, INC.

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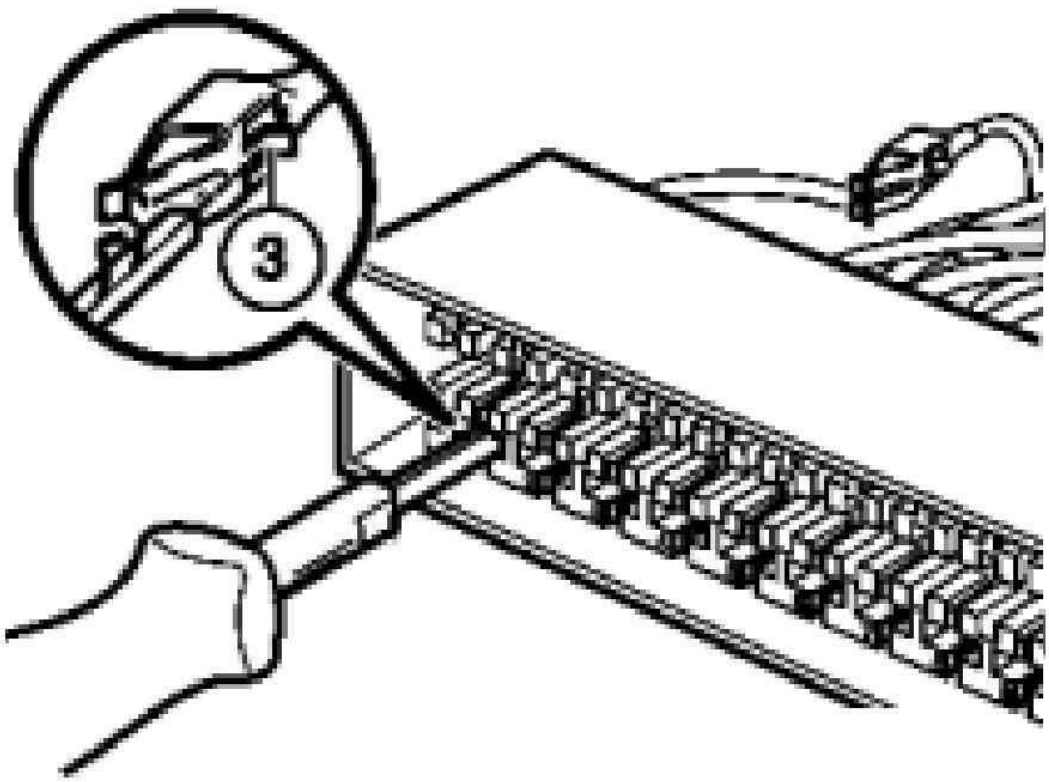


Fig. 76: Removing Connector From Housing Using Special Tool
Courtesy of BMW OF NORTH AMERICA, INC.

ECM Main Relay Connector

- Unlock wire flap (1) of connector being removed.
- Using special tool **61 1 136** or **61 1 137** press the spring latch down (2) and pull the connector from the housing.

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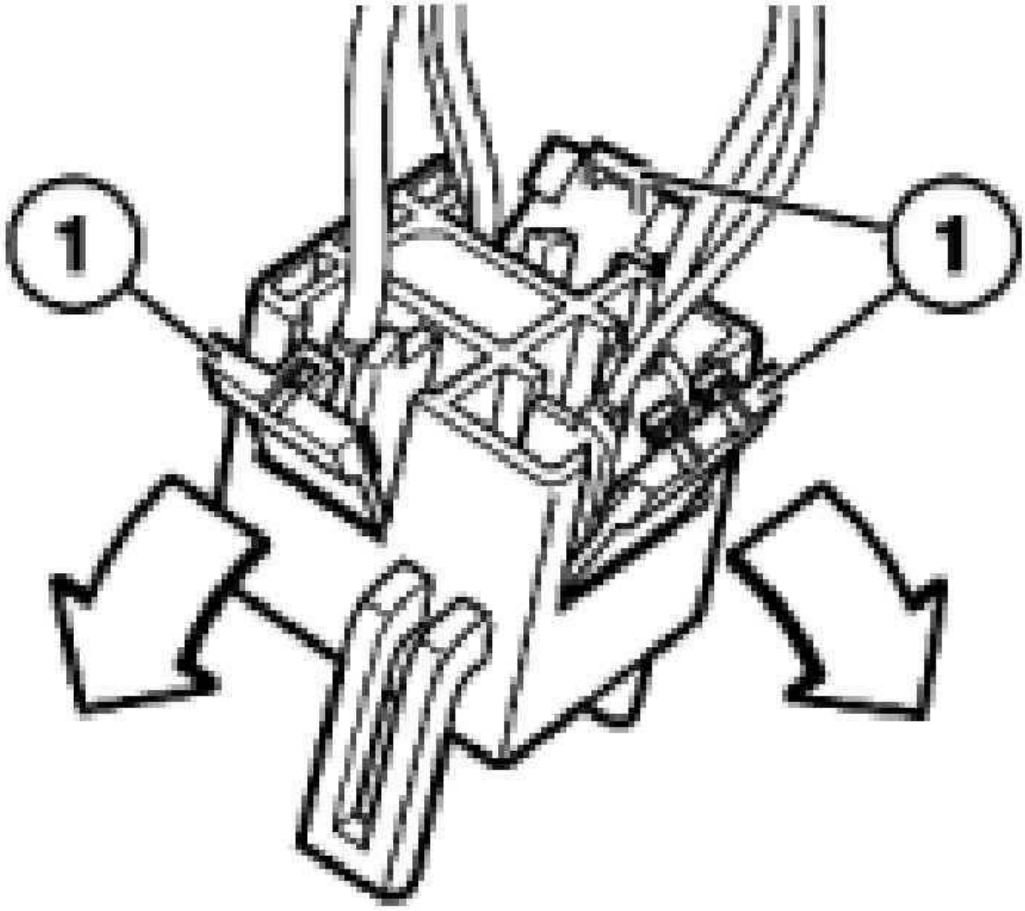


Fig. 77: Removing Wire Flap Of Connector
Courtesy of BMW OF NORTH AMERICA, INC.

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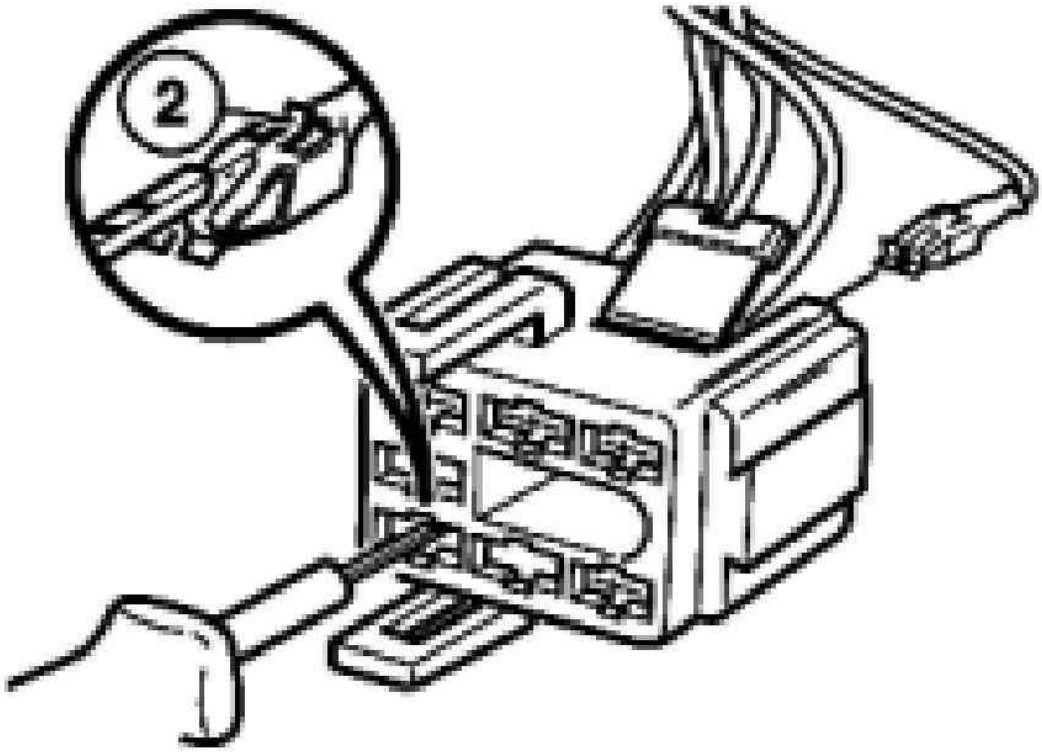


Fig. 78: Locating Spring Latch
Courtesy of BMW OF NORTH AMERICA, INC.

SOLDERLESS TERMINALS AND CONNECTORS

Mechanical strength of solderless terminal design and electrical conductivity must be maintained at all times. To ensure these characteristics are maintained in the vehicles electrical system several BMW repair kits are available.

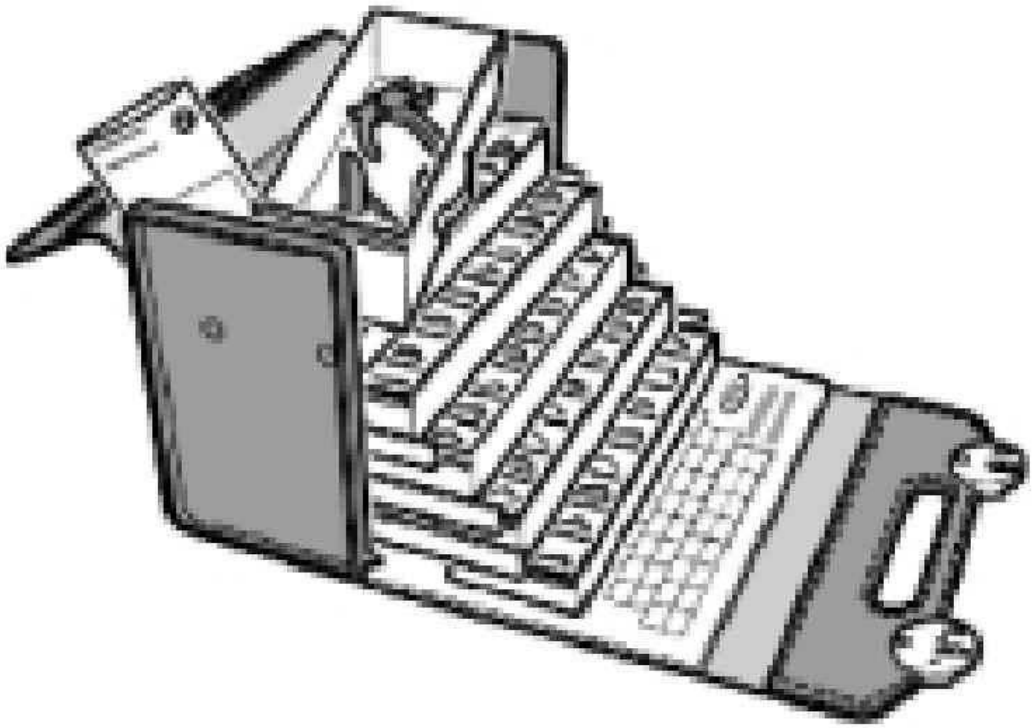
The repair kits listed contain all the approved connectors, pins, and tools required for proper repair of BMW's electrical, electronics components.

- **Electrical Repair Kit IV**

P/N 90 88 6 619 020

The Electrical Repair Kit IV (Ref. SI. 04 18 92) is used in conjunction with the detailed repair procedures.

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Fig. 79: Identifying Electrical Repair Kit IV
Courtesy of BMW OF NORTH AMERICA, INC.

- Disassembling, replacing a plug connection on the various types of connectors.
- Cutting cable to length.
- Crimping stop parts (Contacts).
- Butt connectors for repairing a plug connection.

Operating instructions for special tools and the handling of individual parts in the repair kit are available under PN 61 9 029.

Three previous kits issued by BMW are:

- **Electrical Repair Kit I** (Black Case)

  P/N 81 24 9 408 080

- **Electrical Repair Kit II** (Blue Case)

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P/N 81 24 9 408 300

- **Electrical Repair Kit III** (Red Case)

  P/N 82 11 9 408 400

Electrical repair kits I, II and III are primarily needed for repairing wiring harness and connectors of older vehicles (E30 and earlier).

Operating instructions for special tools in these kits are available under **PN 61 8 084.**

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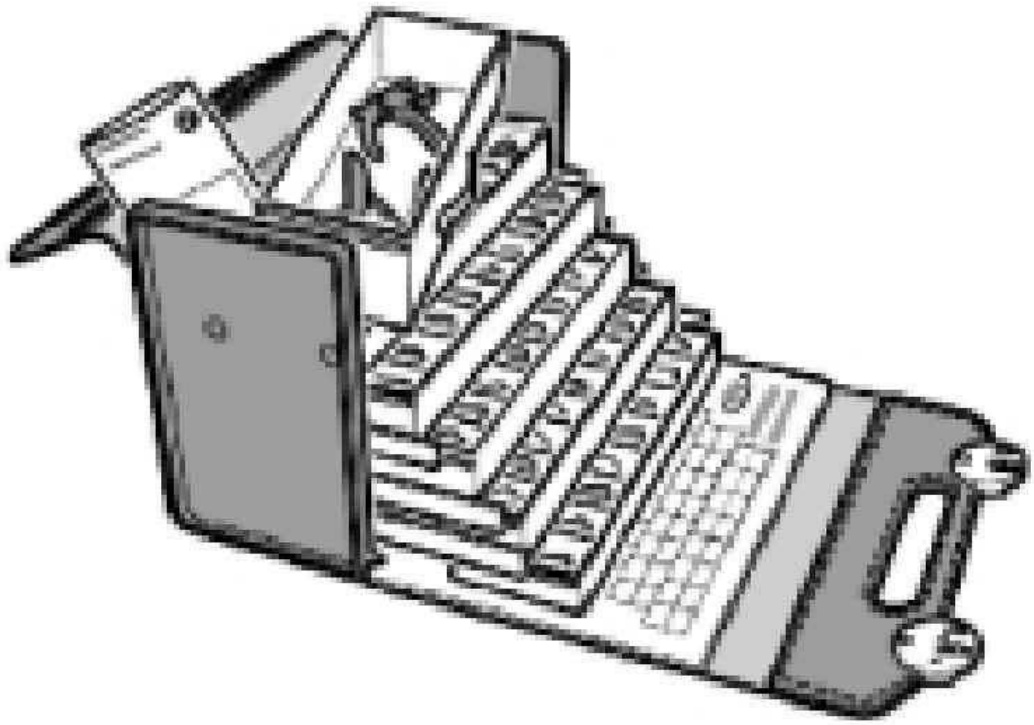
Fig. 80: Identifying Electrical Repair Kits
Courtesy of BMW OF NORTH AMERICA, INC.

ELECTRICAL REPAIR KIT IV

The Electrical Repair Kits (I, II, III and IV) have gone through various upgrades.

Electrical Repair Kit IV (PN 90 88 619 020) has been developed to handle repairs of the specialized state of the art wiring and harnesses of the newest BMW products.

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Fig. 81: Identifying Electrical Repair Kit IV
Courtesy of BMW OF NORTH AMERICA, INC.

CAUTION: The special tools contained in the Electrical Repair Kits I, II, III are not state of the art and are not suitable for specialized wiring harness repairs. Use exclusively Electrical Repair Kit IV for those repairs.

Electrical Repair Kit IV (61 9 020)

Contains the following:

61 9 041 Crimping Tool.

61 9 042 Matrix.

61 9 043 Cable Stripper.

61 9 044 Matrix.

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Assorted Individual Parts.

Cable Stripper

Special Tool **61 9 043** Cable stripper with wire cutter for cutting and stripping insulation from cables.

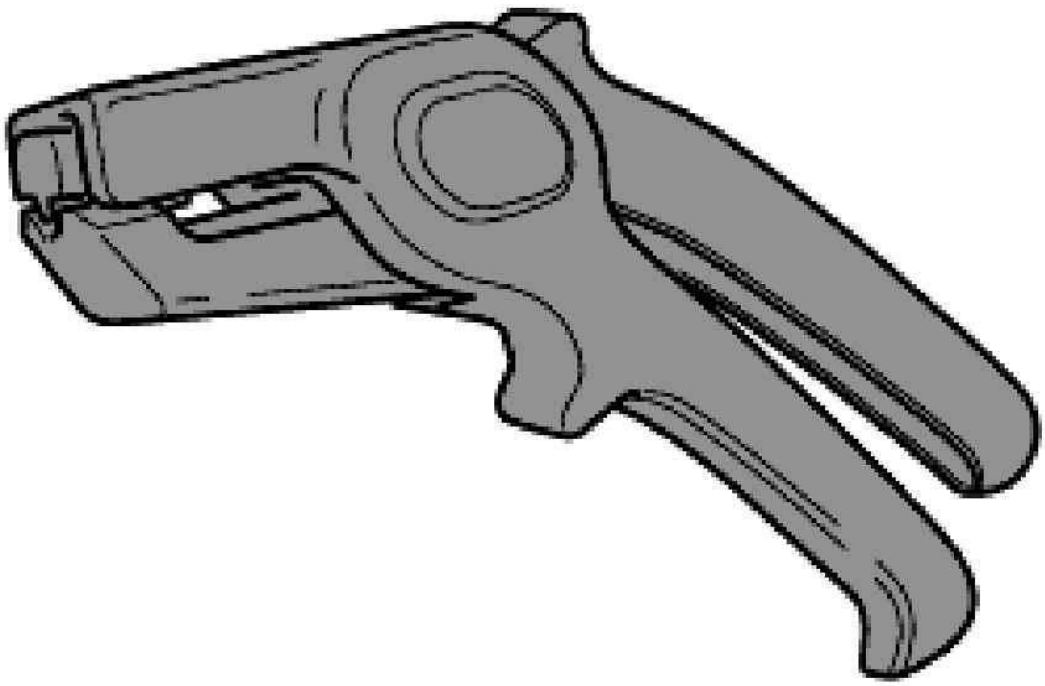


Fig. 82: Identifying Cable Stripper
Courtesy of BMW OF NORTH AMERICA, INC.

Crimping Tool

Special Tool **61 9 041** Crimping Tool with special tool **61 9 044** (matrix) for crimping cable guide and strain relief device on antenna elbow plug.

Supplementary kits for Electrical Repair Kit IV are released periodically.

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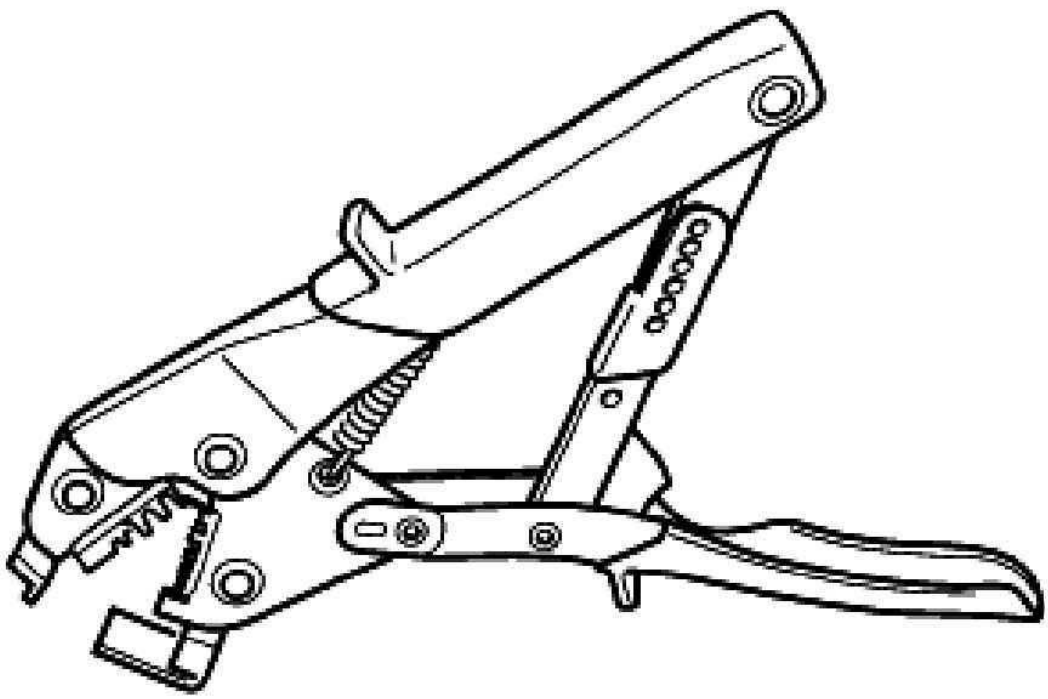


Fig. 83: Identifying Crimping Tool
Courtesy of BMW OF NORTH AMERICA, INC.

CABLE STRIPPING

Proper wire stripping and connector replacement is essential to ensure the integrity of the electrical connection. Always follow specific instructions in the Electrical Repair Kit IV instruction manual.

The length of wire to be stripped is determined by the wire gauge.

WIRE CROSS-SECTION SIZE SPECIFICATIONS

Wire cross-section size	stripped length:
mm^2	mm
0.35... 0.50	4.0
0.75... 1.00	4.5
1.00... 2.50	5.0

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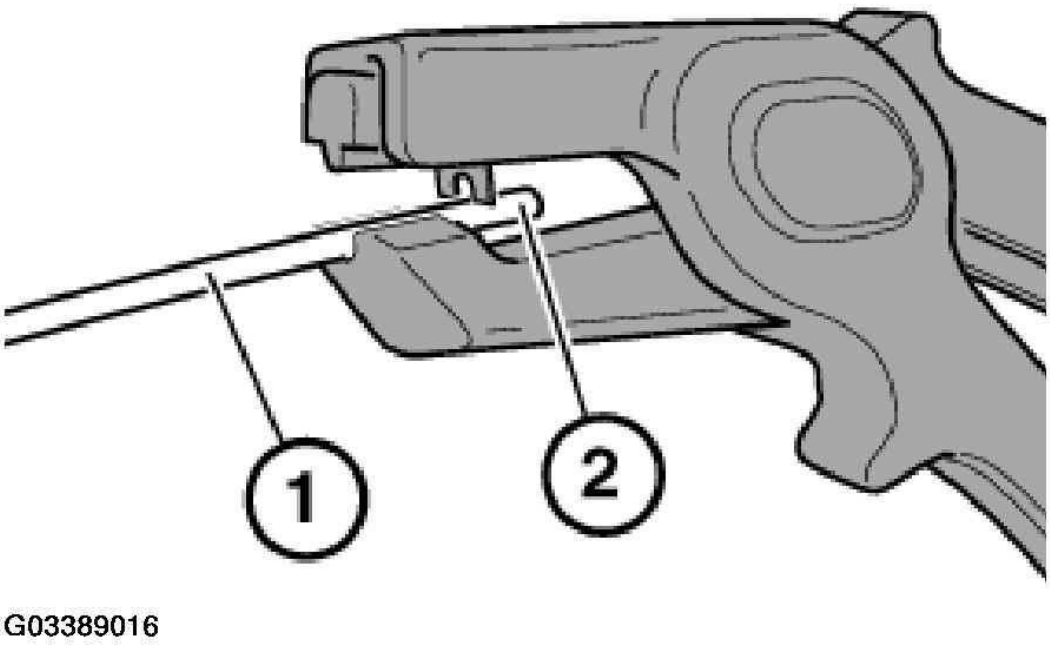


Fig. 84: Inserting Wire Into Cable Stripping Tool
Courtesy of BMW OF NORTH AMERICA, INC.

Proper use of the wire stripping tool will provide consistently positive results. Insert the wire (1) into the stripper. Stop the wire when the required strip length is past the cutter (2). Squeeze the handle of the tool.

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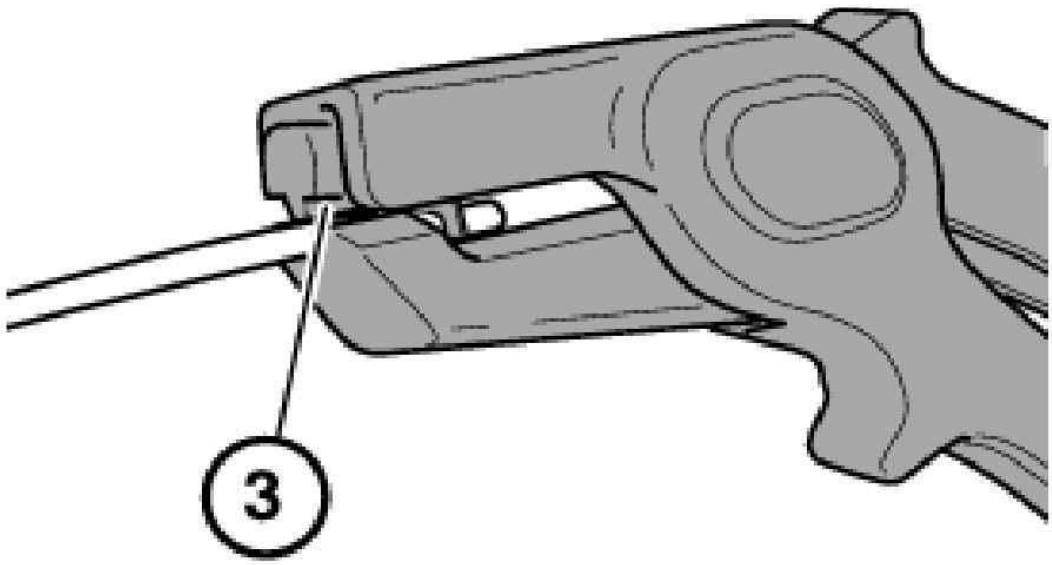


Fig. 85: View Of Wire In Stripper
Courtesy of BMW OF NORTH AMERICA, INC.

When the top jaw of the tool touches the wire (3) the mechanism shifts the clamping action to a pulling action which strips the wire of the insulation (4).

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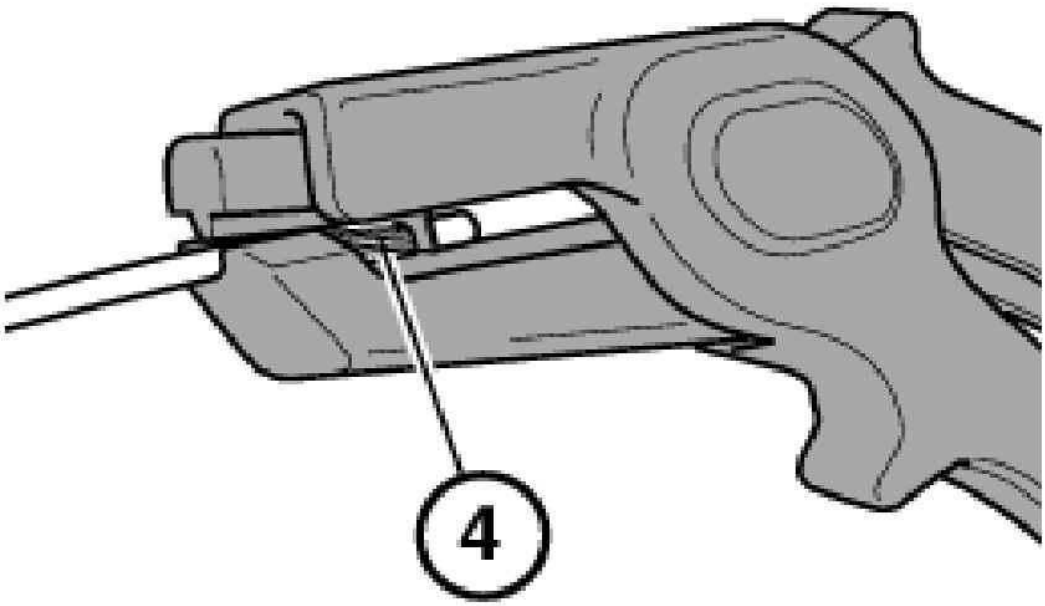


Fig. 86: Removing Insulation Using Stripper
Courtesy of BMW OF NORTH AMERICA, INC.

CRIMPING

Use the wire crimper from the BMW Electrical Repair Kit. This crimper is designed for the specific connectors found in BMW automobiles. Proper use of the tools will provide consistent good quality connector crimps.

The crimper is designed to apply just the right amount of pressure based on the wire gauge and connector size.

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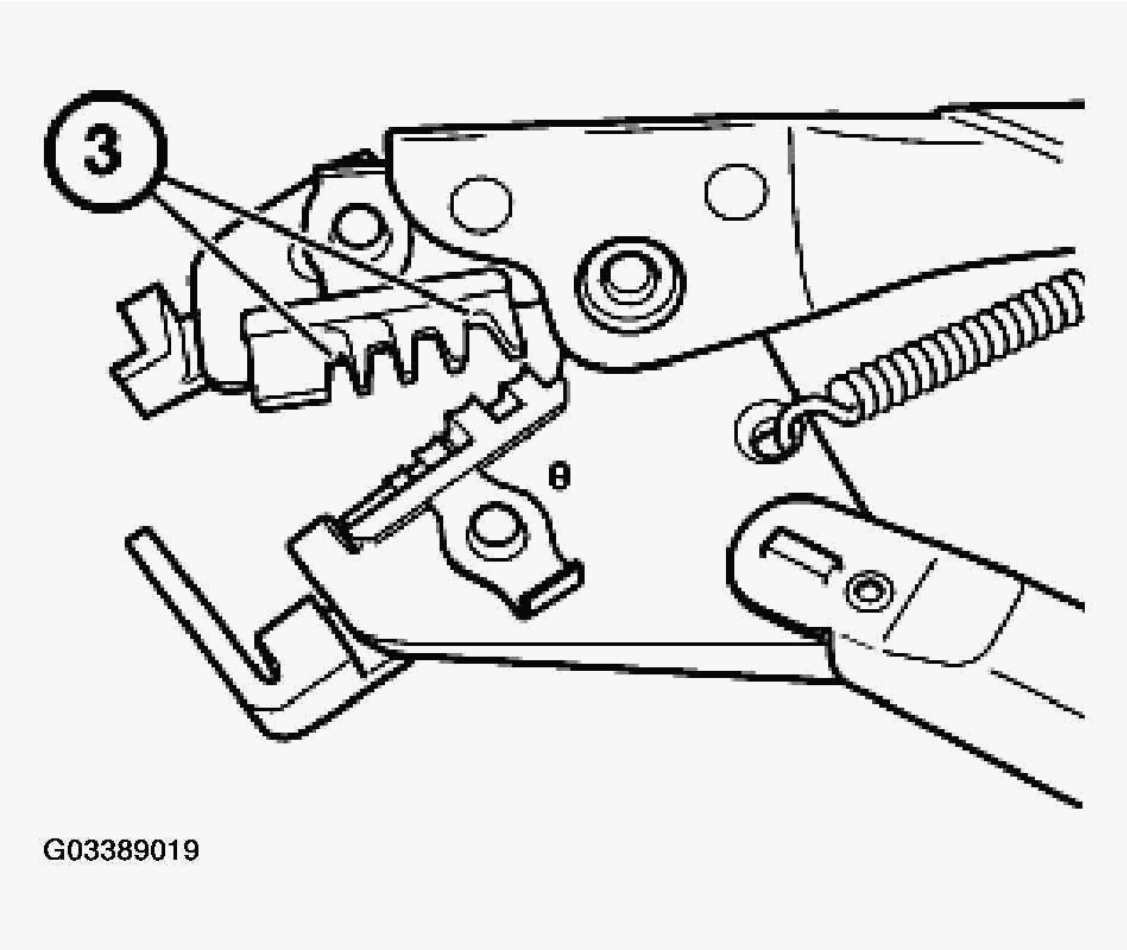


Fig. 87: Identifying Removable Crimper Jaws
Courtesy of BMW OF NORTH AMERICA, INC.

The tool has removable crimper jaws (3). This feature allows for an unlimited number of connector types for future compatibility. The article refers to the different sized crimping slots as "Nests". The gauge of the wire being crimped determines which "Nest" is used.

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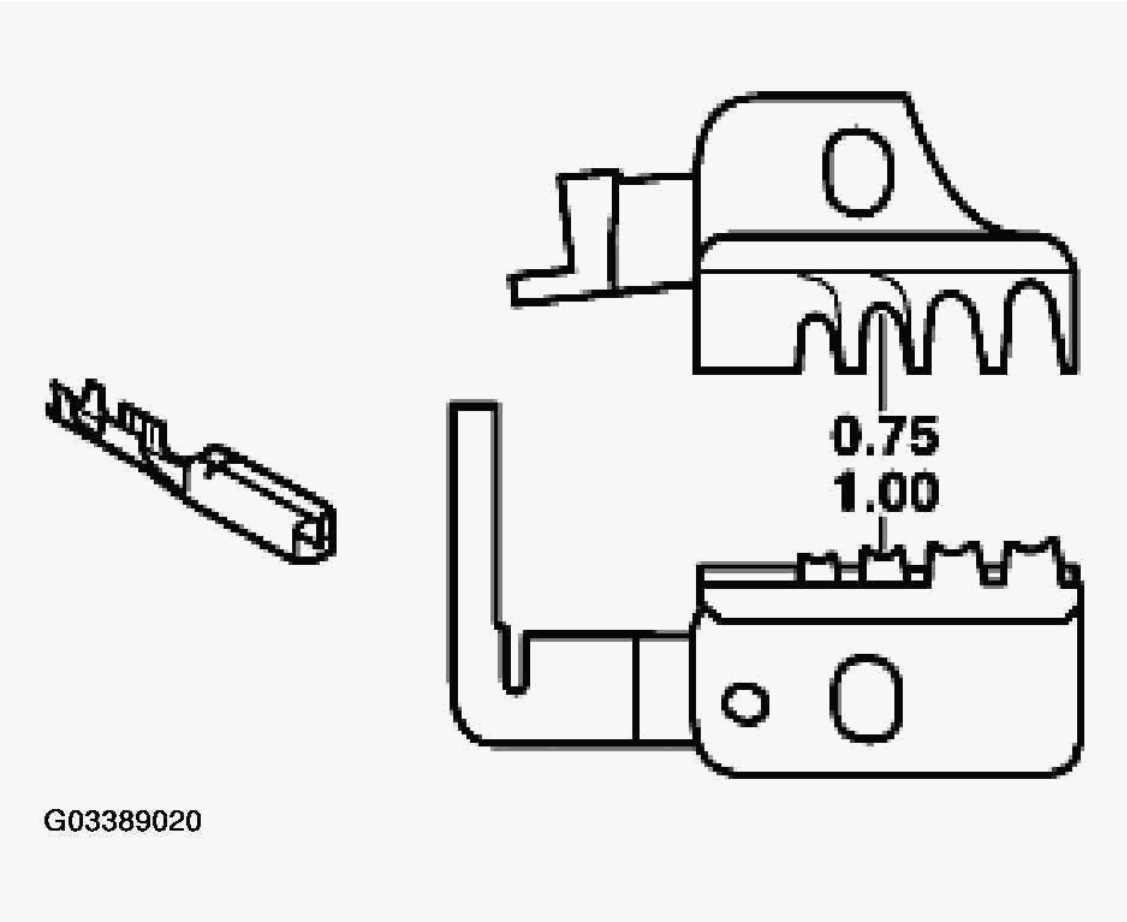


Fig. 88: Identifying Crimper Jaw Dimensions
Courtesy of BMW OF NORTH AMERICA, INC.

WIRE CROSS-SECTION SIZE SPECIFICATIONS

Nest	Wire Cross-section size
1	0.035....0.50mm^2
2	0.75.....1.0mm^2
3	1.5mm^2
4	2.5mm^2

Example:

A. 75 - 1.0mm gauge wire requires nest 2 for proper crimping.

Throughout the Electrical Repair Kit instruction manual are illustrations of various connectors being crimped. The highlighted box of the 16 box grid in these illustrations refers to the storage compartment in the electrical kit drawers in which that specific connector can be found.

Insert the "crimping end" of the connector into the appropriate "nest". Illustration provides example of comb replacement connector (4) and inline splice connector (5).

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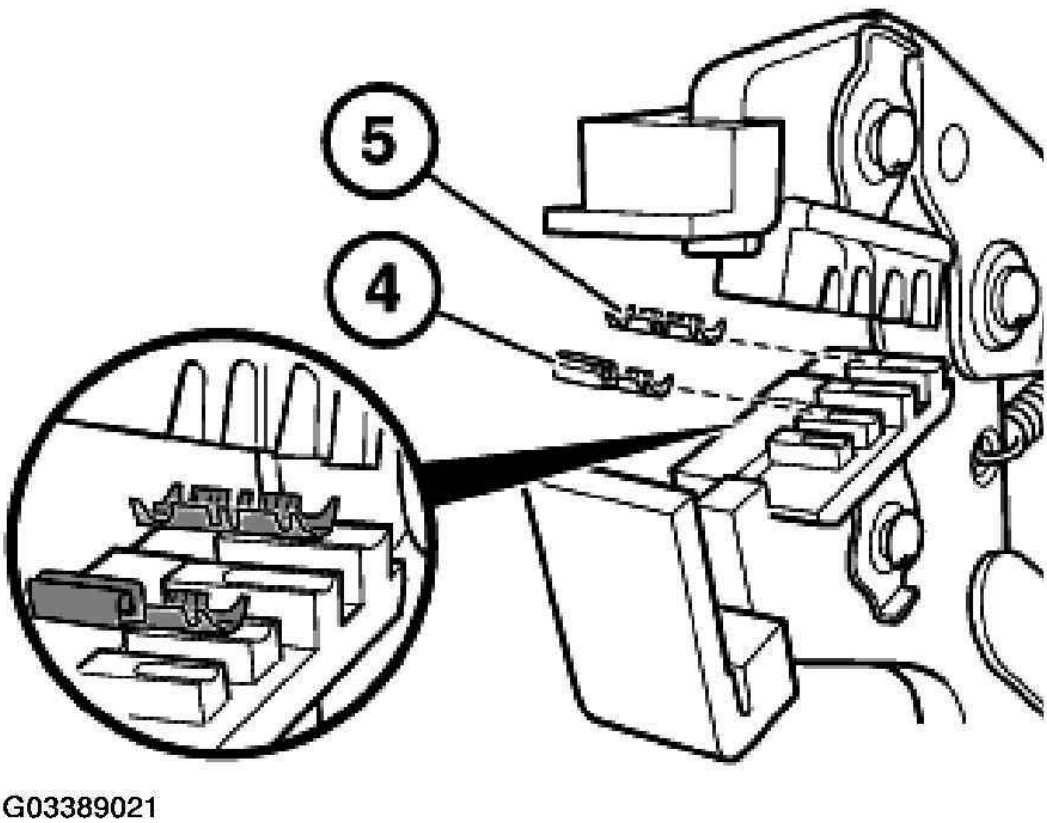


Fig. 89: Identifying Comb Replacement Connector
Courtesy of BMW OF NORTH AMERICA, INC.

Squeeze the tool handle slightly to set the tool in the first ratchet latch position. This will hold the connector in the tool without closing the crimp (6).

Insert the stripped wire into the receiving end of the crimper tool making sure the wire is inserted far enough to ensure that only the wire insulation will be inside the insulation support barrel (7).

Properly crimped connectors exhibit the following characteristics:

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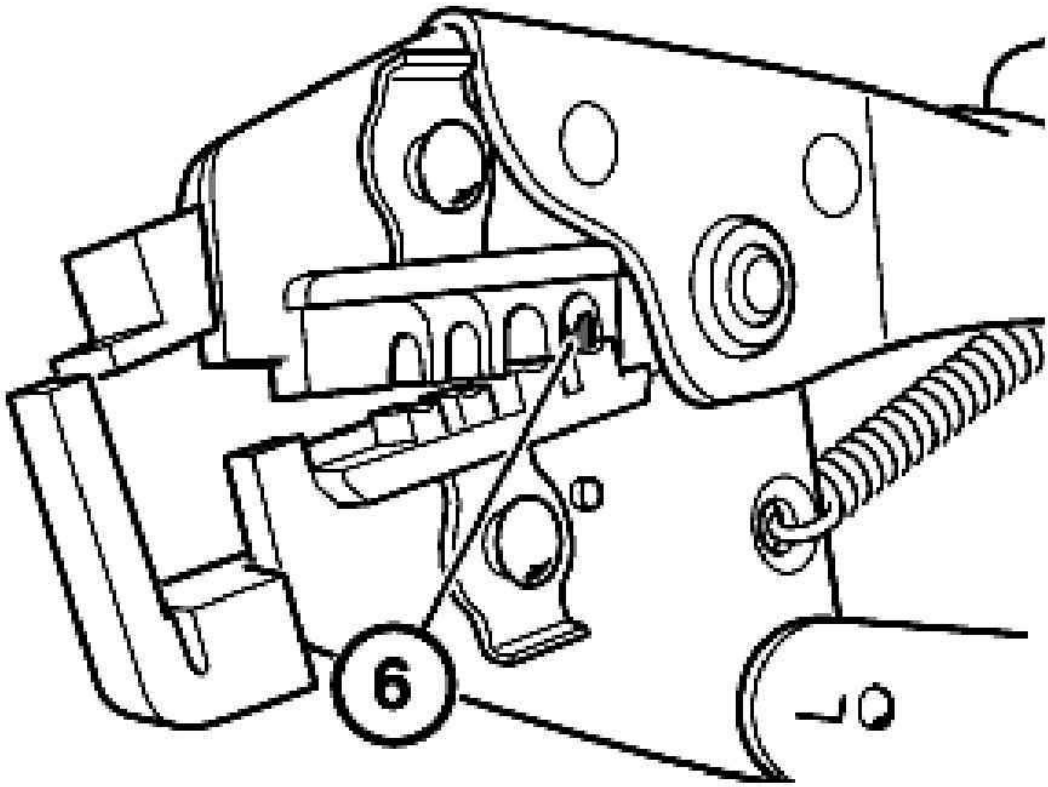


Fig. 90: View Of Connector In Tool
Courtesy of BMW OF NORTH AMERICA, INC.

- The insulation support barrel will be crimped consistently and snug against the insulation. The insulation will not be crushed (8).
- A bellmouth crimp will be visible at the wire end of the of the wire barrel (9).
- Wire strands will be visible at the contact end of the wire barrel (10).
- Insulation end will be visible in this area (11) (**Fig. 92**).

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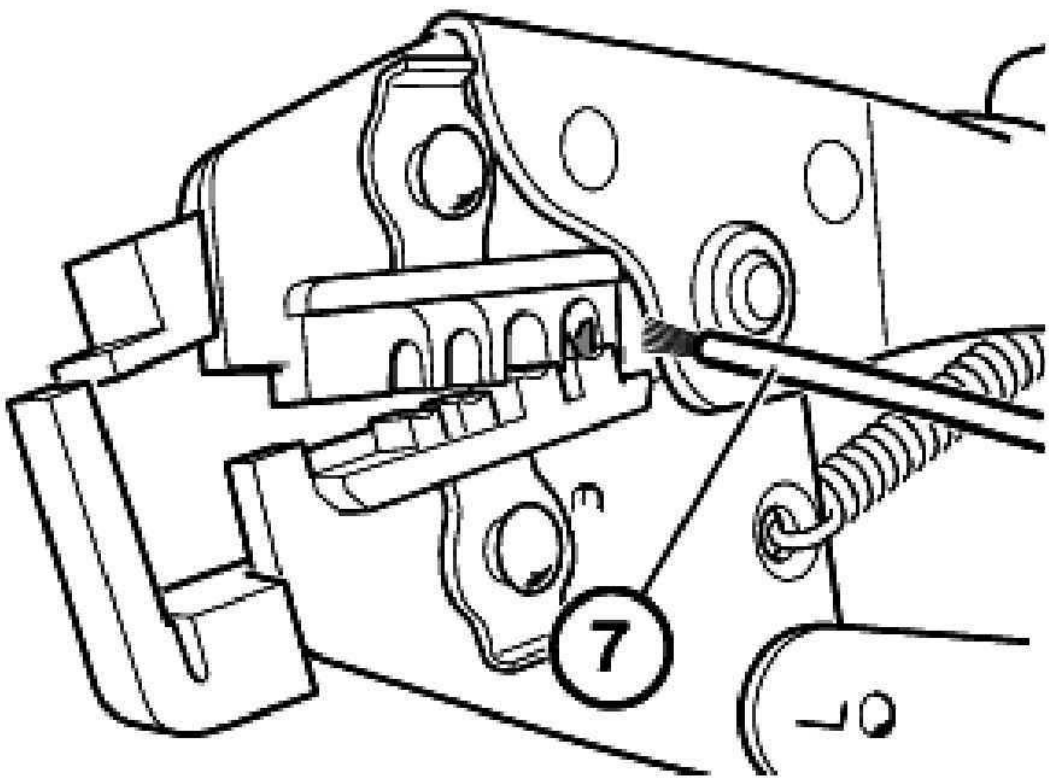


Fig. 91: View Of Wire Insulation In Support Barrel
Courtesy of BMW OF NORTH AMERICA, INC.

The following are examples of unacceptable crimps: (**Fig. 93**)

- Excessive or no wire strands at the contact end of the wire barrel (10).
- Excessive or no insulation end in the acceptable area (11).

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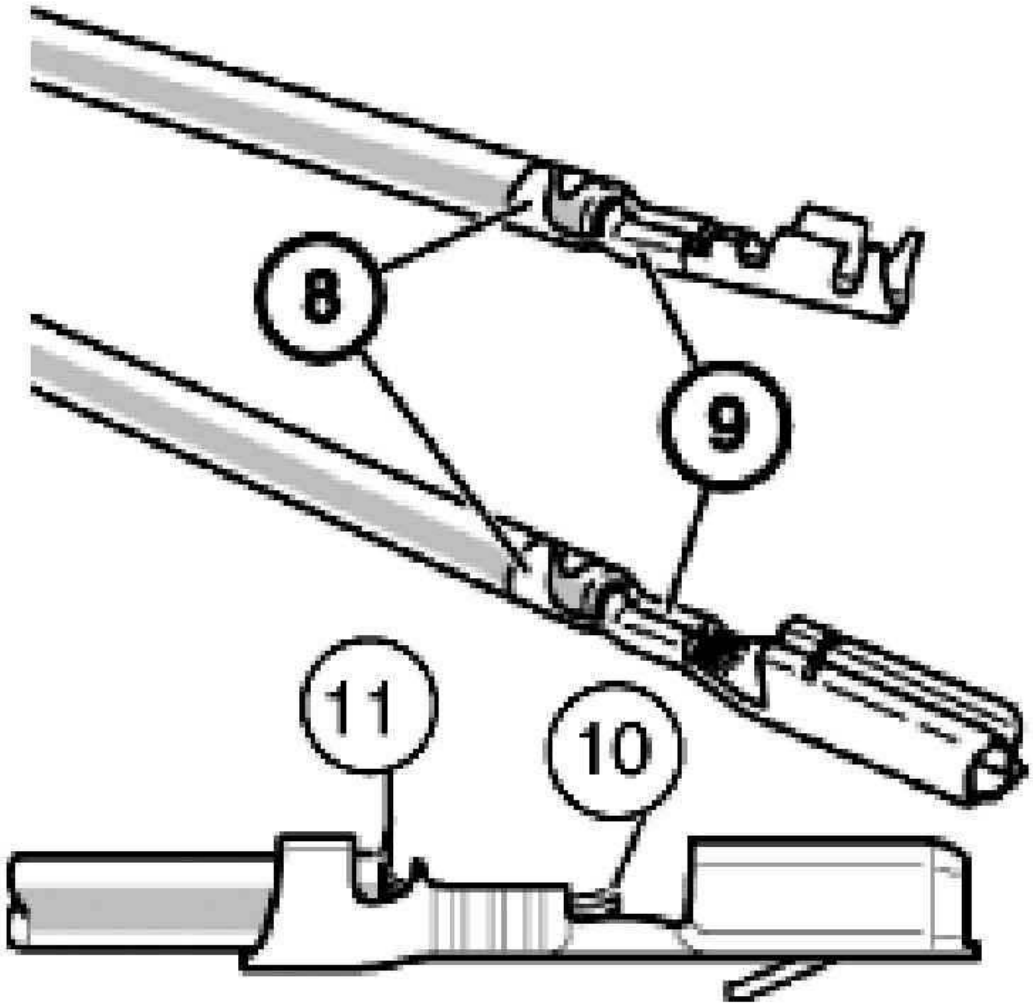


Fig. 92: Identifying Properly Crimped Connector
Courtesy of BMW OF NORTH AMERICA, INC.

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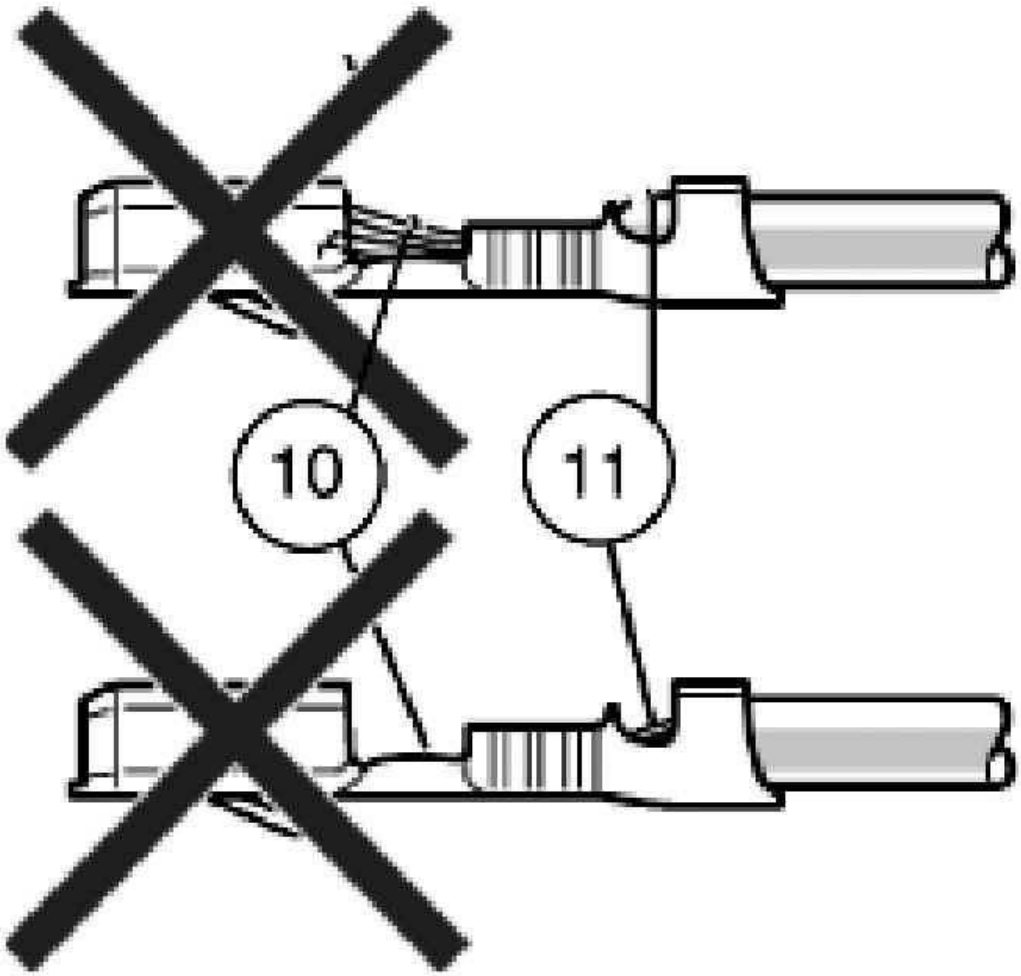


Fig. 93: Identifying Unacceptable Crimps
Courtesy of BMW OF NORTH AMERICA, INC.

PREPACKAGED WIRING REPAIR SETS

Included with the Electrical Repair Kit IV are a variety of wiring repair sets. These sets contain various pre-crimped wiring connectors on assorted gauge wire lengths for simple splice connection repair into a wiring harness.

The repair kits also contain:

1. Various gauge lengths of wire with precrimped connectors.

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2. In-line splice connectors.
3. Heat shrink tubing.

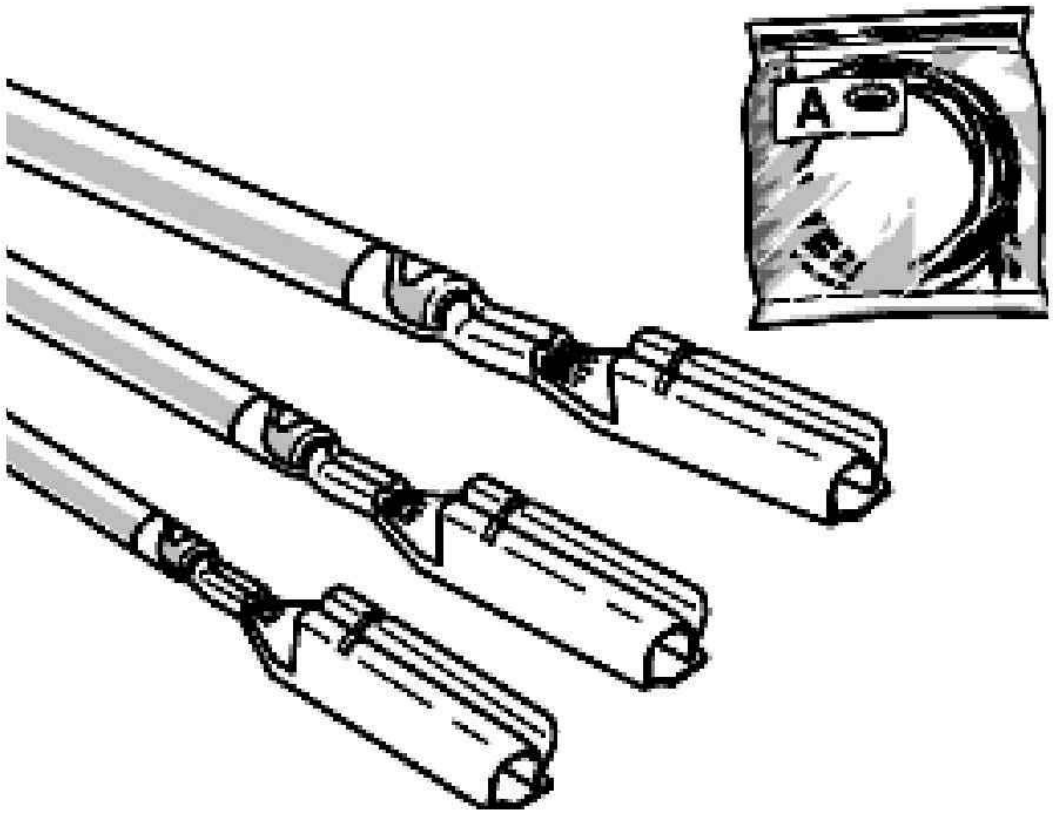


Fig. 94: Identifying Prepackaged Wiring Repair Sets
Courtesy of BMW OF NORTH AMERICA, INC.

When used correctly the in-line splice connectors provide a BMW factory approved wire crimp. Use the correct size nest in the crimper tool and connect one side of the in-line crimp with the wire.

Slide a piece of heat shrink tubing on the wire and crimp the other side of the in-line connector.

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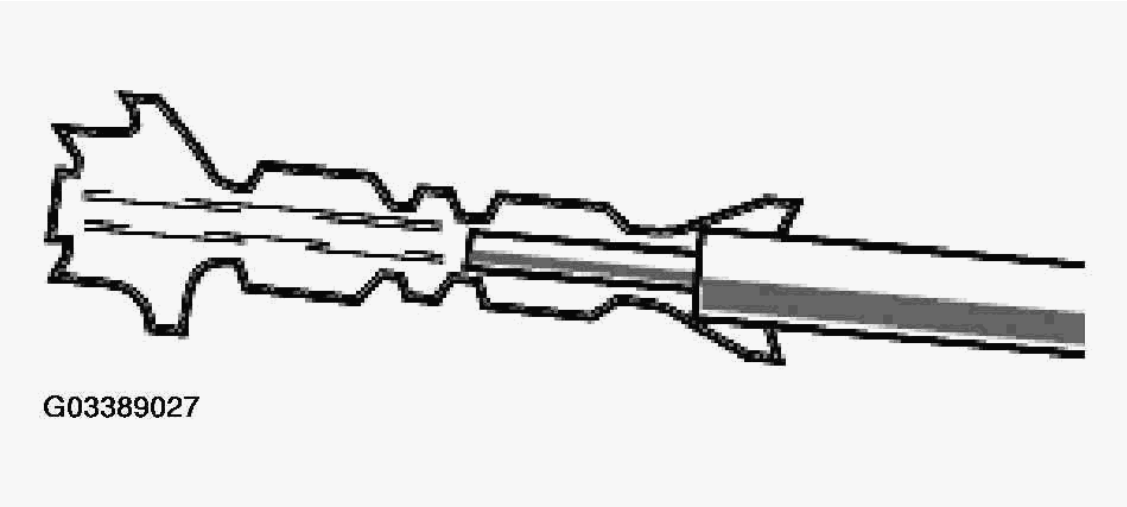


Fig. 95: Using Correct Size Crimper Tool
Courtesy of BMW OF NORTH AMERICA, INC.

Use a heat gun to shrink the tube around the splice connector to provide a moisture resistant seal.

Part numbers for the wire sets or any component of all four electrical repair kits can be reordered from:

- The P/N reference card inside each repair kit.
- Special tools microfiche.
- The Electrical Repair Kit 1-4 component catalog **(SD 92-036).**

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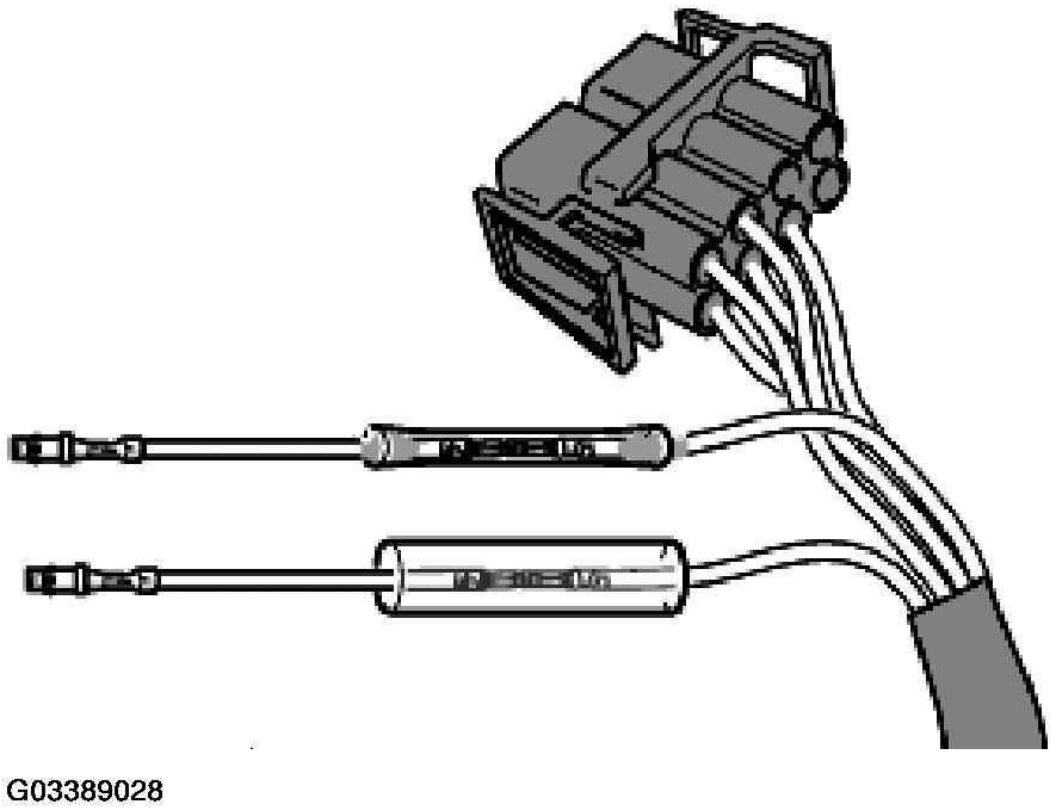


Fig. 96: Identifying Electrical Connectors
Courtesy of BMW OF NORTH AMERICA, INC.

As new connectors are developed for new vehicles, the repair kits will be added to appropriate articles.

Soldering Connections

In the event that a wiring connection must be soldered in a vehicle's electrical system, there are certain procedures which must be followed. Improper soldering will result in poor electrical connections or damage to electrical components.

SAFETY: Adhere to the following basic guidelines when preparing to solder.

- **Safety glasses must be worn.**
- **Disconnect vehicle battery.**
- **Cover vehicle trim surfaces.**
- **Exercise your common sense.**
- **Provide adequate ventilation, it's the best safety precaution!**

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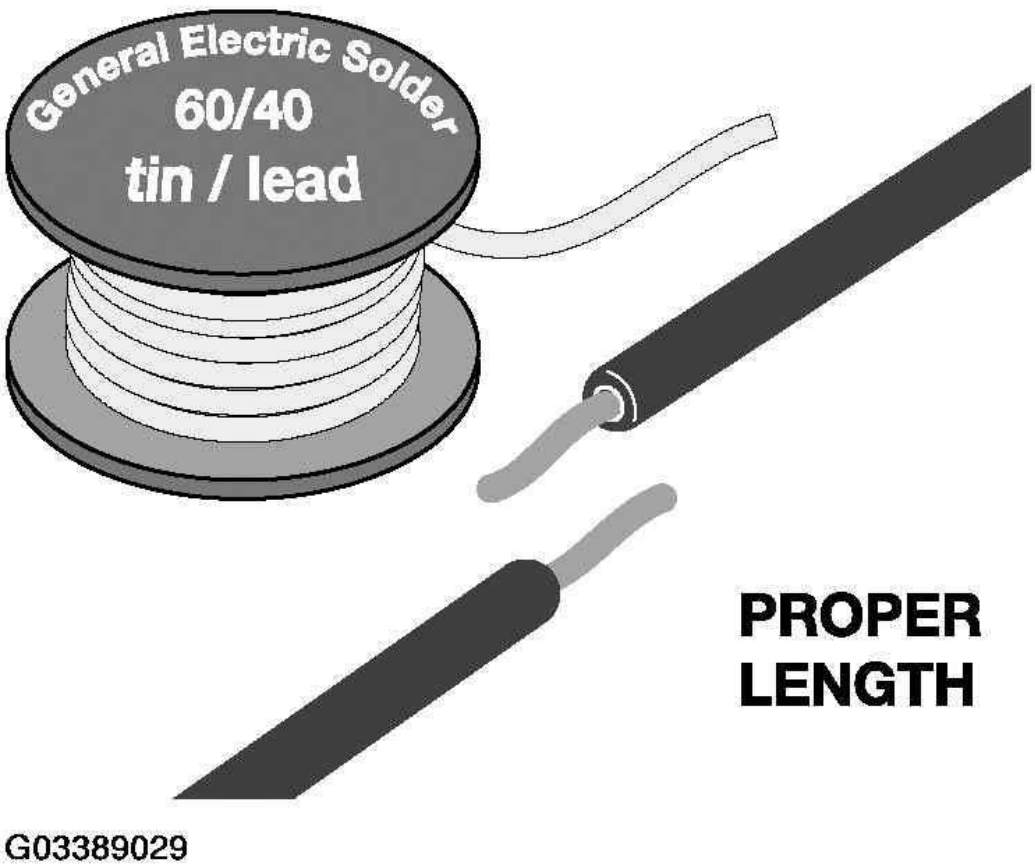


Fig. 97: Identifying Correct Amount Of Wire For Soldering
Courtesy of BMW OF NORTH AMERICA, INC.

Soldering Preparation and Procedure

- The wire insulation must be stripped to expose an adequate amount of bare wire (not too little-not to much.)
- The wires and or connectors must be **clean** and free of grease, dirt, wax, etc.
- A thin coating of **rosin core flux** must be applied to the soldering connection.
- Have enough **60/40 (tin/lead)** general electrical **solder** on hand prior to starting.
- If heat transfer to a heat sensitive component is possible use **"heat sinks".**
- Use a soldering gun tip that is the right size for the job. Do not use an overly large tip which could melt wire insulation and block your view of what is being soldered.
- The soldering tip must be **"tinned"** . This means to keep a thin layer of solder on the tip at all times during soldering. This will transfer the heat quickly and allow the solder to flow easily into the joint being soldered.

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- Preheat the wires or connector. Introduce the solder into the joint not the soldering tip.
- When the solder starts to flow allow it to infiltrate the joint only for a moment. Almost simultaneously, pull the tip off of the joint to prevent overheating.
- A properly soldered joint will be smooth, shinny, and even surfaced.

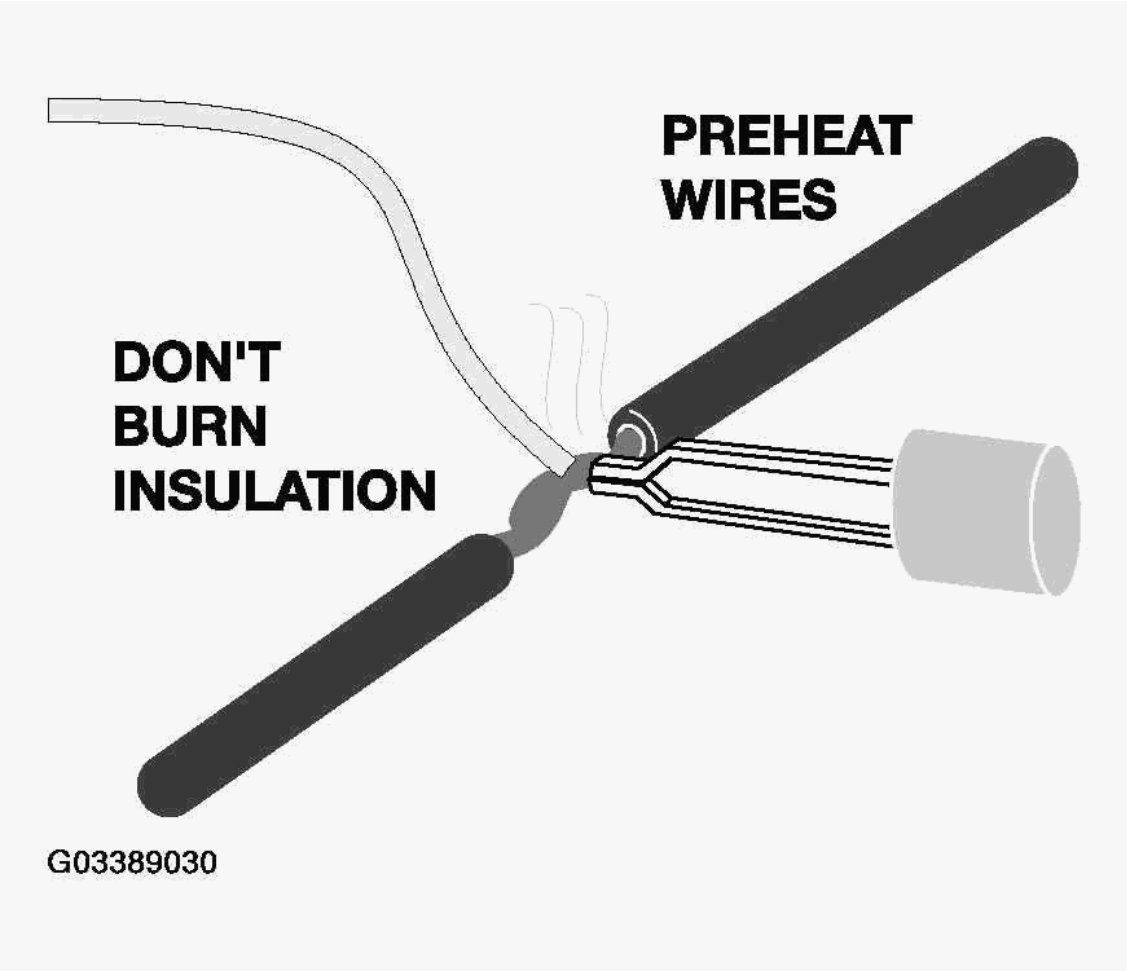


Fig. 98: Identifying Soldering Procedure
Courtesy of BMW OF NORTH AMERICA, INC.

BREAKOUT BOXES AND "V" CABLES

Breakout Boxes are used to:

- Provide a convenient "tap" into an electrical circuit.
- Minimize the possibility of damage to control unit connections and wire harnesses during diagnosis of electrical/electronic systems.
- Ensure solid meter connections for proper diagnosis, this in turn will help the technician to be more organized and efficient.
- Provide easier access to circuits for testing with equipment such as, multimeter, DISplus tester or other diagnostic tools.

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CAUTION: Breakout box cable connections are universal in order to fit the varying coded connectors found in the vehicles. Always confirm that you are connecting the correct control module into the system harness that is on the other side of the breakout box. System damage will occur if it is not the correct system.

Example: DME and EGS/AGS control modules both utilize an 88 or 134 pin control module. These control modules reside in the same E-Box on most vehicles. The control modules are coded to prevent unintentional cross connecting at the vehicle harness. But, this connector coding is not present on the 88 or 134 pin breakout box(s). **Result: A DME control module could be connected to a transmission control system. Damage will result!**

Several different types of breakout boxes are available depending on the particular system being diagnosed.

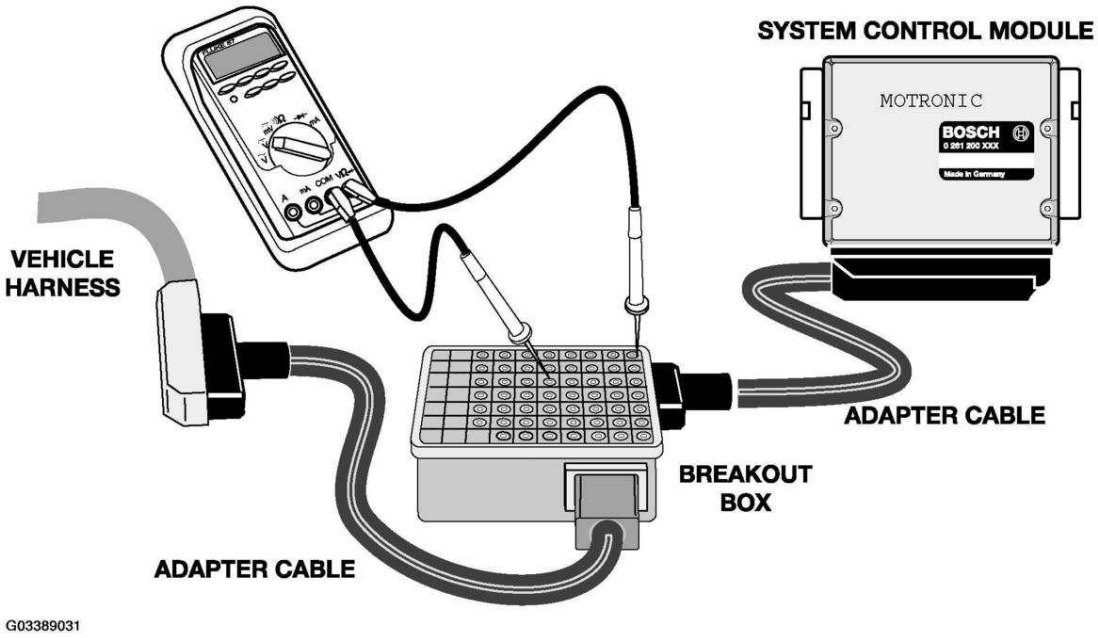


Fig. 99: View Of Breakout Box
Courtesy of BMW OF NORTH AMERICA, INC.

55 pin Breakout Box P/N 81 12 9 425 091

Used with control modules that have single multipin plugs from 25 to 55 pins.

- L-jetronic.
- ABS.
- Motronic.
- EGS.

Adapter cables are required.

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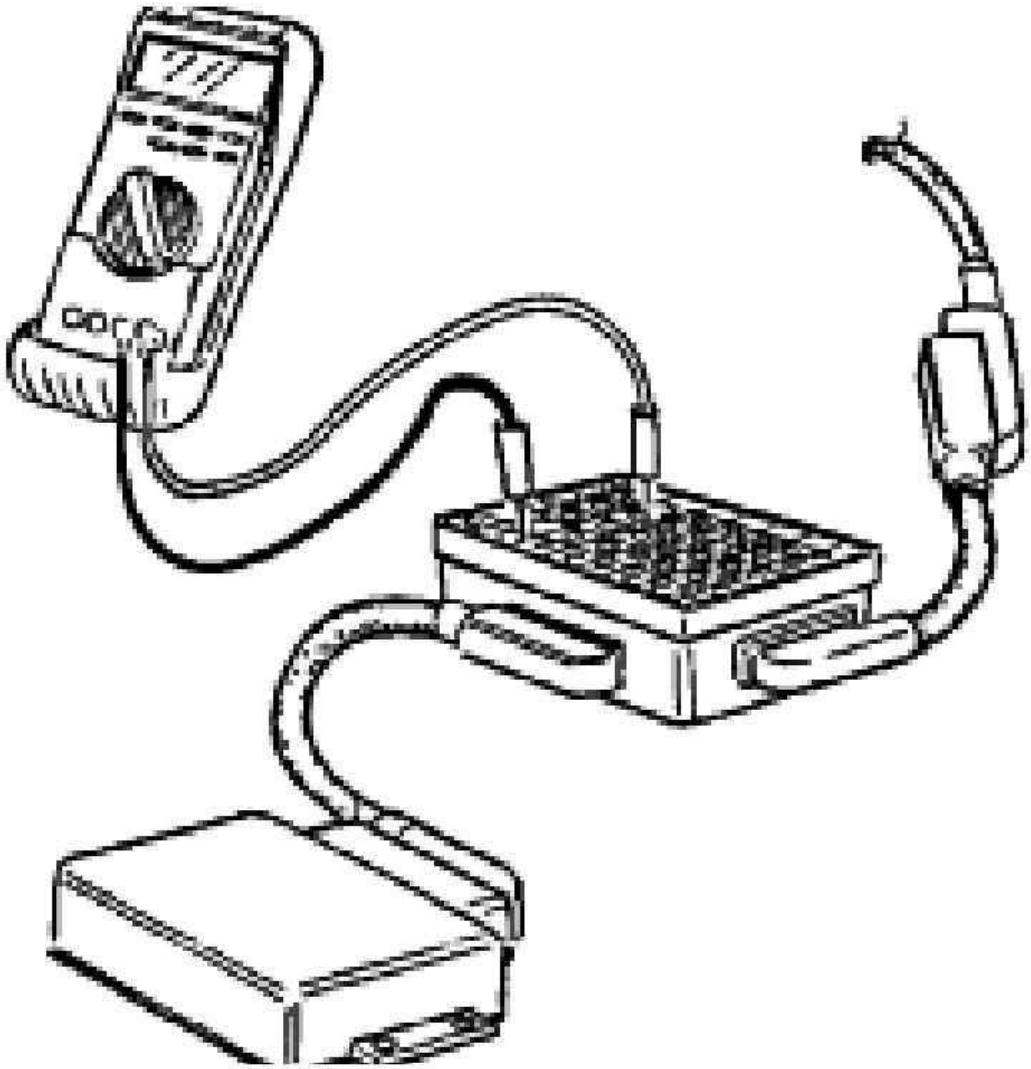


Fig. 100: Identifying 55 Pin Breakout Box P/N 81 12 9 425 091
Courtesy of BMW OF NORTH AMERICA, INC.

83 Pin Breakout Box (Red Face) P/N 90 88 6 614 420

When used with ABS/ASC 5 system, no adapter cables are required. There is an adapter harness for use with the Teves Mark IV G ABS system of the E36.

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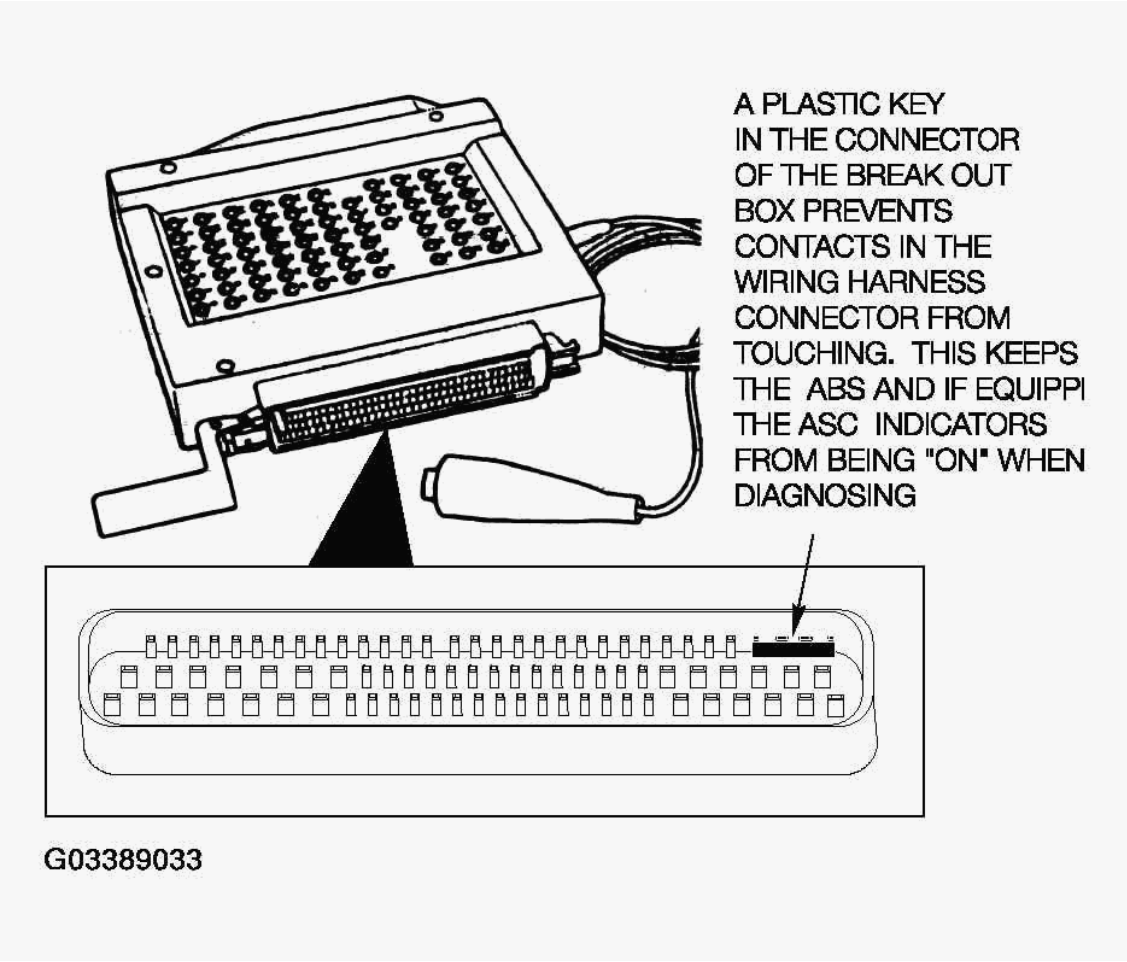


Fig. 101: View Of 83 Pin Breakout Box (Red Face) P/N 90 88 6 614 420
Courtesy of BMW OF NORTH AMERICA, INC.

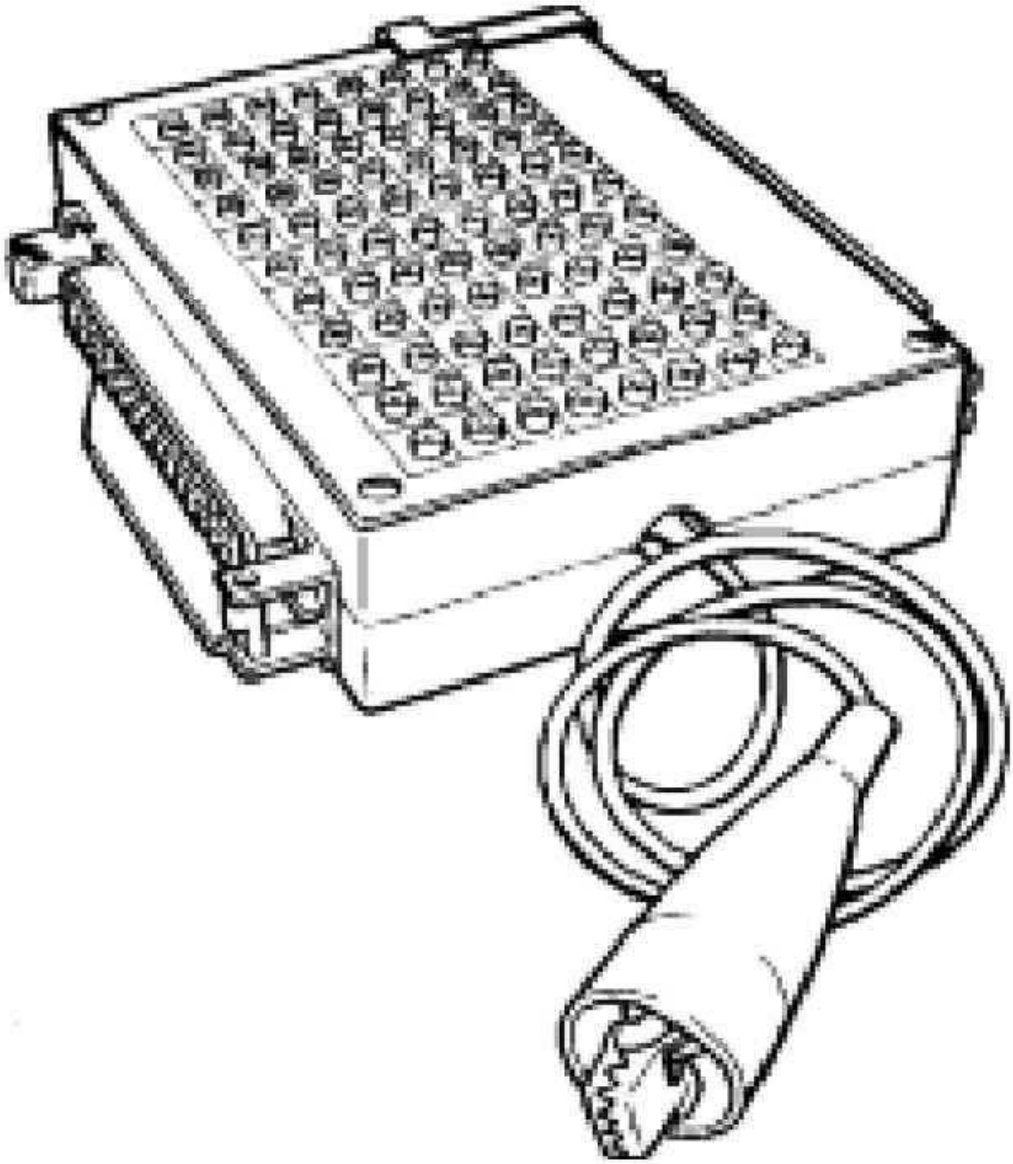
88 Pin Breakout Box (Green Face) P/N 88 88 6 614 410

Used with control units that have up to 88 pins;

- DME.
- EGS/AGS.
- ZAE/MRS.
- LCM.

No adapter cables are required when connected to a DME or EGS/AGS control module. There are adapter harnesses for ZAE/MRS and LCM systems.

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Fig. 102: Identifying 88 Pin Breakout Box (Green Face) P/N 88 88 6 614 410
Courtesy of BMW OF NORTH AMERICA, INC.

134 Pin SKE Control Module Breakout Box Set P/N 90 88 6 121 300

The 134 pin modular connector DME and AGS control modules use a combination of breakout boxes for troubleshooting. The part number above provides three breakout boxes and five adapter harnesses. The two

outside edge connectors use the familiar 26 pin breakout boxes. The three inside connectors use the boxes from the ordered set.

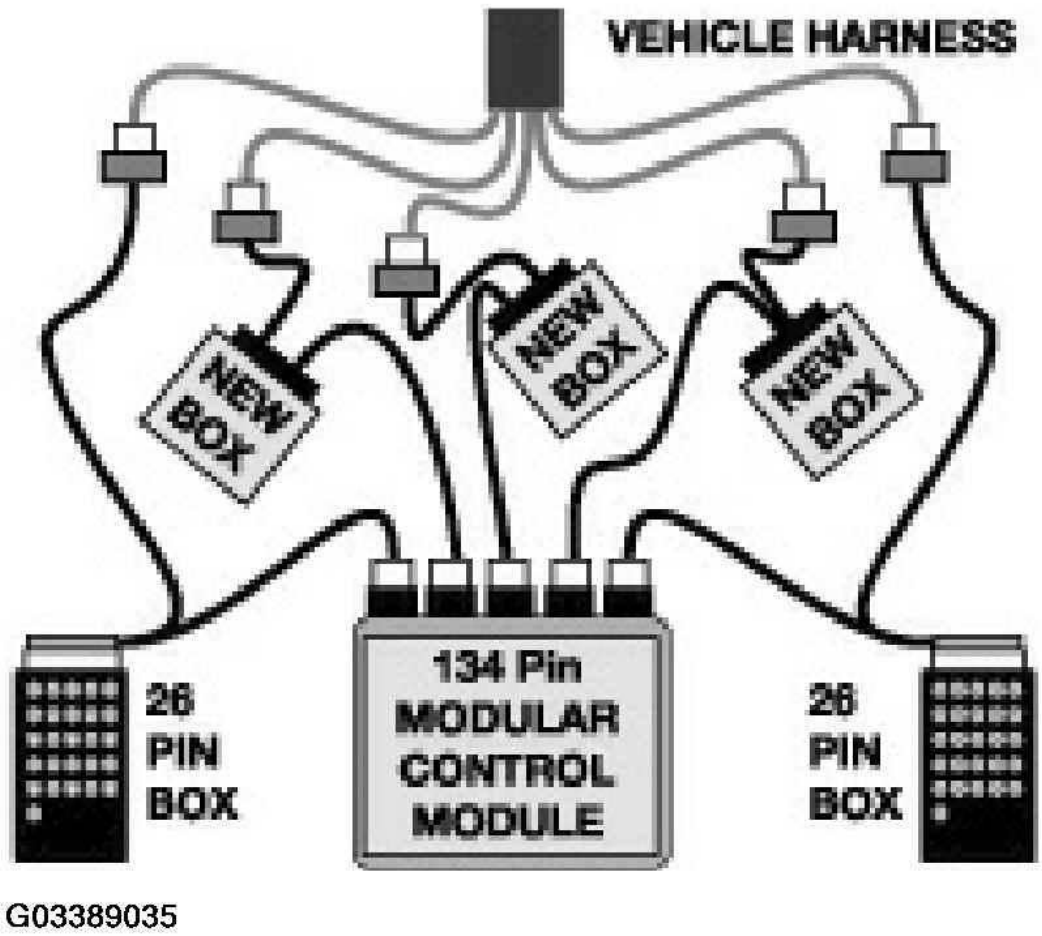


Fig. 103: View Of 134 Pin SKE Control Module Breakout Box Set P/N 90 88 6 121 300
Courtesy of BMW OF NORTH AMERICA, INC.

26 Pin Breakout Box P/n 88 88 6 611 459

Used with system or peripheral control module that have up to 26 pins. This breakout box is used in conjunction with adapter cables called "V" Cables. There are many different types of "V" cables for the various connectors found on the vehicles.

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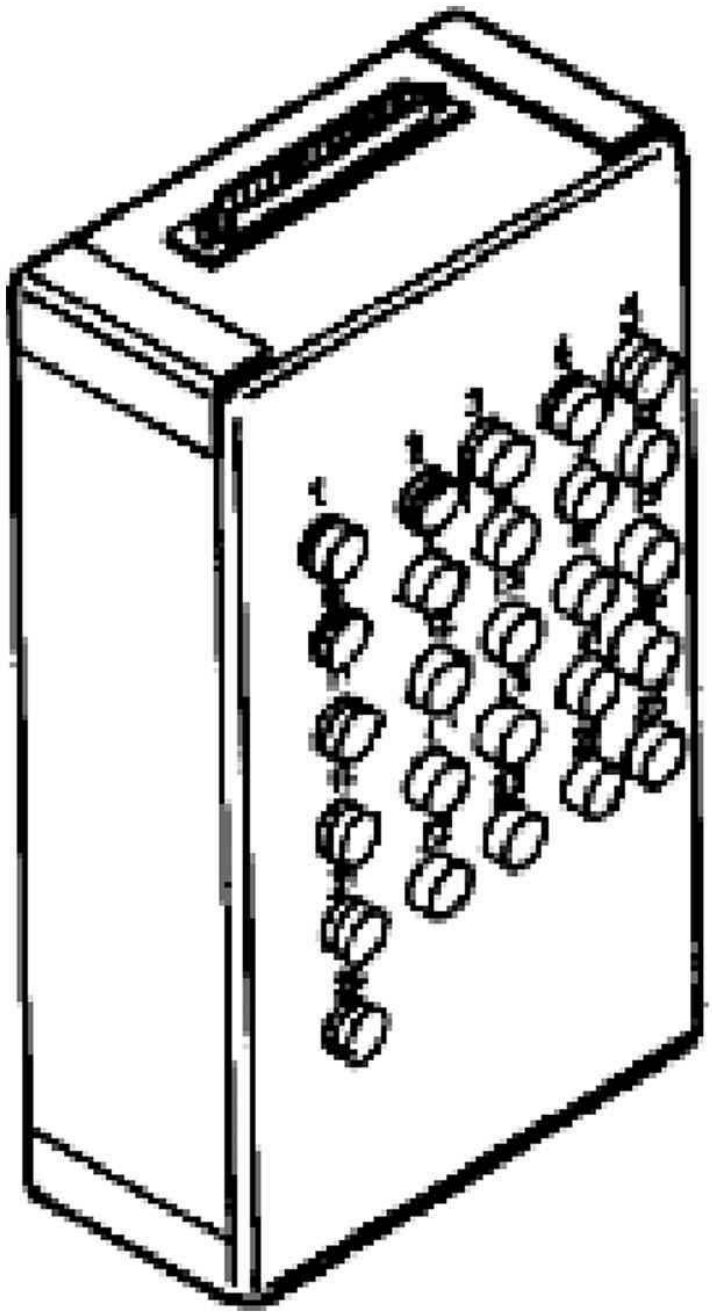
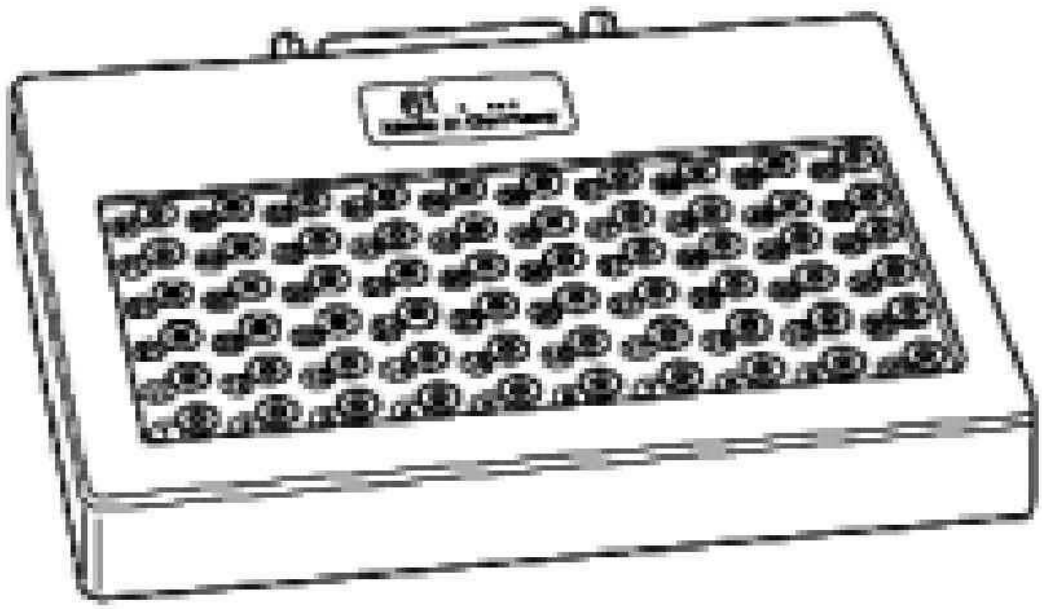


Fig. 104: Identifying 26 Pin Breakout Box P/N 88 88 6 611 459
Courtesy of BMW OF NORTH AMERICA, INC.

60 Pin Breakout Box P/N 90 88 6 614 390

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Used for connecting all adapter leads with 27 pin to 60 pin plug connections.



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Fig. 105: View Of 60 Pin Breakout Box P/N 90 88 6 614 390
Courtesy of BMW OF NORTH AMERICA, INC.

TESTER AND ADAPTER SET FOR RELAYS

The Relay Adapter provides a platform to test a relay while allowing the relay to remain active in a circuit.

The adapters included enable different pin configurations of relays to be tested using a single tester.

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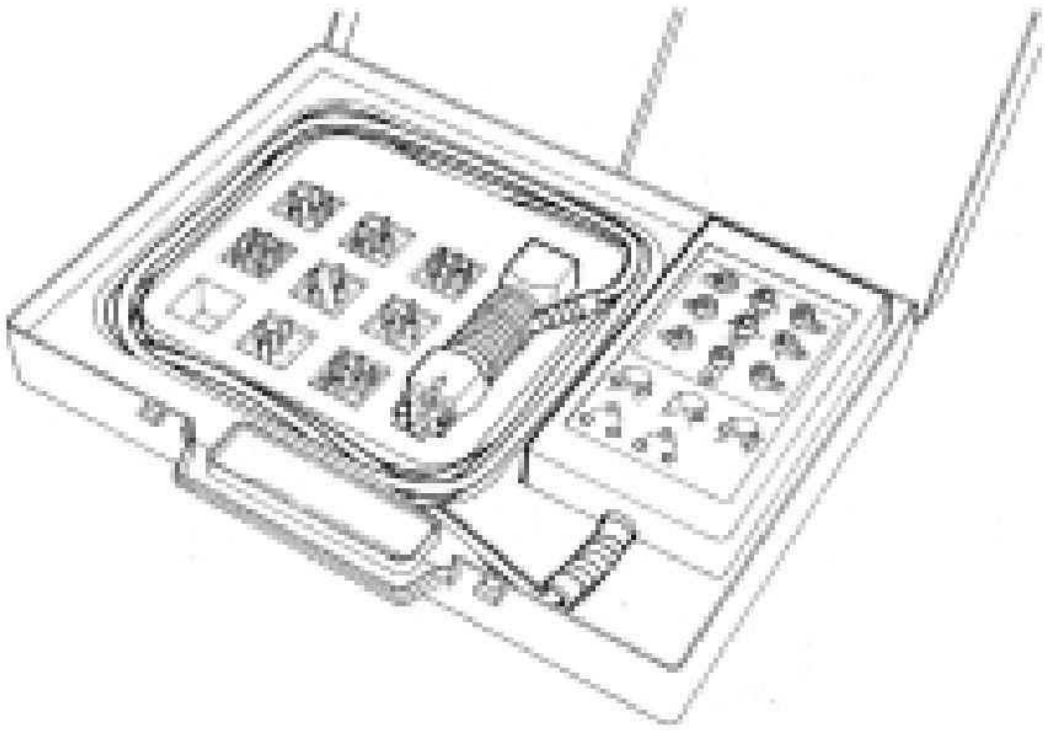


Fig. 106: Identifying Tester And Adapter Set For Relays
Courtesy of BMW OF NORTH AMERICA, INC.

Remove relay and compare plug in adapter with plug pattern on relay. Choose correct adapter (**Fig. 107**).

Fit adapter to Measuring bridge, noting the marker arrows (A). Fit the relay to the measuring bridge (**Fig. 108**).

Plug the assemble measuring bridge into the socket of the relay to be checked. Test using a multimeter. See the circuit diagram, testing instructions in the appropriate article for subsequent procedure (**Fig. 109**).

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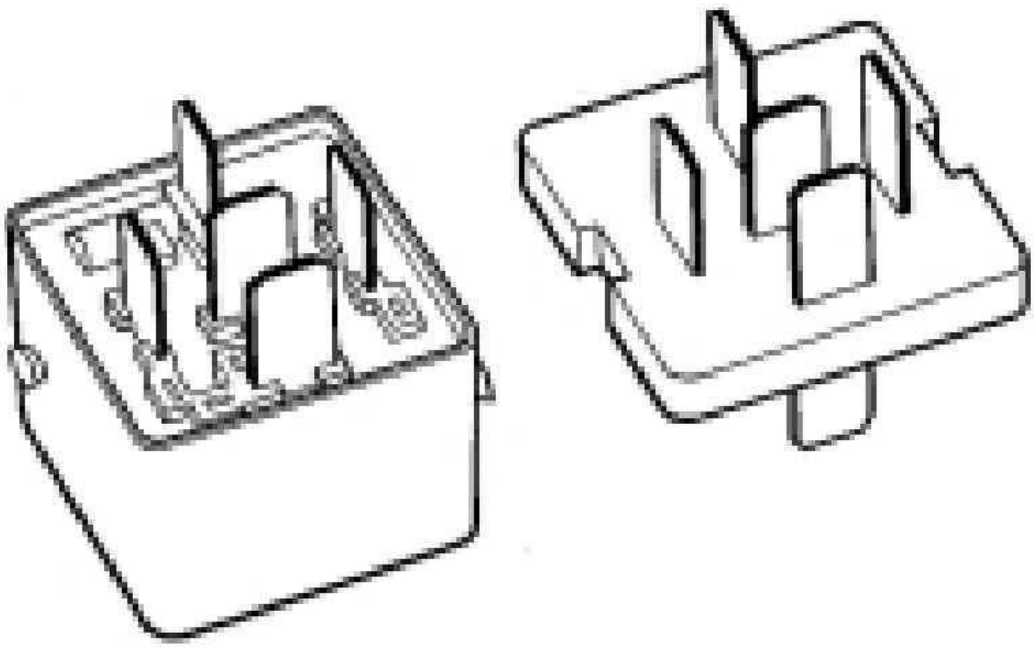


Fig. 107: Identifying Relay And Compare Plug
Courtesy of BMW OF NORTH AMERICA, INC.

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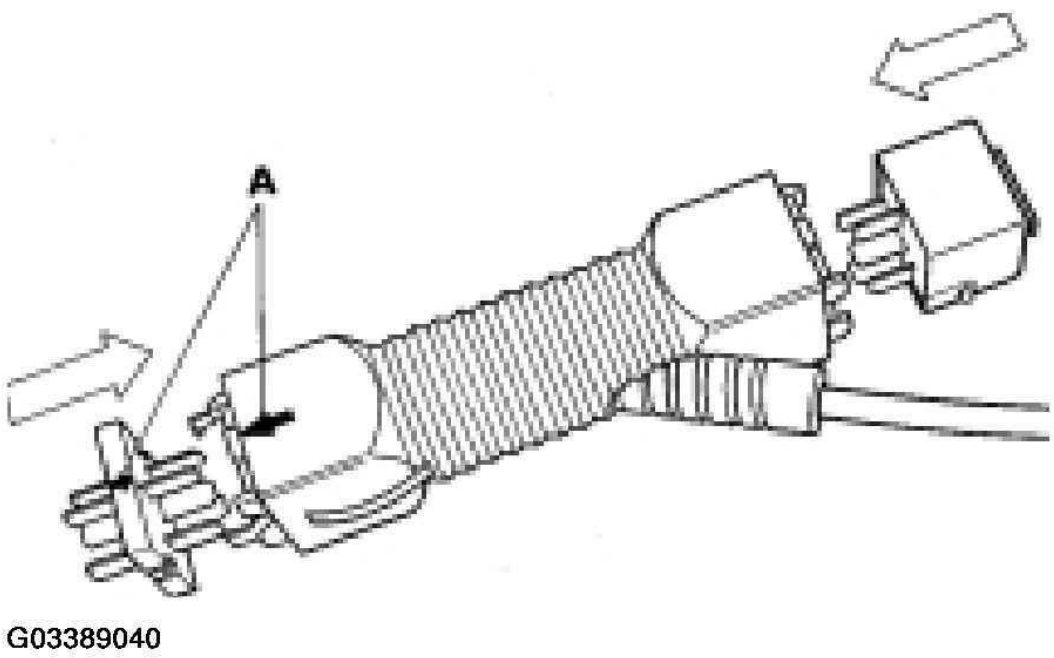
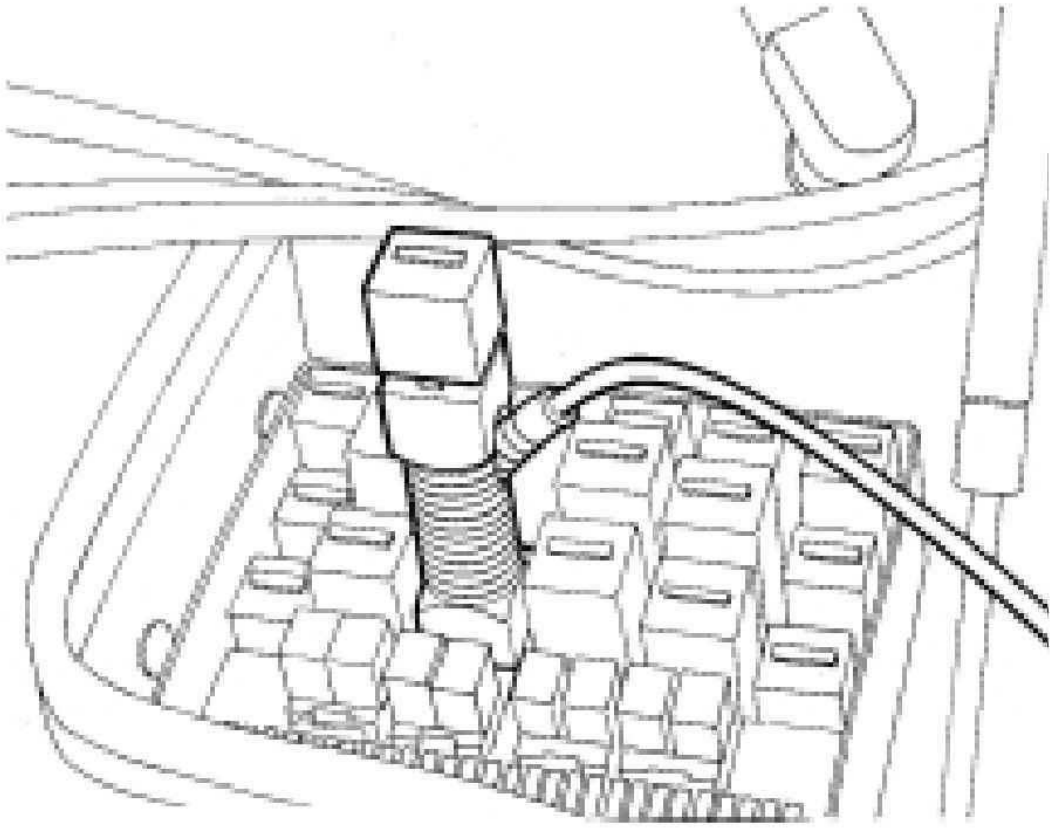


Fig. 108: Fitting Adapter To Measuring Bridge
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 109: View Of Measuring Bridge In Socket
Courtesy of BMW OF NORTH AMERICA, INC.

"V" Cables

"V" cables are available in different versions depending on the system being diagnosed. Always refer to the most recent information for the required special tools.

"V" cables are only used with the 26 pin breakout box to access input and output signals of peripheral modules and systems.

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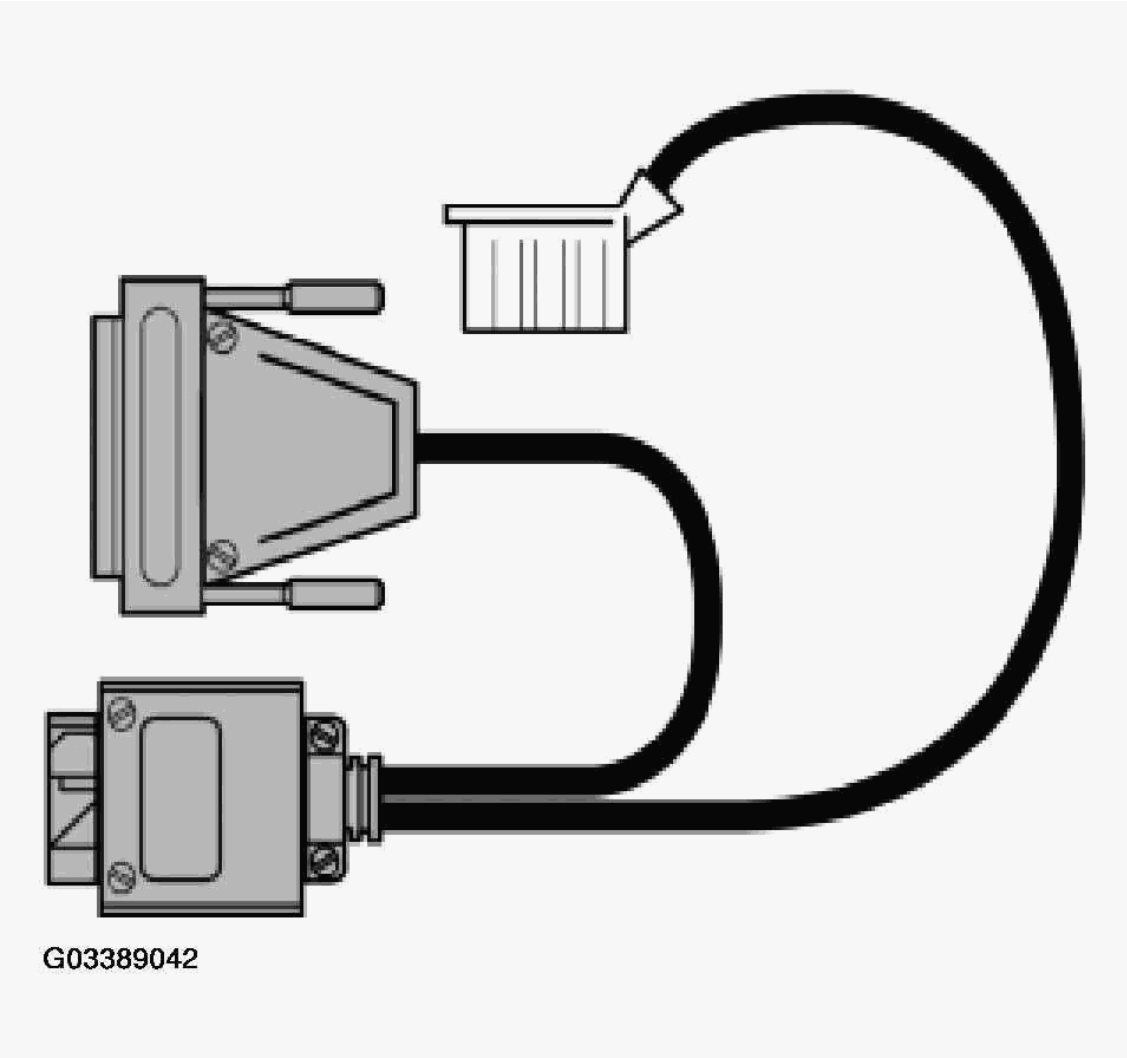


Fig. 110: Identifying "V" Cables
Courtesy of BMW OF NORTH AMERICA, INC.

- The appropriate cable is distinguished by the color of the connector end.
- The color will match the particular modules connector color. Unless the color matches, the cable will not fit the connector on the module being tested.
- Each colored "V" cable has a series of alignment tabs that will only fit it's particular module or system.

"V" cables with ELO connectors are also being used with the 26 pin breakout box. These cables are unique in that they have a locking arm on the component side of the cable. They are light green in color, and the number of pins will vary depending on the system being tested.

"V" harness adapters were introduced with the E38. These also have light green ELO connectors on the component side, but they do not require a breakout box.

There is a black plug on one side with same number of pins as the component being tested.

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The plug has numbers stamped on it's side that corresponds with the pins on that particular component.

You access the signals by plugging the test equipment directly into those pin numbers.

As new systems and components are being introduced, new breakout boxes and cables will also be introduced.

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2007 ACCESSORIES & EQUIPMENT

Car Care Products - Operating Fluids

1.0 BMW CAR CARE PRODUCTS AND ALTERNATE SUPPLIERS

BMW CAR CARE PRODUCTS AND ALTERNATE SUPPLIERS REFERENCE

Item	BMW P/N	Description/Application	3M	Wurth	Loctite	CRC
Glass Cleaner	82 14 9 400 349(1)	For effortless and intensive cleaning of windows and mirrors. This glass cleaner removes tenacious dirt, silicone and oil residues and dead insects.	8968	890925	82544	
	82 14 9 406 684(1)		8968	890925	82544	Siloo 68A
	82 14 9 406 685(1)		3585		82544	Siloo 68A
Window De-Icer	82 14 9 407 426(1)	For use on iced-over windows. Contains no methanol and is nontoxic.				Siloo 22A IceOff
Car Shampoo	83 12 0 004 826	For washing cars. Cleans and protects paint finish.				
Paint Cleaner	82 14 9 400 132(1)	For removing dirt imbedded in the paint finish. Leaves a new glossy look. Especially suited for older cars.	6049			
Car Polish-Cream	82 14 9 400 131(1)	For use on metallic as well as lacquer paint. Cleans and seals paint from detergent and weather. Produces an excellent shine and long-term protection. Best for older finishes.	6055	8909671		
Car Polish-Liquid	83 12 9 407 779(1)	Same as above except in liquid.	6005			
Car Wax	83 12 9 408 527	For the care of newer metallic and lacquer finishes. Cleans and seals paint from detergent and weather. Non-abrasive.				
Leather Care (Karneol)	81 22 9 400 901	Cleans leather upholstery of mild stains or dirt; provides conditioners.				
Plastic Cleaner	82 14 9 407 415(1)	For cleaning soiled plastic interior surfaces.	6046	89024		

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Cockpit Spray	83 12 9 407 769	For cleaning door liners, head liner, and upholstery. Prevents materials from becoming brittle and has antistatic effect.				
Tar Remover	82 14 9 407 018(1)	For removing tar, asphalt, and oil stains.	3607	89026	3607	89026
Insect Remover	81 22 9 407 444(1)	Removes insects rapidly and effortlessly from glass, paint, chrome and plastics.	3607	89026	3607	89026
Chrome Polish	82 14 9 400 890(1)	A perfect cleaner which provides a genuine gloss and forms an invisible silicone film to protect the chrome work against bad weather, corrosion, dirt etc.	6049	3607	89026	3607
Engine Cleaner	81 22 9 407 760(1)	For removing grease and built-up dirt from engines and engine parts. Washes off with water. Will not harm paint, rubber, or plastics.	8899	890923	80043	14045
Rubber Care-Spray	82 14 9 400 195(1)	For use on gaskets, tires, weather stripping. Rubber care cleans, helps maintain elasticity, and renews color.	5959	890110	82333	
Rubber Care - Tube	82 14 9 407 015	Same as spray except in tube form.				
Car Care Kit	82 14 1 467 126	Kit contains: ○ BMW Wheel Cleaner Spray (P/N 82 14 1 467 045) ○ BMW Car Shampoo (P/N 82 14 9 400 129) ○ Sponge ○ Long-handled brush ○ Synthetic chamois ○ Bucket with BMW				

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		logo				
Car Wash Liquid	82 14 1 467 131	Meguiar's Hi-Tech Wash maintains optimum gloss on a continuing basis, by blending in conditioners and gloss enhancers while foaming away dirt and grime.				
Final Inspection	82 14 1 467 132	Meguiar's Spray Applicator to give a "show car shine". Removes light dirt without scratching, leaves high-gloss look. Ideal for maintaining perfect finish on display cars. Not for heavily soiled finishes.				
Vinyl/Rubber Cleaner	82 14 1 467 133	Meguiar's Cleaner/Conditioner thoroughly cleans, penetrates and rejuvenates the surface, and provides exceptionally durable protection against drying out and cracking.				
Cleaner Wax	82 14 1 467 134	Meguiar's Cleaner/Wax cleans, polishes and protects paint in one application. Removes light oxidation, adds depth of color and provides durable protection.				
Wheel Cleaner	82 14 1 467 045	Clean wheels and protect finish.				
Soft Top Cleaner	83 12 9 407 806	Clean soft top.				

(1) *These items are no longer available through BMW NA Parts Department.

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GENERAL INFORMATION

Charging Systems - Overview

CHARGING SYSTEMS

Model: All

Production Date: All

PURPOSE OF THE CHARGING SYSTEM

The purpose of the charging system is to convert the mechanical energy of the engine into electrical energy that is used to recharge the battery and power the electrical accessories. When the engine is first started, the battery (s) supplies all the current required by the starting and ignition systems.

As the battery drain continues and engine speed increases the charging system is able to produce more voltage than the battery can deliver. When this occurs, the electrons from the charging device are able to flow in a reverse direction through the battery's positive terminal. The charging device now supplies the electrical system's load requirements and recharges the battery.

The charging system consists of:

- Battery.
- Generator.
- Drive Belt.
- Rectifier Assembly.
- Voltage Regulator.
- Charge Indicator.
- Ignition Switch.
- Cables and Wiring Harness

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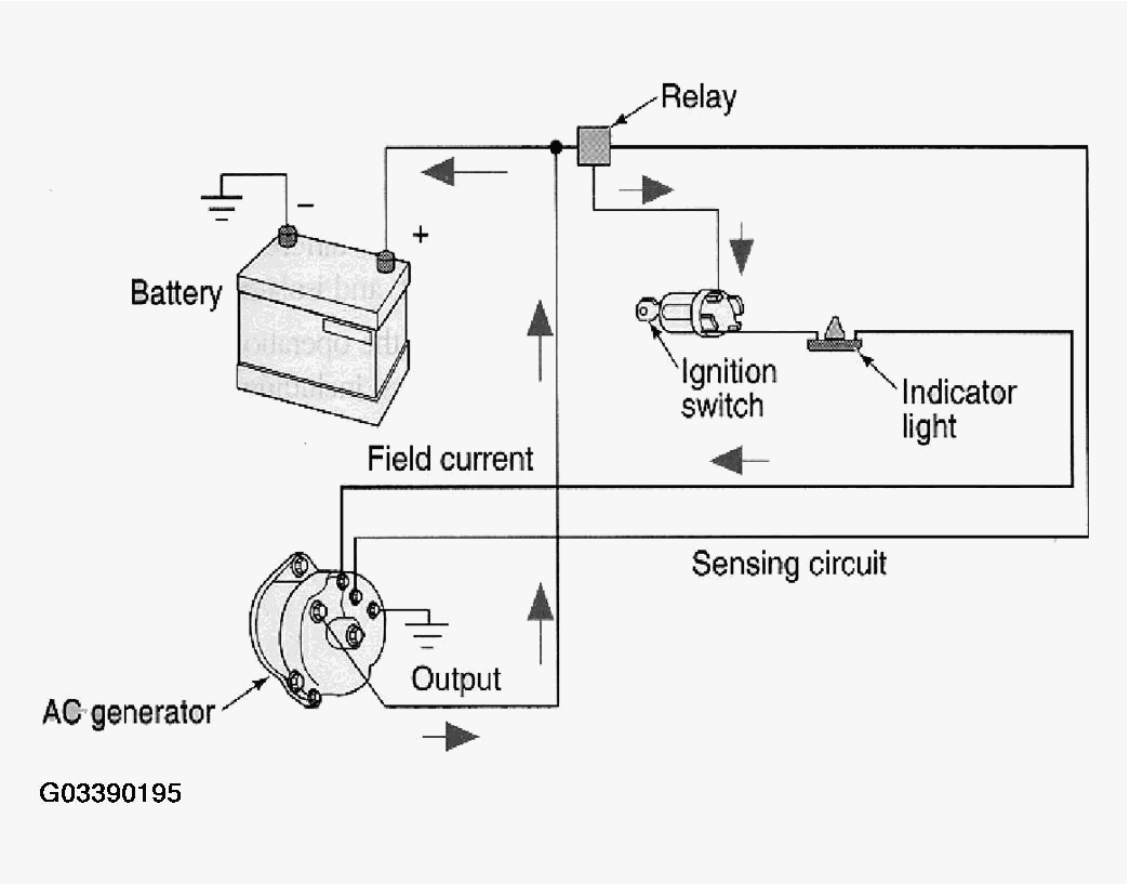


Fig. 1: Identifying Battery Charging System
Courtesy of BMW OF NORTH AMERICA, INC.

SYSTEM COMPONENTS

Battery

The Battery is the primary EMF source in the automobile. The automotive battery is an electromechanical device that provides the potential difference (voltage). The battery does not store electrical energy. It stores chemical energy that is converted to electrical energy as it discharges.

Generator

The Generator produces free electrons necessary to charge the battery. The electron flow is produced through inductance, a magnetized rotor spinning inside a stator. The generator produces AC voltage which is converted to DC voltage or rectified.

Generator styles:

- Brush Type.
- Brushless Type.

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NOTE: In an attempt to standardize terminology in the industry, the term alternator is being replaced with generator. Often an alternator is referred to as an AC generator.

Air or liquid (coolant) is used for generator cooling.

BRUSH TYPE GENERATORS

Brush Type generators consist of the following main components:

- Generator Housing.
- Stator Assembly.
- Rotor Assembly.

Generator Housing

The Housing is made of two pieces of die-cast aluminum. Aluminum is used because it is nonmagnetic, light weight and provides good heat dissipation.

Bearings for support of the rotor assembly are mounted in the front and rear housings.

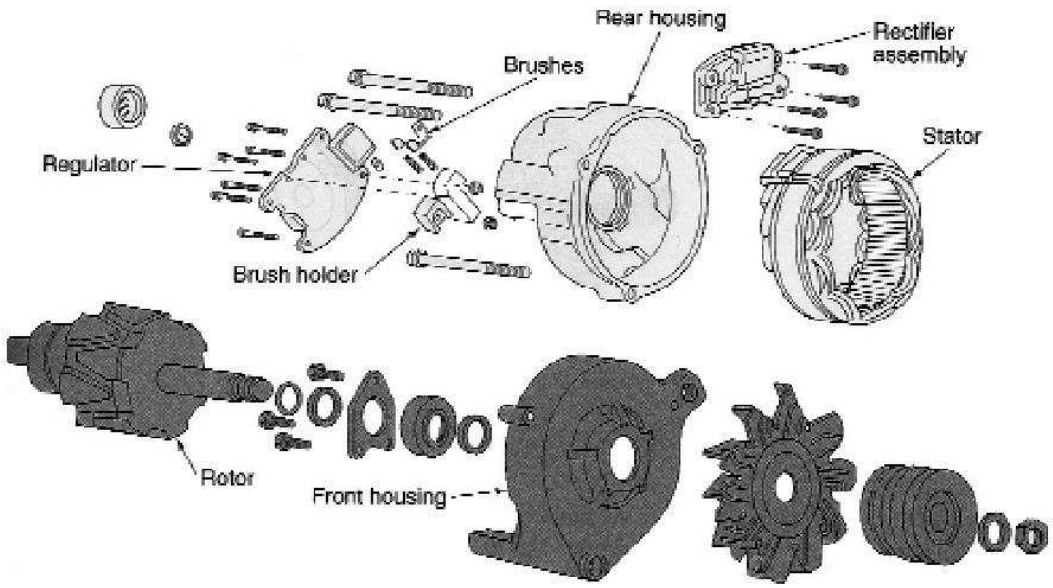


Fig. 2: Exploded View Of Generator Housing
Courtesy of BMW OF NORTH AMERICA, INC.

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Stator Assembly

The Stator is fixed to the housing of the generator and does not turn. It contains three main sets of windings wrapped in slots around a laminated, circular iron frame. Each of the three windings has the same number of coils as the rotor has pairs of north and south poles. The coils of each winding are evenly spaced around the core.

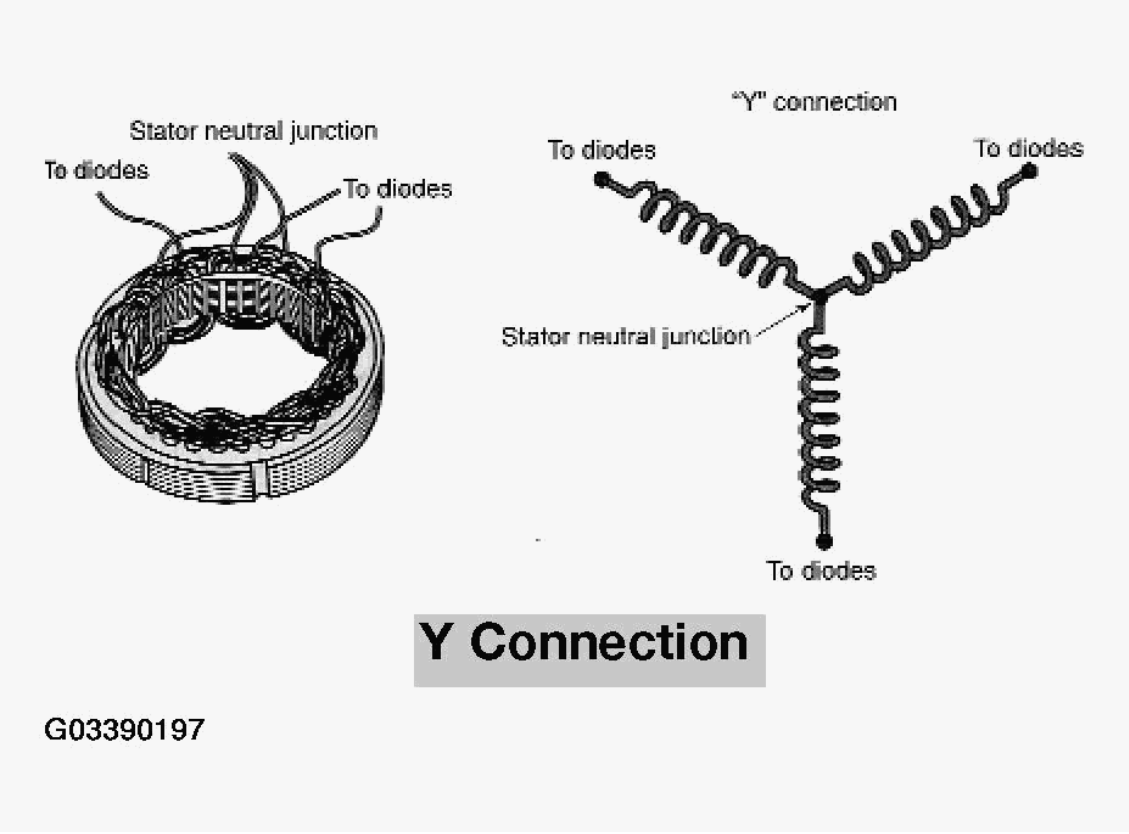


Fig. 3: View Of Stator Assembly (Y Connection)
Courtesy of BMW OF NORTH AMERICA, INC.

The three sets of windings alternate and overlap as they pass through the core in order to produce the required phase angles.

Each group of windings occupy one third of the stator, or 120 degrees of the circle.

The voltage produced by each loop of the stator is at a different phase angle, as a result the output of the stator is divided into three phases.

Two common methods of connecting the windings are:

- Y Connection.
- Delta Connection.

The parallel path of the Delta connection makes more current available.

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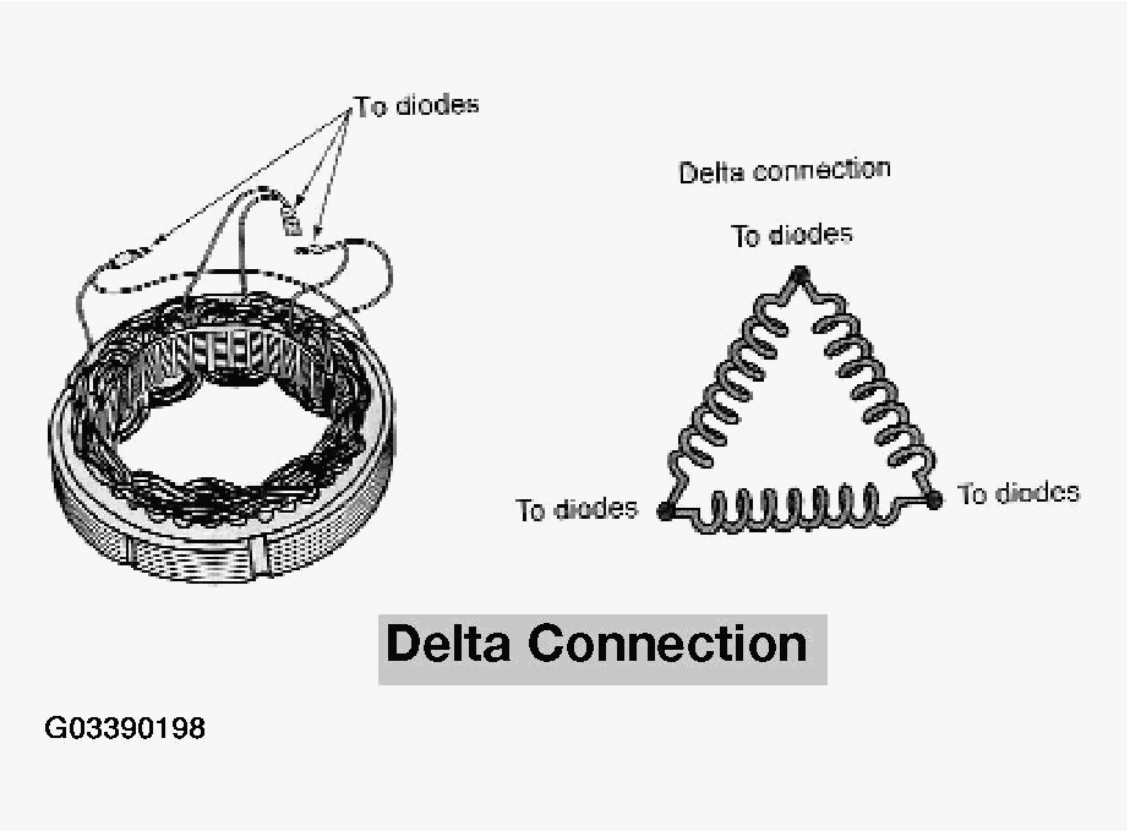


Fig. 4: Identifying Stator Assembly (Delta Connection)
Courtesy of BMW OF NORTH AMERICA, INC.

Rotor Assembly

The Rotor Assembly consists of the rotor shaft, a winding around an iron core, two pole pieces and slip rings.

The rotor shaft is pressed into the core, then six-fingered malleable iron pole pieces are assembled on the shaft against each end of the winding core.

The pole pieces are placed so that the fingers mesh but do not touch. When direct current is passed through the field coil winding, the fingers become alternately North and South poles.

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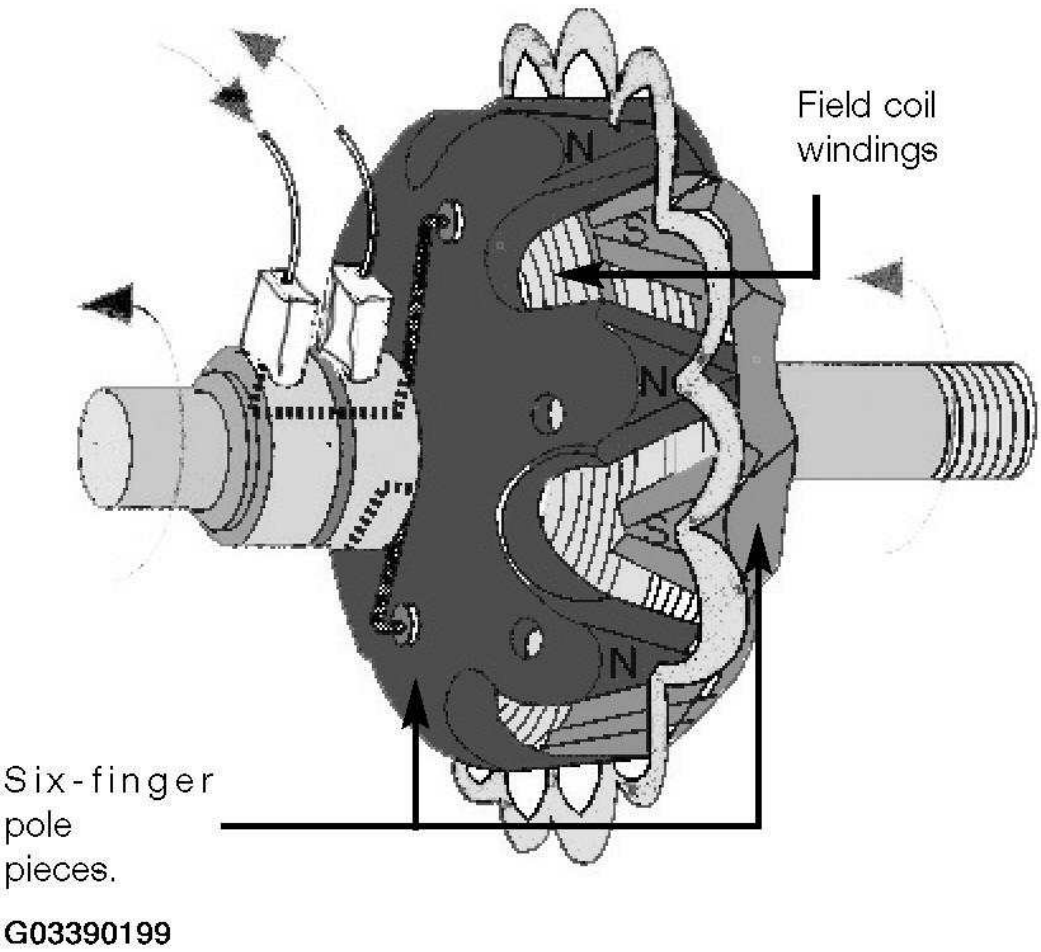


Fig. 5: View Of Rotor Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

As a result of this arrangement of poles, the magnetic flux lines will move in opposite directions between adjacent poles.

(Flux lines always move from North to South.)

This arrangement provides for several alternating magnetic fields to intersect the stator as the rotor is turning.

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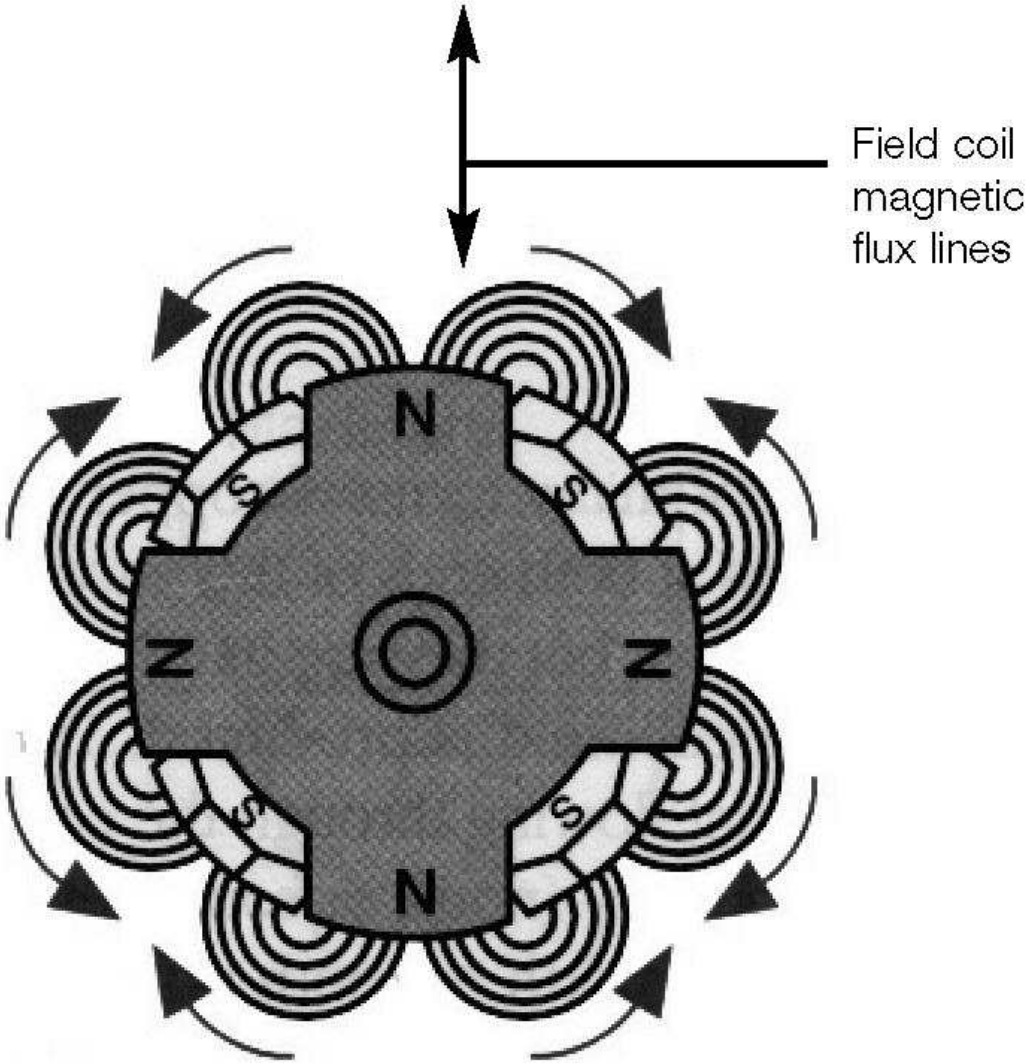


Fig. 6: Identifying Rotor Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

A slip ring pressed on to the rotor shaft is connected to the two ends of the field winding.

Two brushes are held by springs against the slip rings. One brush is connected through a switch to the battery B+, the other to the voltage regulator.

The brushes conduct only the field current (2 to 5 amps).

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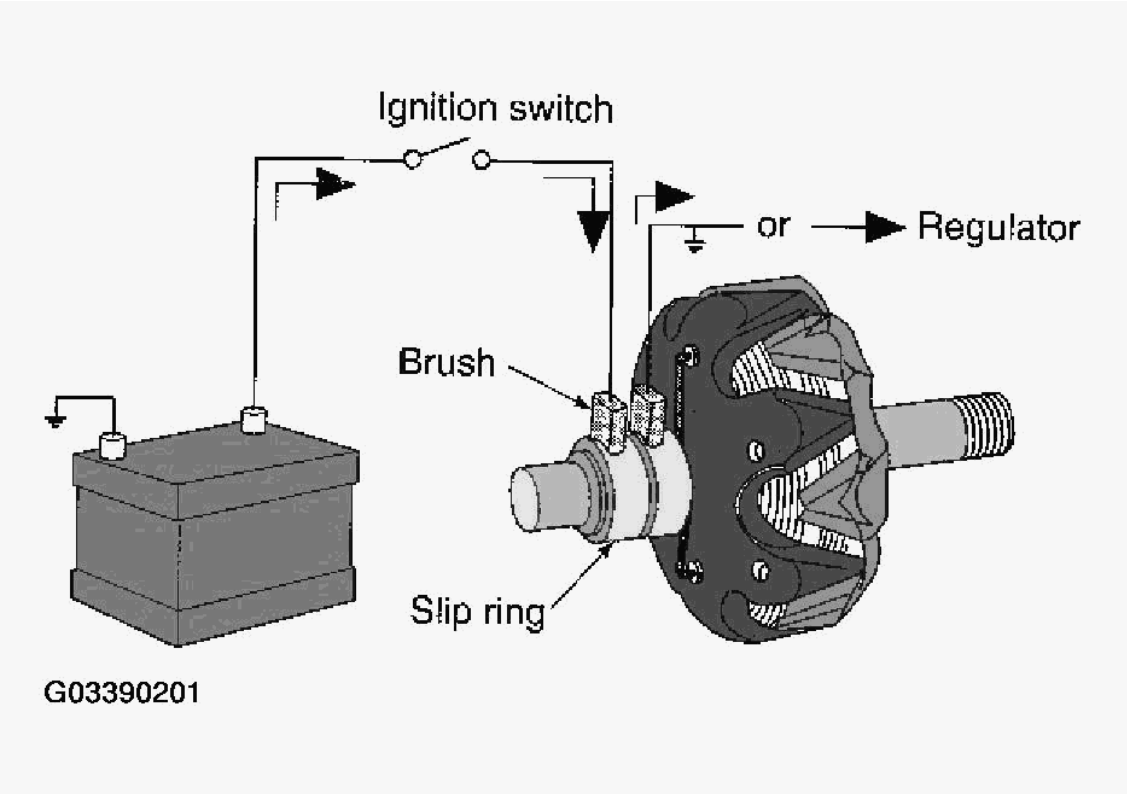


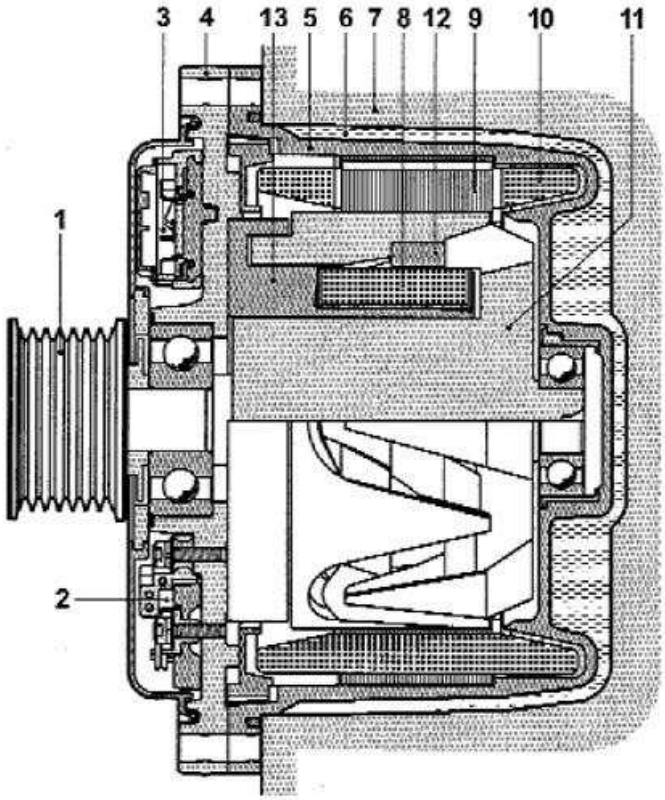
Fig. 7: Locating Brushes On Rotor Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

BRUSHLESS TYPE GENERATORS

Brushless Type generators are liquid cooled (coolant) and consist of the following main components:

- Generator Housing.
- Stator Assembly.
- Rotor Assembly.

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1. Pulley
2. Rectifier
3. Voltage Regulator
4. Drive End Shield
5. Generator Housing
6. Coolant
7. Coolant Housing
8. Field Winding
9. Stator Housing
10. Stator Winding
11. Rotor
12. Non Magnetic Intermediate Ring
13. Rotor Pole

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Fig. 8: Cross Sectional View Of Brushless Type Generator
Courtesy of BMW OF NORTH AMERICA, INC.

Generator Housing Water Cooled

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The Water Cooled Generator is housed in an encapsulated metal shell enclosure. The enclosure is installed an aluminum shell.

The space between the inner surface of the shell and the outer surface of the generator creates a water jacket that engine coolant flows through.

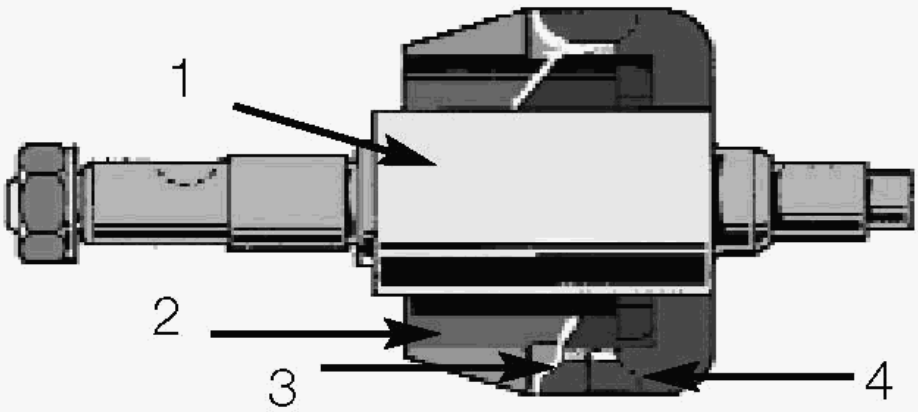
Coolant flows from the engine into the shell through internal ports and exits via hose connections.

Liquid cooling minimizes noise generation through elimination of generator cooling fan.

Stator Assembly

Although different in appearance the Stator Assembly in a brushless generator performs the same functions as the brush type.

Rotor Assembly



1. Rotor Shaft With Pole Core
2. Left Pole-Finger Crown
3. Non-,Magnetic Retaining Ring
4. Right Pole-Finger Crown

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Fig. 9: Identifying Rotor Assembly

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Courtesy of BMW OF NORTH AMERICA, INC.

The brushless generator Rotor does not contain the field coil. The pole-finger crowns rotate around a fixed field coil and are magnetized by the flux field of the field coil.

The two crowns form claw-pole half sections and are retained by a non-magnetic ring positioned below the pole fingers.

Rectifier Assembly

The Rectifier Assembly consists of six diodes, a pair of diodes for each stator winding. Each pair contain one positive biased diode and one negative biased diode. By using a pair of diodes that are reversed biased to each other, rectification of both sides of the AC sine wave is achieved. The negative biased diodes allow for conducting current from the negative side of the AC sine wave and putting this current into the circuit as positive current. The use of positive and negative biased diodes provide for full wave rectification because both halves of the sine wave are used.

Drive Belt

It is the function of the Drive Belt to transfer rotating energy from the engine to the generator. The drive belt rotates the rotor, spinning the magnetic field. A loose belt can inhibit charging system efficiency and a belt that too tight causes early bearing failure.

VOLTAGE REGULATOR

Voltage Regulators prevent excessively high voltage output of the generator. Excessive voltage would cause damage to the battery (through overcharging), light bulbs, motors, and particularly sensitive electronic components.

The regulator prevents these problems by limiting the current output of the generator.

Two types of regulators that are used:

- Standard Regulator.
- Multifunction Controller.

Standard Regulator

Electronic Voltage Regulators are mounted internally in the back of the generator assembly. Generator output is controlled by varying the amount of time the field coil is energized. The duty cycle of the field coil ground side is varied based on the demand placed on the electrical system.

The electronic voltage regulator compares field current supply voltage (from the stator windings through the diode trio) against a set voltage level (using a zener diode).

As the field current supply voltage surpasses the zener diode's breakdown voltage, the field current to the rotor is switched off. When the field current voltage to the rotor is off, the generator is not producing voltage. A rapid switching of the field current allows a fixed voltage output to be maintained. Additional diodes in the regulator,

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prevent current flow when the ignition is off preventing battery drain.

Multifunction Controller

In addition to voltage regulation, the Muti-function Control electronic regulator provides the following features:

- Load response during start-up.
- Load response during driving.
- Fault display (under voltage, drive belt breakage, field coil interruption).

NOTE: Multi-function Control electronic regulators are available with and without start load response. The only difference is the time limitation of the rated current during the start procedure.

The start-up load response system provides for the alternator exciter current (field coil) to be started by a transistor two seconds after the battery indicator goes out. This means that engine start-up is unaffected by generator induced drag.

The load response during driving ensures that when large current consumers are switched on the generator output increases linearly allowing the DME/EML system to stabilize the engine speed and/or modify injection time if necessary.

Charge Indicator

The purpose of the Charge Indicator is to advise the driver that the vehicle's electrical system is not operating at peak efficiency and service should be performed.

The charge indicator operates differently depending on which type of regulator the vehicle is equipped with.

Standard Regulator

The charge indicator operates on the basis of opposing voltages. If there is no output through the diode trio, then the lamp circuit is completed to ground through the rotor field. Diode output applies voltage to the previously grounded side of the bulb, turning the bulb off (No current flow with equal voltage on both sides of the bulb).

Multifunction Controller

The charge indicator is activated by an electronic switch integrated in the controller. This internal switch receives its voltage supply from KL15 of the 2 pin generator connector. The controller measures internally the difference in voltage between KL30 and KL15 and switches the indicator circuit low in case of a fault.

Ignition Switch

The Ignition Switch provides initial power for the field circuit of the alternator, reducing the time required for the field to develop the magnetic field. Depending on which type of regulator is employed the ignition switch supplies power to the charge indicator to check bulb integrity.

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Cables and Wiring Harness

The Cables and Wiring Harness are used to deliver the voltage produced by the generator to the battery for storage, and to vehicle systems to supplement battery voltage.

CHARGING SYSTEM PRINCIPLE OF OPERATION

Charging Systems (Brush or Brushless) use the principle of electromagnetic induction to generate electrical power. Electromagnetic induction occurs in a generator when a magnetic field is rotated within a stationary conductor. The magnetic field can be generated by permanent magnets or as in the case of the automotive generator by powerful electromagnets.

Passing electric current through a wire or winding causes a magnet field to surround the wire or winding. The number of turns in the winding and the magnitude of the current flowing through the winding determine the magnetic field strength.

The strength of the field is further increased by surrounding the coil with pole pieces. The poles will take on the polarity (North or South) of the side of the coil they touch or the ones they are closest to. The combined windings (field coil) and pole pieces are referred to as the rotor. Output of the generator is regulated through control of field coil intensity.

An examination of single phase AC voltage generation, will aid in the understanding of 3 phase AC voltage generation.

SINGLE-PHASE AC VOLTAGE GENERATION

Single Phase AC Voltage Generation requires one stator frame with windings and one magnetic field (North and South pole pieces).

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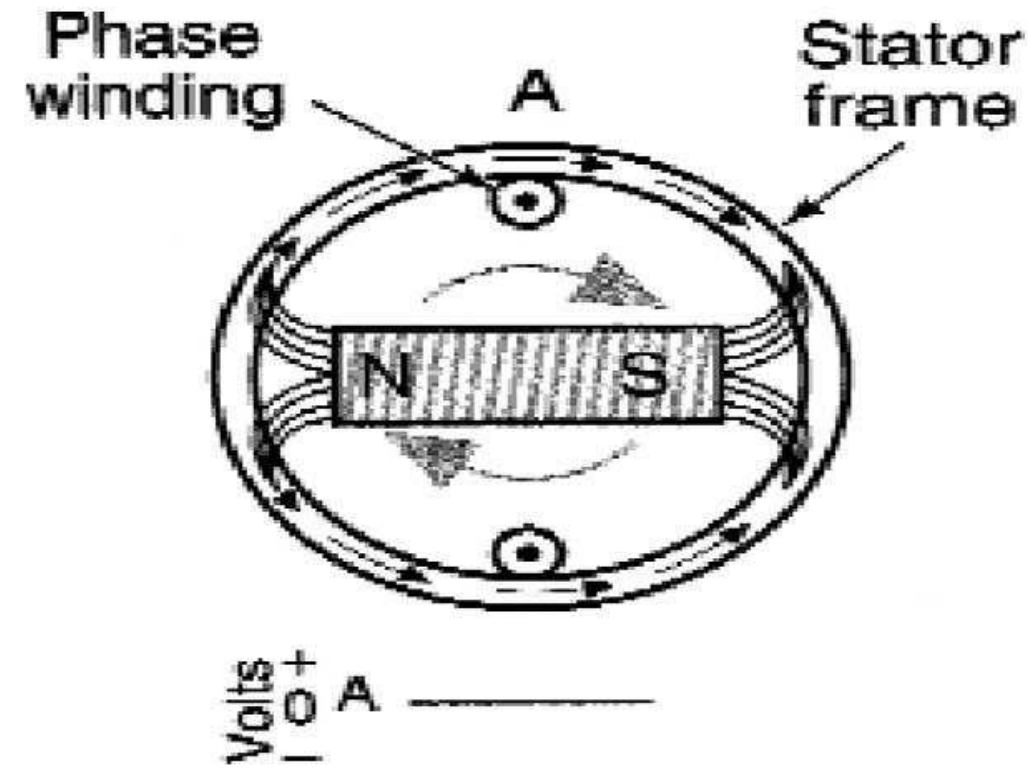


Fig. 10: View Of North/South Poles And Stator Frame
Courtesy of BMW OF NORTH AMERICA, INC.

As the North pole of the rotor pole piece approaches the winding of the stator, induced voltage level in the stator begins to rise. The closer the North pole gets to the stator winding the higher the induced voltage. As the North pole reaches 90° to the stator winding the maximum amount of flux lines are acting on the winding, induced voltage is at its highest positive value (1/4 turn).

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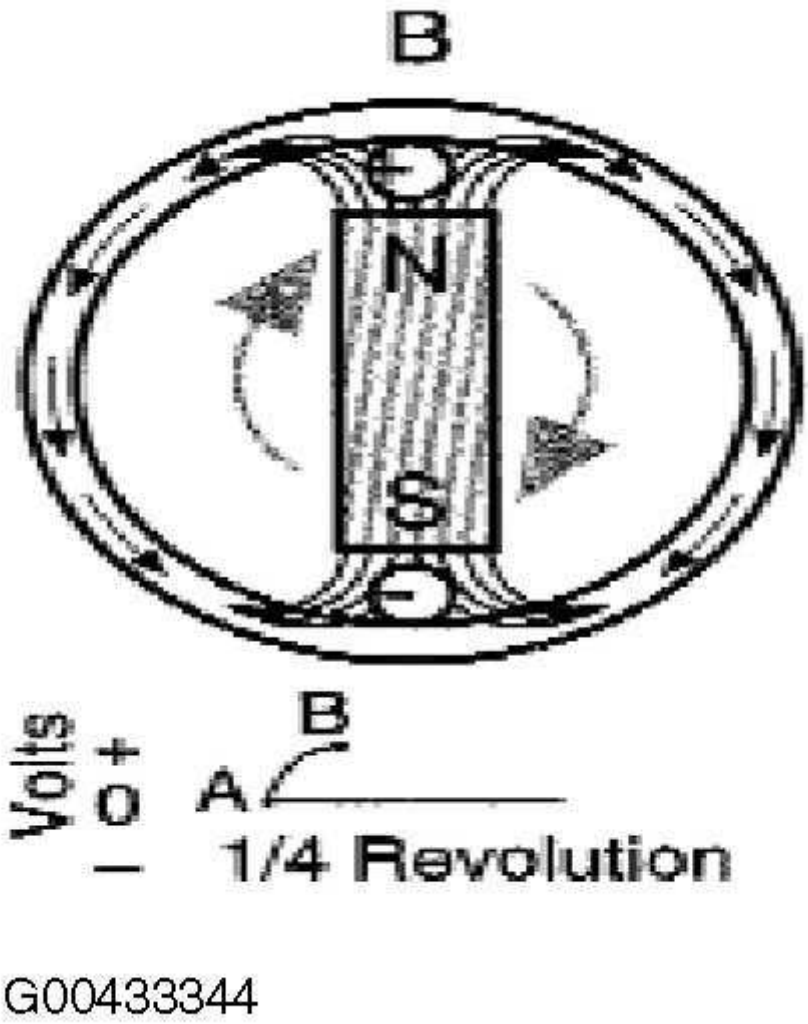


Fig. 11: Identifying Stator Rotation (1/4 Turn)
Courtesy of BMW OF NORTH AMERICA, INC.

The rotor continues to rotate and the North pole gets further away from the winding. The voltage drops, until 0 voltage is induced through the stator (1/2 turn).

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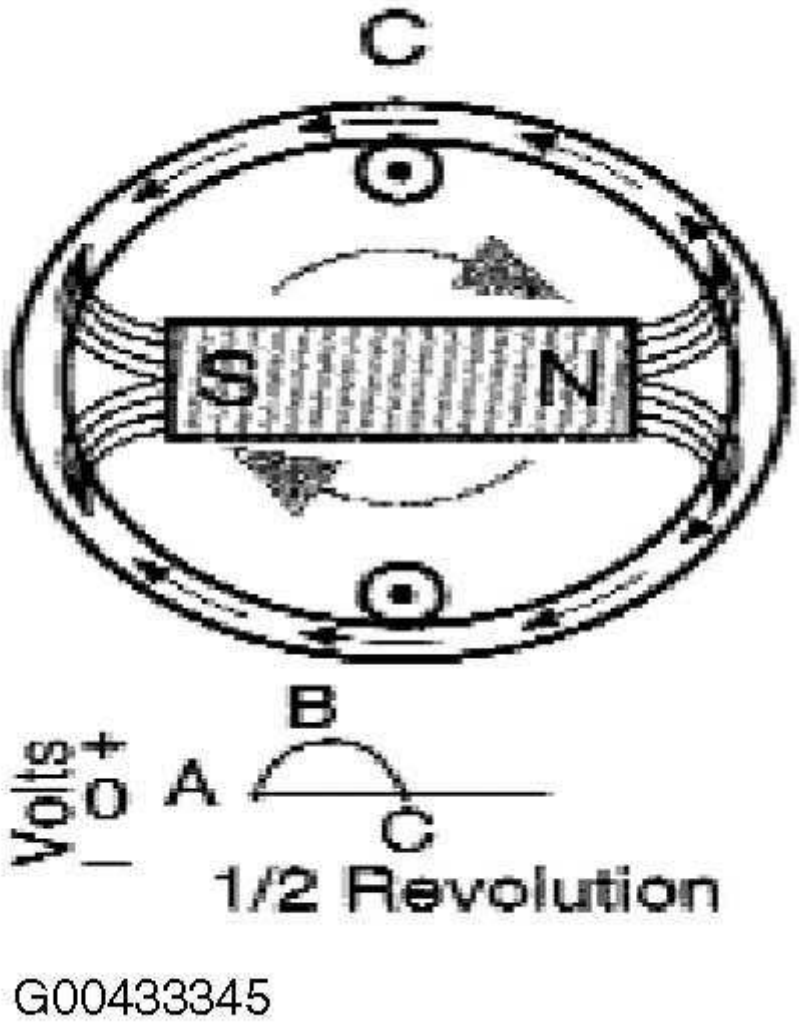


Fig. 12: Identifying Stator Rotation (1/2 Turn)
Courtesy of BMW OF NORTH AMERICA, INC.

With the South pole now approaching the winding voltage begins to increase negatively. When the South pole reaches 90° to the winding, again the maximum amount of flux lines are acting on the winding and induced voltage is at its greatest negative value (3/4 turn).

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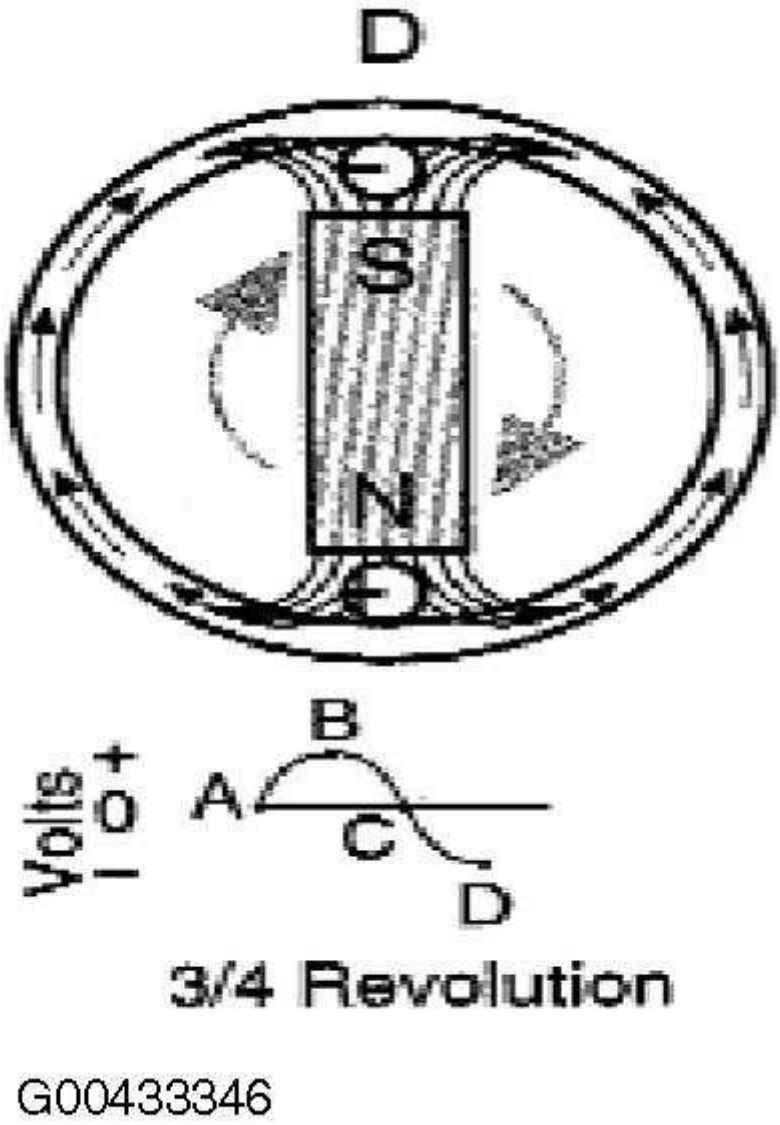


Fig. 13: Identifying Stator Rotation (3/4 Turn)
Courtesy of BMW OF NORTH AMERICA, INC.

The South pole continues to travel farther away from the winding decreasing the negative voltage value until 0 voltage is again reached (1 full turn).

This comprises one cycle or 360° rotation of the magnetic field.

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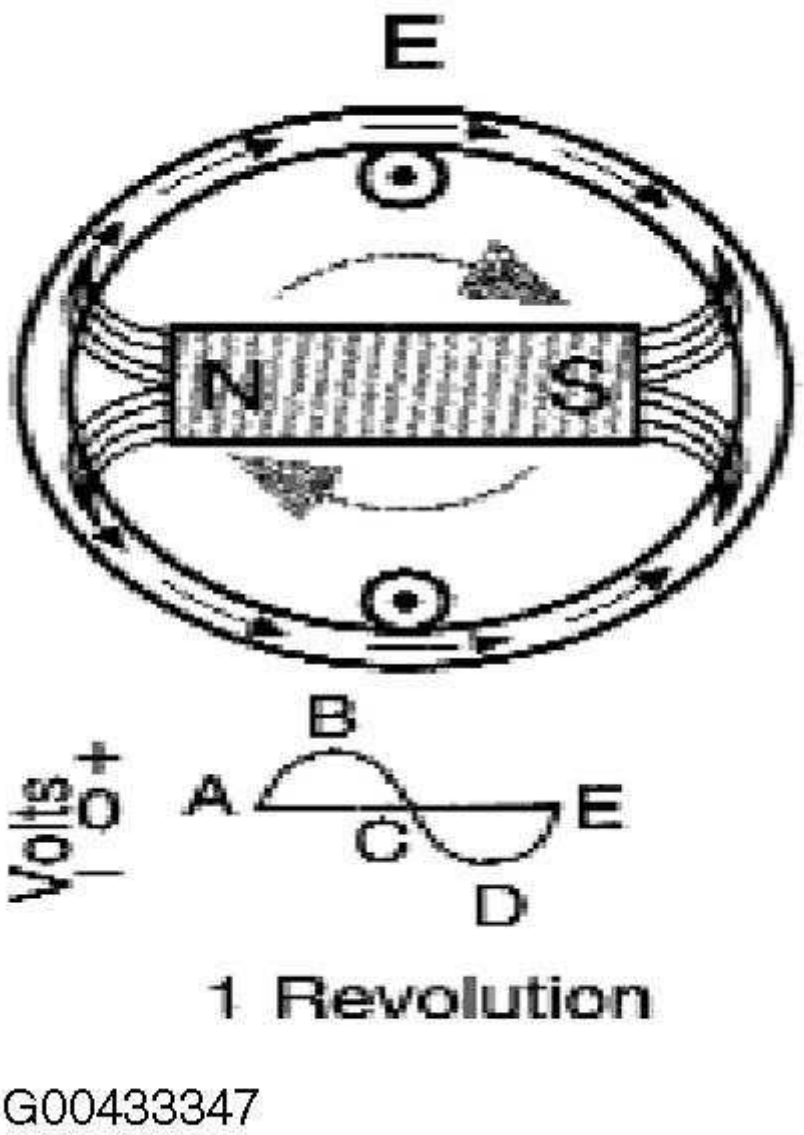


Fig. 14: Identifying Stator Rotation (1 Full Turn)
Courtesy of BMW OF NORTH AMERICA, INC.

Sine wave produced by a single winding of the stator during a single revolution of one pair of pole pieces is called single phase voltage.

THREE-PHASE AC VOLTAGE GENERATION

Most AC generators use either a twelve or a fourteen pole rotor. Each pair of poles (North and South) produce one complete sine wave in each winding per revolution.

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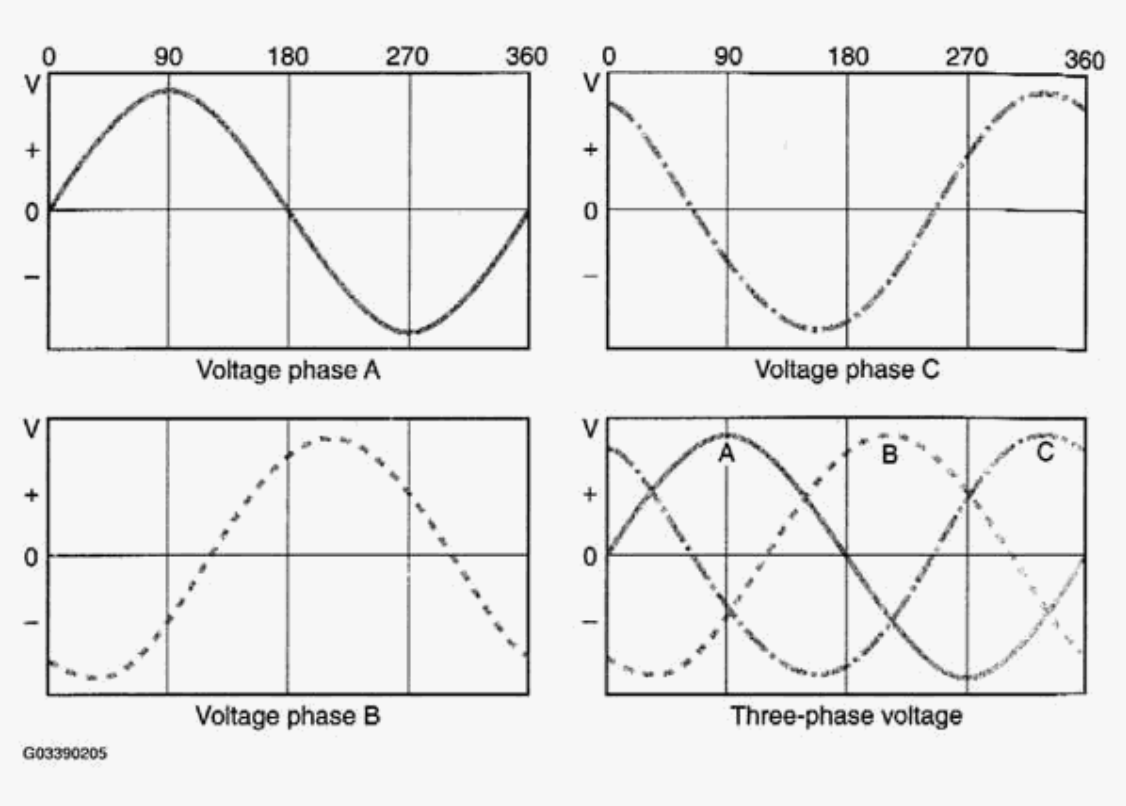


Fig. 15: Three-Phase AC Voltage Graph
Courtesy of BMW OF NORTH AMERICA, INC.

Voltage of each stator winding is added together to create three-phase voltage.

During one revolution a fourteen pole rotor will produce seven sine waves. (The stator has one winding (coil) for each pair of rotors.)

The rotor generates three overlapping sine wave voltage cycles in the stator (one rotor three sets of windings in the stator).

The total output would be twenty one sine wave cycles per revolution (3 sets of stator windings, each with 7 coils).

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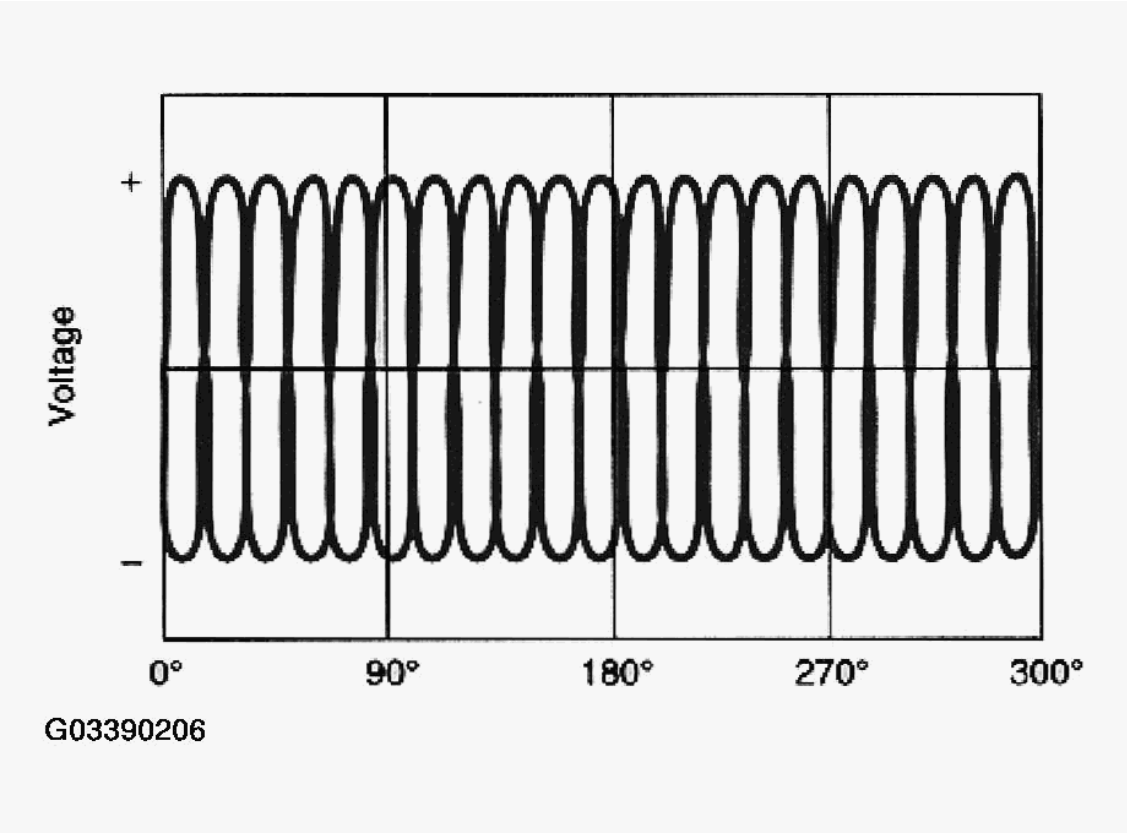


Fig. 16: Identifying Wave Cycle
Courtesy of BMW OF NORTH AMERICA, INC.

Sine wave cycle of a fourteen pole rotor and three phase stator.

VOLTAGE RECTIFICATION

The battery and the electrical system cannot store or use the 3-phase AC voltage produced by a generator, it must be rectified or converted to DC voltage.

A diode rectifier bridge is used to make the conversion.

The diode is similar to a non-return or one way valve which permits the passage of a fluid or gas in only one direction.

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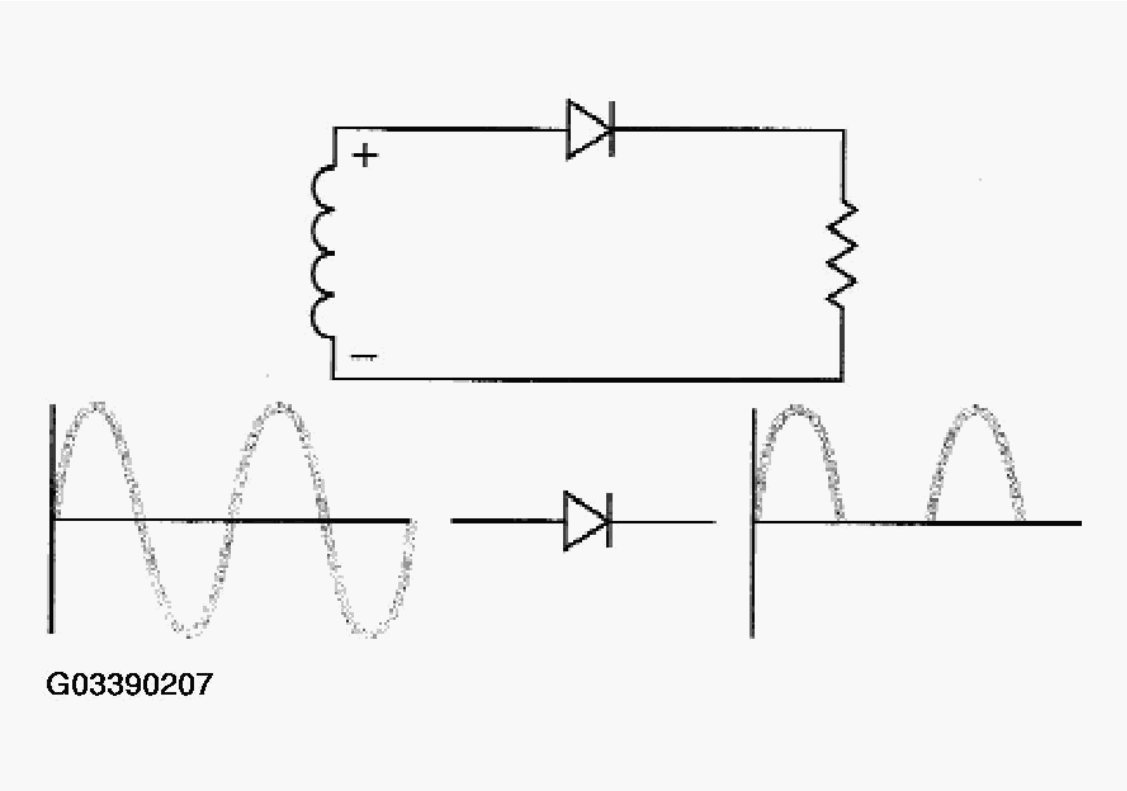


Fig. 17: Identifying Voltage Rectification
Courtesy of BMW OF NORTH AMERICA, INC.

In a simple conversion the rectifier diode suppresses the negative half waves and allows only positive half waves to pass.

To make use of the negative value half waves full rectification is applied.

Full rectification of the negative half waves invert them into positive half waves.

The result is a rectified pulsating direct current.

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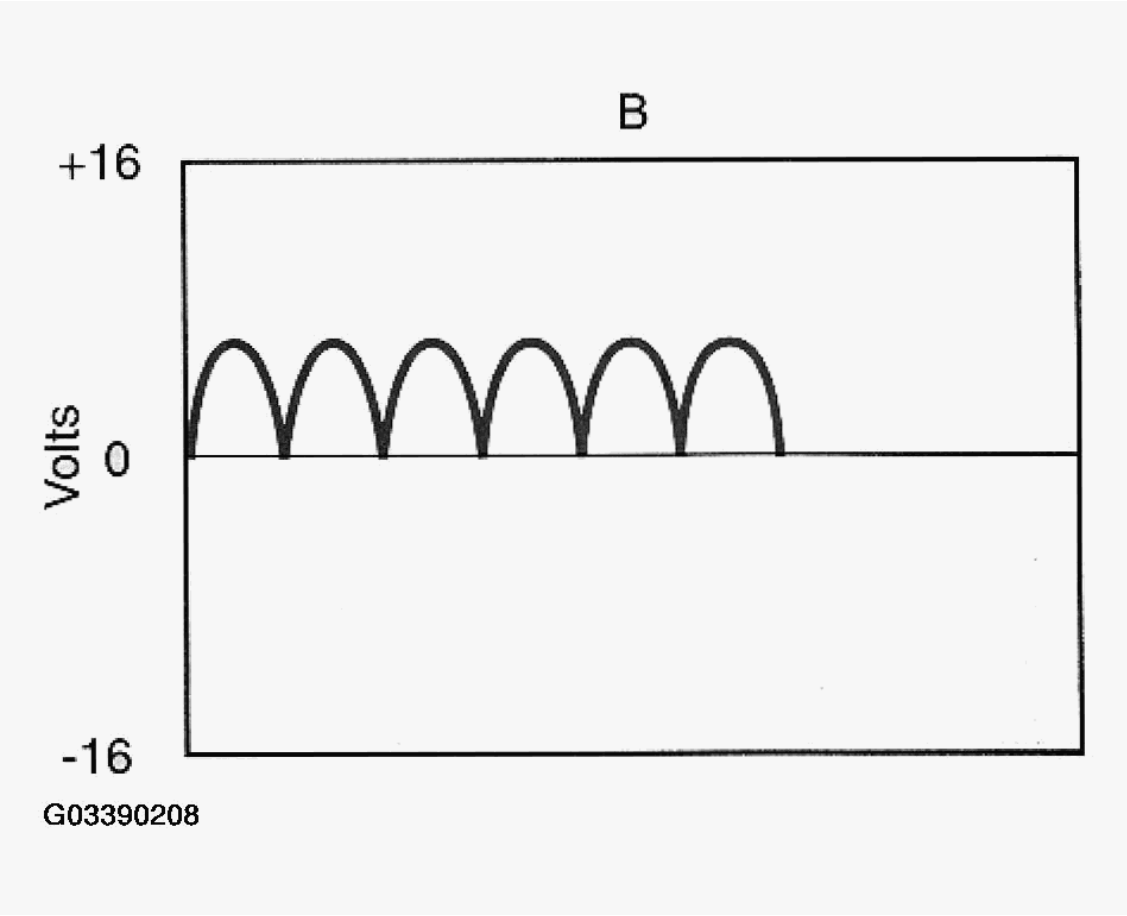


Fig. 18: Identifying Half Waves
Courtesy of BMW OF NORTH AMERICA, INC.

Rectified Pulsating DC current

THREE-PHASE VOLTAGE REGULATION

Six diodes are used to achieve three-phase AC voltage rectification. Three diodes are positive biased and three are negative biased.

The positive half-waves pass through the positive biased diodes and the negative halfwaves through the negative biased diodes.

Diode rectification of the negative half-waves invert them into positive half-waves.

With full rectification DC voltage supplied to vehicle by generator is not ideally smooth, but exhibits a slight ripple. This ripple is further smoothed by the battery which is connected in parallel with the generator.

The rectifier diodes in the generator not only convert the current but also prevent battery discharging through the 3 phase windings of the stator. Current flow can only take place from the generator to the battery.

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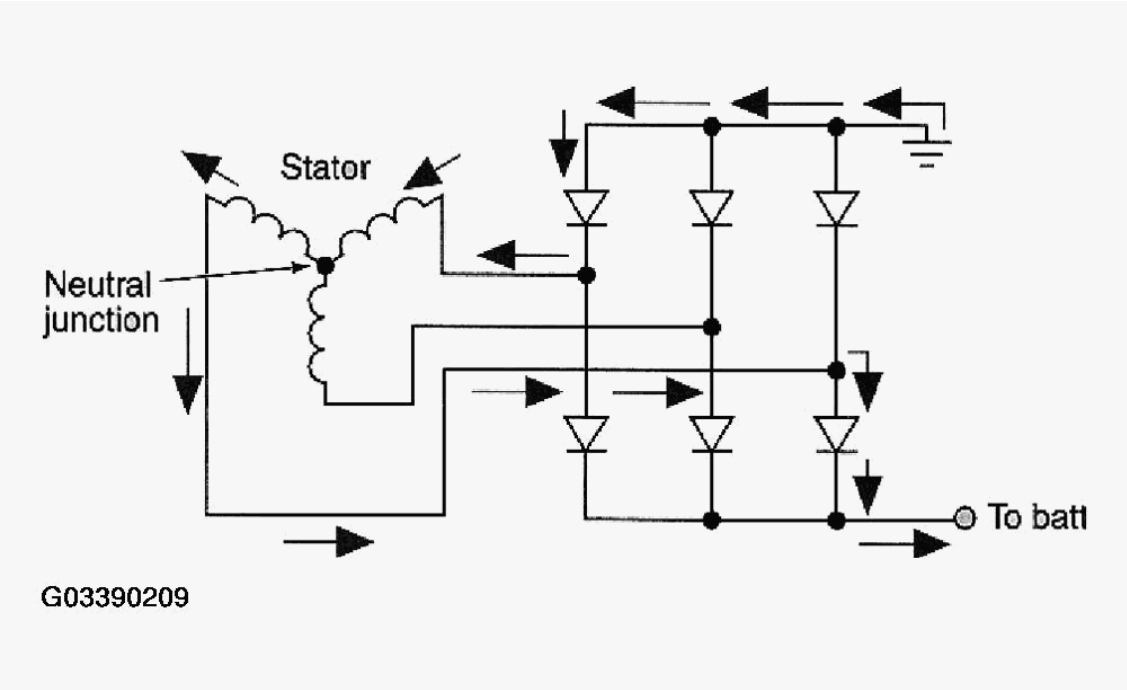


Fig. 19: Rectifier Diodes Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Current flow through Y wound stator.

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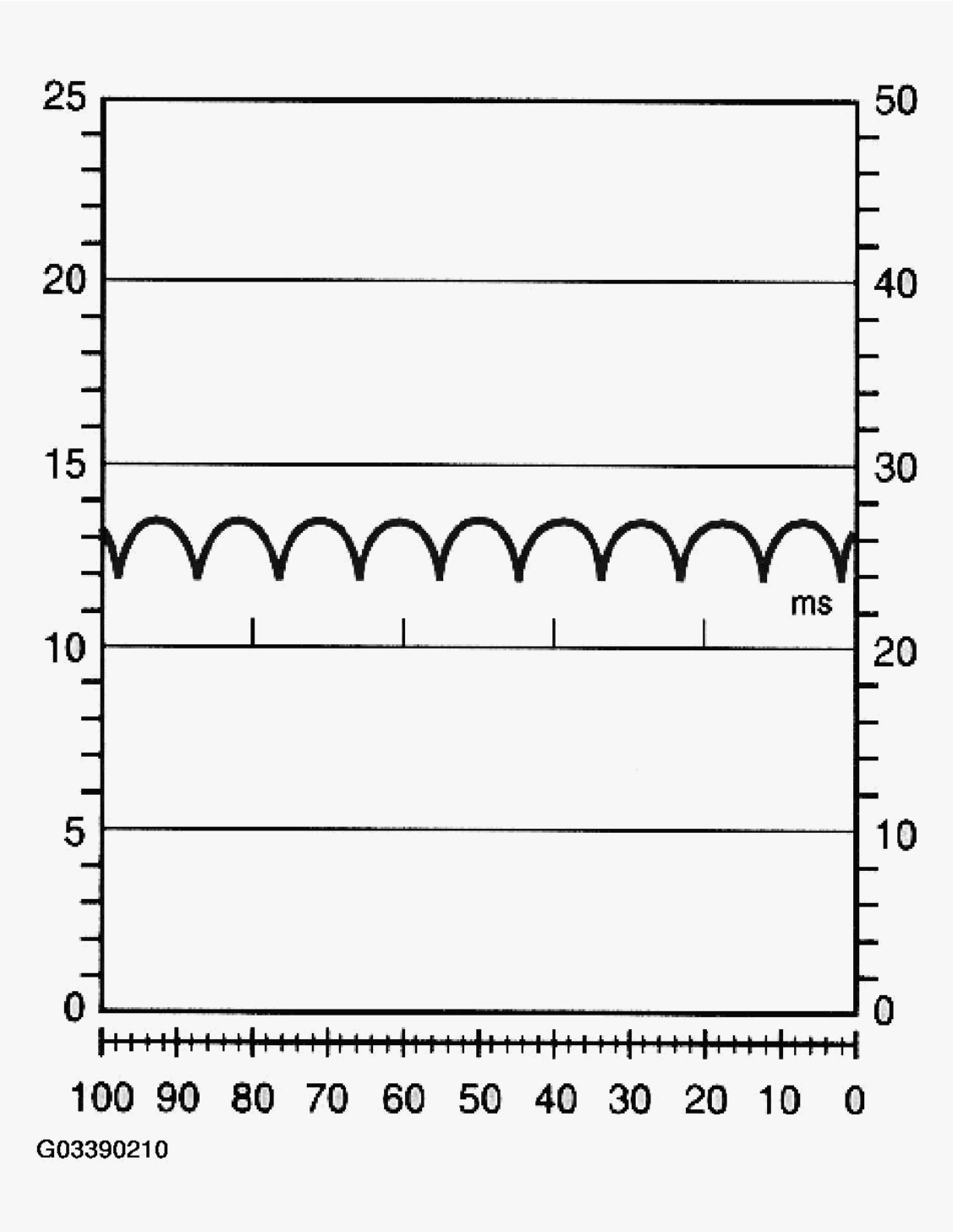


Fig. 20: Oscilloscope Graph
Courtesy of BMW OF NORTH AMERICA, INC.

Rectified AC output has a ripple as seen on oscilloscope.

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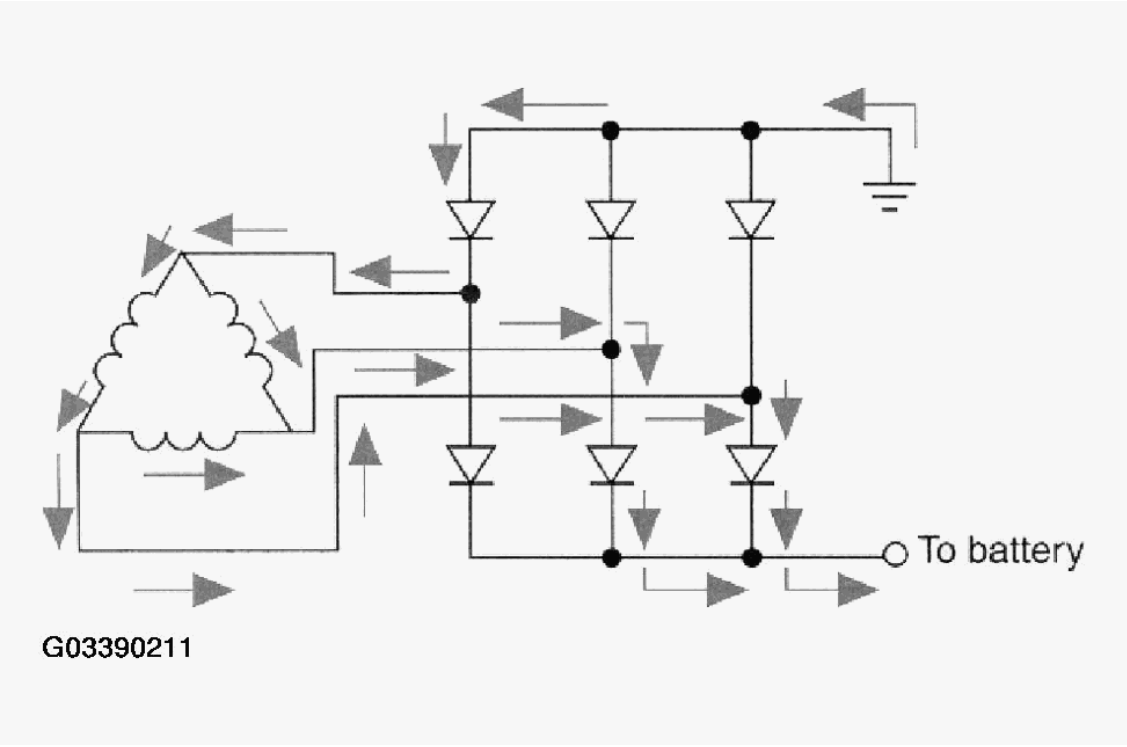


Fig. 21: Identifying Current Flow Through Delta Wound Stator
Courtesy of BMW OF NORTH AMERICA, INC.

Current flow through Delta wound stator.

Voltage Regulation

Standard Regulator

The Electronic Regulator uses a zener diode that blocks current flow until a specified voltage is obtained.

Sensing current from terminal 2 passes through a thermistor to the zener diode (D2). As the system voltage exceeds the breakdown voltage of the zener diode, current flows through the zener diode turning transistor 2 (TR2) on. With TR2 on transistor 1 (TR1) is shut off.

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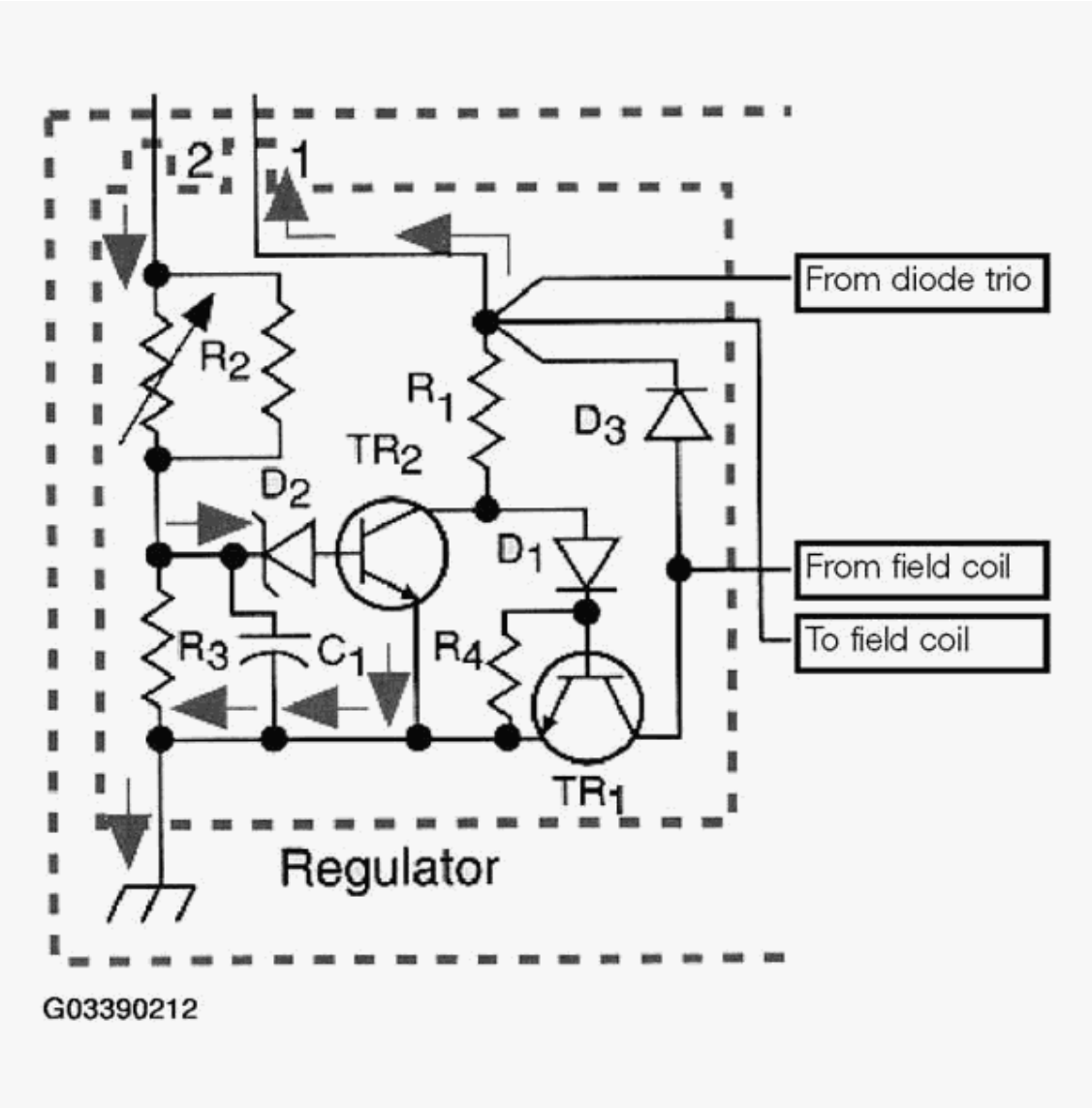


Fig. 22: Regulator Circuit Diagram (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Transistor 1 controls field current to the rotor. With TR1 off no current flows to the field coil and the generator has no output.

A voltage drop below the breakdown voltage of the zener diode stops the current flow to TR2 which turns on TR1.

Voltage is again applied to the field allowing the generator to produce voltage.

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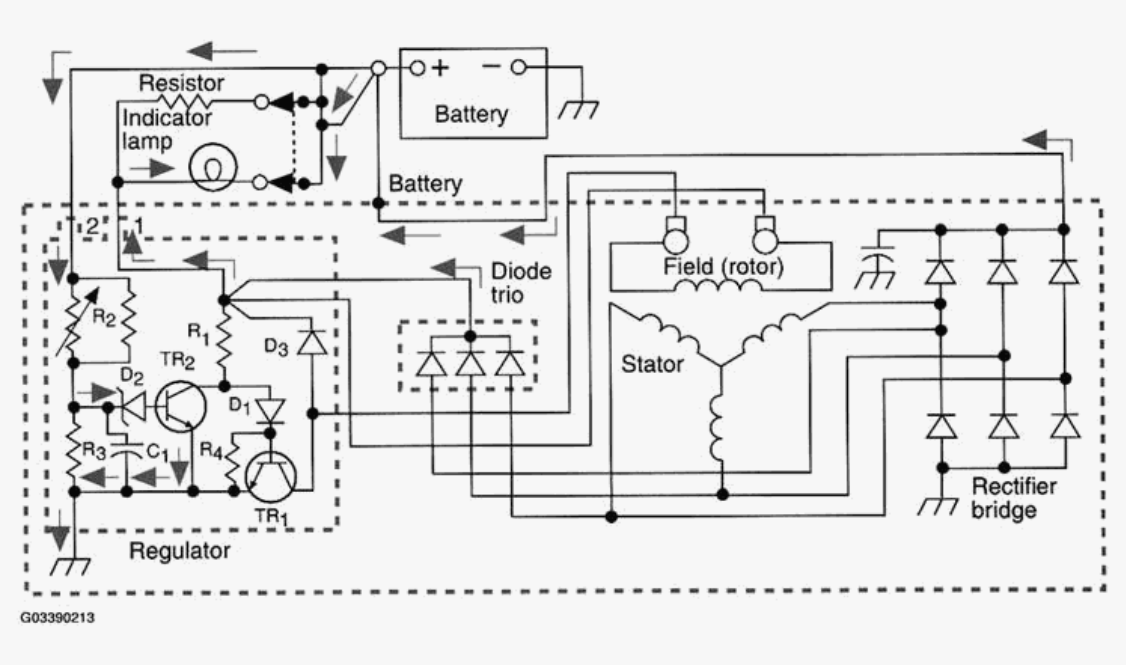


Fig. 23: Regulator Circuit Diagram (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Field coil off, no charging.

Multifunction Controller

The Multifunction Controller regulates voltage in the same manner as the standard voltage regulator. Regulation is through duty cycle control of the field coil.

The differences as compared to the standard regulator are:

- Manner in which malfunction indicator lamp is controlled.
- Connections to wiring harness.

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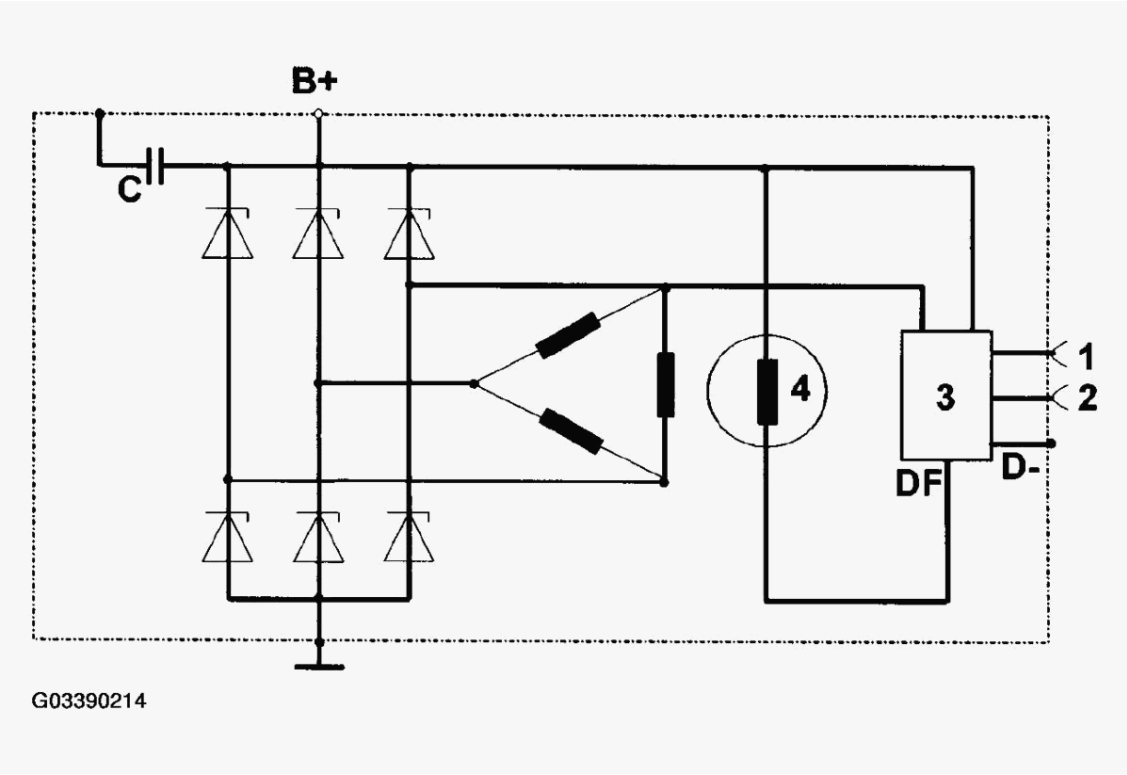


Fig. 24: Identifying Multifunction Controller Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Terminal 1:

KL 15 from fused source.

Terminal 2:

D+ (KL61) to DME.

B+

Generator output to Battery.

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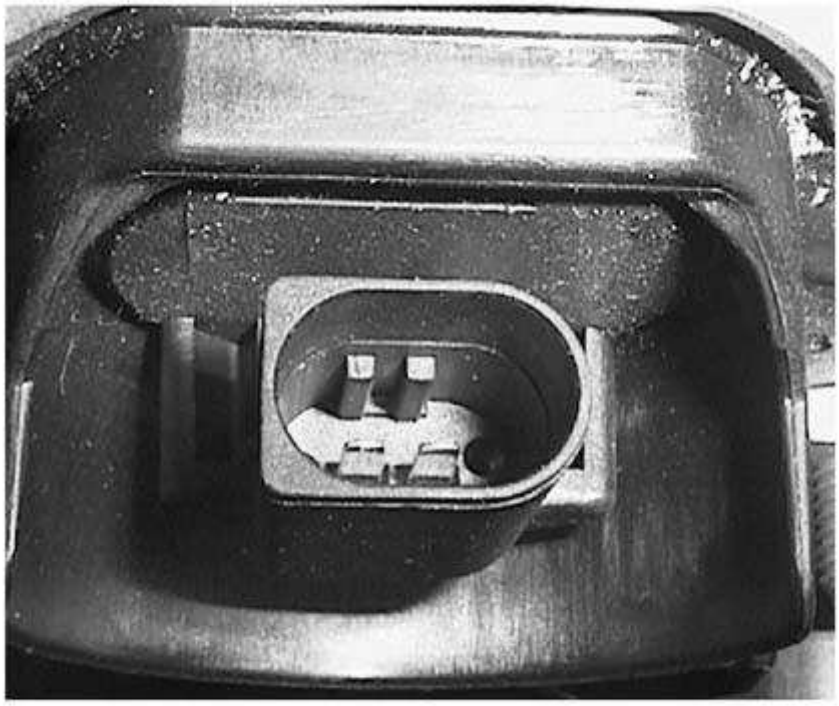


Fig. 25: Identifying Two Pin Wiring Harness Connector
Courtesy of BMW OF NORTH AMERICA, INC.

Two Pin wiring harness connector

Harness connector

B+ connection.

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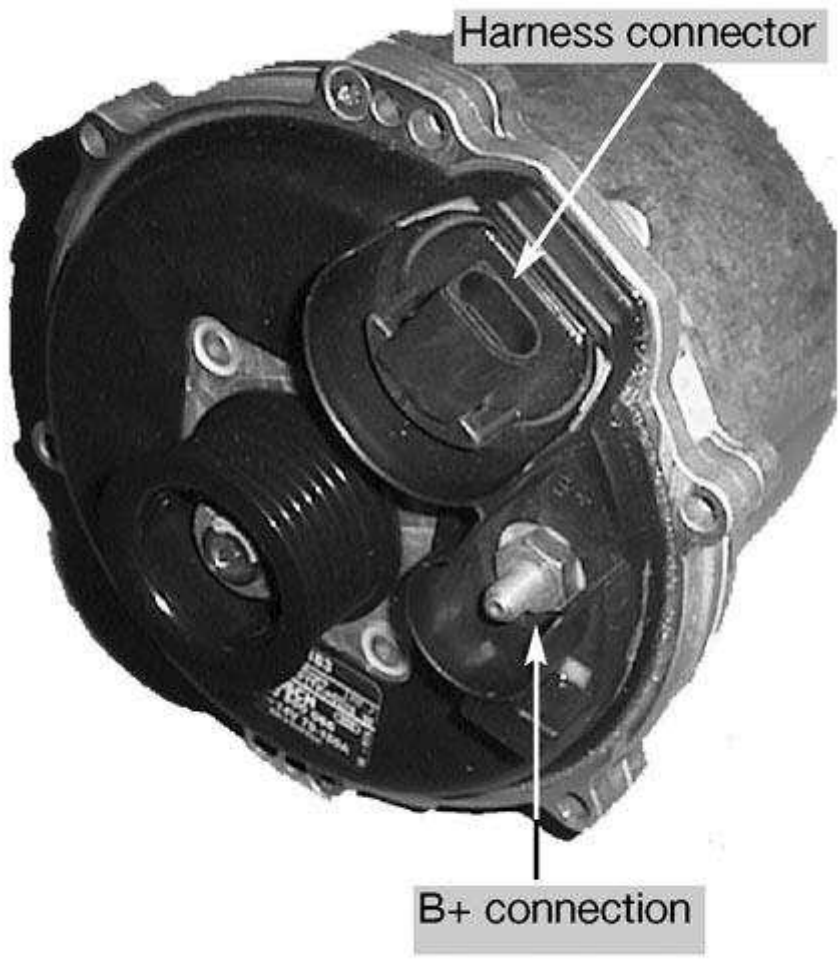


Fig. 26: Identifying Harness Connector
Courtesy of BMW OF NORTH AMERICA, INC.

CHARGE SYSTEM INDICATOR

Standard Regulator

The Charging System Indicator light operates on the principle of opposing voltage. Battery voltage is supplied to one side of the light bulb, the other side of the bulb is connected to the voltage regulator. With the key turned on, power is sent to the light bulb, through to the regulator. No voltage is being produced by the stator, so there is no voltage from the diode trio. This lack of voltage from the diode trio, allows the voltage from the ignition switch to flow through the regulator to ground. This completes the circuit allowing the charge indicator bulb to burn.

As the generator begins to produce voltage, the output of the diode trio equals battery voltage. This equal voltage is supplied to the light bulb. With equal voltage on each side of the light bulb, no current can flow and

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the light is turned off.

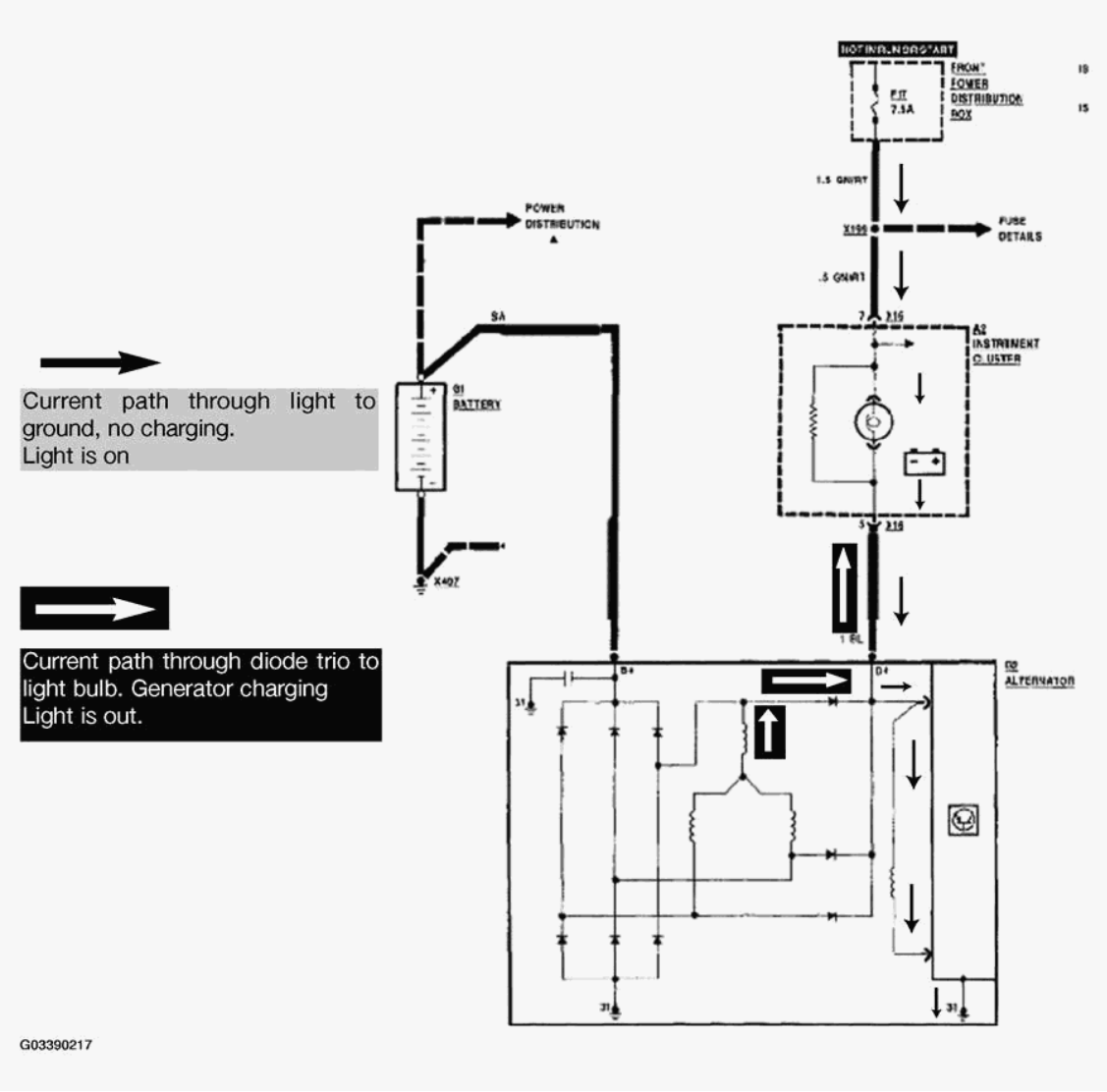


Fig. 27: View Of Charge Indicator System Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Multifunction Controller

The charge indicator light is activated by means of an electronic switch integrated into the controller. This switch receives its voltage supply from terminal 15 on the 2 or 3 pin connector on the generator. Terminal D+ is replaced by an isolated electronic terminal 61E in generators with a multifunction controller. The task on this terminal is to activate the battery charge indicator lamp and to indicate to the various loads that the generator is in charge mode.

The indicator lamp is supplied with voltage via terminal 15 from the instrument cluster. The lamp is illuminated when the voltage at terminal 61E is below 1.5v and goes out when the voltage is above 8v.

The indicator is on during the following conditions:

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- Key on, engine off.
- Generator not charging.
- Failure of drive belt.
- Interruption of field coil.
- Controller overvoltage.
- Break in charging cable.

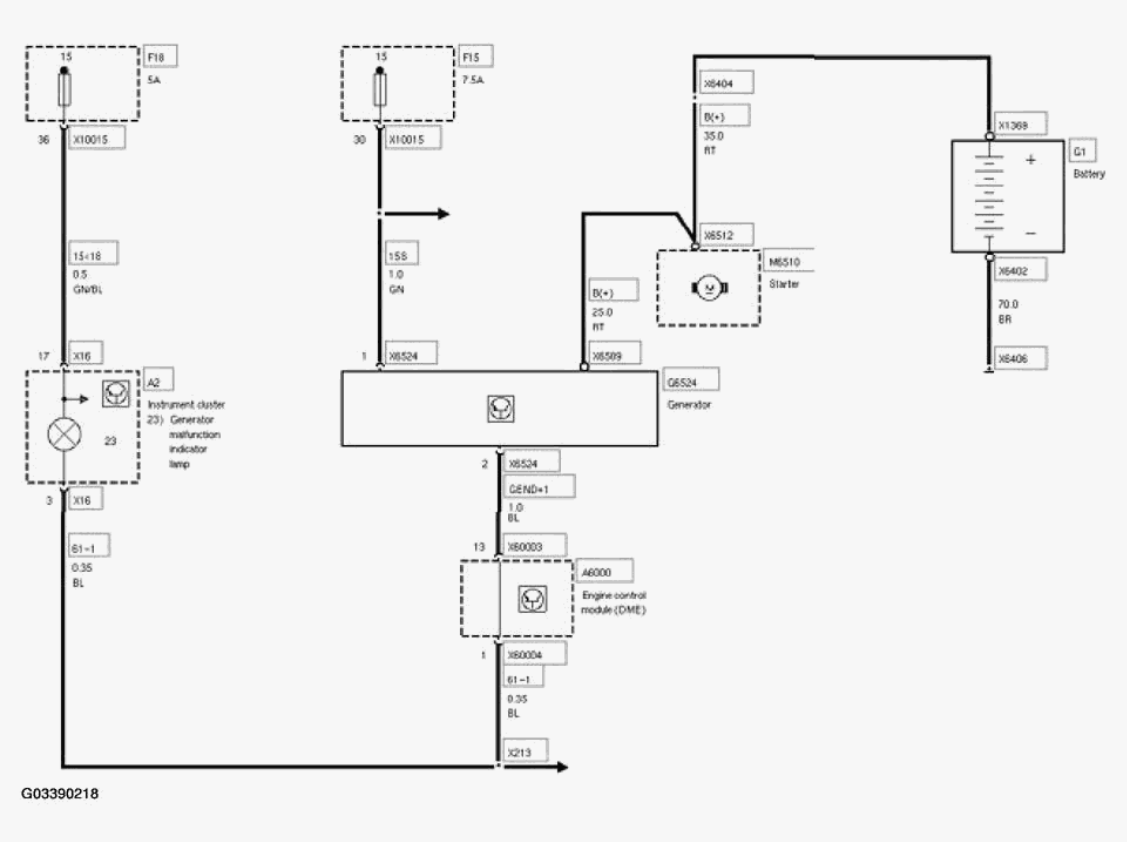


Fig. 28: View Of Multifunction Controller Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

GENERATOR DIAGNOSIS

Before beginning any generator diagnosis, ensure that the battery is in good condition and has passed all testing procedures. A weak or defective battery will influence the generator testing.

The generator may be tested using:

- DISplus.
- VAT testing equipment.

Workshop Hint:

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Before beginning diagnostic procedures on the charging system do the following:

- Run engine at idle speed for about 5 minutes.
- Switch off all electrical loads.

This is done to ensure the battery is charged to such a level that the generator will not be fully utilized and that loads required during starting (e.g. starter, secondary air pump) will be already switched off.

Testing Generator With DISplus

Two modes of testing are available when using DISplus.

- Testing using Test Plan.
- Testing using Preset Measurement.

Testing Generator Using Test Plan

Testing the charging system using a test plan is the more complete method of testing.

When selecting this mode of testing, other components in the charging system are tested in addition to the generator.

Test plans available:

- Generator (Checks voltage and current output).
- Wiring from generator to battery (Performs voltage drop test).
- Charge indicator lamp (Condition of bulb, wiring and signal to bulb).
- ON delay and Start ON delay (If applicable).
- Ground side circuit wiring (Voltage drop test).

Sub-tests may be available with some of the component testing.

There are many advantages to using the test plan.

1. Complete system testing.
2. Functional description of system on screen.
3. Proper wiring diagrams provided during testing.
4. Test instructions and notes.
5. Instructions for proper test set-up.
6. Display of nominal values.
7. Solutions.

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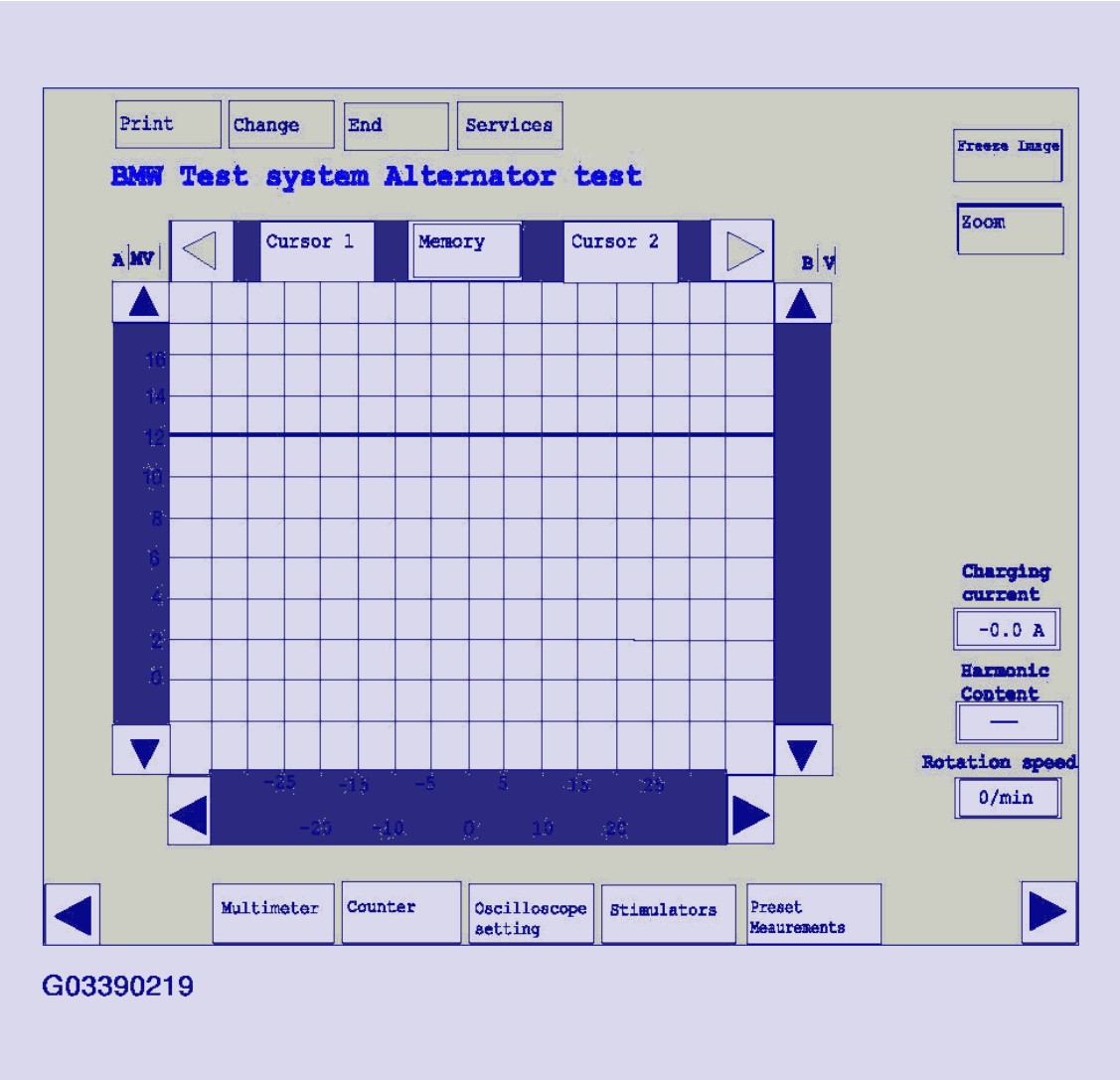


Fig. 29: Identifying DISplus Screen
Courtesy of BMW OF NORTH AMERICA, INC.

Testing Generator Using Measurement System

Enter the measurement system and select **Preset Measurements.**

Instruction on the proper hook-ups required are available through the **HELP** button, selecting **Help using Preset Measurement.**

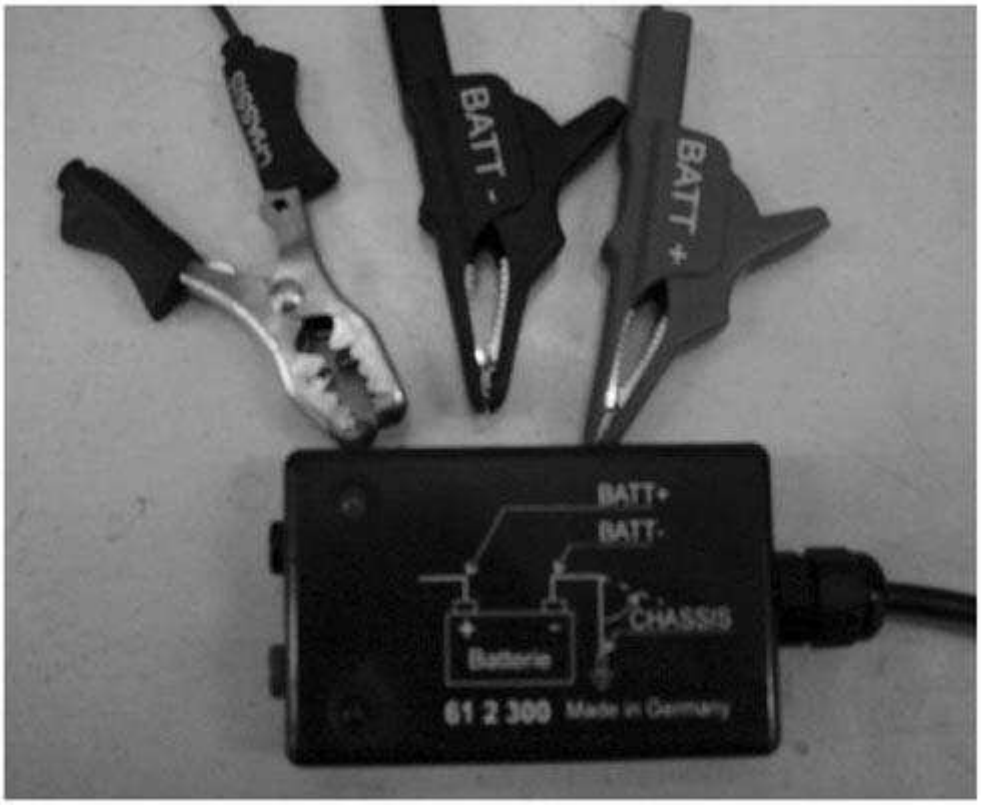
The oscilloscope will display pre-configured for the testing.

Diagnostic information available through oscilloscope.

- Voltage Graph.
- Charging Current.
- Harmonic Content.

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- Rotation Speed (Engine RPM).



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Fig. 30: View Of Special Tool 61 2 300
Courtesy of BMW OF NORTH AMERICA, INC.

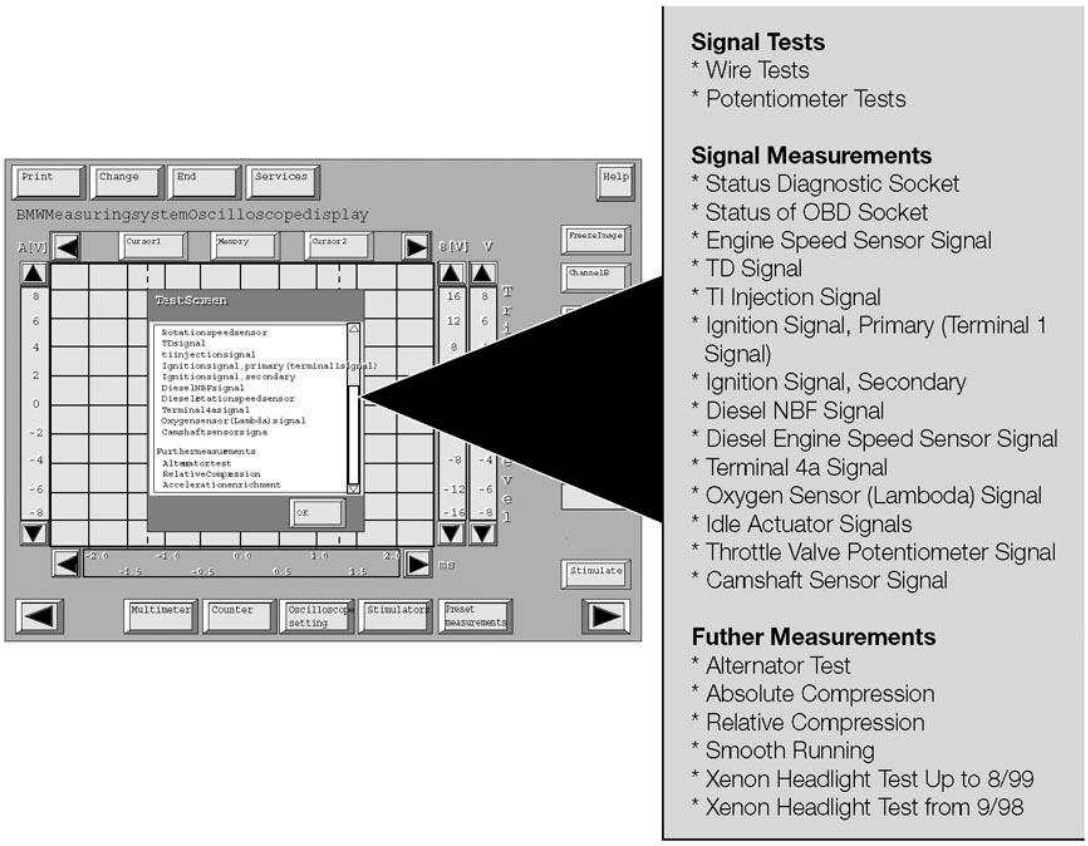
Harmonic Content:

This is an expression of AC voltage contained in DC voltage.

The higher the percentage of harmonic content the larger the amount of residual AC voltage in the DC voltage.

High residual AC voltage is caused by weak or failing diodes in the generator. Generators which have harmonic content readings higher than specified (In TIS) should be replaced.

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Signal Tests
* Wire Tests
* Potentiometer Tests

Signal Measurements
* Status Diagnostic Socket
* Status of OBD Socket
* Engine Speed Sensor Signal
* TD Signal
* TI Injection Signal
* Ignition Signal, Primary (Terminal 1 Signal)
* Ignition Signal, Secondary
* Diesel NBF Signal
* Diesel Engine Speed Sensor Signal
* Terminal 4a Signal
* Oxygen Sensor (Lamboda) Signal
* Idle Actuator Signals
* Throttle Valve Potentiometer Signal
* Camshaft Sensor Signal

Futher Measurements
* Alternator Test
* Absolute Compression
* Relative Compression
* Smooth Running
* Xenon Headlight Test Up to 8/99
* Xenon Headlight Test from 9/98

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Fig. 31: Functional Description Of System On Screen
Courtesy of BMW OF NORTH AMERICA, INC.

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GENERAL INFORMATION

CIP Programming - Overview

CIP PROGRAMMING

CIP PROGRAMMING SCREENS

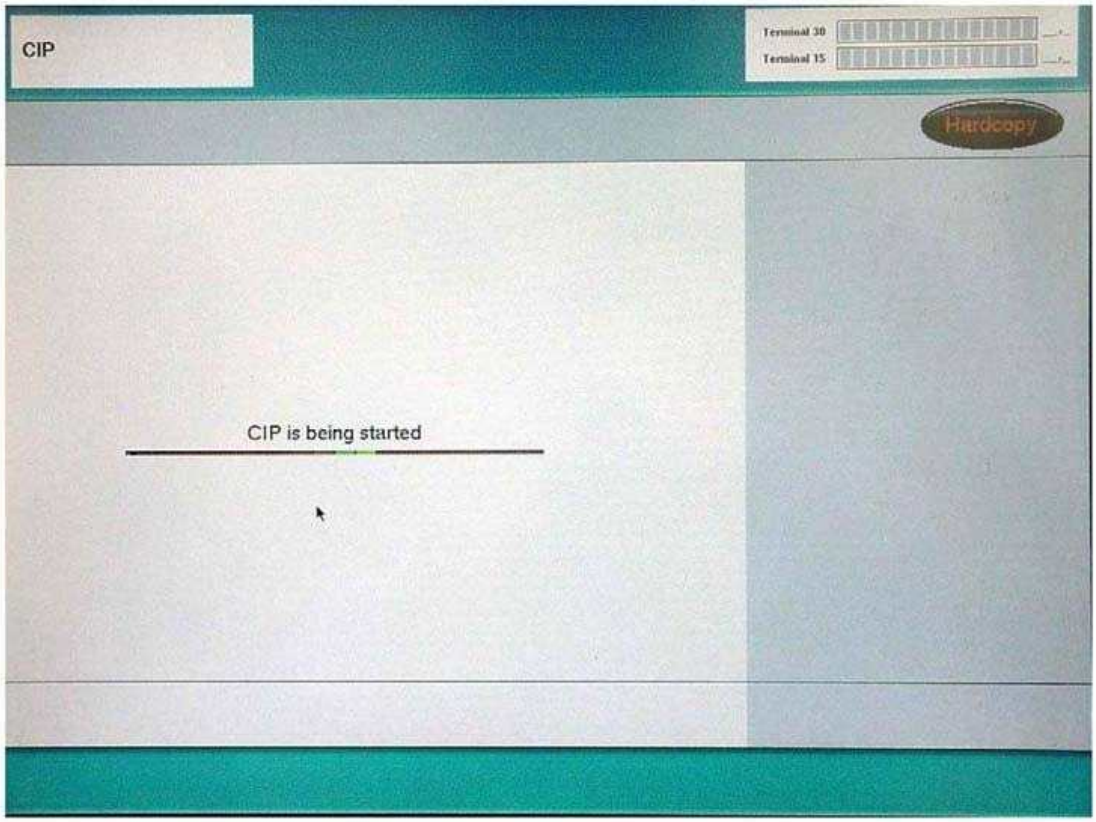


Fig. 1: CIP Programming Screen
Courtesy of BMW OF NORTH AMERICA, INC.

The opening screen when CIP is started.

Choose which vehicle you will be programming.

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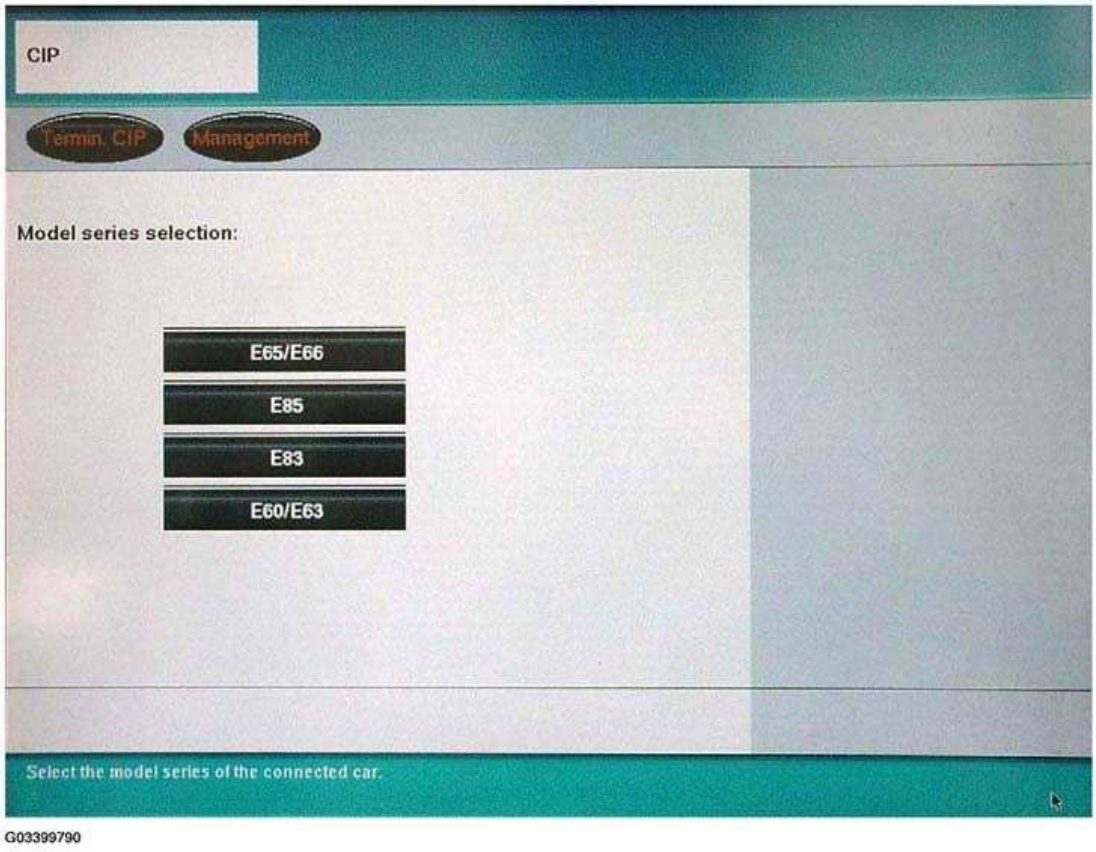


Fig. 2: Vehicle Selecting Programming Screen
Courtesy of BMW OF NORTH AMERICA, INC.

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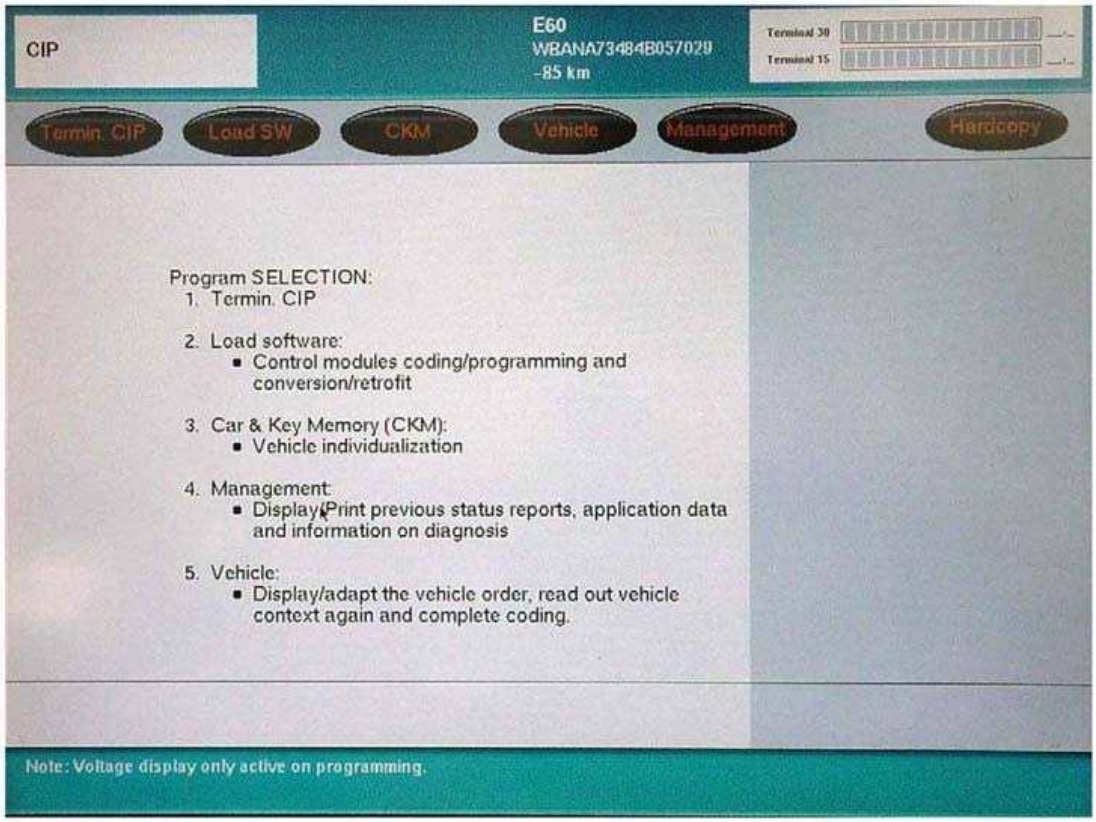


Fig. 3: Programming Screen - Retrofit Select
Courtesy of BMW OF NORTH AMERICA, INC.

Select depending upon programming required.

To retrofit select **Load SW.**

To update a vehicle select **Vehicle.**

Selecting Vehicle will ensure that complete encoding is performed.

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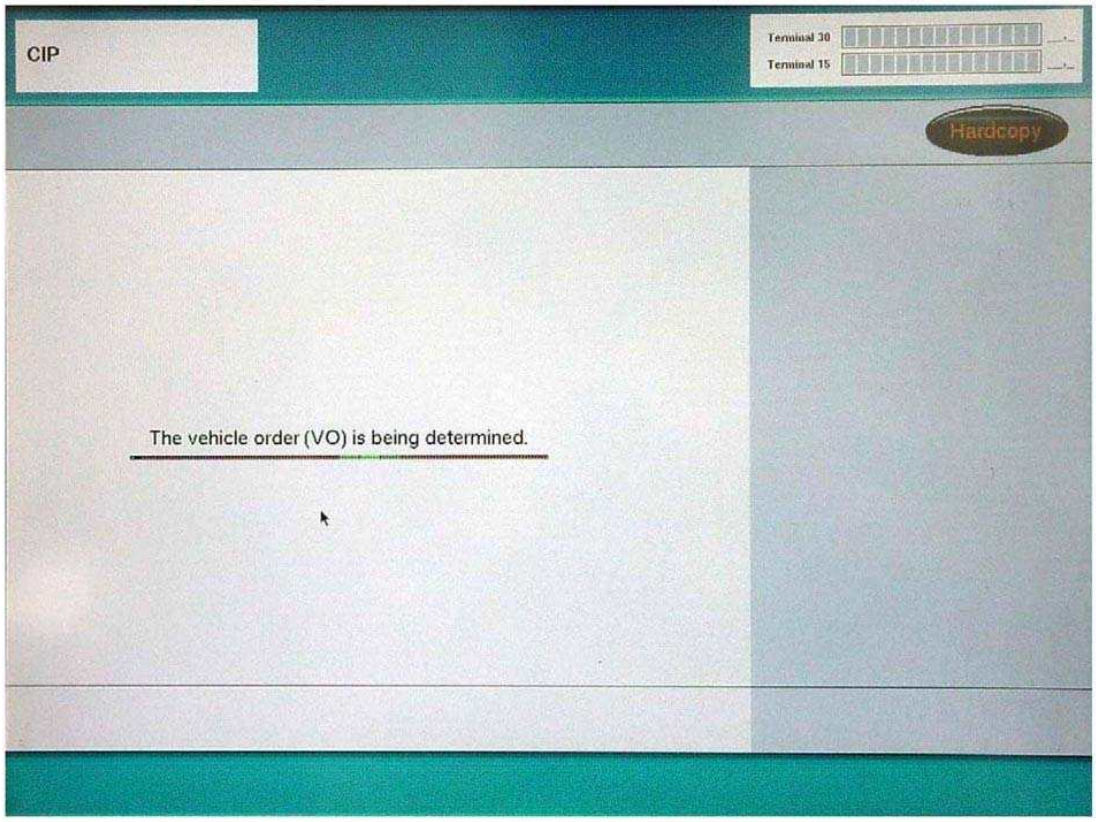


Fig. 4: Programming Screen - Load Software
Courtesy of BMW OF NORTH AMERICA, INC.

Regardless of whether you have selected Load SW or Vehicle, the VO will be determined.

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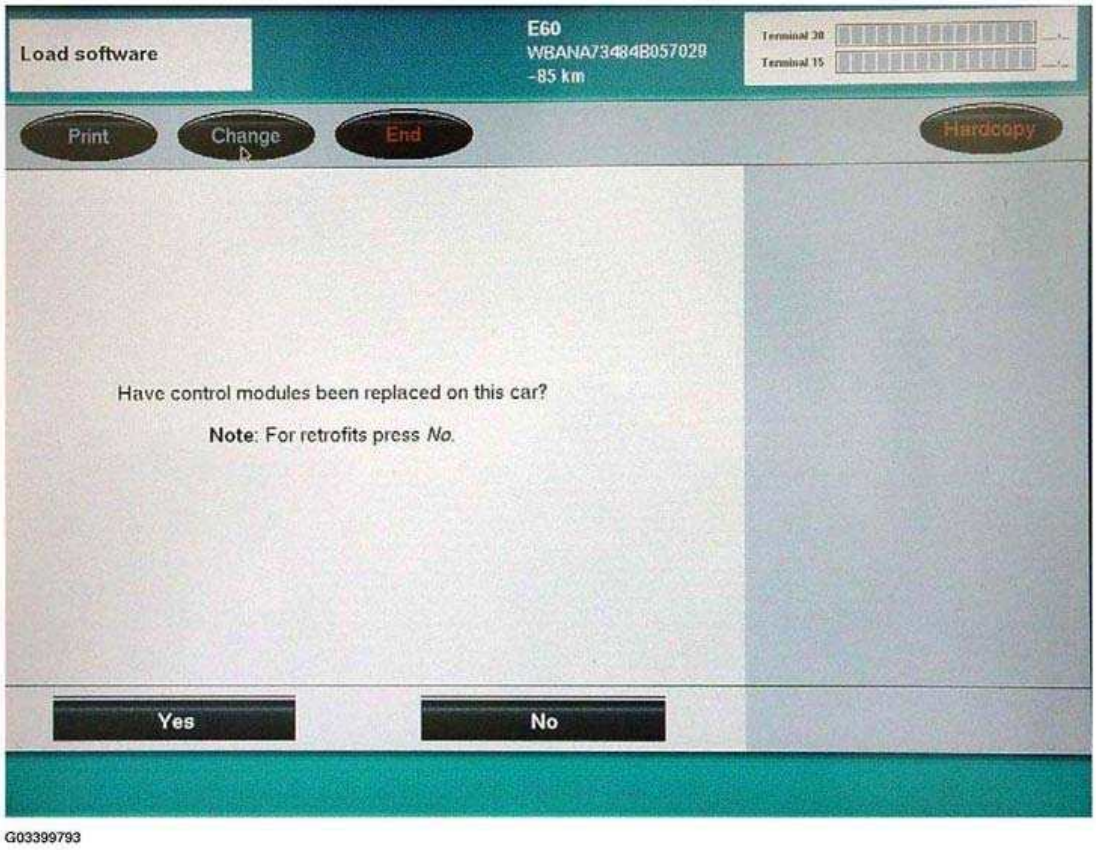


Fig. 5: Programming Screen - Determine
Courtesy of BMW OF NORTH AMERICA, INC.

A **YES** selection will lead you to choose which control module(s) have been replaced.

A **NO** selection will lead you to **Retrofits** .

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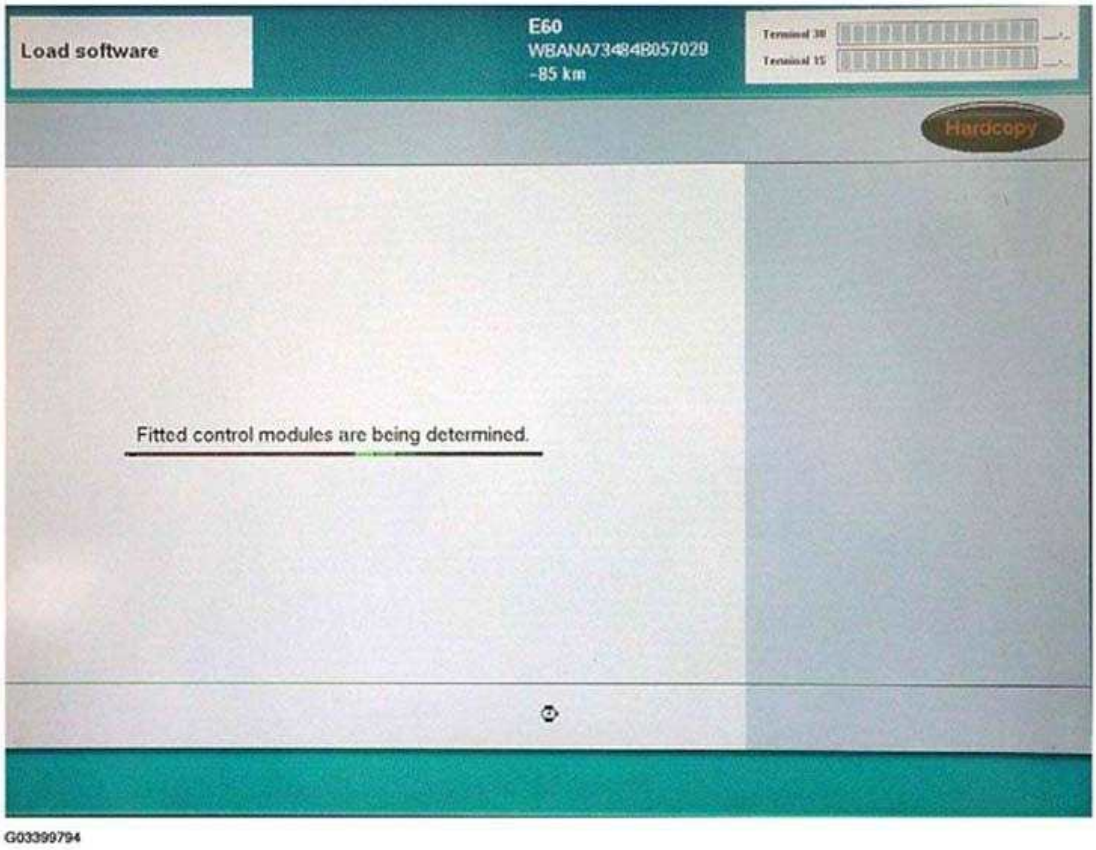
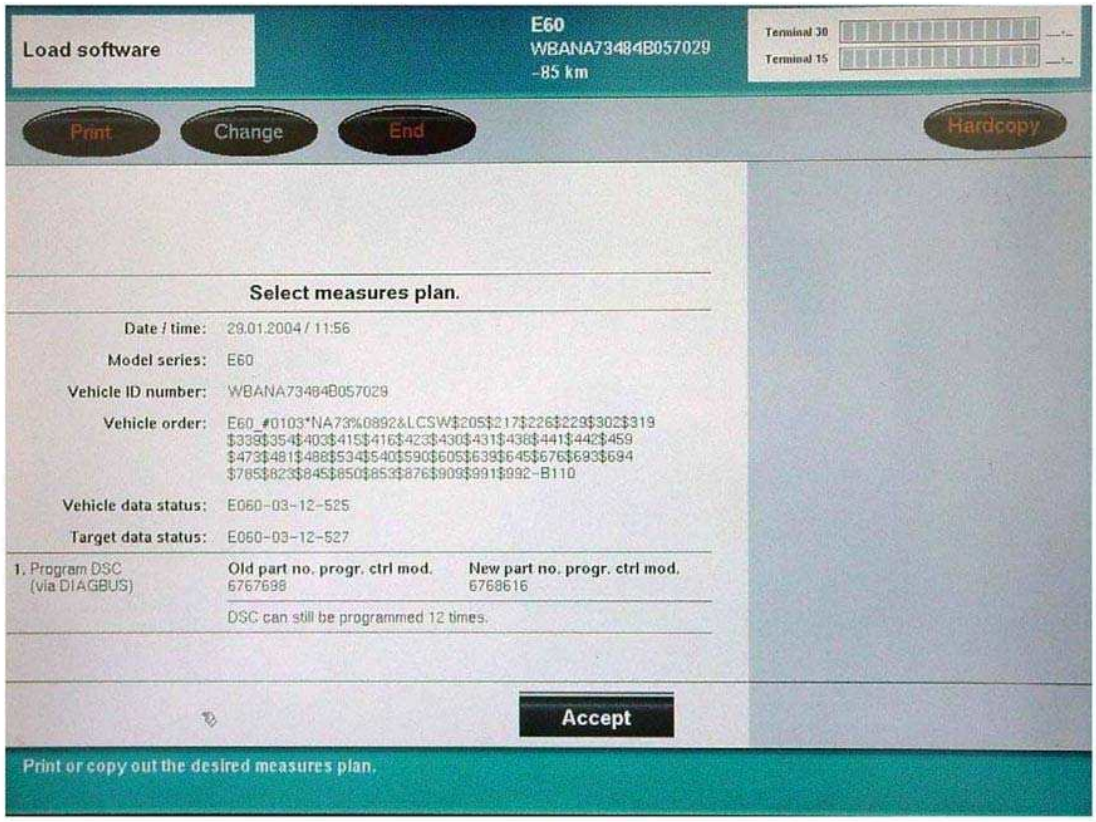


Fig. 6: Programming Screen - Measure Plan
Courtesy of BMW OF NORTH AMERICA, INC.

After selecting YES fitted control modules will be determined.

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Fig. 7: Programming Screen - Control Modules
Courtesy of BMW OF NORTH AMERICA, INC.

After determining the fitted modules, a measures plan will be made. At this point you will be notified if control modules need to be replaced.

Control module replacement is required if the hardware level in a module can not be upgraded to a high enough software level.

In the case above no modules need replacement, in fact on the DSC needs to be reprogrammed.

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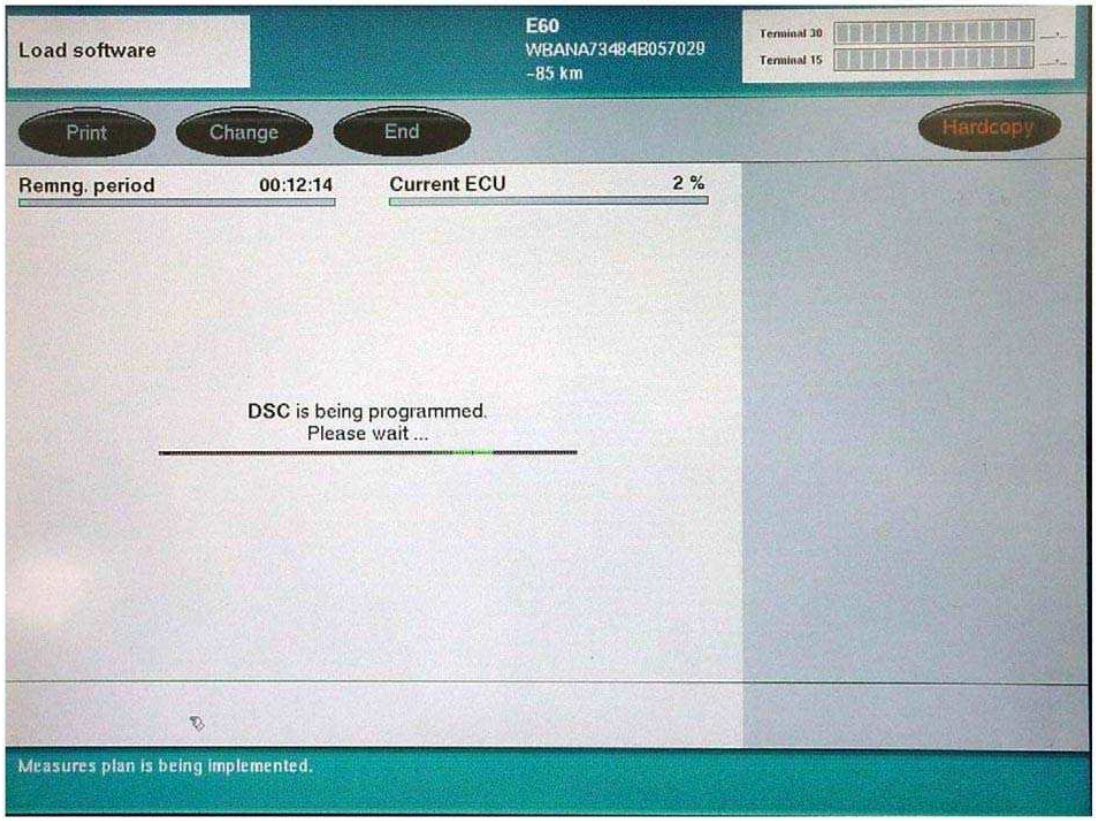


Fig. 8: Programming Screen - DSC Being
Courtesy of BMW OF NORTH AMERICA, INC.

DSC programming is being carried out.

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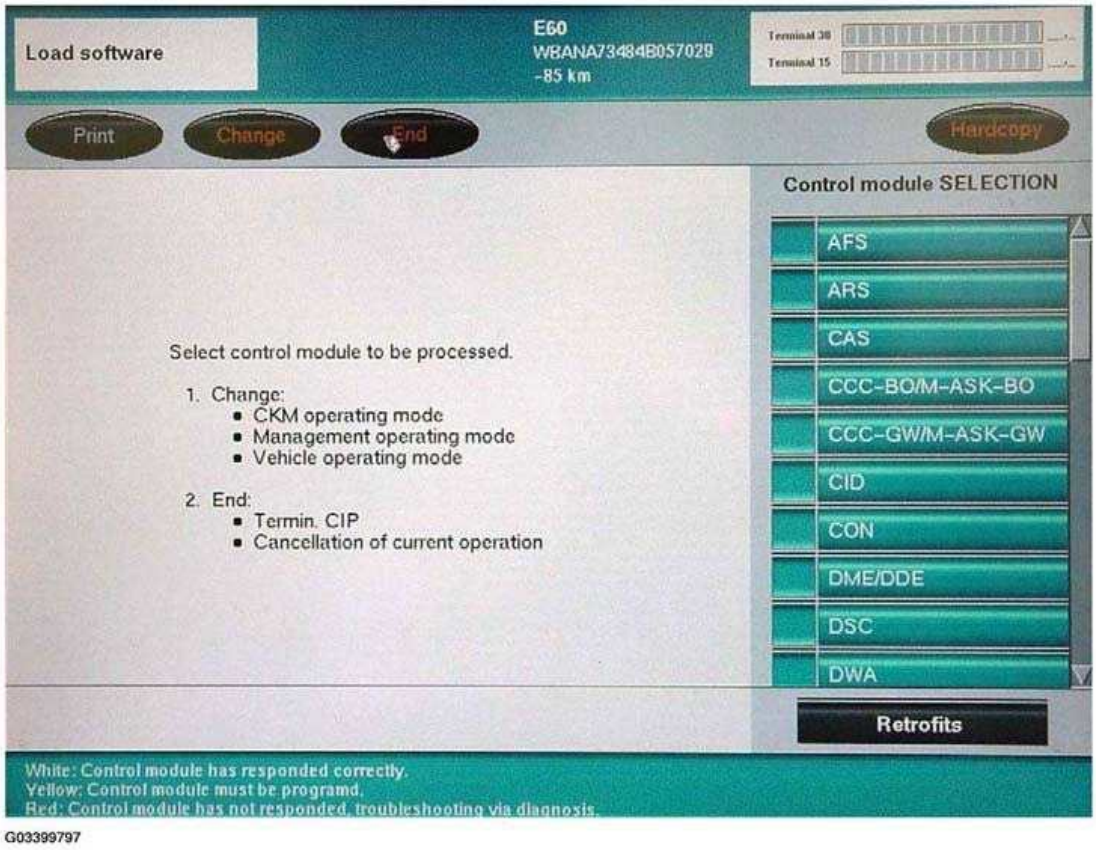


Fig. 9: Programming Screen - Retrofit Programming
Courtesy of BMW OF NORTH AMERICA, INC.

If you selected no earlier (Have any control modules been replaced?) you would come to this screen.

Here selections to reprogram individual modules can be made or entry into retrofit programming.

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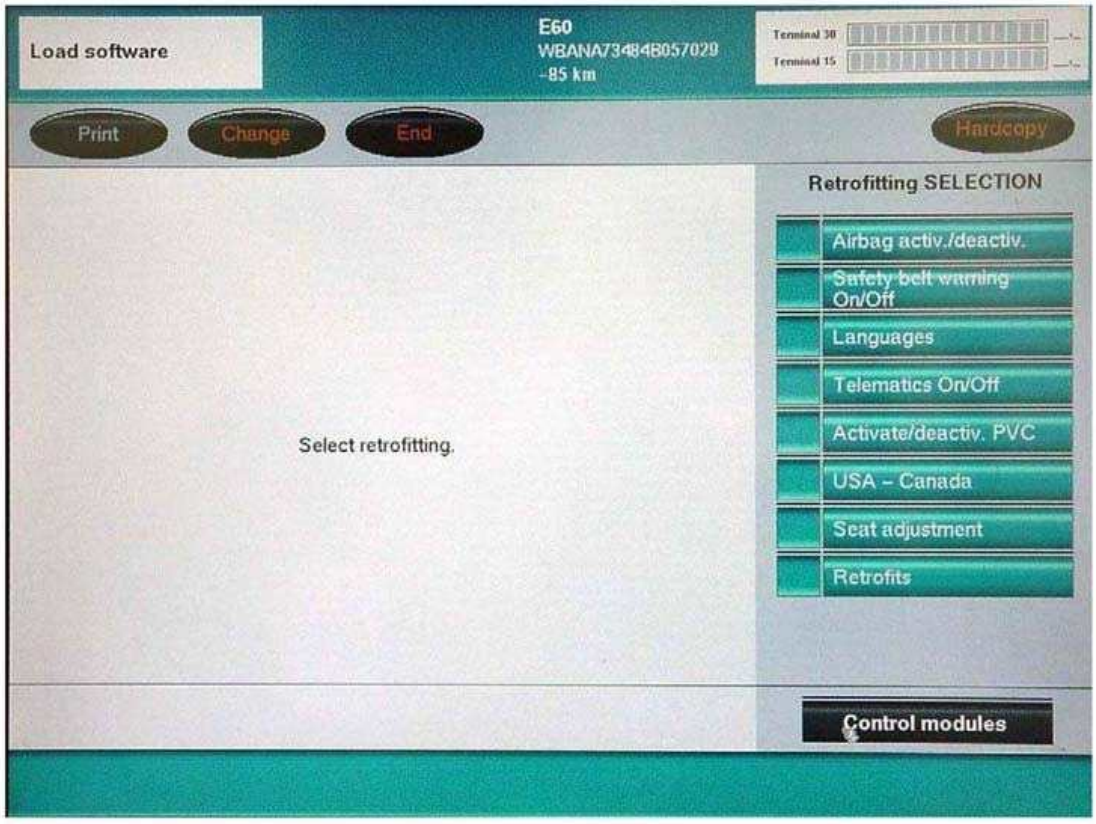


Fig. 10: Programming Screen - Selecting Retrofit
Courtesy of BMW OF NORTH AMERICA, INC.

Selecting retrofit on the previous screen brings you here.

More selections (such as mobile phone USA) are on the next page, accessed by pressing retrofits on bottom of selection list.

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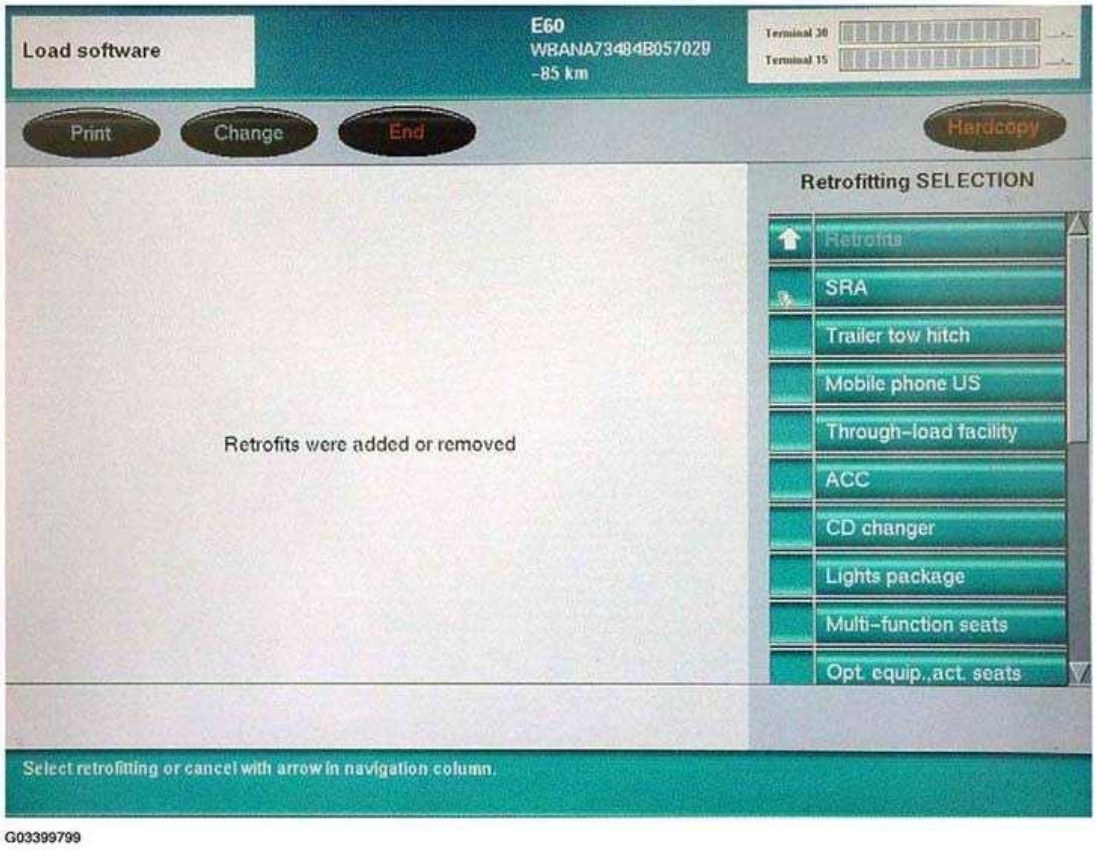


Fig. 11: Programming Screen - Retrofit
Courtesy of BMW OF NORTH AMERICA, INC.

Select the retrofit, in this case the Mobile phone USA.

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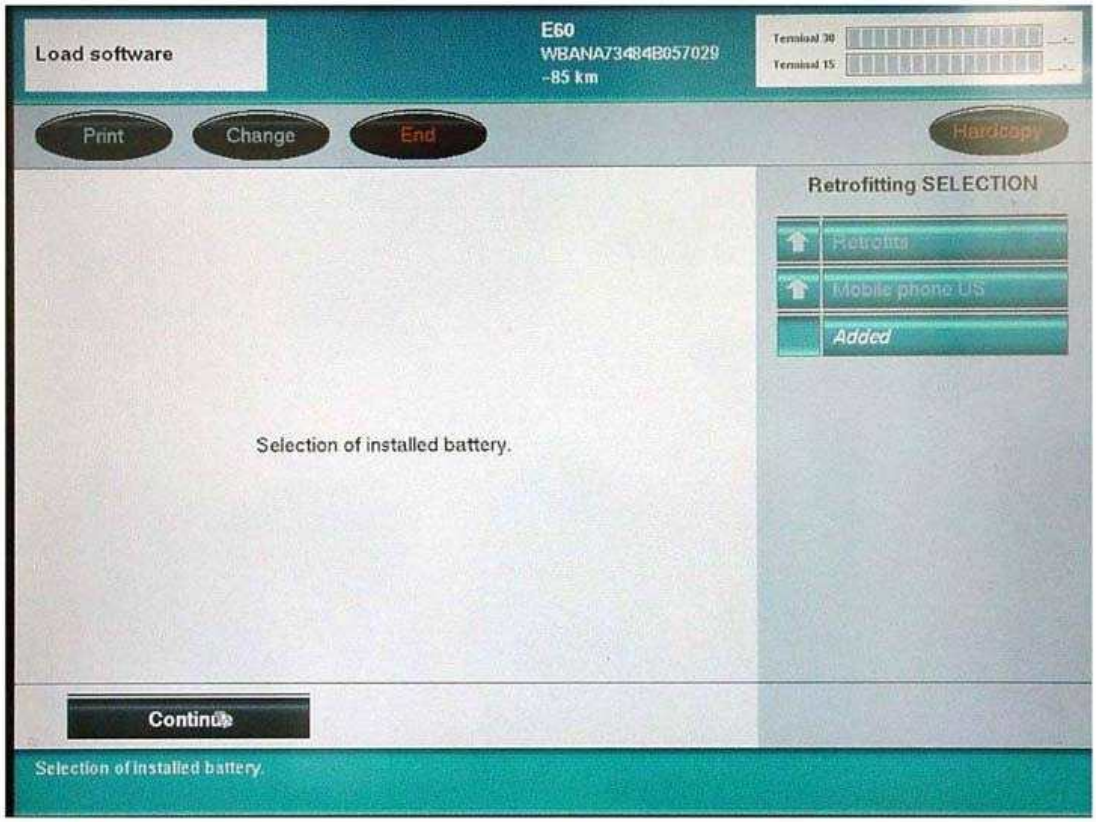
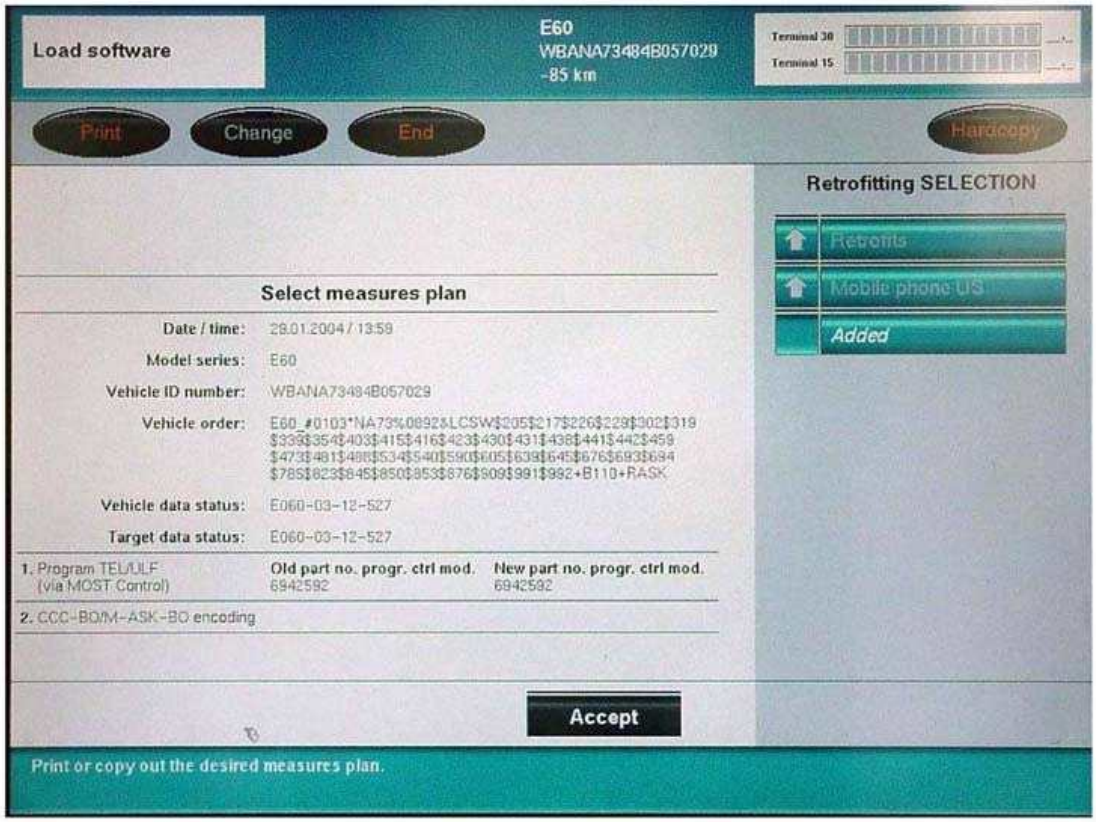


Fig. 12: Programming Screen - Battery
Courtesy of BMW OF NORTH AMERICA, INC.

You will be asked which battery the car has installed.

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G03399801

Fig. 13: Programming Screen - Measures Plan
Courtesy of BMW OF NORTH AMERICA, INC.

A measures plan will be determined and displayed to accomplish the retrofit.

Press Accept.

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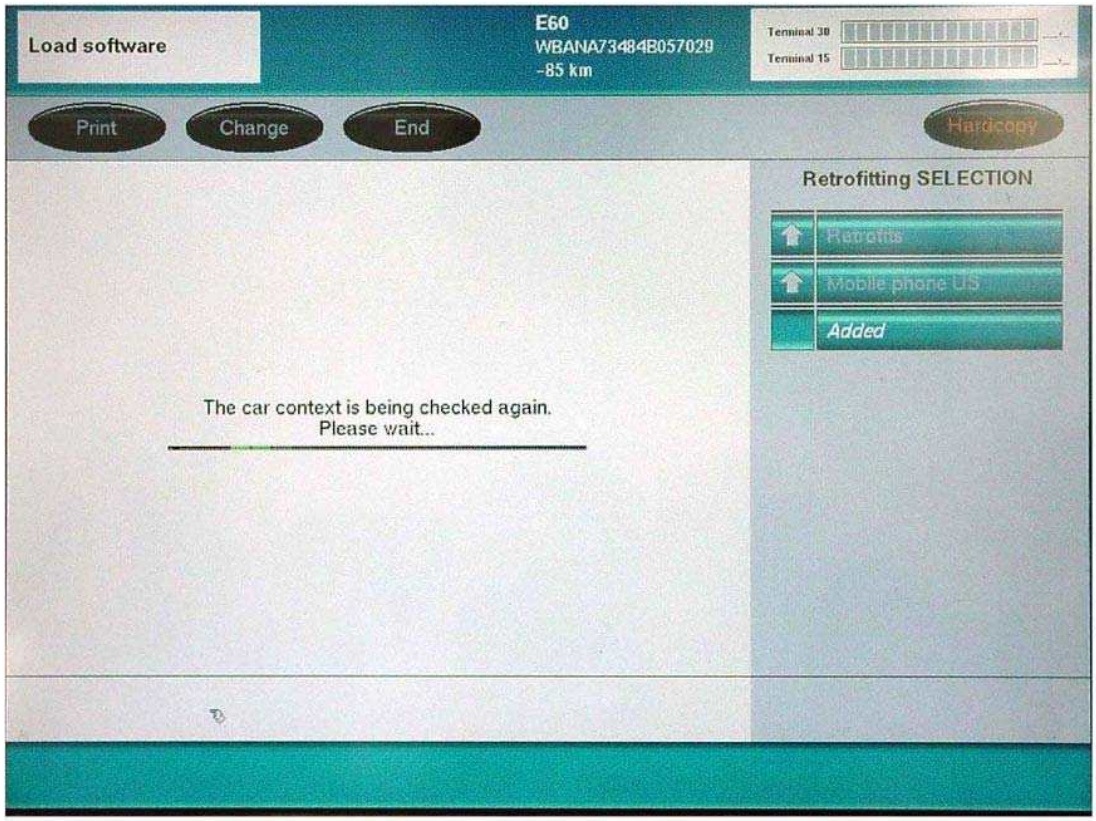


Fig. 14: Programming Screen - Retrofit Being Carried Out
Courtesy of BMW OF NORTH AMERICA, INC.

The retrofit is being carried out.

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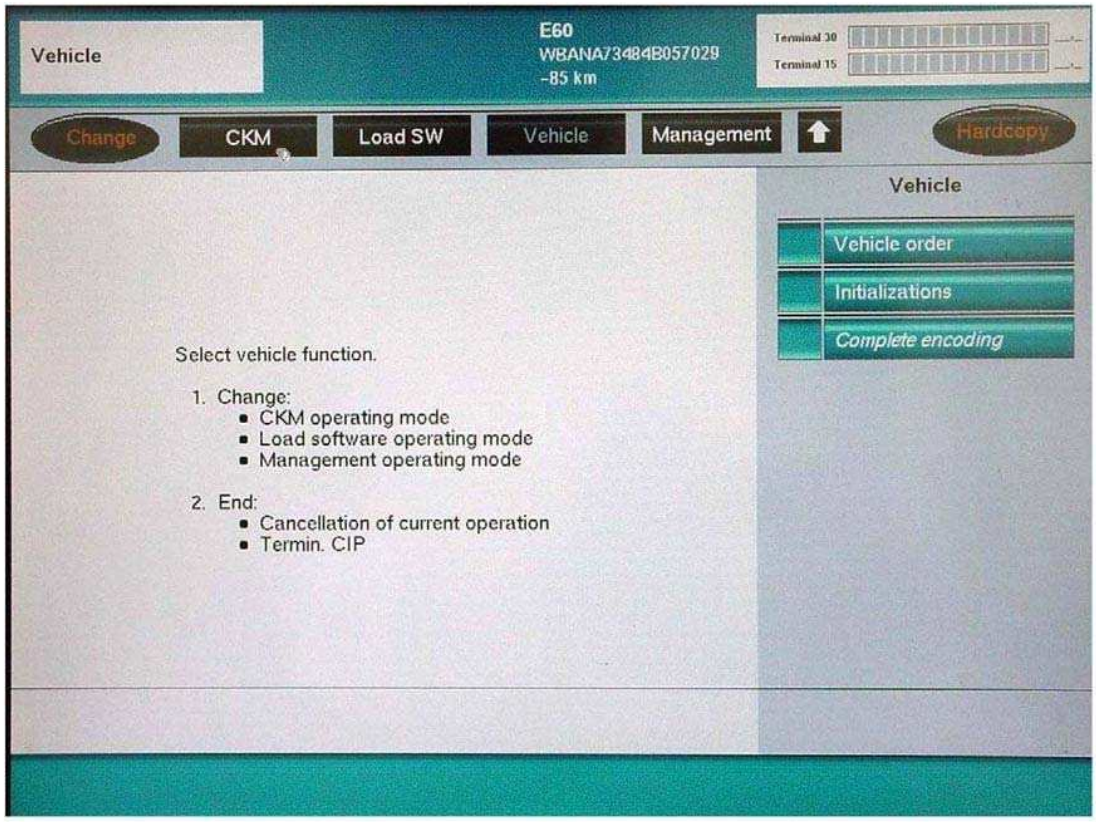


Fig. 15: Programming Screen - Vehicle Function
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting Vehicle initially when entering CIP, you will save time when updating the vehicle.

Updating through Load SW differs from Measures Plan determined through Vehicle.

When updating through Load SW only the module programmed is re-coded. You still need to come to this screen and perform Complete Encoding.

By updating through Vehicle, the entire car is automatically encoded, after the programming is complete.

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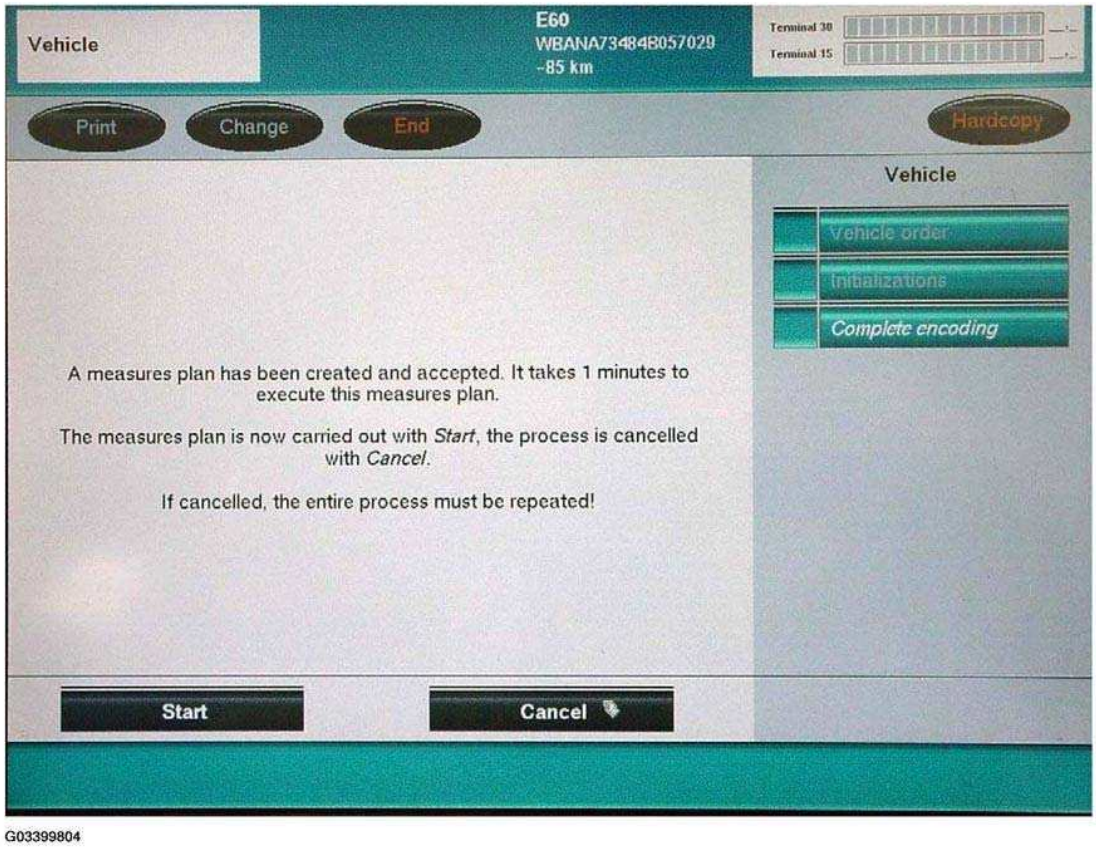


Fig. 16: Programming Screen - Pressing Start
Courtesy of BMW OF NORTH AMERICA, INC.

Press start to begin the programming and encoding procedure.

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1986-06 GENERAL INFORMATION

Coding And Programming - Overview - All Models

INTRODUCTION TO CODING & PROGRAMMING

Model: All

Production: All

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, TLEV, ULEV, SULEV, 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".

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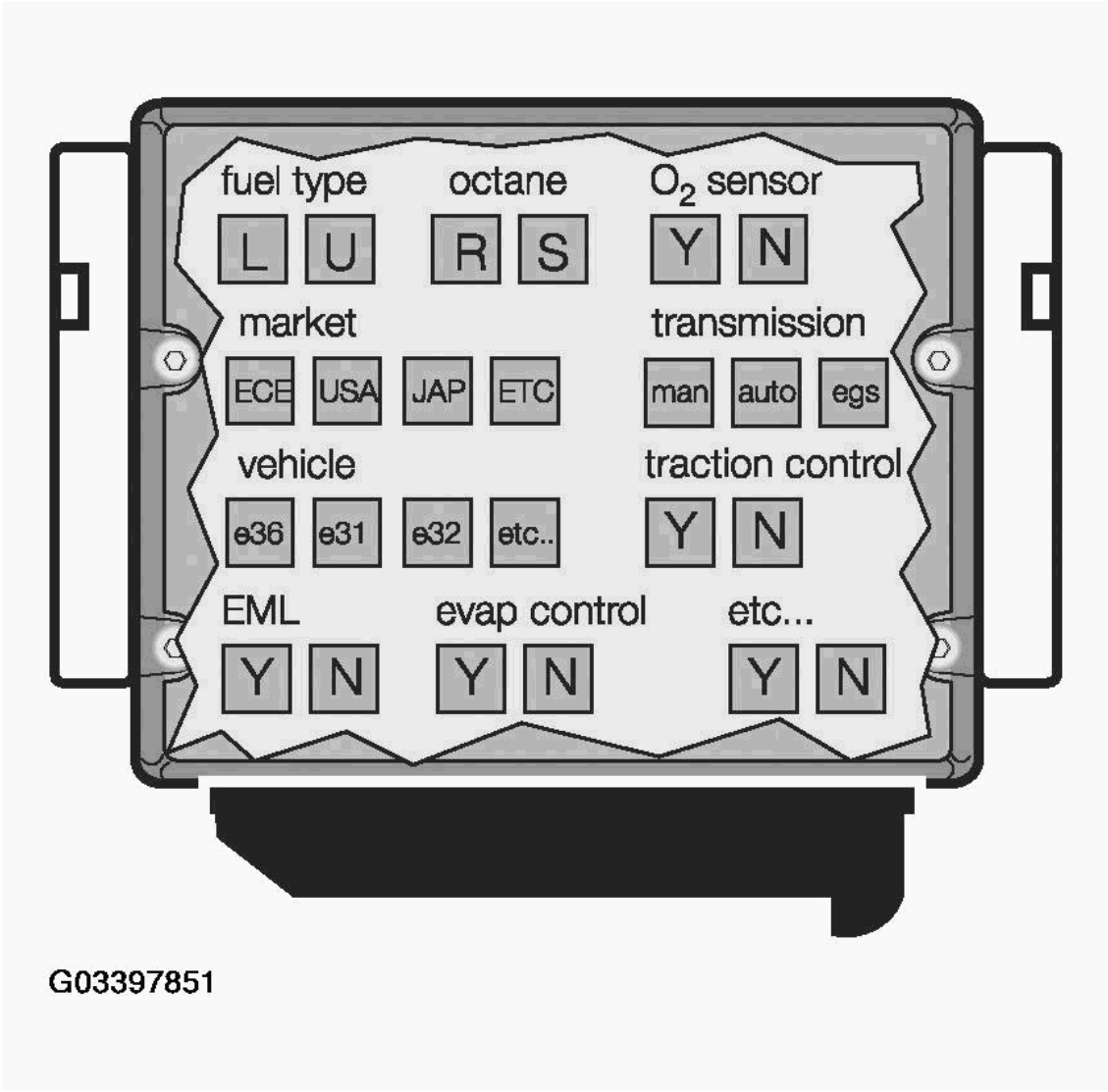


Fig. 1: Identifying Data Before Coding
Courtesy of BMW OF NORTH AMERICA, INC.

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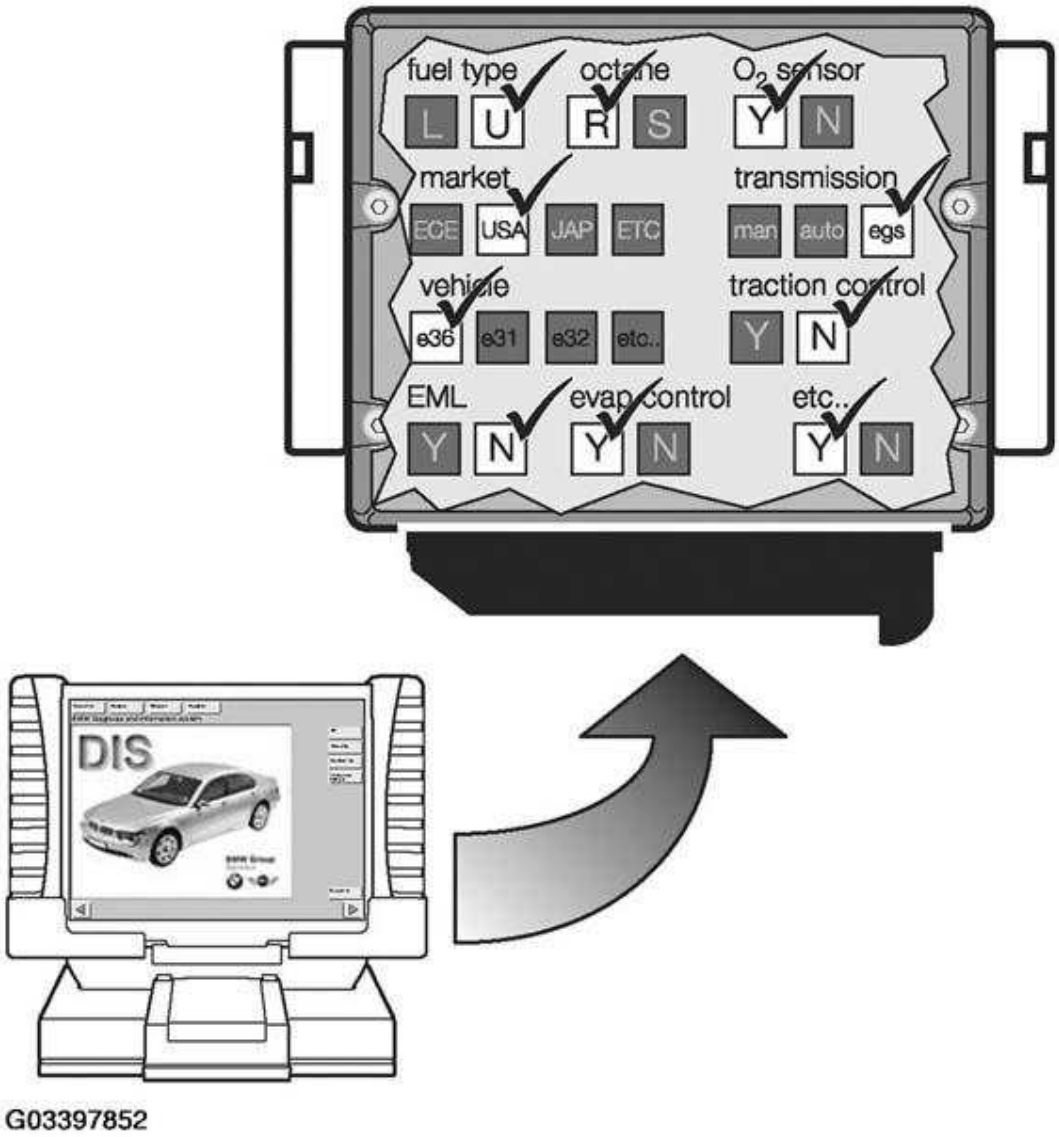


Fig. 2: Identifying Data After Coding
Courtesy of BMW OF NORTH AMERICA, INC.

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:

- By installing a specific plug (coding plug) into a device/component
- By entering a 4 digit alpha-numeric code (variant code) via the programming selection on

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DISplus/GT1/SSS

- Selecting customer specific system operational settings from a list of available features (VKM)
- Automatically by selecting a specific coding process available via ZCS Coding or CIP using the DISplus/GT1/SSS

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



Fig. 3: Identifying Data Before Programming
Courtesy of BMW OF NORTH AMERICA, INC.

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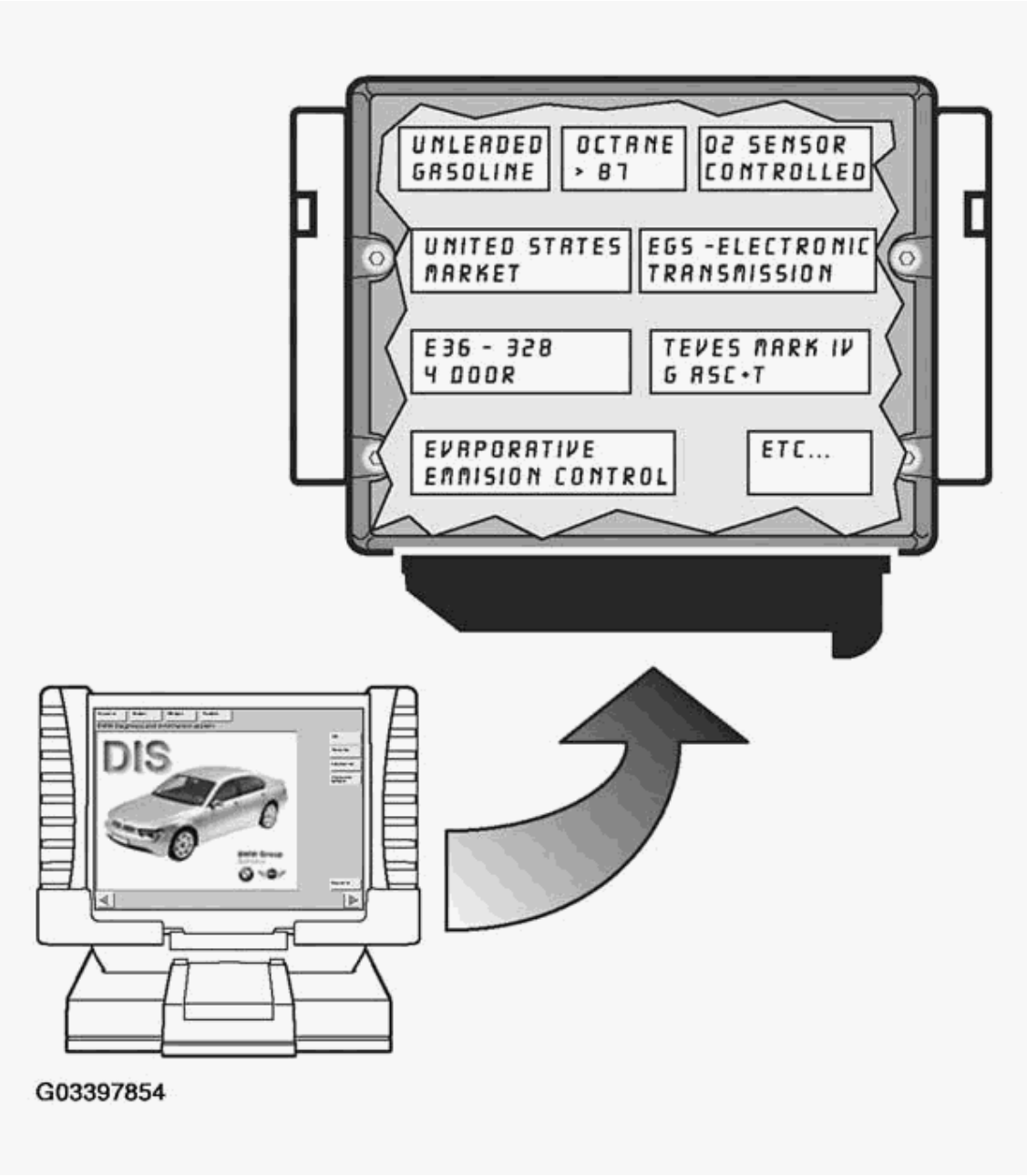


Fig. 4: Identifying Data After Programming
Courtesy of BMW OF NORTH AMERICA, INC.

(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 a DISplus/GT1/SSS.

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NOTE: Programmable control modules are system specific and not all control modules are programmable using workshop equipment like the DISplus,GT1 or SSS. 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, TLEV, ULEV, SULEV, Diesel, ...)
- 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 theses 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

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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 preprogrammed 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.

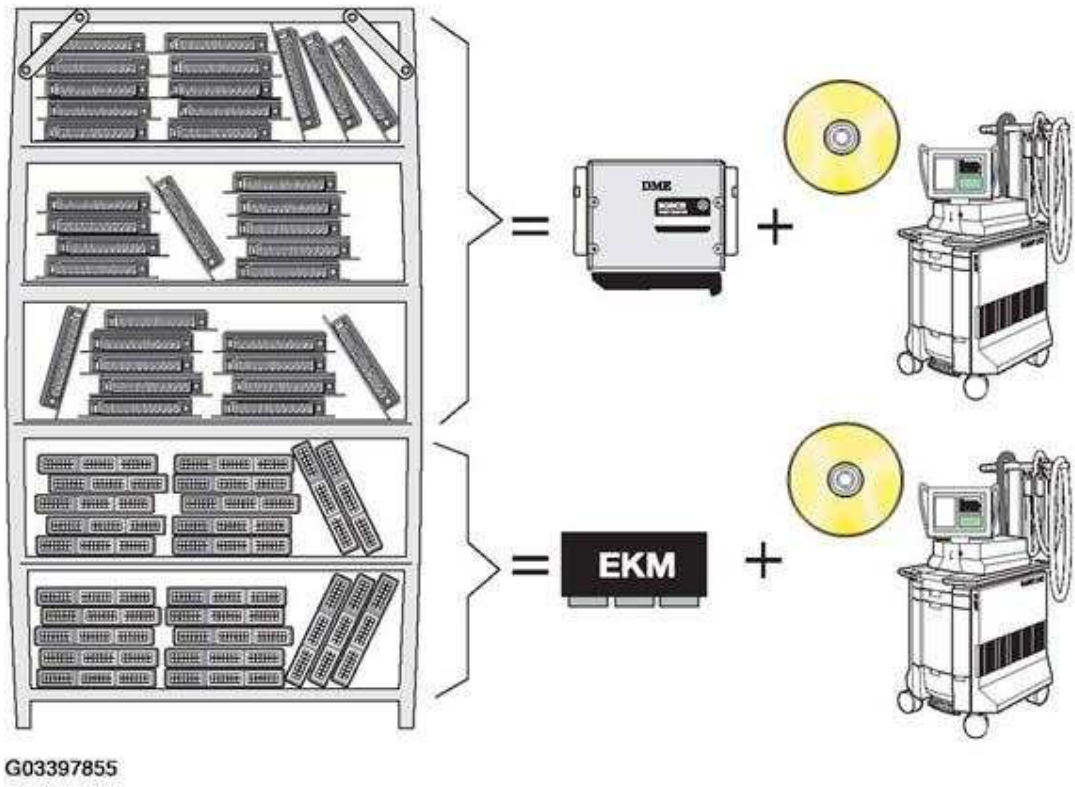


Fig. 5: Identifying BMW Workshop
Courtesy of BMW OF NORTH AMERICA, INC.

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,

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...)
- 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 (**E** lectrically **P** rogrammable **R** ead **O** nly **M** emory)
- EEPROM (**E** lectrically **E** rasable **P** rogrammable **R** ead **O** nly **M** emory)

In essence these devices are similar to the harddrive 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 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.

Early engine control modules (DME 3.X) and transmission control modules were the first devices which allowed technicians to first remove the chip from the module, install a new "blank" EPROM and then program the module.

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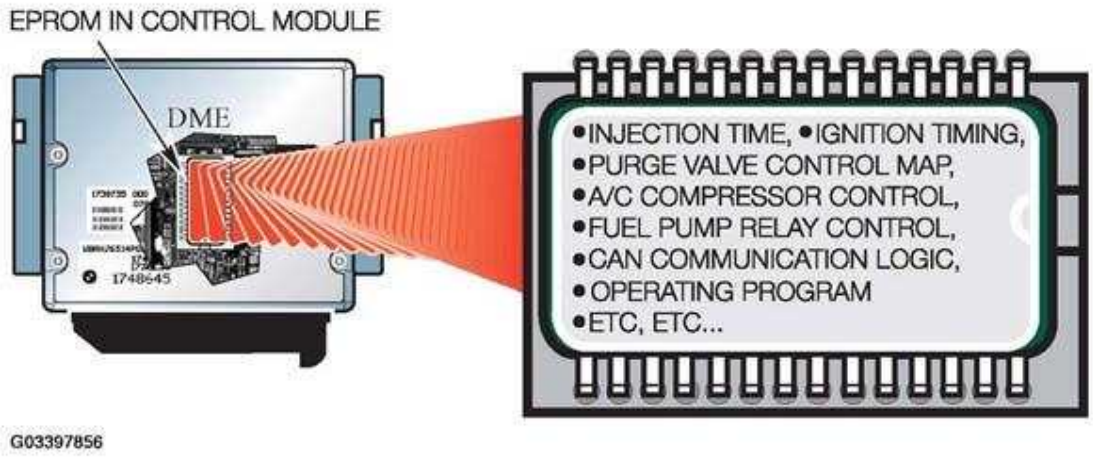


Fig. 6: Identifying EPROM (Electrically Programmable Read Only Memory)
Courtesy of BMW OF NORTH AMERICA, INC.

EEPROM (Electrically 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.

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, ...)

What is needed to Code and Program?

In order to code or program a vehicle, specific equipment and special software is required such as a DISplus, GT1 and an SSS which must all be connected to a network and have the must current version of CIP (**C** oding, **I** ndividualization & **P** rogramming) installed. CIP is the software program that contains all the latest data and program information to allow control modules to be updated to the latest level to address customer concerns and implement service solutions.

With the release of CIP 15.0 and the implementation of Progman (see **PROGMAN**) the DISplus and GT1 will only be capable of performing vehicle diagnosis and activation/initiation of a Coding, Individualization or Programming task through the SSS. A special program management tool (Progman) will only allow the DISplus

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and GT1 to act as remote terminals to the SSS (regarding Coding, Individualization & Programming), which means that the SSS will be the single supplier of Coding, Individualization and Programming information to a vehicle and its respective control modules.

CODING & PROGRAMMING EQUIPMENT

Model: All

Production: All

EQUIPMENT AND SOFTWARE

Coding and Programming of a control module can only be performed within the workshop network using BMW Group Equipment and Software.

As of 2004 the standard diagnostic equipment available for a workshop consists of:

DISplus (Diagnostic Information System)

Used For: Vehicle Diagnosis, Coding, Programming and Individualization

With PROGMAN (CD14) the DISplus will no longer be able to do coding and programming directly, it will only be used as a remote terminal that can initiate Coding & Programming through SSS.

Connection: Direct to LAN/Workshop Network or Direct to OPPS/OPS/Diagnostic Head

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Fig. 7: Identifying DISplus (Diagnostic Information System)
Courtesy of BMW OF NORTH AMERICA, INC.

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GT1 (Group Tester 1)

Used For: Vehicle Diagnosis, Coding, Programming and Individualization

With PROGMAN (CD14) the GT1 will no longer be able to do coding and programming directly, it will only be used as a remote terminal that can initiate Coding & Programming through SSS.

Connection: Wireless LAN or Direct to LAN/Workshop Network or Direct to OPPS/OPS/Diagnostic Head



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Fig. 8: Identifying GT1 (Group Tester 1)
Courtesy of BMW OF NORTH AMERICA, INC.

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SSS (Software Service Station)

Used For: Vehicle Coding, Programming and Individualization. NO DIAGNOSTIC CAPABILITY.

With release of PROGMAN (CD 14) the SSS becomes the only tool for performing Coding, Programming and Individualization. All requests from GT1 or DISplus will be performed by the SSS. The SSS can also be used to directly initiate a Coding, Programming or Individualization request.

SSS will be capable for coding/programming multiple vehicles, Max 5 vehicles at a time.

Connection: LAN/Workshop Network or Direct to OPPS/OPS Head



Fig. 9: Identifying SSS (Software Service Station)
Courtesy of BMW OF NORTH AMERICA, INC.

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Diagnostic Head

Interface between vehicle and DISplus, GT1 or SSS

Used For:

- Vehicle Diagnosis, Coding, Programming and Individualization
- Not to be used for programming vehicles with a MOST bus (E60/63/64/65/66...)

Connection:

- Wireless to LAN/Workshop Network via access point
- Wireless connection direct to GT1
- Directly to LAN/Workshop Network using DK LAN cable
- Directly to GT1/DISplus/SSS using DK LAN Cable and adapter

Refer to **EQUIPMENT CONFIGURATIONS**



Fig. 10: Identifying Diagnostic Head
Courtesy of BMW OF NORTH AMERICA, INC.

OPPS Head - (Optical Testing & Programming System)

Interface between vehicle and DISplus, GT1 or SSS

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Used For:

- Vehicle Diagnosis, Coding, Programming and Individualization on Most bus equipped vehicles.

NOTE: The OPPS is NOT ABLE to perform Diagnosis, Coding, Individualization & Programming on an I-bus equipped vehicle.

- Optical diagnosis of MOST and Byteflight Bus systems.
- Simultaneously program vehicles equipped MOST Bus system (except E65/66) via MOST Bus access port and OBD Connections.

Connection:

- Directly to LAN/Workshop Network connection using DK LAN cable or
- Directly to GT1/DISplus/SSS using DK LAN Cable and adapter.

Refer to **EQUIPMENT CONFIGURATIONS**

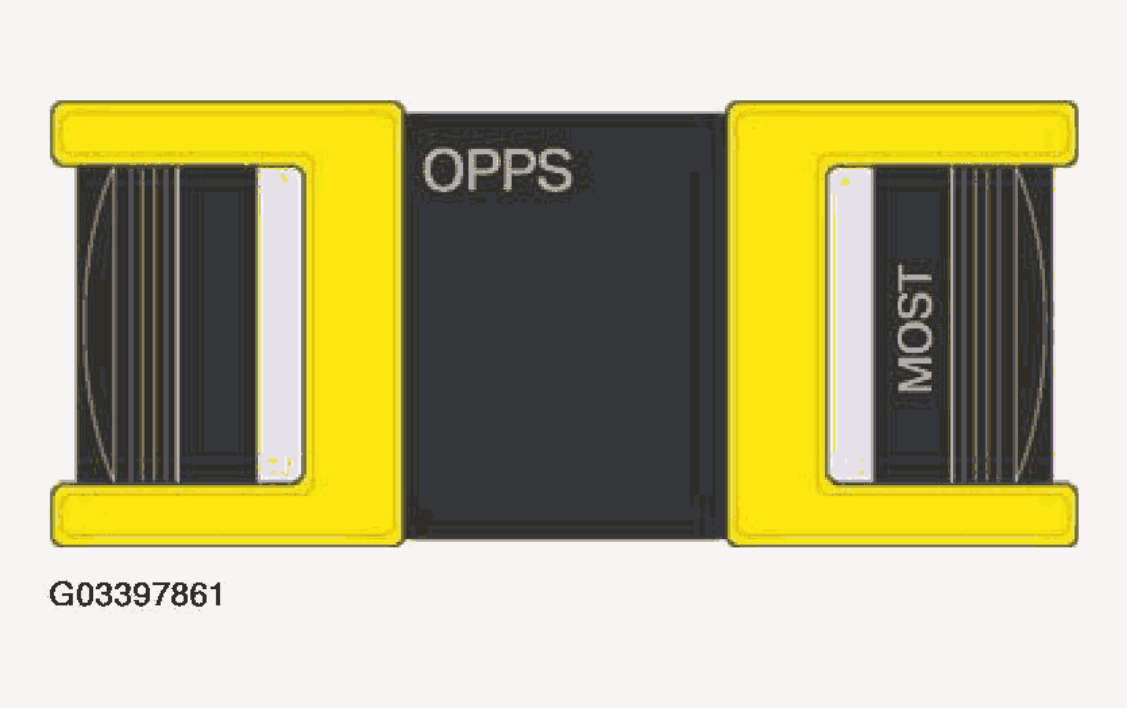


Fig. 11: Identifying OPPS Head - (Optical Testing & Programming System)
Courtesy of BMW OF NORTH AMERICA, INC.

OPS Head - (Optical Programming System)

Interface between vehicle and DISplus, GT1 or SSS

Used For:

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- Vehicle Diagnosis, Coding, Programming and Individualization

NOTE: The OPS is not able to perform optical diagnosis of MOST Bus and Byteflight systems nor can it be used to perform Diagnosis, Coding, Individualization & Programming on an I-bus equipped vehicle.

Connection:

- Directly to LAN/Workshop Network or
- Directly to GT1/DISplus/SSS using DK LAN Cable and adapter.

Refer to **EQUIPMENT CONFIGURATIONS**

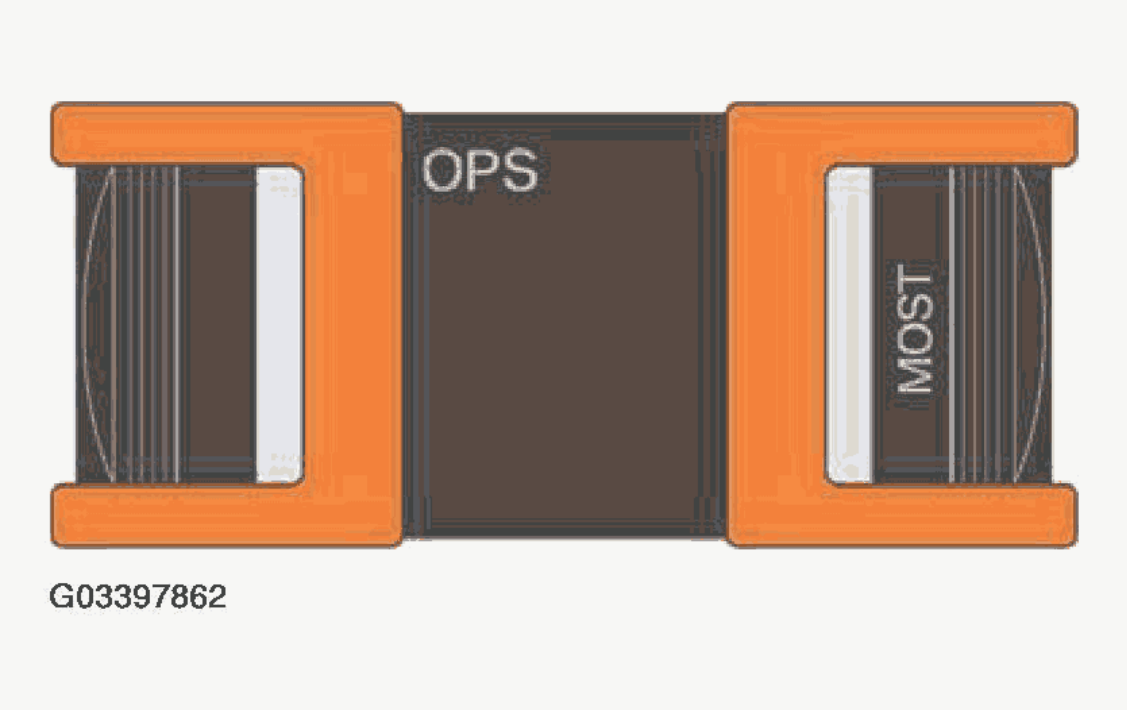


Fig. 12: Identifying OPS Head - (Optical Programming System)
Courtesy of BMW OF NORTH AMERICA, INC.

Deutronic Automatic Battery Charger

Used For:

- Maintaining proper vehicle battery voltage level during Diagnosis, Coding and Programming.
- Follow the initial setup of the charger as indicated in the SIB.

Connection:

- During Coding or Programming Procedure the battery charger must be in the Power Supply (PS) mode.

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- Place the charger into the power supply mode by depressing the "MENUE" button 3 times in rapid succession.

Refer to section on **EQUIPMENT CONFIGURATIONS**



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Fig. 13: Identifying Deutronic Automatic Battery Charger
Courtesy of BMW OF NORTH AMERICA, INC.

Hardware Operating Conditions

HARDWARE OPERATING CONDITIONS

Device	Operating Temperature	Relative Humidity
GT1	+3°C - +43°C = +37.4°F - +109.4°F	10 - 80% (no condensation)
OPPS/OPS	+3°C - +43°C = +37.4°F - +109.4°F	10 - 90% (no condensation)
SSS	+10°C - +35°C = +50F - +95°F	10 - 90% (no condensation)
Monitor SSS	+3°C - +35°C = +37.4°F - +95°F	10 - 90% (no condensation)

Coding & Programming Software

Whenever coding and programming are to be performed on a vehicle, the latest version of software for DISplus/GT1 and SSS must be loaded/installed on the equipment being used.

The DIS CD xx contains the diagnostic programs (test modules, schematics, system status values...) prior to CIP 15.0 all coding and programming information for early production vehicles (E31, E32, E34, E36, E38, E39,

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E46, E53 and E52) was also available.

NOTE: With the introduction of CIP 15.0 all coding and programming information will be migrated to CIP and incorporated within Progman.

Whenever a new version of either DIS CD xx or CIP xx.x is released this indicates that an update or addition to a specific coding, programming or diagnostic routine has occurred. The change can be reflected by a new/updated programming software for a specific control module, the ability to code a new module or the ability to perform a new retrofit procedure when installing a new system.

NETWORKS

As the level of technology in our vehicles continues to increase so does the level of technology that we use in our diagnostic and programming equipment within the workshop.

In order to meet the ever growing demand for more rapid transfer of information we can no longer have multiple "stand alone" systems, therefore various infrastructures have been created to allow multiple "stand alone" devices/systems to interact with each other to share information.

The sharing of information with various control modules in our vehicles has been occurring for quite some time, now we will also be doing this with the diagnostic equipment in the workshop as well.

Vehicle Bus Systems

In order to make the components used in our vehicles more efficient we utilize bus structures (commonly referred to as I-Bus, K-Bus, MOST Bus, Byteflight, PT-CAN, etc.). By using bus structures in vehicles, we can accelerate communication between several different control modules. Many common vehicle systems (such as entertainment, safety, powertrain, etc.) are "stand alone" systems but also require information from other modules/systems in order to be more efficient. In order to obtain the required information the systems must also be able to simultaneously communicate without interfering with each other, which is accomplished by using various bus structures.

Example:

The ISIS (Intelligent Safety Integration System) system on the E65 uses the Byteflight bus structure.

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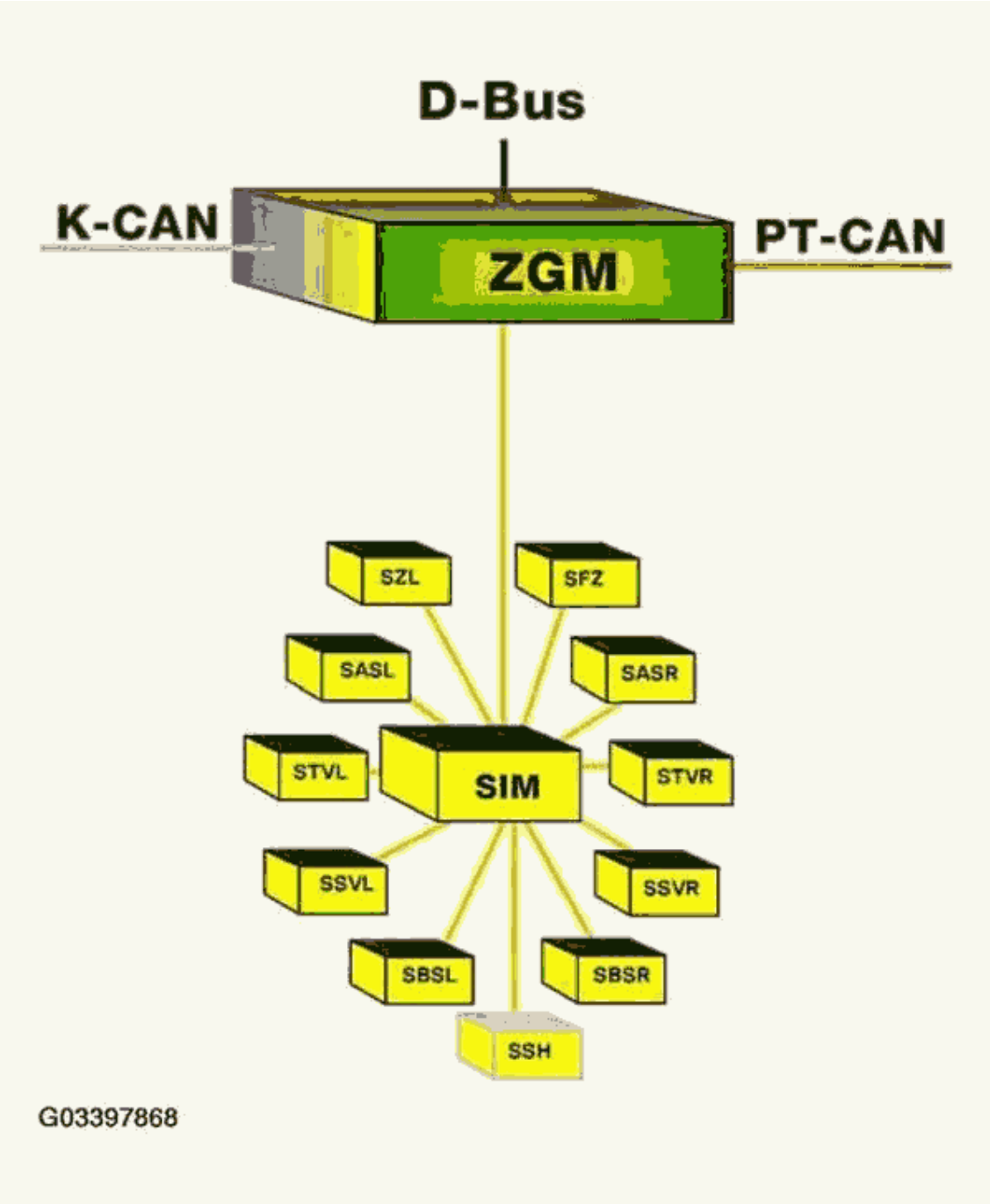


Fig. 14: Identifying Vehicle Bus Systems
Courtesy of BMW OF NORTH AMERICA, INC.

Depending on the equipment level of the E65, the ISIS may consist of 11 satellite components (Control Modules/Sensors) that are connected, using fiberoptic cables, to the SIM (Safety Information Module) which monitors the status of the satellite components. Since this is a safety system, components need to be activated within a fraction of a second in order to be effective, there can not be any processing delays. The SIM is connected to the ZGM (Central Gateway Module) which monitors the activity of the SIM and will direct information to the SIM and other devices in the vehicles as necessary.

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Workshop LAN Network

A network is nothing more than a group of devices interconnected so that they can communicate with each other. A LAN is a network that is localized to a specific area, such as a workshop or office.

The bus systems (I-Bus, K-Bus, PT-CAN, Byteflight, MOST Bus, ...) that we have been using in our vehicles for quite sometime, are nothing more than networks with different configurations. By looking at the byteflight system mentioned previously, a similarity to a workshop network can be established.

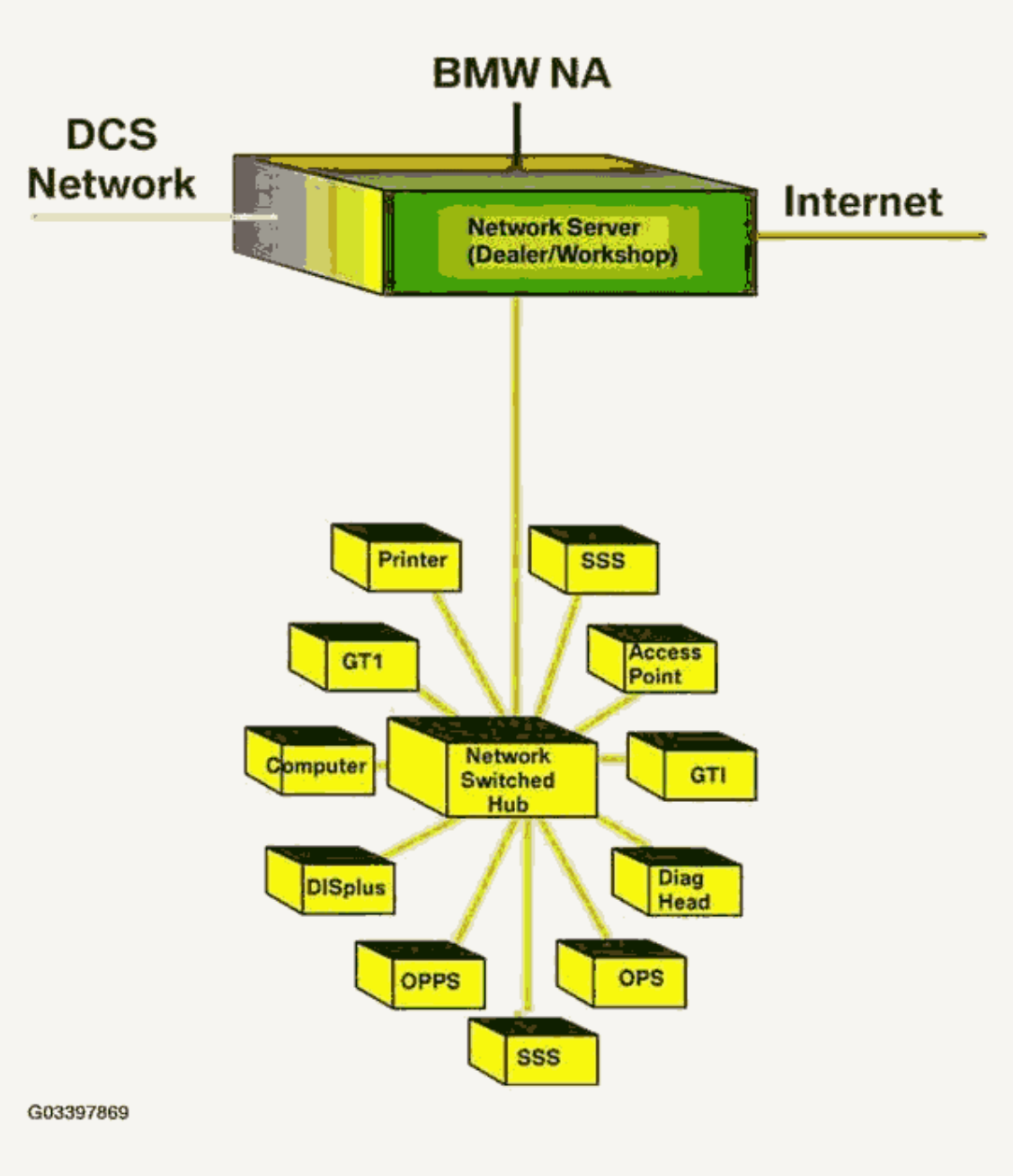


Fig. 15: Identifying Workshop LAN Network
Courtesy of BMW OF NORTH AMERICA, INC.

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Workshop Network

All workshops are currently equipped with a GT1, DISplus, SSS, OPS, OPPS, Diagnostic Head, Access Point, desktop computer(s) and printer(s) which can be considered as satellite components (control modules/sensors). In order for these components to communicate with each other, either directly or indirectly, they must be interconnected via a cable/wire to a common point or switching device. Consider the switching device/hub to be similar to the SIM, which monitors all devices connected to it and allows the devices to communicate with each other. The interconnection of these devices results in the establishment of a network localized to the workshop area thereby establishing a Local Area Network (LAN) in the workshop.

Network Structure

By having the workshop configured to allow the various devices used on a daily basis to be interconnected/networked with each other, as indicated in the illustration, additional components can easily be added and online updates can automatically be installed on all connected devices, as long as they have an approved IP address.

Example: *The network that exist in the workshop is not much different than the network structure that is used in our vehicles. In order for control modules to communicate with each other they must be correctly identified. The identification process can be considered to occur as part of the coding procedure which is done at the end of the assembly process or at anytime a new component/module/system is added to the vehicle. By not recoding the vehicle after adding or removing a module/system, the communication on a particular bus can be hampered especially if a response form a module that is no longer installed is expected or a new module transmits data that is not expected by anyone else on the bus because it is not correctly identified. The VO for a vehicle can be considered to contain the IP addresses of the modules installed in the vehicle.*

If the devices on the workshop network do not have a rigidly assigned IP address, online updates to specific devices can not occur. The operation/performance of a network can be greatly hampered if multiple devices share an address, since the transmitted data is not able to reach the correct device, it can result in jamming up the operation of the network.

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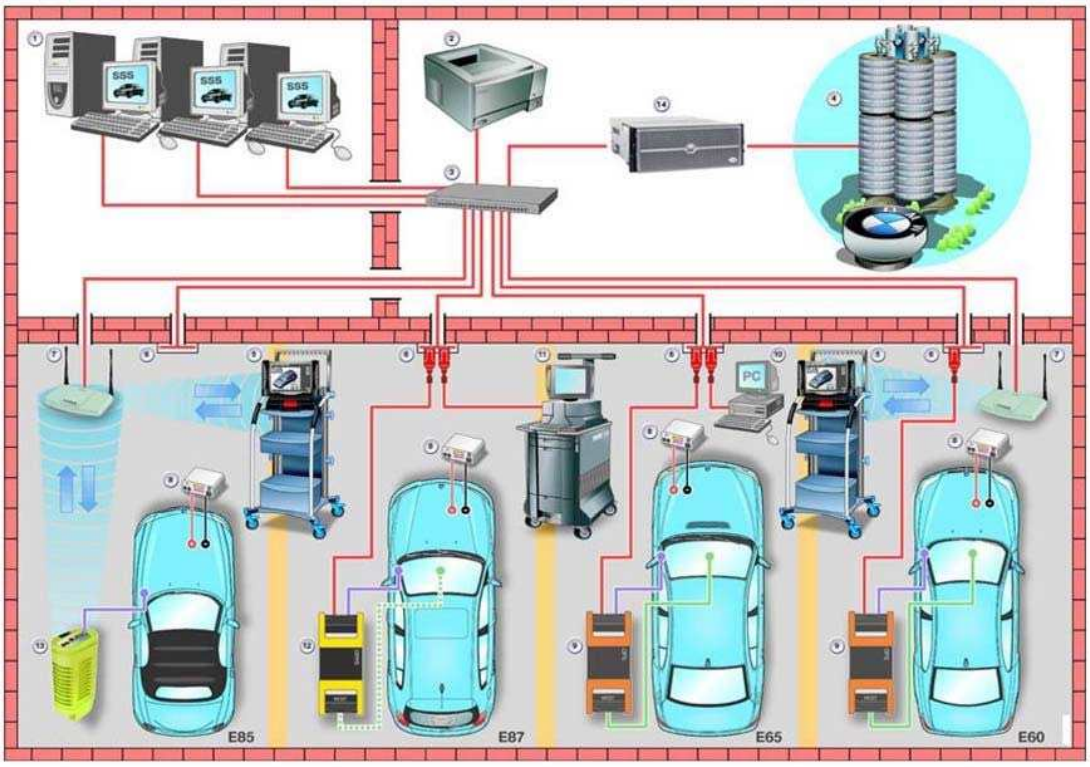


Fig. 16: Identifying Network Structure
Courtesy of BMW OF NORTH AMERICA, INC.

Network Connections

When establishing a network which will utilize multiple access terminals/jacks it is recommended that the jacks and cables attached to the specific jacks are numbered and that the corresponding end of the cable that connects to the router/switched hub should be numbered as well.

Example: *The illustration below shows a basic network structure with no miscellaneous devices connected, other than a Server and Switched Hub. The cables running to/from the Switched Hub are all numbered on both ends to make troubleshooting the network easier in the event of a problem with the cabling, wall jack or Switched Hub connections.*

Not having the cable and wall jacks number would be like trying to troubleshoot a problem with an electrical circuit in the vehicle where all the wires are the same color and the components connected have no pin assignments.

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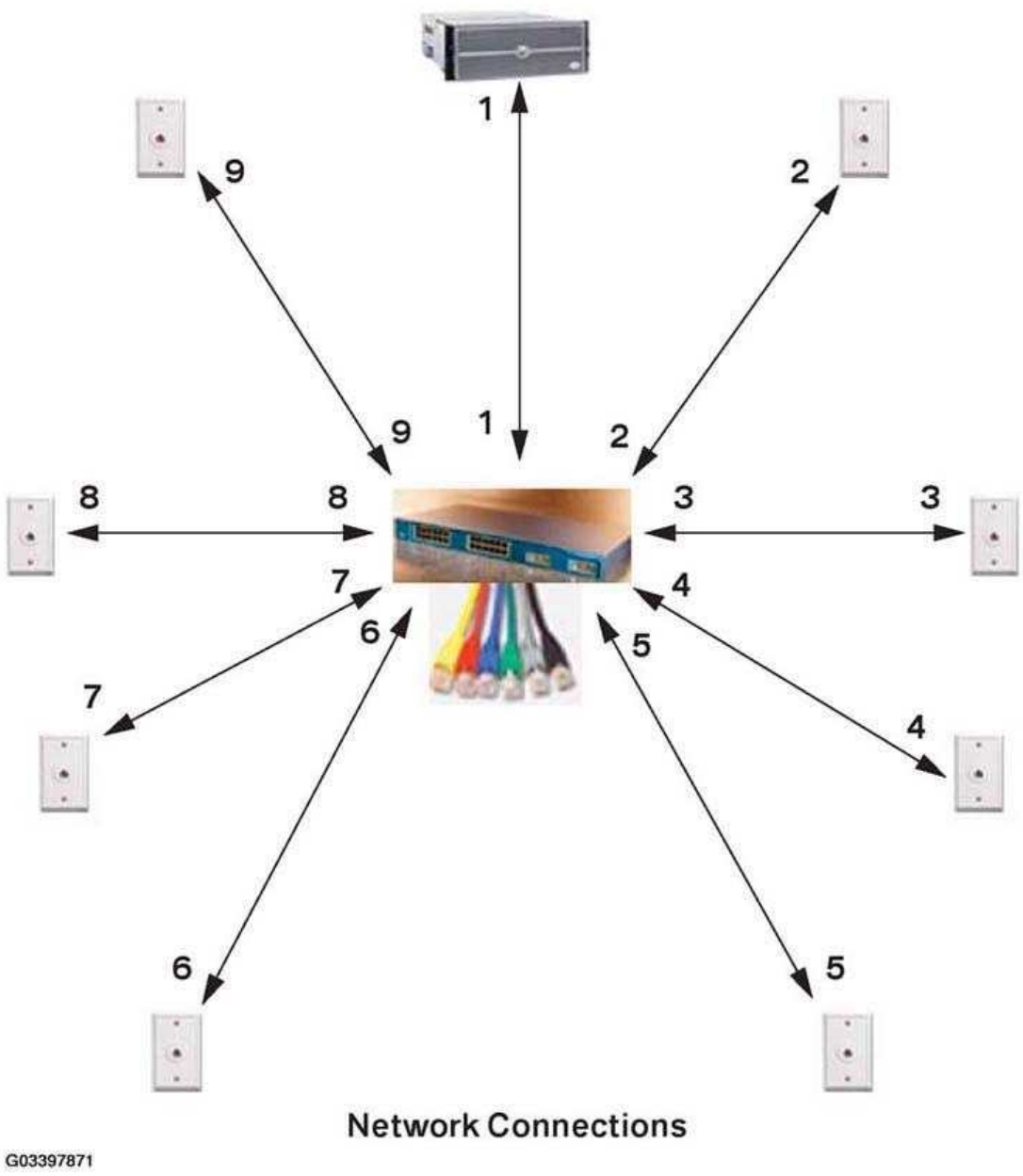


Fig. 17: Identifying Network Connections (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Once additional devices are connected it becomes very important that the configuration information (IP Address, Gateway Address, Subnet Mask and Device Name) is entered correctly for each device that is connected to the network. Each device must be assigned a specific/unique IP Address.

It is very important that the IP address not be shared by multiple devices located on the network, as this can result in "Locking-up" the network, which can have a detrimental effect on any control module(s) being programmed or coded.

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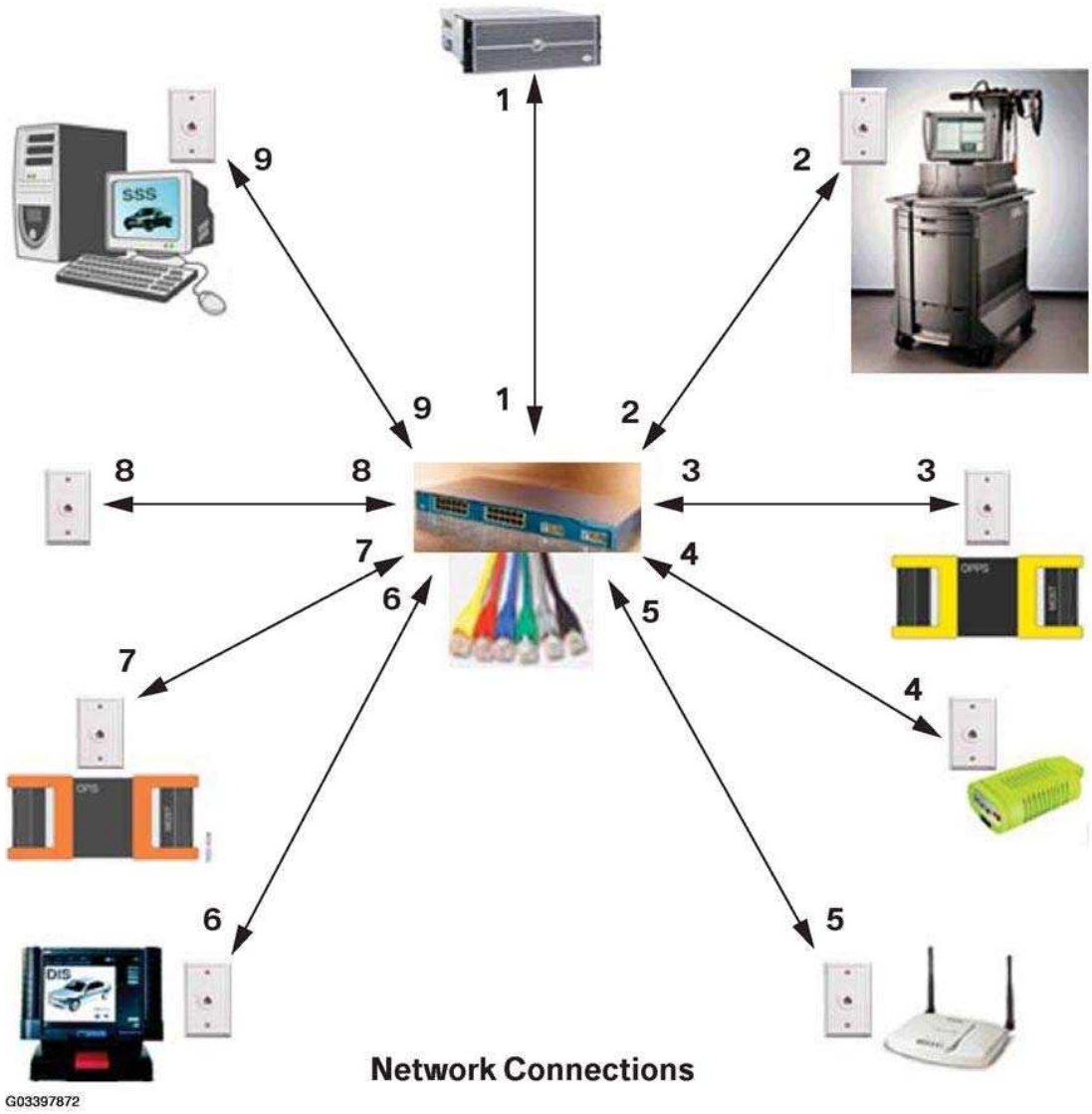


Fig. 18: Identifying Network Connections (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Accessing Configuration Information - DISplus/GT1 & Interface(s)

Select **"Administration".**

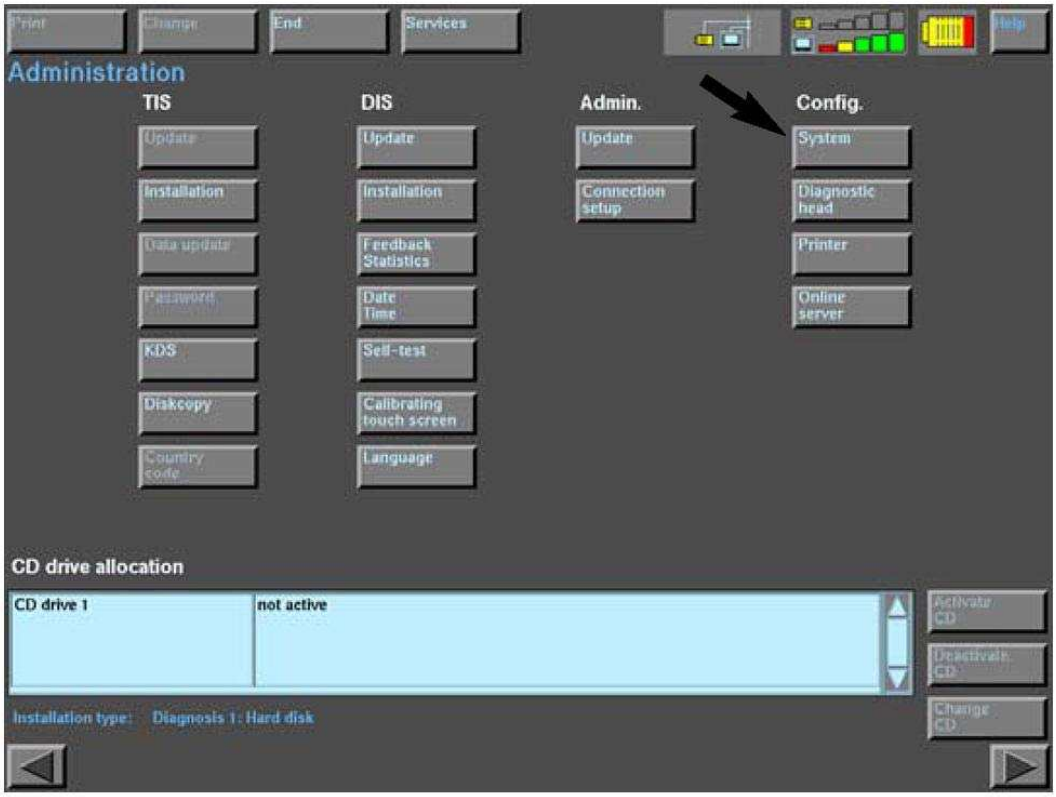
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Fig. 19: Display DISplus/GT1 (Administration)
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"System".**

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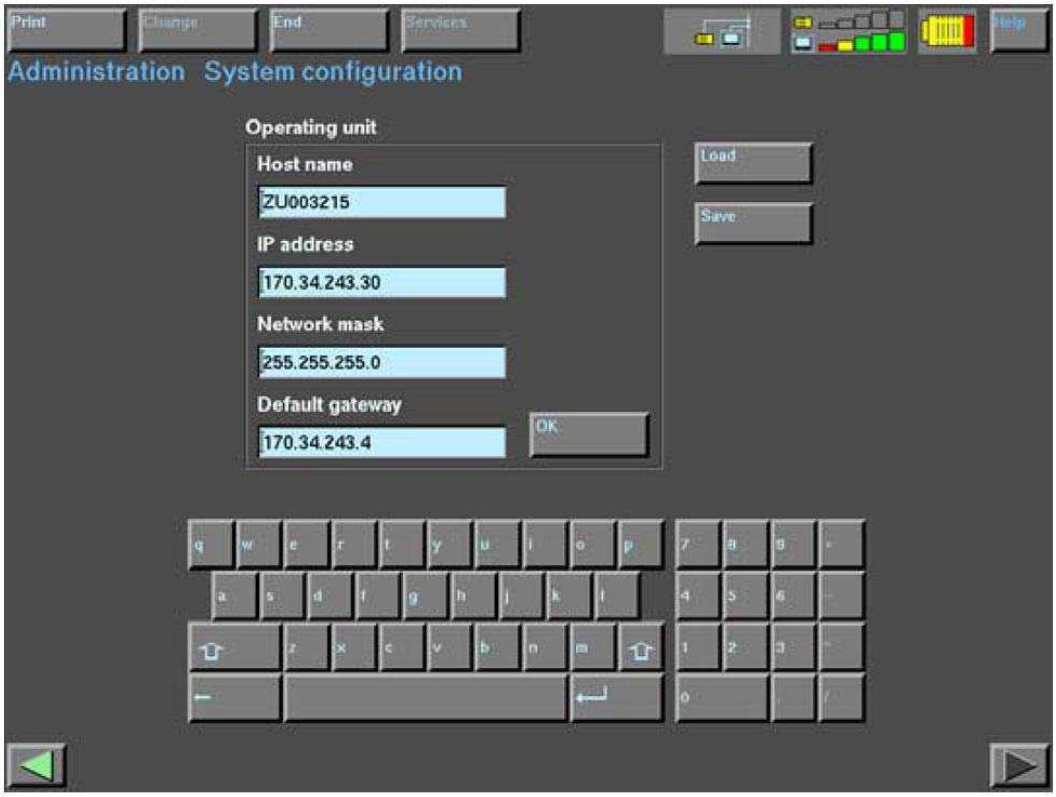


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Fig. 20: Display DISplus/GT1 (System)
Courtesy of BMW OF NORTH AMERICA, INC.

The screen now displays the network configuration information for the device being used DISplus/GT1.

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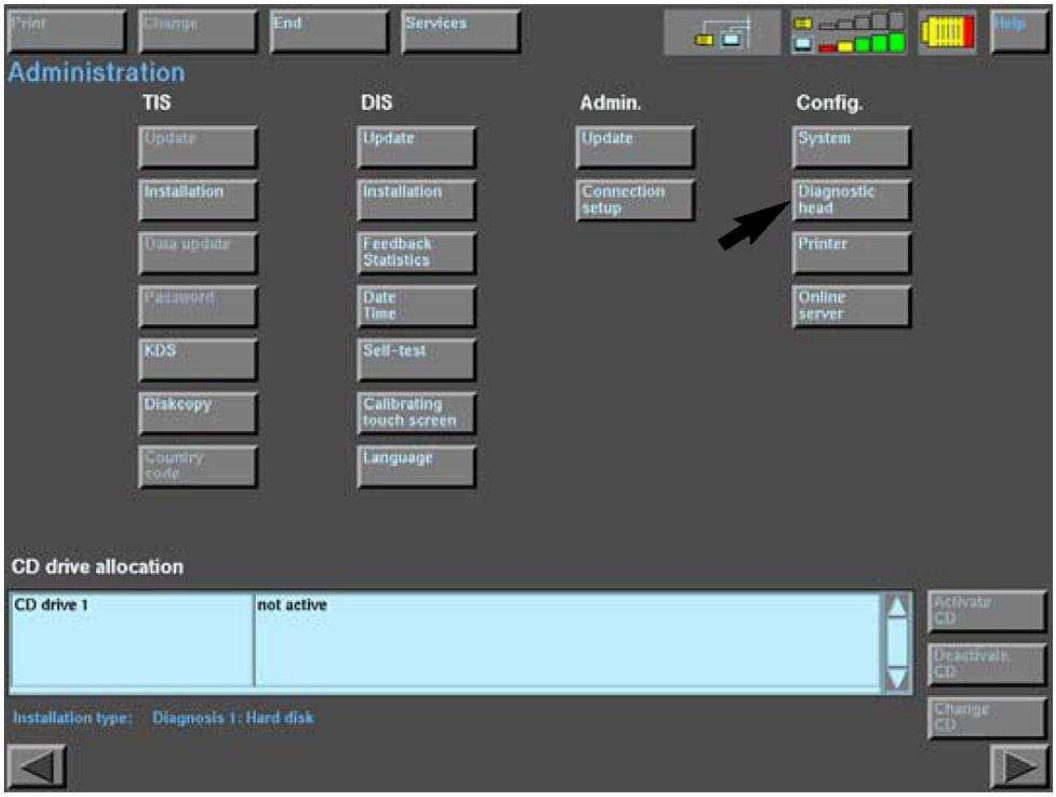


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Fig. 21: Display DISplus/GT1 (Network Configuration Information)
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Diagnostic Head".**

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Fig. 22: Display DISplus/GT1 (Diagnostic Head)
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Free diagnostic head".**

NOTE: In order for an interface to be displayed it must be connected to a vehicle and the ignition turned on.

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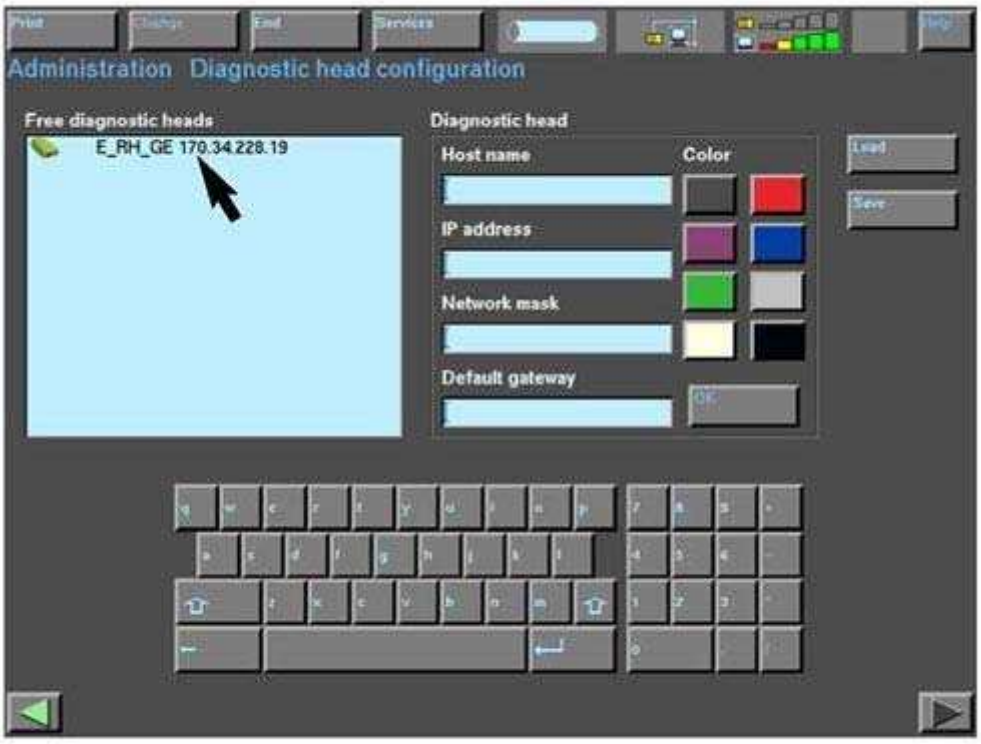


Fig. 23: Display DISplus/GT1 (Free Diagnostic Head)
Courtesy of BMW OF NORTH AMERICA, INC.

Network configuration information for the selected interface is displayed.

Example: *A red color band will be assigned to this interface once* **"OK"** *is selected.*

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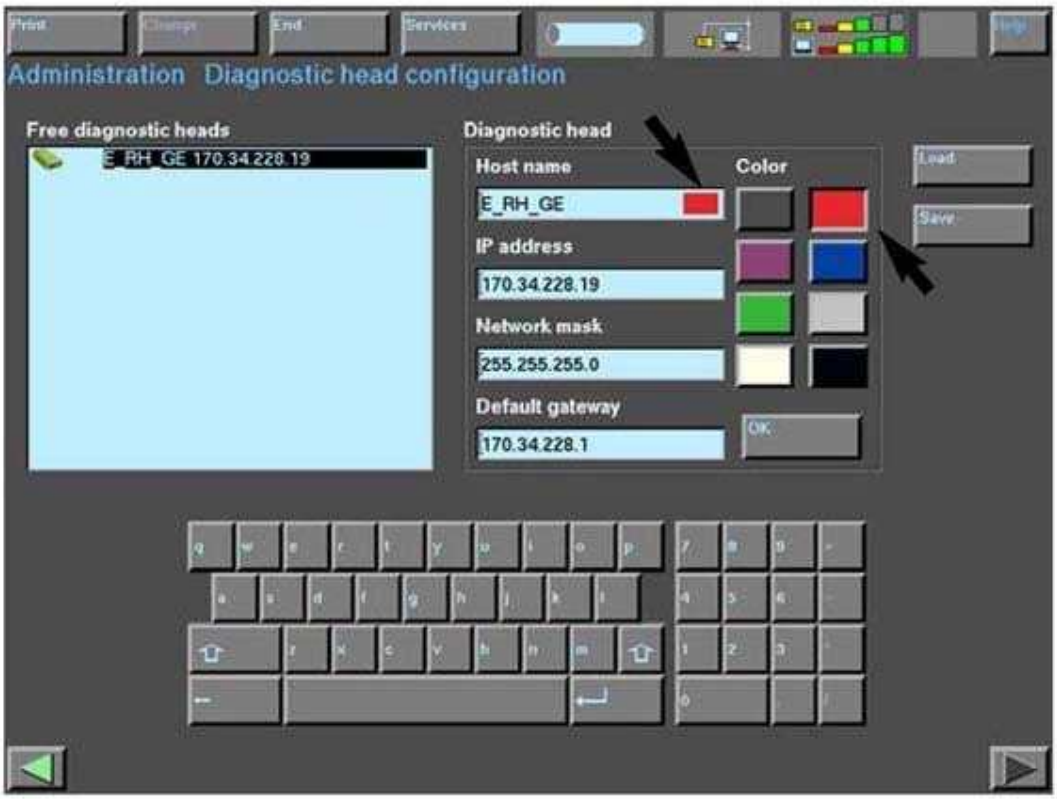
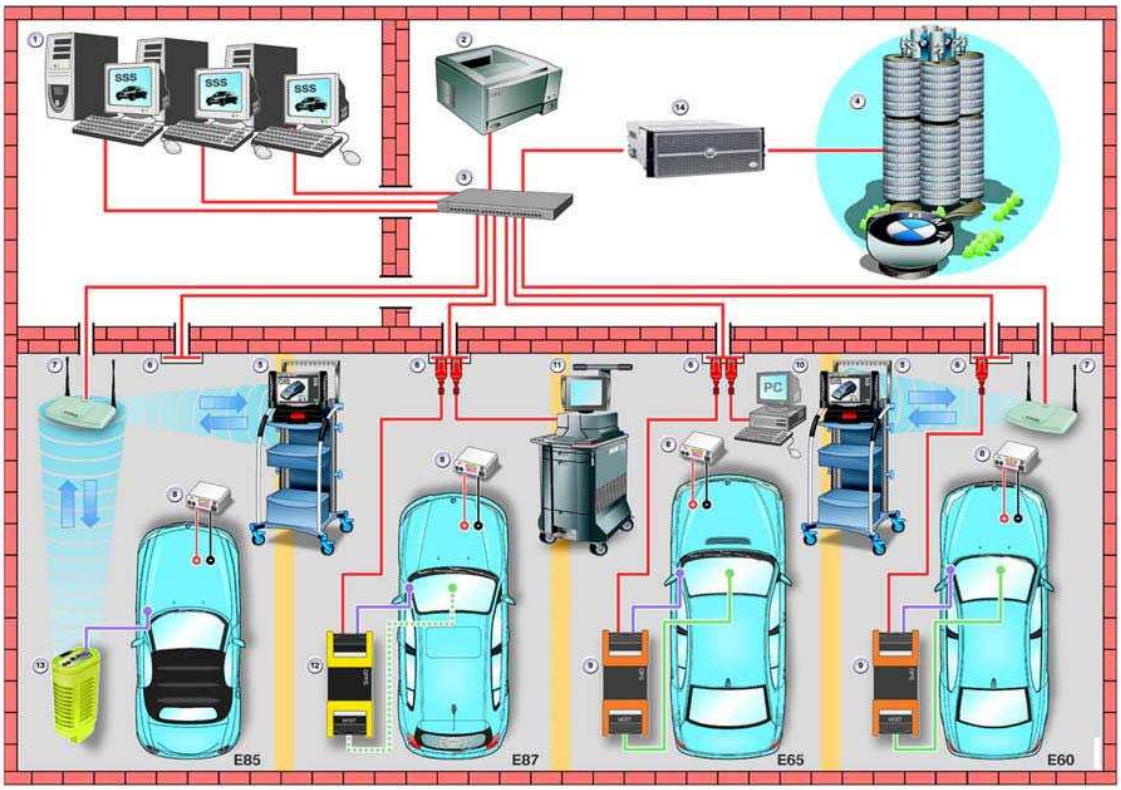


Fig. 24: Display DISplus/GT1 (Network Configuration Information)
Courtesy of BMW OF NORTH AMERICA, INC.

Workshop Layout

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Fig. 25: Identifying Workshop Layout Chart
Courtesy of BMW OF NORTH AMERICA, INC.

Workshop Layout Index

WORKSHOP LAYOUT INDEX

Device #	Device Name/Description
1	Software Service Station (SSS)
2	Network Printer
3	Switched Hub (Cisco Switch WS C2950-24)
4	BMW Network
5	GT1
6	Wall Jack/Ethernet Connection point to workshop Network
7	Access Point
8	Deutronic Automatic Battery Charger
9	OPS
10	Workshop PC
11	DISplus
12	OPS Head
13	Diagnostic Head
14	Network Server

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Workshop Network Components

A LAN currently exists in all workshops to allow the diagnostic equipment (DISplus, GT1, SSS, OPPS, OPS & Diagnostic Head) to communicate with each other. In order to successfully diagnose, code and program a vehicle, it is required to have all equipment connected to the workshop network.

Components used to create a network infrastructure in the workshop consist of:

Access Point

Allows direct wireless access to LAN for GT1 and Diagnostic Head

OR

Diagnostic head establishes connection to LAN via wireless communication and thereby can be connected to DISplus or GT1, which are connected to LAN

Access point is connected directly to LAN.

Symbol - Model Spectrum 24/AP 3020-100

Wall Jack

Connection point for devices such as GT1, DISplus, Access Point, SSS, Diagnostic Head, OPPS/OPS Head, Printer and Network Server to Switched Router via RJ45 cable.

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Fig. 26: Identifying Wireless
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Fig. 27: Identifying CAT 5 Ethernet Cable With RJ-45 Connectors
Courtesy of BMW OF NORTH AMERICA, INC.

CAT 5 Ethernet Cable with RJ-45 Connectors

Used to establish a connection between:

- Wall jack and Switched Router/Hub
- Wall jack and devices such as GT1, DISplus, Access Point, SSS, Diagnostic Head, OPPS/OPS Head and Network Server.

Switched Hub

LAN switched distribution hub for all devices connected to the network. Routes communication telegrams/messages to specific devices from specific devices. Allows multiple devices to communicate with each other without reducing data transfer rate.

Cisco Switch WS-C2950-24

Server

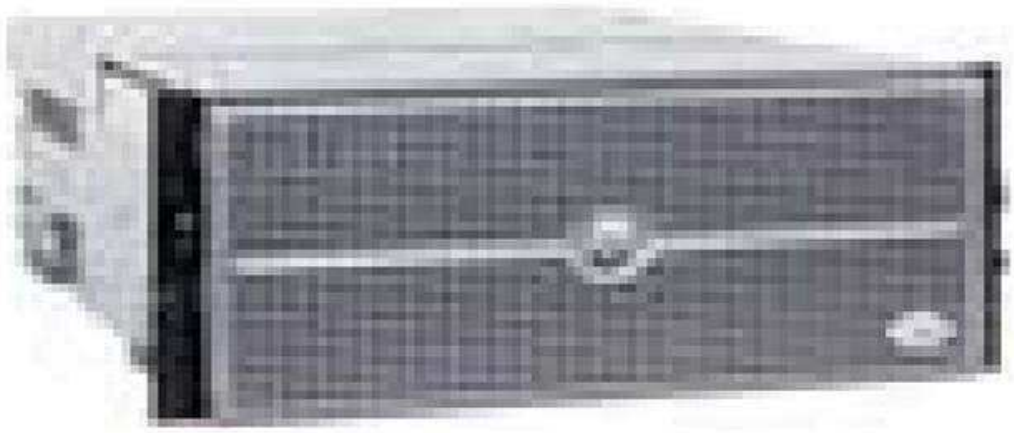
Central computer which controls interface/communication between all devices on the Workshop LAN and communication to external networks and internet. Keystone device for network operation along with switch/router.



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Fig. 28: Identifying Switched Hub
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 29: Identifying Server
Courtesy of BMW OF NORTH AMERICA, INC.

Common Terminology

Network

A group of computers that are interconnected with each other and able to communicate with each other either by transferring data via a wired or wireless connection.

Local Area Network (LAN)

A network that exists within a specific area.

Example: *By having all computers, testers and printers in the workshop interconnected results in a Workshop LAN.*

Ethernet

The term Ethernet is a communications protocol used to define a method & speed by which interconnected devices are able to communicate with each other by either a wired (twisted pair) or fiberoptic connection.

Common Ethernet communication protocol terms:

10BaseT - Able to transmit data at a rate of 10Mbps for a maximum distance of 100 meters per segment.

100BaseT - Able to transmit data at a rate of 100Mbps for a maximum distance of 1000 meters per segment.

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The speed differences are obtained by modifying the method of encoding the data to be transferred. The maximum distance consist of the distance from switched hub to wall jack plus length of cable used to connect a particular device. The greater the distance the greater the chance of signal loss/disturbance.

Ethernet Cable (CAT 5)

A standard used to define an 8 wire cable (4 twisted pair) that is commonly used to interconnect various computers in the establishment of an ethernet network. Certified to transmit data at a maximum rate of 100Mbps.

RJ-45 Connectors

The plastic connectors at the end of a CAT 5 cable, used to connect the cable to device/computer, wall jack and hub.

Wall Jack

Accepts RJ-45 connectors when connecting devices to the network. Connection point for devices like DISplus, GT1, SSS, OPPS, OPS, Diagnostic Head, workshop computers and printer.

Recommendation is that outlet/jack is numbered and the corresponding end of the ethernet cable connected to the switched hub is numbered as well, to assist in troubleshooting in the event of a problem.

Example: *A wall jack outlet is labeled as #1 the other end of the cable at the hub should also be labeled #1.*

Switched HUB

Allows multiple devices to send information over the network at the same time without slowing down the communication process. A switched hub essentially isolates the two devices that are communicating, thereby providing each component on the network a separate connection at the maximum data transfer rate of the network.

Example: *A switched HUB is similar to the use of cloverleafs on the highway, traffic does not need to stop if a change in direction needs to be made, plus traffic flows smoothly from point to point.*

A regular HUB does not provide each component with a separate connection point to the network but rather a shared connection point. By sharing a connection point the data transfer rate of the network is reduced when multiple devices try to communicate.

Example: *A regular HUB is similar to the use of a 4 way intersection, the smaller the amount of traffic using the intersection the quicker a car can go through the intersection and reach its desired destination. The greater the traffic the longer it will take for a car to reach its desired destination.*

The switched hub installed as part of the workshop wiring project is a Cisco WS-C2950-24.

Network Server

A computer that provides information/data to other computers located on the network. A server allows

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computers on its network to access information on another network, such as the internet. The server is the keystone device that allows computers on its specific network to access information on another network.

As an example a server can obtain and distribute software updates to all computers located on its network, instead of having to physically install the updates to each computer individually.

Automatic/Online Updates

The ability to connect the network server to the BMW server and check for new software updates (Diagnostic, Coding & Programming data) then downloads the information to all computers/equipment located on the network automatically at a specific time.

Example: *New updates can be installed on SSS, GT1 and DISplus overnight in order to have latest data available the next morning.*

The application that performs online updates is referred to as JETstream.

Access Point

The access point is a wireless communication device that is able to establish a wireless connection with a GT1 and/or a diagnostic head and allows them to communicate with other devices on the network.

Manufactured by Symbol - Model Spectrum 24 /AP 3020-100.



Fig. 30: Identifying Access Point
Courtesy of BMW OF NORTH AMERICA, INC.

Interface Name

The specific name assigned to the device (Ex. OPS Blue A)

IP Address

It is a unique four segment number used to identify a specific device located on a specific network. The number

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represents the address of the device on the network and is necessary when communicating with other devices located on the network.

Example: *92.168.100.10*

Usually the first three segments are used to identify the network and the last segment identifies the device. The IP Subnet Mask information generally defines which segments are needed to identify the network and which identify the device.

In order for a devices on the network to communicate with other devices on the network it must know the addresses of those devices. If a print command is sent from a computer to a printer on the network, the command must be addressed specifically to the desired printer.

Example: *An IP address is no different than your home address, in order to receive a letter specifically directed to you, your name and address must be correctly displayed on the letter.*

IP addresses are assigned by the network administrator/provider and are rigidly assigned to the device(s) located within the workshop network, by entering it into the device during the initial setup.

IP Subnet Mask

This information is used to define which segment(s) of the four segment IP address specifically identifies the device and which identify the specific network.

Example: *255.255.255.0*

Indicates that the first three segments (255.255.255) identify the specific network that the device is located on. The last segment (0) indicates that this is the segment that will identify the specific device.

Gateway

This information identifies the four segment address of the component located on the network responsible for communicating from the current network to another network. If there is no address in this location then a connection to any devices outside of the current network can not be established.

NOTE: The network and device address information must be entered exactly as defined by the network administrator for your facility, otherwise the devices can not be accessed.

REMOTE CODING, INDIVIDUALIZATION & PROGRAMMING TERMINALS

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Fig. 31: Identifying GT1
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Fig. 32: Identifying DISplus
Courtesy of BMW OF NORTH AMERICA, INC.

With the release of CIP 15.0 and the implementation of Progman (see **PROGMAN** section for additional information) the DISplus and GT1 will only be capable of performing vehicle diagnosis and activation/initiation of a Coding, Individualization or Programming task through the SSS. A special program management tool (Progman) will only allow the DISplus and GT1 to act as remote terminals to the SSS (regarding Coding, Individualization & Programming), which means that the SSS will be the single supplier of Coding, Individualization and Programming information to a vehicle and its respective control modules. By having all devices (DISplus, GT1 and SSS) connected to the network, the DISplus and GT1 can be utilized to perform diagnosis on a new vehicle after a request for vehicle programming as an example, has been sent to the SSS for the current vehicle.

Example: *GT1(7) is connected to the LAN via access point (3) and to OPPS head (6) which is connected to LAN(4) and vehicle (5):*

1. *Diagnosis of complaint is completed and test module result indicates that a control module needs to be updated/reprogrammed.*
2. *Coding and Programming/CIP is accessed on GT1(7) and a request to program specific control module on vehicle (5) connected to OPPS head (6) is made.*
3. *The SSS (1) takes over the programming process and begins to reprogram the control module and recode the vehicle (5).*
4. *At this point the GT1(7) is free to connect to a new OPPS/diagnostic head and begin a diagnostic routine or initiate another programming/coding session on a new vehicle.*

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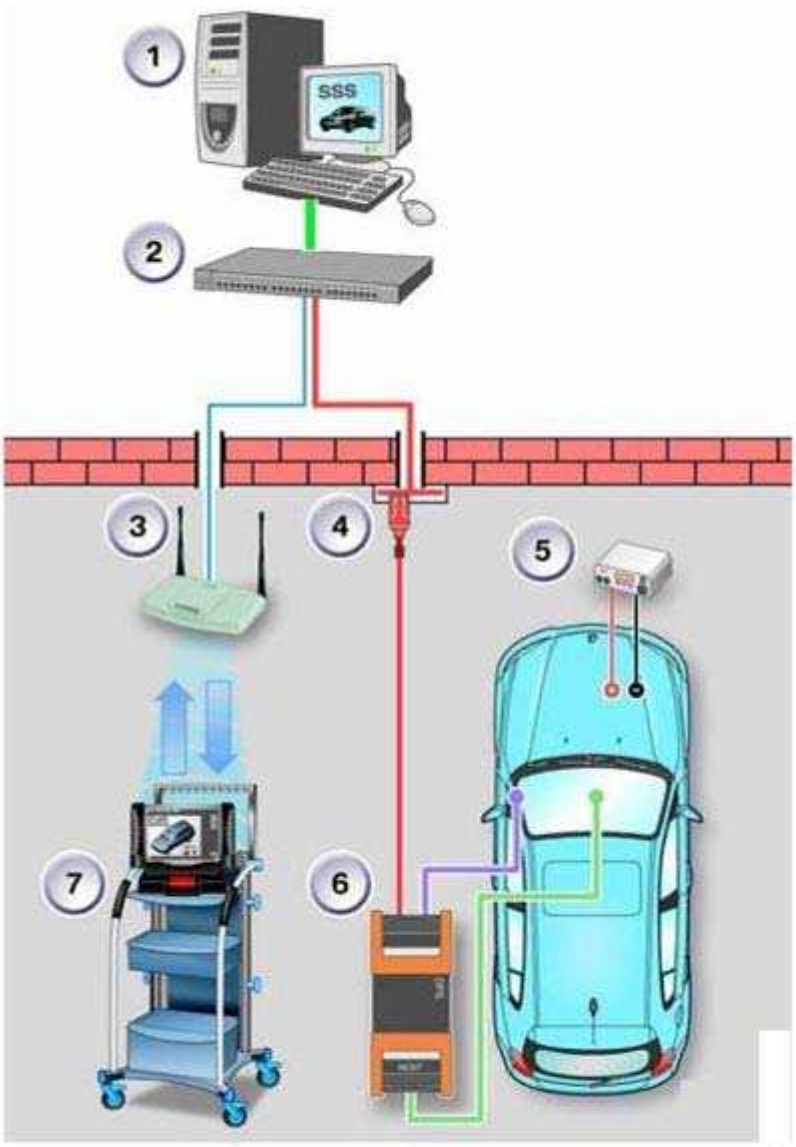


Fig. 33: Connecting GT1 To LAN Via Access Point And To OPPS Head
Courtesy of BMW OF NORTH AMERICA, INC.

Software Service Station

The Software Service Station (SSS) was released to all centers for the sole purpose of Coding and Programming vehicles that can only be Coded/Programmed using CIP. The SSS is a dedicated desktop PC, that supplements the DISplus and GT1 diagnostic systems, since the SSS is only capable of performing Coding and Programming it frees up the DISplus and GT1 for diagnostic functions.

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Fig. 34: Identifying Software Service Station
Courtesy of BMW OF NORTH AMERICA, INC.

With the release of CIP 15.0 and the implementation of Progman, the SSS replaces the DISplus and GT1 (Group Tester One) diagnosis systems as the primary programming system. The DISplus and GT1 will only be able to send a request to Program or Code a vehicle directly through the SSS. The SSS performs the actual programming and coding process. In this configuration the SSS is able to program up to five vehicles at a time and the DISplus and GT1 are free to be used for other tasks, provided that all devices are connected to the workshop network and have been assigned specific IP addresses.

As with the DISplus and GT1, data is supplied to the Software Service Station by means of a CIP DVD-ROM or CD-ROM, additional data can also be provided by online updates via JETStream.

OPPS/OPS/Diagnostic Head

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The OPPS (Optical Testing and Programming System), OPS (Optical Programming System) and the diagnostic head can all be used with the Software Service Station to serve as the interface to the vehicle. Optimal programming speed on MOST bus equipped vehicles is obtained by using the OPPS/OPS head connected to the OBD connector and directly to the MOST access port on E60, E63/64 and newer vehicles.

OPPS

The OPPS was first introduced with the E65 and is able to:

- Acts as interface between vehicle and DISplus/GT1/SSS
- Reduce programming time of MOST Bus control modules
- Diagnosis the fiber optic communication system utilized on the byteflight and MOST bus systems.

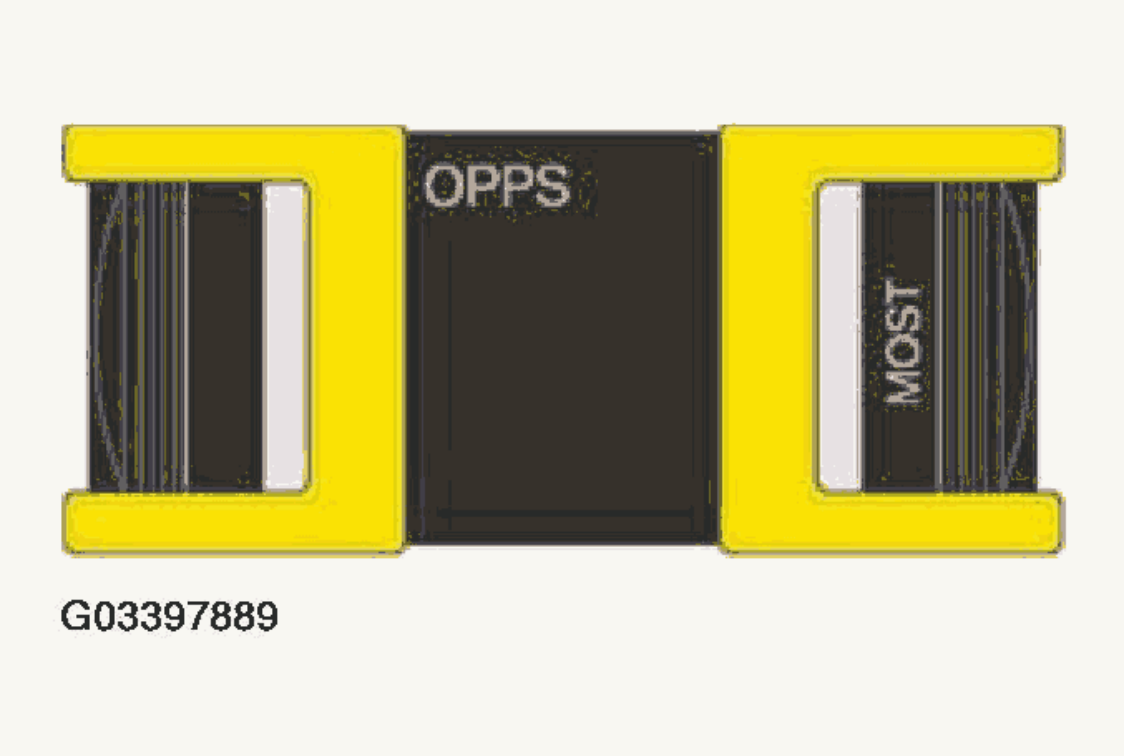


Fig. 35: Identifying OPPS
Courtesy of BMW OF NORTH AMERICA, INC.

- Simultaneously program vehicles equipped with a MOST bus system (except E65/66 up to 3/05 prod.) via MOST Bus access port and OBD connections.
- Perform vehicle diagnosis, coding and programming on all vehicles equipped with a MOST bus.
- Communicates via a wired connection (DK LAN cable) to Network or directly to GT1/DISplus/SSS

The OPPS is NOT ABLE to perform Diagnosis, Coding & Programming on an I-bus equipped vehicle.

OPS

The OPS is able to:

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- Acts as interface between vehicle and DISplus/GT1/SSS
- Reduce programming time of MOST Bus control modules
- Simultaneously program vehicles equipped with a MOST bus system (except E65/66) via MOST Bus access port and OBD connections.
- Perform vehicle diagnosis, coding and programming on all vehicles equipped with a MOST bus.
- Communicates via a wired connection (DK LAN cable) to Network or directly to GT1/DISplus/SSS

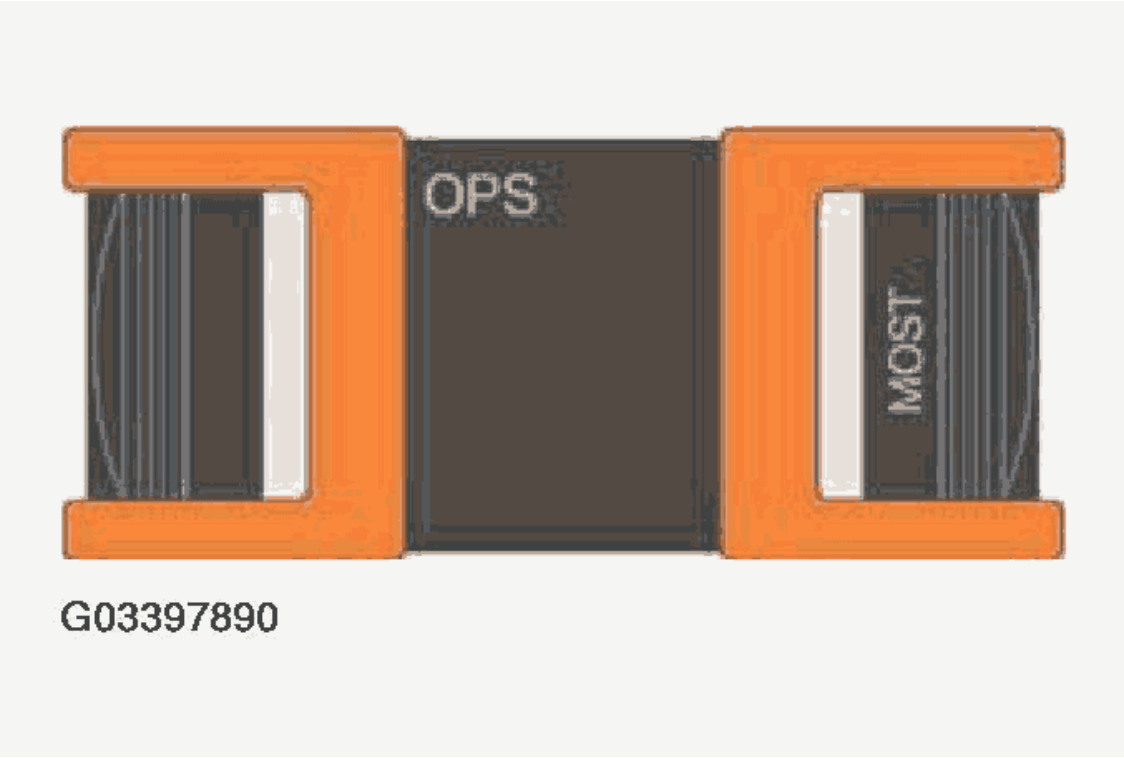


Fig. 36: Identifying OPS
Courtesy of BMW OF NORTH AMERICA, INC.

The OPS is NOT ABLE to perform Diagnosis on the fiber optic communication system utilized on the byteflight and MOST bus systems nor can it be used to perform Diagnosis, Coding & Programming on an I-bus equipped vehicle.

Diagnostic Head

The diagnostic head is able to:

- Acts as interface between vehicle and DISplus/GT1/SSS
- Perform vehicle diagnosis, coding and programming and Vehicle & Key Memory on most vehicles.

Should not be used for coding and programming vehicles equipped with a MOST bus (E60/63/64/65/66...) as processor is too slow.

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Fig. 37: Identifying Diagnostic Head
Courtesy of BMW OF NORTH AMERICA, INC.

- Communicates via a wired connection (DK LAN cable) to Network or directly to DISplus/GT1/SSS
- Wireless communication to LAN/Workshop Network Connection via Access Point

MOST Direct Access Port

The MOST Direct Access port is installed on vehicles equipped with a MOST bus such as E60/E62/E63.... The port is utilized to allow separate programming of control modules connected to the MOST bus when using the OPPS/OPS head for Programming & Coding. By using this port in conjunction with the OBD socket when programming a vehicle the overall programming/coding time is reduced.

Access to the port differs corresponding to the model.

For E60 the port (5) is located on the left side of the glove box (3) behind the strut (2). To access the connection remove the cover (1) and remove the terminating plug (4) from the cable to allow connection to the port (5).

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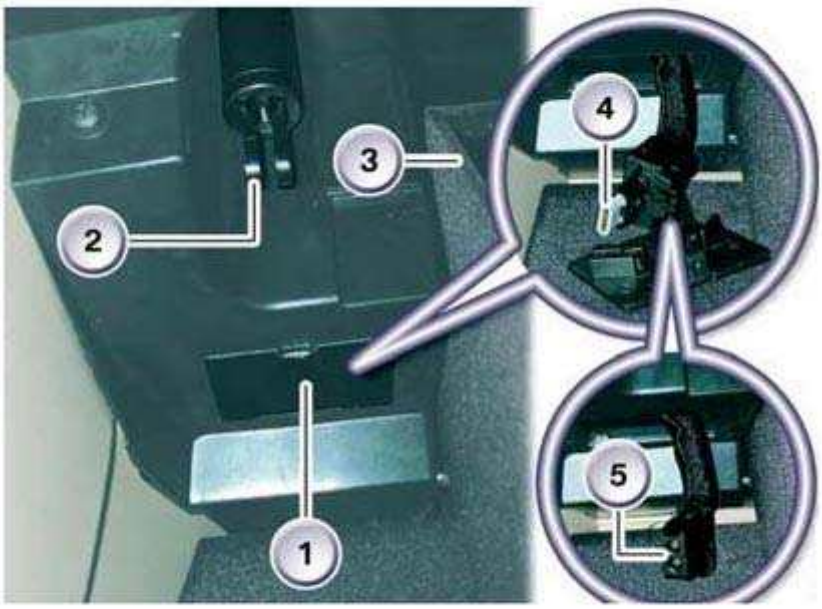


Fig. 38: Identifying MOST Direct Access Port
Courtesy of BMW OF NORTH AMERICA, INC.

Example: *Referring to the illustration below - Parallel programming of an E60 using OPPS head in conjunction with short OBD cable (1) P/N 666 111 and MOST bus programming cable (2) P/N 663 121 which connects to the MOST Access Port located in the glovebox. The OPPS is connected to the network via DK LAN cable 3.*

NOTE: The OPS can be substituted for the OPPS.

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Fig. 39: Identifying OBD Cable P/N 666 111 And MOST Bus Programming Cable P/N 663 121
Courtesy of BMW OF NORTH AMERICA, INC.

Equipment Configurations

The diagnostic and programming equipment available in the workshop should always be configured to have the DISplus, GT1 and SSS connected directly to the LAN/Workshop network. **To ensure uninterrupted service/data transmission, it is highly recommended that the radio/wireless connection of the diagnostic head is NOT used to perform any type of Programming or Coding function.**

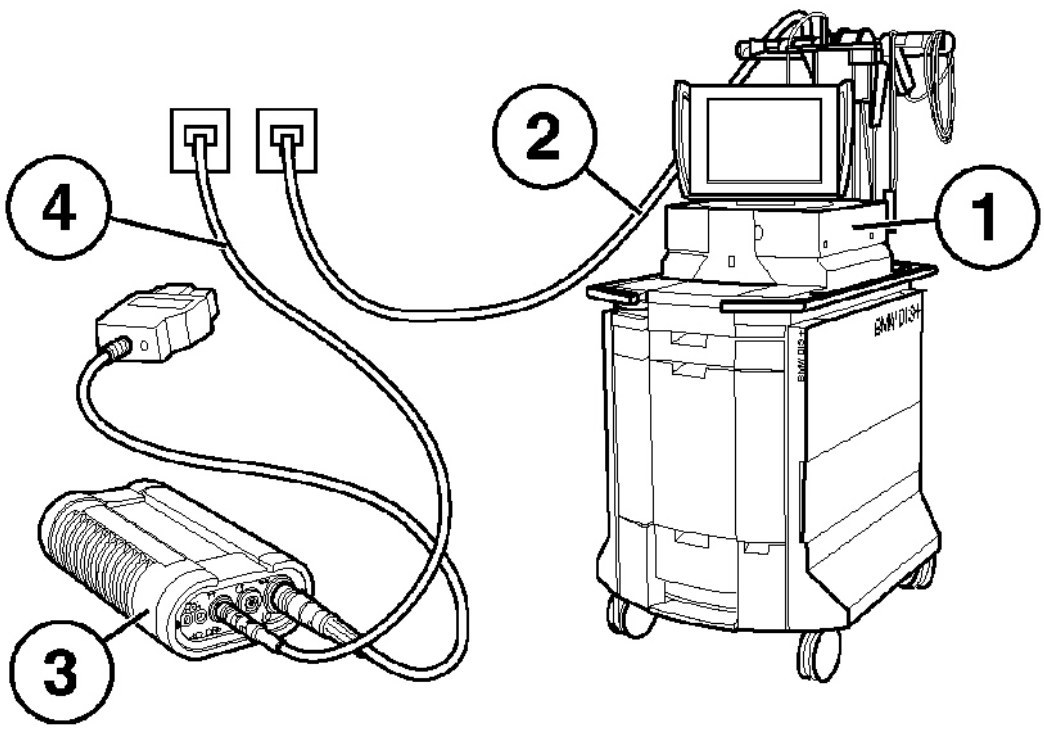
The normal configuration (when coding or programming) of the DISplus & GT1 to the diagnostic/OPPS/OPS head are as follows:

DISplus (1) - Connected to network using SI LAN cable (2)

+ Diagnostic/OPPS/OPS head (3) - Connected to network using DK LAN cable (4)

+ OBD or Diagnostic plug cable - Connecting diagnostic head to vehicle

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Fig. 40: Connecting DISplus To Network Using SI LAN Cable
Courtesy of BMW OF NORTH AMERICA, INC.

GT1 (1) - Connected to network using SI LAN cable (3) and LAN adapter BT1:1 (2)

+ Diagnostic/Opps head (5) - Connected to network using DK LAN cable (4)

+ OBD or Diagnostic plug cable - Connecting diagnostic head to vehicle.

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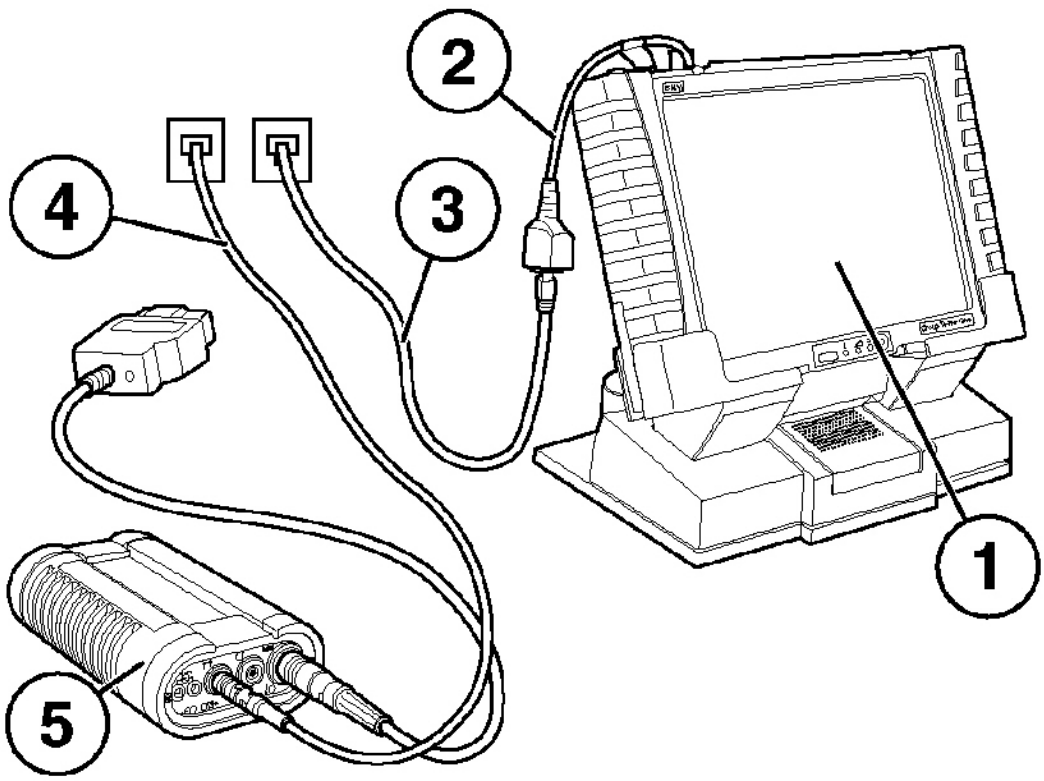


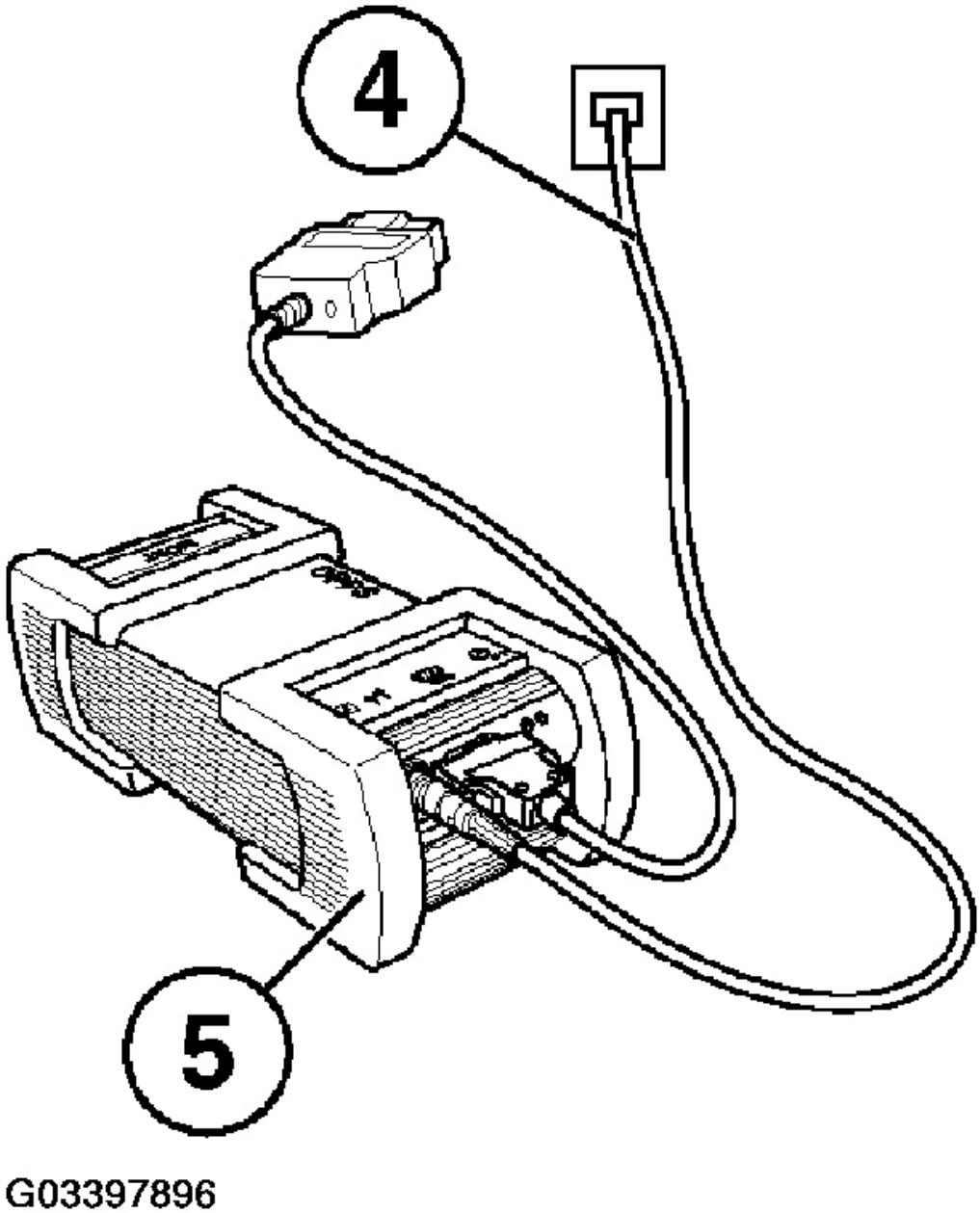
Fig. 41: Connecting GT1 To Network Using SI LAN Cable And LAN Adapter BT1:1
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: For optimum programming speed the OPPS/OPS head (5) can be substituted for the diagnostic head:

+ Connect OPPS/OPS head (5) directly to a network drop via a DK LAN cable (4)

+ Connect OPPS/OPS head to the OBD connector using the short OBD cable P/N 663 111

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Fig. 42: Connecting OPPS/OPS Head Directly To Network Drop Via DK LAN Cable
Courtesy of BMW OF NORTH AMERICA, INC.

In the event that the workshop network is disabled/down the DISplus and GT1 can still be used to diagnose a vehicle by utilizing the following configurations:

GT1 (1) - Not connected to network

+ Diagnostic/OPPS head (5) - Connected to GT1 using DK LAN cable (4) and LAN adapter BT1:1(2) plus LAN adapter BT X (3))

+ OBD or Diagnostic plug cable (5) Connecting diagnostic head to vehicle

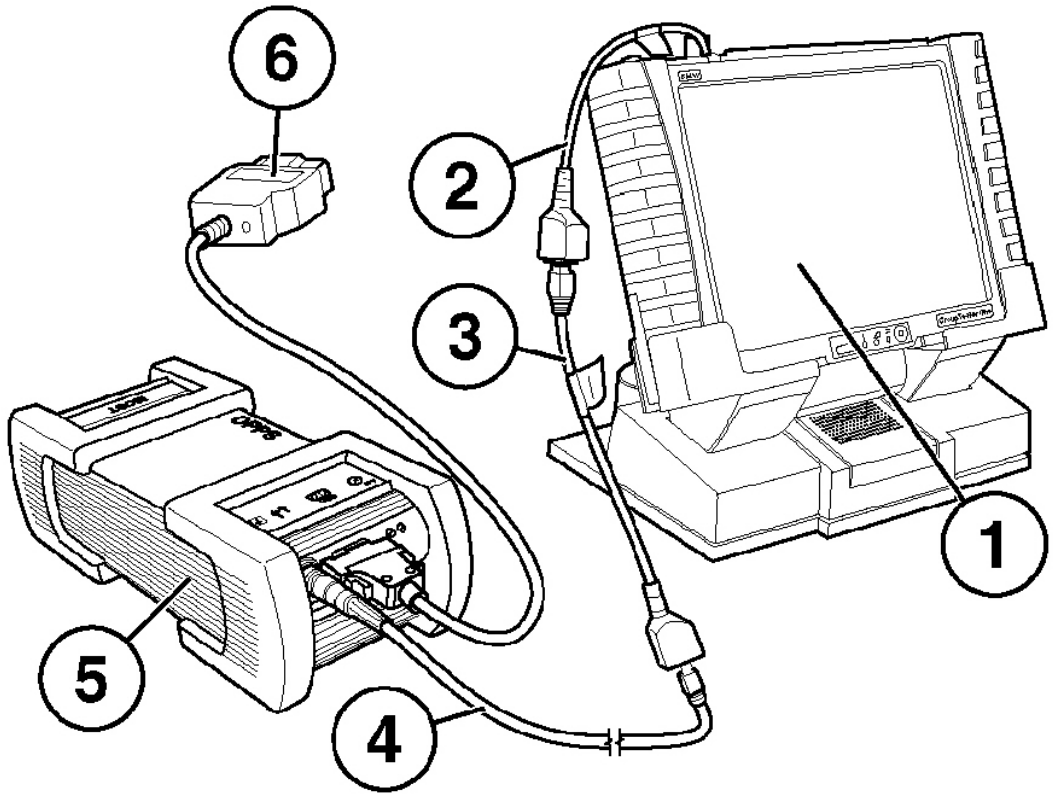


Fig. 43: Connecting Diagnostic/OPPS Head To GT1 Using DK LAN Cable And LAN Adapter BT1:1 Plus LAN Adapter BT X
Courtesy of BMW OF NORTH AMERICA, INC.

DISplus (1) - Not connected to network

+ Diagnostic/OPPS/OPS head (3) - Connected to DISplus using DK LAN cable (4) and PC LAN cable (2)

+ OBD or Diagnostic plug cable - Connecting diagnostic head to vehicle

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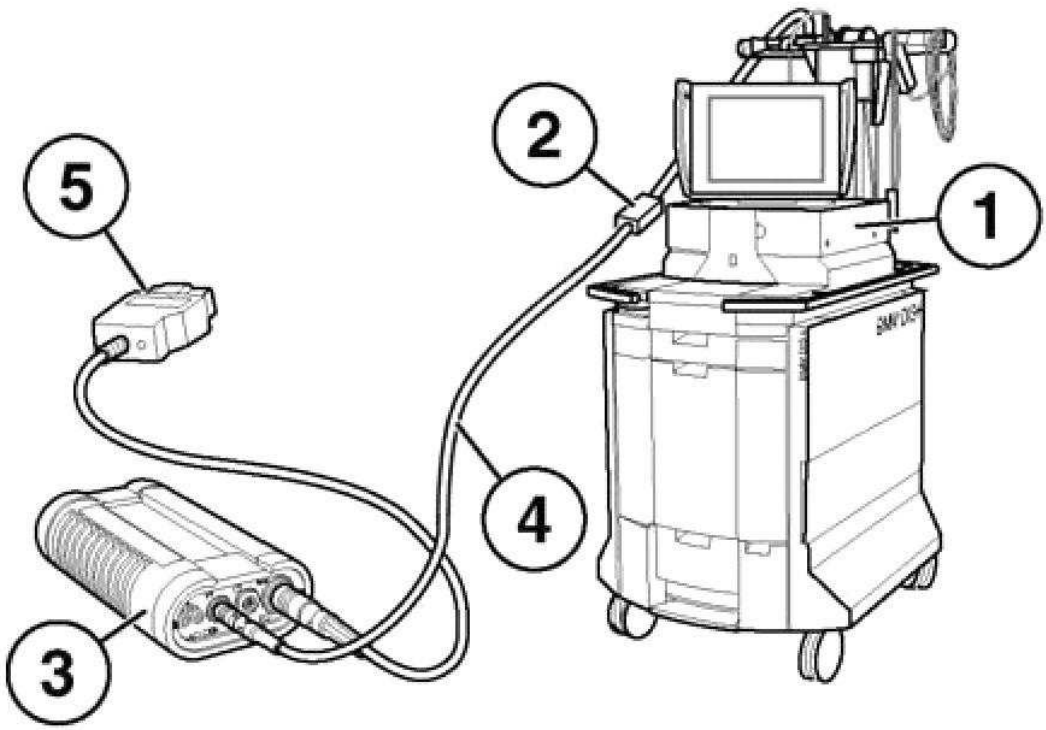


Fig. 44: Connecting Diagnostic/OPPS/OPS Head To DISplus Using DK LAN Cable And PC LAN Cable
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: OPPS/OPS can not be used to perform diagnosis on an I-bus equipped vehicle (i.e. E32, E36, E38, E46, E53...).

PROCEDURE FOR CODING & PROGRAMMING

An important prerequisite for ensuring trouble-free programming is the correct preparation of the vehicle.

A diagnostic procedure must first be performed on the vehicle prior to any programming. Programming must not be started before faults in the vehicle electrical system are ruled out.

Correct preparation of the vehicle avoids errors during programming.

The programming procedure may be terminated if a bus signal is generated as the result of activation of electric loads during programming. The programming procedure should be repeated following termination. In exceptional cases it may be necessary to replace the control unit if communication is no longer possible.

Prior to beginning any programming or coding procedure some general guidelines need to be considered in

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order to ensure that the process goes as smoothly as possible:

Check

Action /Procedure

Engine

Turn off engine, ignition key on - KL15



G03397899

Fig. 45: Identifying Engine Start/Stop Switch

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Courtesy of BMW OF NORTH AMERICA, INC.

Manual gearbox/SMG

Transmission in neutral.

Parking brake applied.



Fig. 46: Identifying Manual Gearbox/SMG
Courtesy of BMW OF NORTH AMERICA, INC.

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Automatic Transmission

- Transmission in position P.
- System temperature below 80°C.

Attention: Do not apply parking brake on vehicles equipped with the electromechanical parking brake.

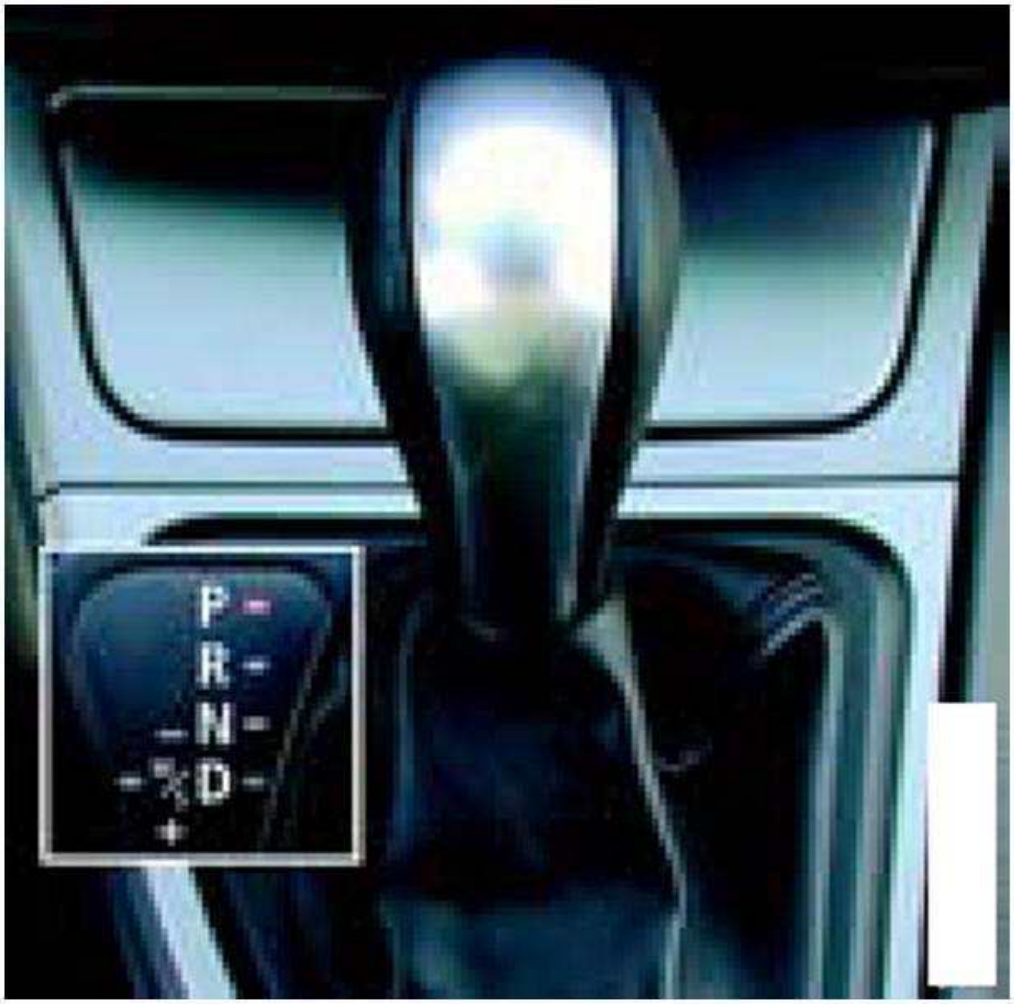


Fig. 47: Identifying Automatic Transmission Selector Lever
Courtesy of BMW OF NORTH AMERICA, INC.

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Loads

- All electric loads, lights and indicator lights switched off.
- Wipe/wash system switched off. Insure that the wipers can move freely. Wipers may be activated during programming.

Do Not Block the Wipers.



G03397902

Fig. 48: Identifying Button
Courtesy of BMW OF NORTH AMERICA, INC.

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Check

Action /Procedure

Diagnosis

Perform quick test.

Using the diagnosis system, rectify any problems before programming and clear stored fault codes.



Fig. 49: Identifying DISplus
Courtesy of BMW OF NORTH AMERICA, INC.

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Battery

The battery should be sufficiently charged at the start of the programming procedure (12.6 V).



Fig. 50: Identifying Battery
Courtesy of BMW OF NORTH AMERICA, INC.

Battery Charger

IMPORTANT: Vehicles must be connected to the Deutronic Automatic Battery Charger prior to beginning the programming or coding procedure, this is the only approved battery charger for MOST bus-equipped vehicles.

During the programming or Coding procedure the battery charger must be in the Power Supply (PS) mode.

Place the charger into the power supply mode by depressing the "MENUE" button 3 times in rapid succession.

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Do not connect or disconnect the charger during programming. The system voltage must not drop below 12.6 V during the programming procedure.



Fig. 51: Identifying Battery Charger
Courtesy of BMW OF NORTH AMERICA, INC.

DO NOT USE Radio Connection for Programming or Coding!!

Diagnostic head/OPPS head (5) must be connected directly to a network drop to ensure uninterrupted programming.

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The DK LAN cable (4) MUST NOT BE routed through an open window of the vehicle, leave a door open.

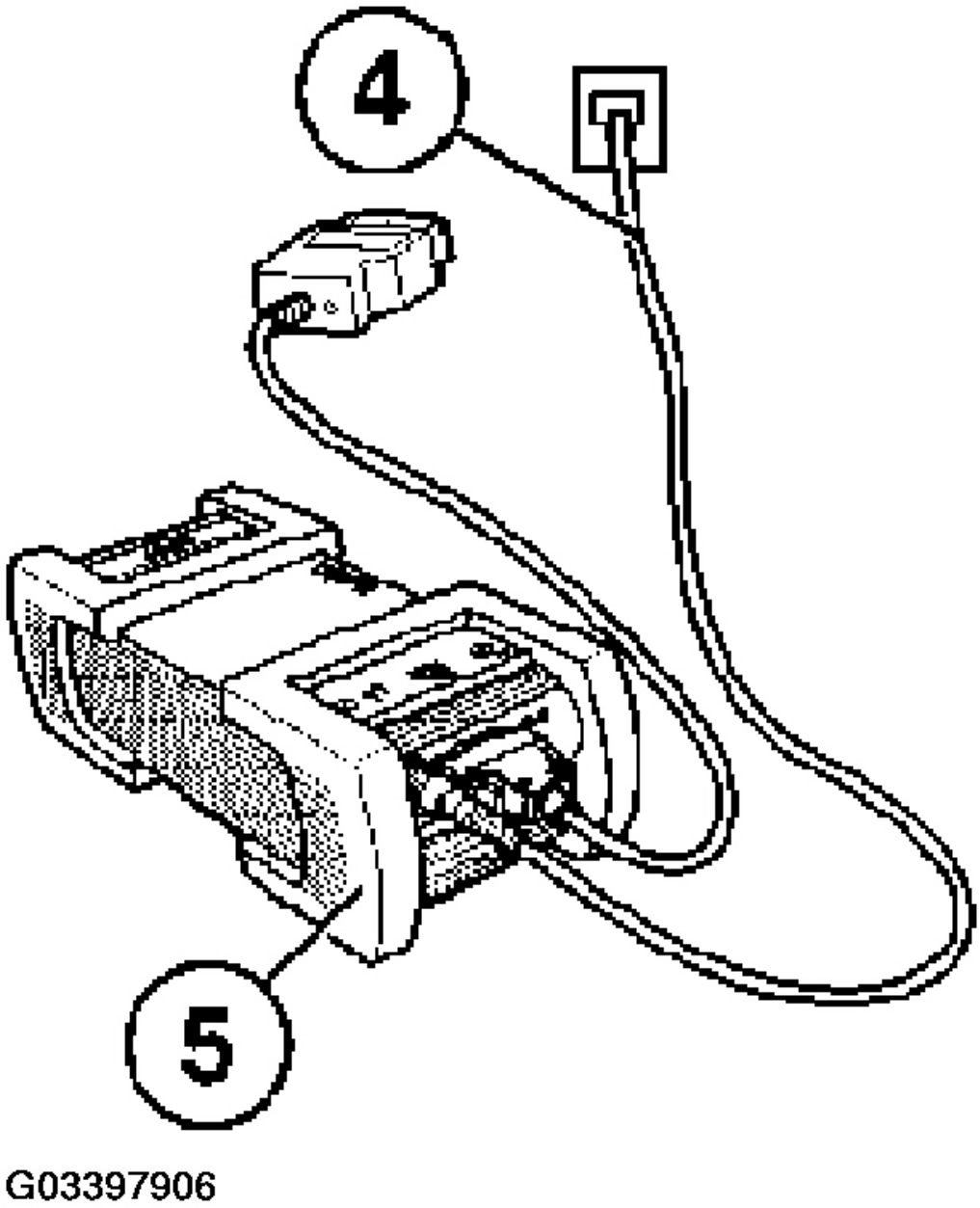


Fig. 52: Connecting Diagnostic Head/OPPS Head To Network
Courtesy of BMW OF NORTH AMERICA, INC.

Programming

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Check CKM values, also observe individual settings on the vehicle if applicable, start programming procedure.

Attention: The data status of the Software Service Station must always be kept updated!

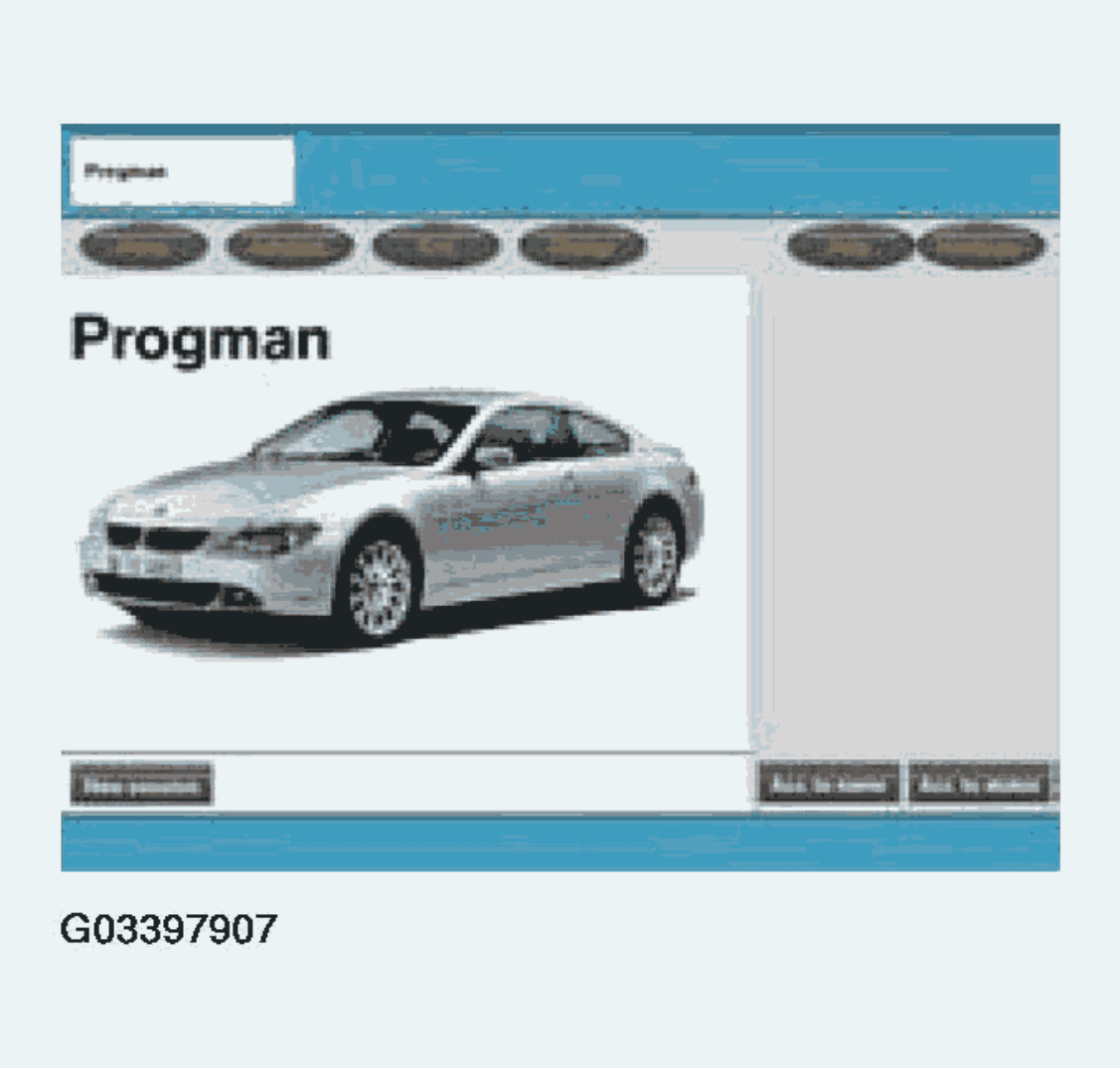


Fig. 53: Identifying Progman
Courtesy of BMW OF NORTH AMERICA, INC.

Make sure that no switches, radio etc. are operated during programming as this could terminate the programming procedure.

DO NOT TOUCH CODING/PROGRAMMING ACTIVE

CODING PLUG

Model: E23, E24, E28, E30, E32, E34, E36

Production: 9/87 - 2002

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CODING PLUG

A coding plug is a mechanically keyed or electronically coded device/plug, that can open or bridge circuits in a particular component to allow it to operate differently dependent on the type of plug installed/inserted.

BMW used a mechanical coding plug which simply opened or bridged circuits to assign market specific data to the instrument cluster of the E23, E24, E28 and E30 vehicles. With the introduction of the E32 in 1988 and the E34 in 1989, electronic coding plugs were utilized in the instrument cluster.

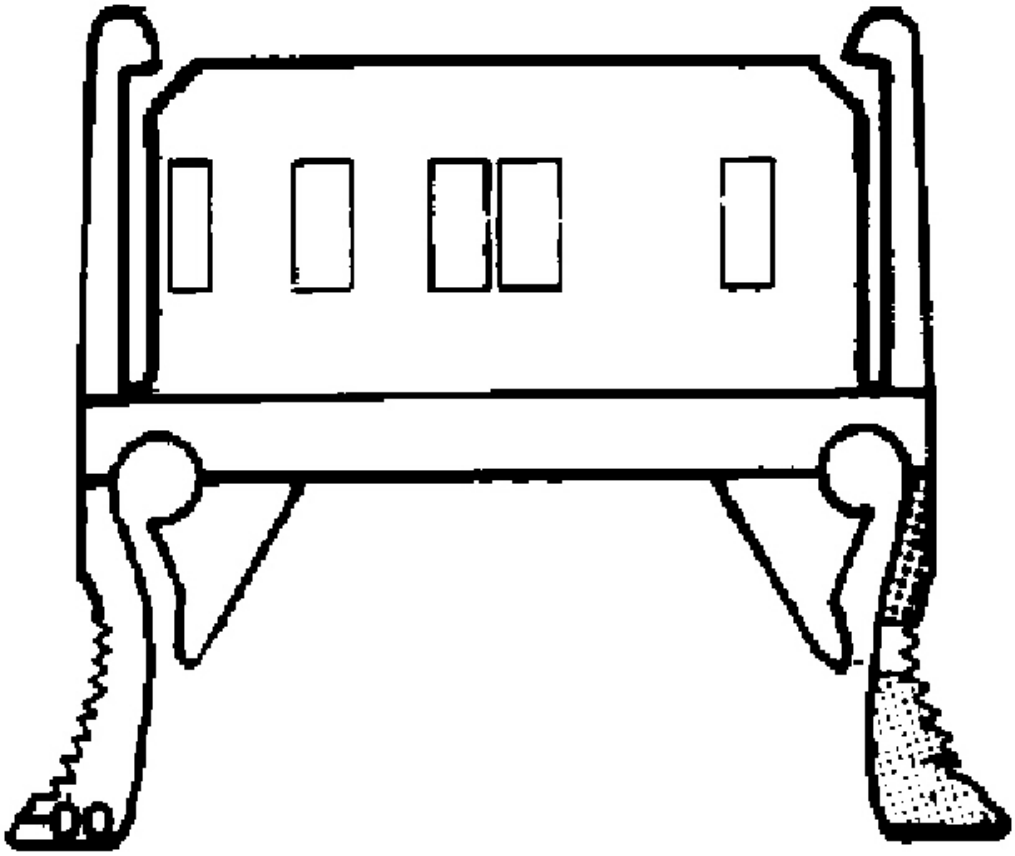


Fig. 54: Identifying Coding Plug
Courtesy of BMW OF NORTH AMERICA, INC.

The change to an electronic coding plug which allowed market specific data to be assigned to the instrument cluster also contained Non-Volatile Random Access Memory (NV-RAM), which provided an ability to retain vehicle specific data in the plug such as:

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- Vehicle Identification Number
- Accumulated Mileage
- Service Indicator Information
- Coding plug number
- Fuel Tank Size data

By using a plug that is able to store data, the instrument cluster can be replaced without loosing vehicle mileage, unless the coding plug is damaged.

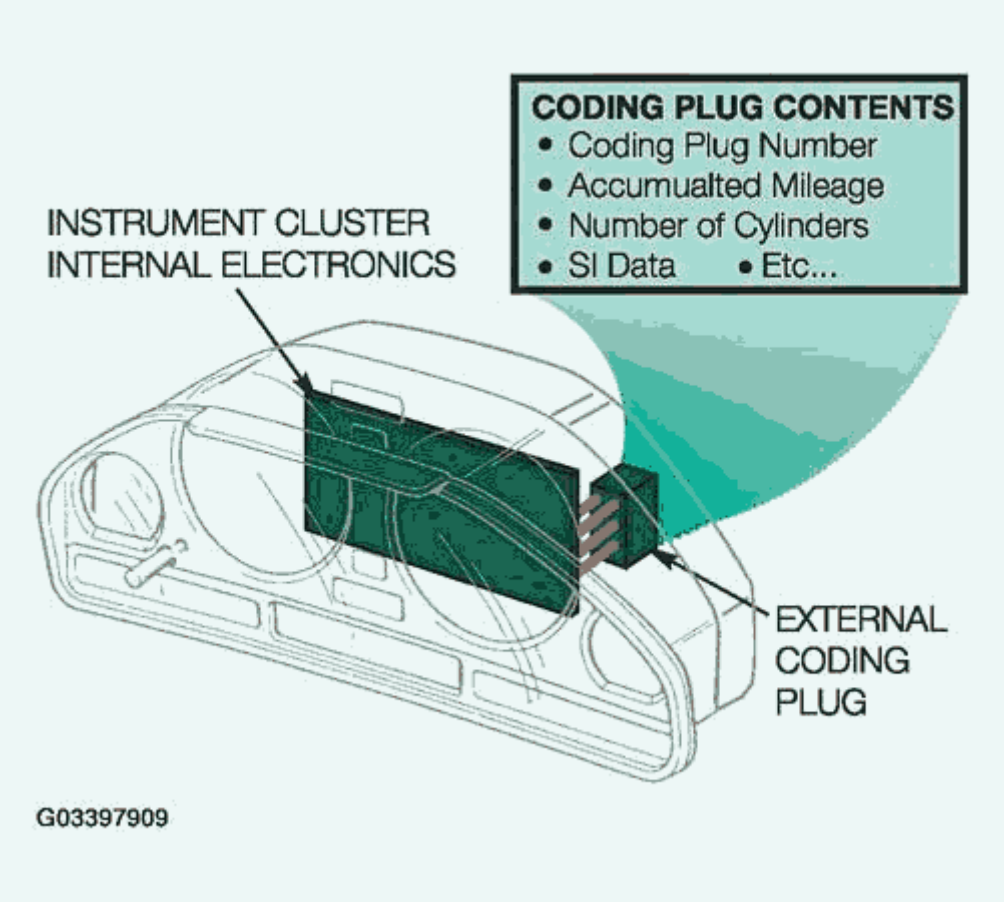


Fig. 55: Identifying External Coding Plug
Courtesy of BMW OF NORTH AMERICA, INC.

With the introduction of vehicles like the E31 and E38 the instrument cluster no longer utilizes a coding plug since it receives most of its input signals directly from a control module, EKM (E31) or IKE (E38), this allows vehicle data to be directly stored in the control module and the instrument cluster is no longer coded. For these vehicles and newer models, market specific data is stored in the control module (EKM or IKE). By coding these modules by way of ZCS coding (refer to **ZCS CODING PROCEDURE**) market specific data is assigned/released to the control module.

Coding Plug Identification

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Each coding plug features a stored 5-digit numerical code that varies between model/equipment, etc.

The code can be read out through the instrument cluster display by pressing the odometer reset button and turning the ignition switch to KL R. The coding plug number will be display in the instrument cluster matrix.



Fig. 56: Identifying Coding Plug Identification Number
Courtesy of BMW OF NORTH AMERICA, INC.

If this is no longer possible, the coding plug must be removed in order to read the code on the label of the coding plug.

Ordering Replacement Coding Plug

The coding plugs are received pre-coded and installing them automatically codes the cluster.

The first digits of the 5-digit code is changed on coding plugs when they are replaced.

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ORDERING REPLACEMENT CODING PLUG

E32		E34
ORIGINAL NUMBER	**1** 1101	**2** 0101
REPLACEMENT NUMBER	**5** 1101	**4** 0101

NOTE: It is not possible to input the mileage reading, the service interval status and the chassis number into the replacement coding plug.

CODING PLUG OVERVIEW

Since the introduction of the E32 several versions of instrument cluster coding plugs have been introduced, this section will provide an overview of the different versions, plus provide identification and coding information.

Coding Plug Identification - E32/E34

The E32/E34 Instrument cluster coding plugs progressed through three variations of design.

Start of production up to 2/89.

The original E32/E34 instrument cluster coding plug was installed in the wiring harness connector (X16) which plugged into the instrument cluster. This plug contained all of the vehicle specific coding data for the instrument cluster and retained accumulated mileage and service interval information.

In the event that the instrument cluster must be replaced the coding plug is reused with the new cluster. By reusing the old/original plug the mileage in the odometer does not change, since the coding plug is able to retain the information.

- If the coding plug must be replaced, the total mileage and Service Interval information will be lost.

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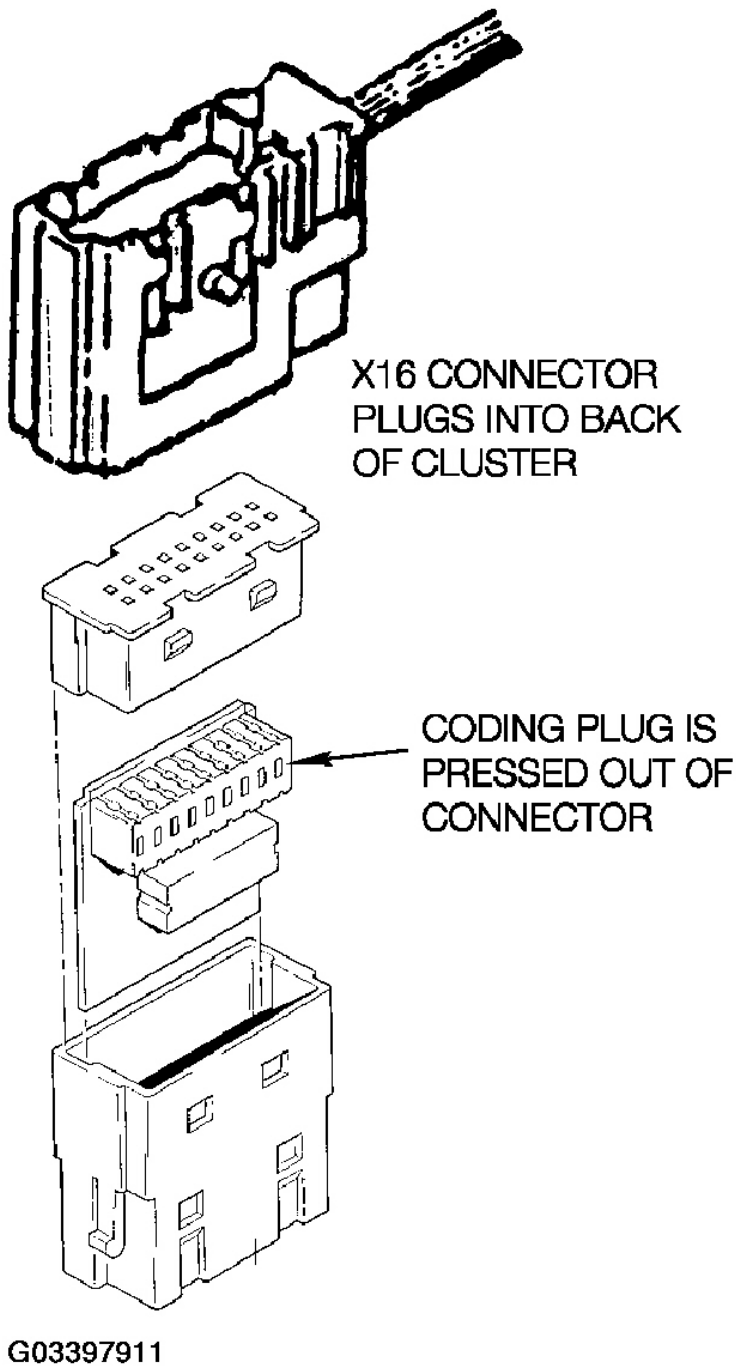


Fig. 57: Removing Coding Plug
Courtesy of BMW OF NORTH AMERICA, INC.

- Replacement coding plugs pre-coded by part number and are available from the parts department.

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From 2/89 to 9/91 Production

The E32/E34 instrument cluster and coding plug were redesigned in 2/89. As a result of this redesign the coding plug became an external component and plugged directly into the back of the instrument cluster, no longer part of the X16 connector.

Even though the plug can be removed without disconnecting the harness, all power must be disconnected from the cluster prior to removal, to prevent data loss from the coding plug.

9/90 Revision

In 9/90 the cluster was slightly redesigned again to address changes in the fuel gauge and some minor physical changes. The electronics of the cluster as well as the coding plug were upgraded considerably.

The coding plug and the instrument cluster are not compatible with the earlier redesign. The printed circuit board and the coding plug are colored blue for distinction over the components of the earlier redesigned cluster.

The new blue coding plug is also keyed differently to prevent unintentional exchange with the earlier coding plug.

E32/34 as of 9/91 (1992 Model Year)

After 9/91 production, the instrument cluster coding plug can be coded using the ZCS function within CIP by selecting the specific module via the DISplus/GT1/SSS. The physical characteristics of the coding plug did not change.

A replacement uncoded coding plug (P/N 62 11 8 359 368) must be coded after installation into the instrument cluster, refer to **ZCS CODING PROCEDURE** .

A precoded coding plug (P/N 62 11 8 359 369) is available for this cluster as well. When ordering include with your order the following information:

- ZCS code for the vehicle
- VIN for the vehicle

E36 Instrument Cluster

318i/is, 325i/is and M3

The instrument cluster for these vehicles does not utilize a coding plug. The entire cluster is coded model specific, by using the ZCS coding procedure in CIP by selecting E36.

Recently, a new procedure has been made available that transfers the accumulated mileage and service interval data from a defective instrument cluster into a new replacement cluster for these vehicles.

318ti and Z3 Roadster

These vehicles are equipped with an instrument cluster that is not connected to the diagnostic link and therefore

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can not be coded using ZCS. Since the cluster can not be coded, these vehicles require a coding plug for vehicle specific coding.

Like the E32/E34, the coding plug is able to store the accumulated mileage and service interval information. In addition to storing the data on the coding plug the instrument cluster is also able to internally store the data on an EEPROM (Electrically Erasable Programmable Read Only Memory), as redundant back. If the cluster main processor or coding plug need to be replaced, the mileage and SI Indicator data can be transferred to the new component using the clusters test step procedure #9. higher value overwrites the lower.

Test No. 09

DISTANCE READING Test - 09 allows the total stored mileage to be updated if one of the storage components has to be replaced. The test step will be used if the manipulation dot is illuminated in the cluster display. This test step will identify which component has the lower mileage.

Display Example:

012654 I - *Indicates the mileage in the internal EEPROM is lower than the mileage stored in the coding plug.*

000325 E - *Indicates the mileage in the external coding plug is lower than the total mileage stored in the internal EEPROM.*

Pressing the reset button for 4 seconds will over write the lower mileage with the higher mileage and cancel the manipulation dot. The SI data will also be transferred at the same time.

To remove the coding plug from the instrument cluster first remove the snap off cover. Pull the coding plug from the connector in the cluster.

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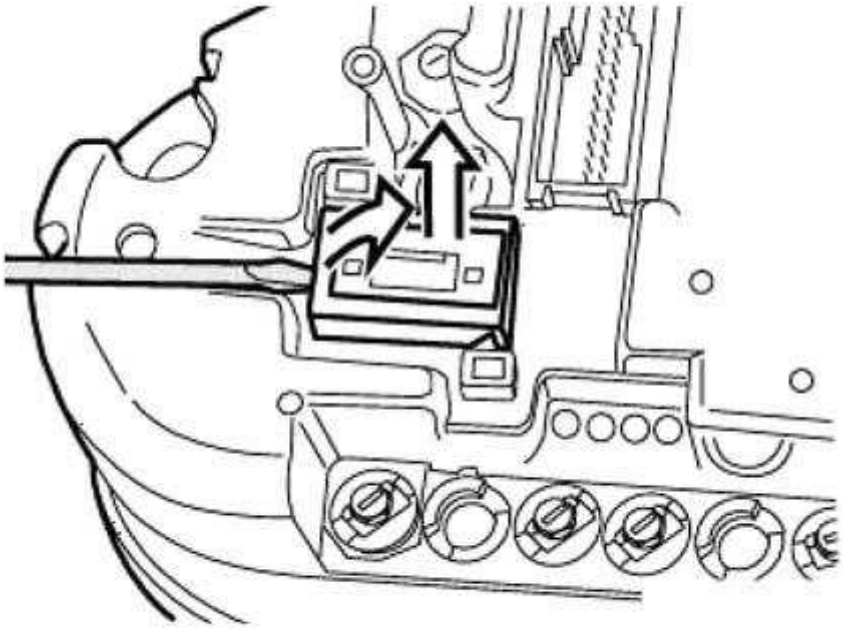


Fig. 58: Removing Coding Plug From Instrument Cluster
Courtesy of BMW OF NORTH AMERICA, INC.

FEDERAL ODOMETER DISCLOSURE REQUIREMENT 92-513

The Federal Odometer Disclosure Requirement 92-513 states that, whenever an instrument cluster component is replaced that brings the odometer back to 0 (coding plug), the mileage prior to its replacement along with the date that the replacement occurred must be recorded on the left door frame of the vehicle.

A permanent label to record this information is included with every coding plug (except E36/5 and E36/7) that is ordered from the parts department.

Additional labels can be ordered separately under Part Number 89 89 1 000 500.

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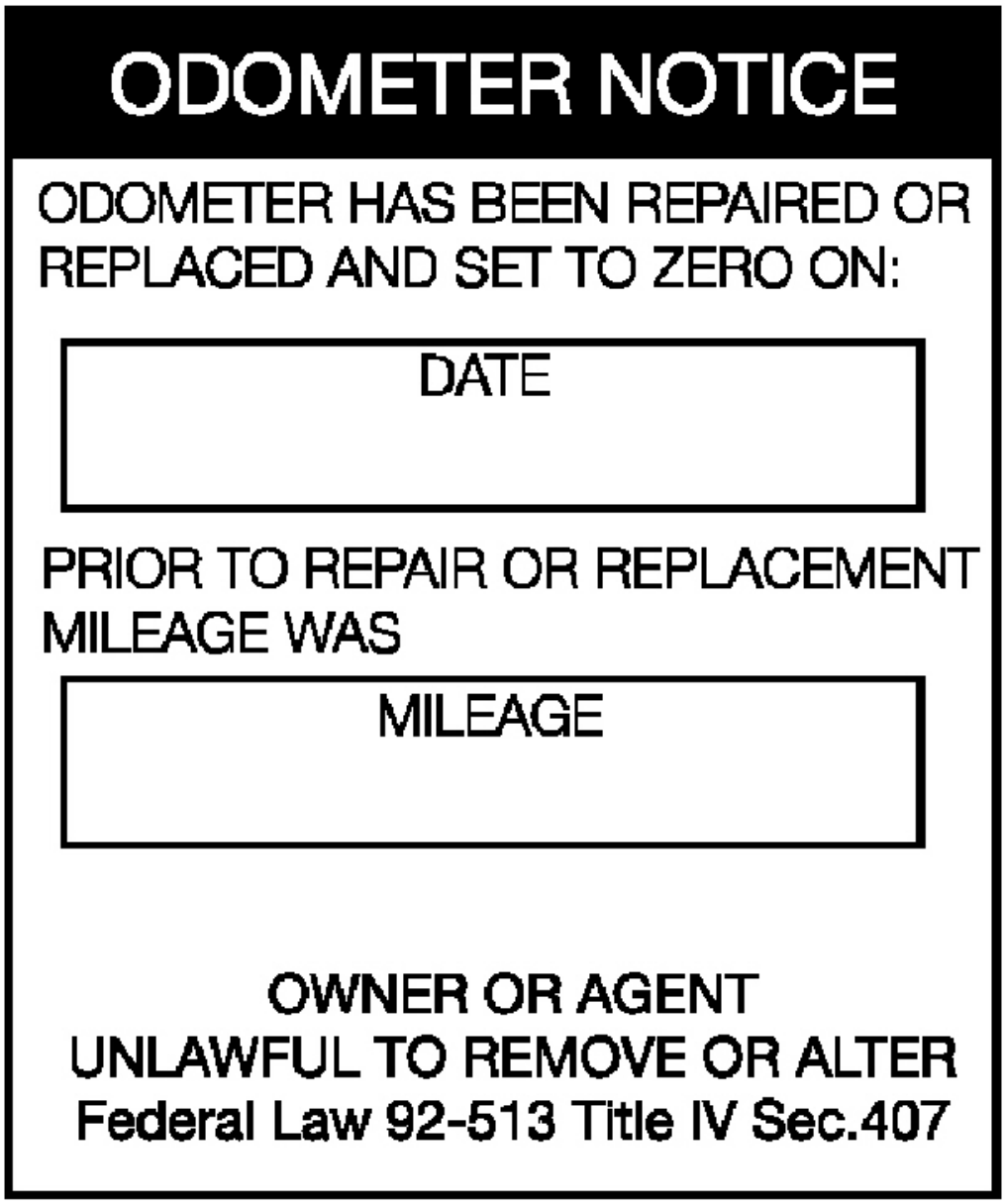


Fig. 59: Identifying Odometer Notice
Courtesy of BMW OF NORTH AMERICA, INC.

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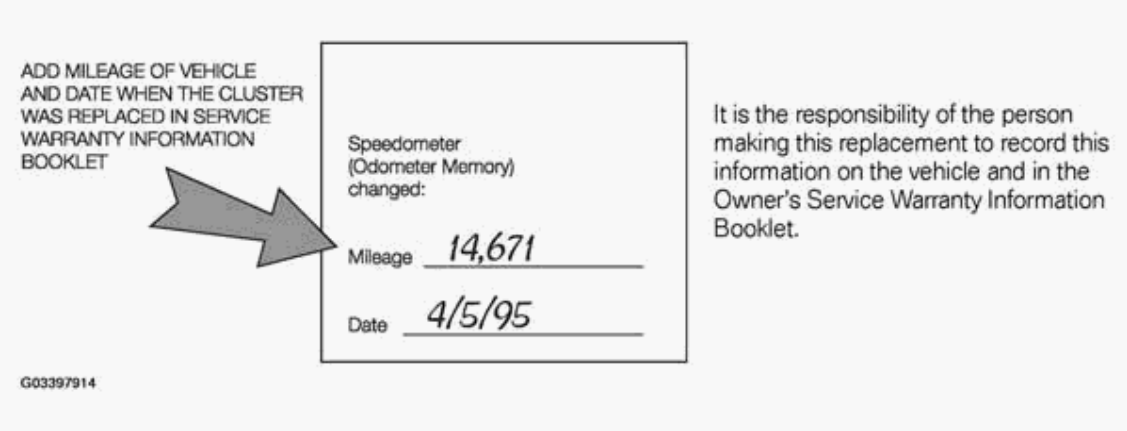


Fig. 60: Identifying Vehicle Mileage And Cluster Replacement Date
Courtesy of BMW OF NORTH AMERICA, INC.

Strict compliance with this requirement must be followed through with the following vehicles if mileage is reset to 0:

VARIANT CODING

Model: E24, E28, E30, E32, E34, E36

Production: 3/87 - 12/95

VARIANT CODING

A Variant Code is another means by which market specific application data can be released/assigned to a control module, this process allows one base control module to be utilized for different market applications.

The variant code is a 4 digit hexadecimal (alpha-numeric) code that is entered into a control module as part of the coding process. By entering a valid code into the module a set of operational data (characteristic maps) specific to the code entered is assigned to the operating program of that control module. The operational data and code are semi rigidly assigned, meaning that if a new code is entered, a different set of data is assigned to the program.

Variant coding is only used on engine control modules. Engine control modules which utilize variant coding were first introduced into production vehicles as of 3/87 production with Motronic M1.1 (Engine Control Module ECM/DME).

Variant coding is only used on Engine Control Modules with version M1.X.

ENGINE CONTROL MODULE ECM/DME INFORMATION

DME Version	Series	Cyl.	Engine	Year
M1.1	E28/E30	6	M20/M30	3/87 - 8/92
M1.2	E24/E28	6	S38	87 - 88
M1.3	E34	6	M20/M30	6/87 - 9/90

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M1.3	E34	6	M30	6/88 - 12/92
M1.3	E32	6	M30	3/87 - 7/92
M1.7	E30/E36	4	M42	3/90 - 12/93
M1.7.2	E36	4	M42	1/94 - 12/95

Using the DISplus/GT1/SSS with the latest CIP programming software contained within Progman, allows the technician to:

- Code a new, uncoded control module.
- Recode a previously coded control module.

The variant code is entered into the control module either by:

- Adopting the existing code from the defective DME control module (if diagnostic communication is possible).
- Manually entering the variant code via the keypad displayed on the screen of the DISplus/GT1/SSS.

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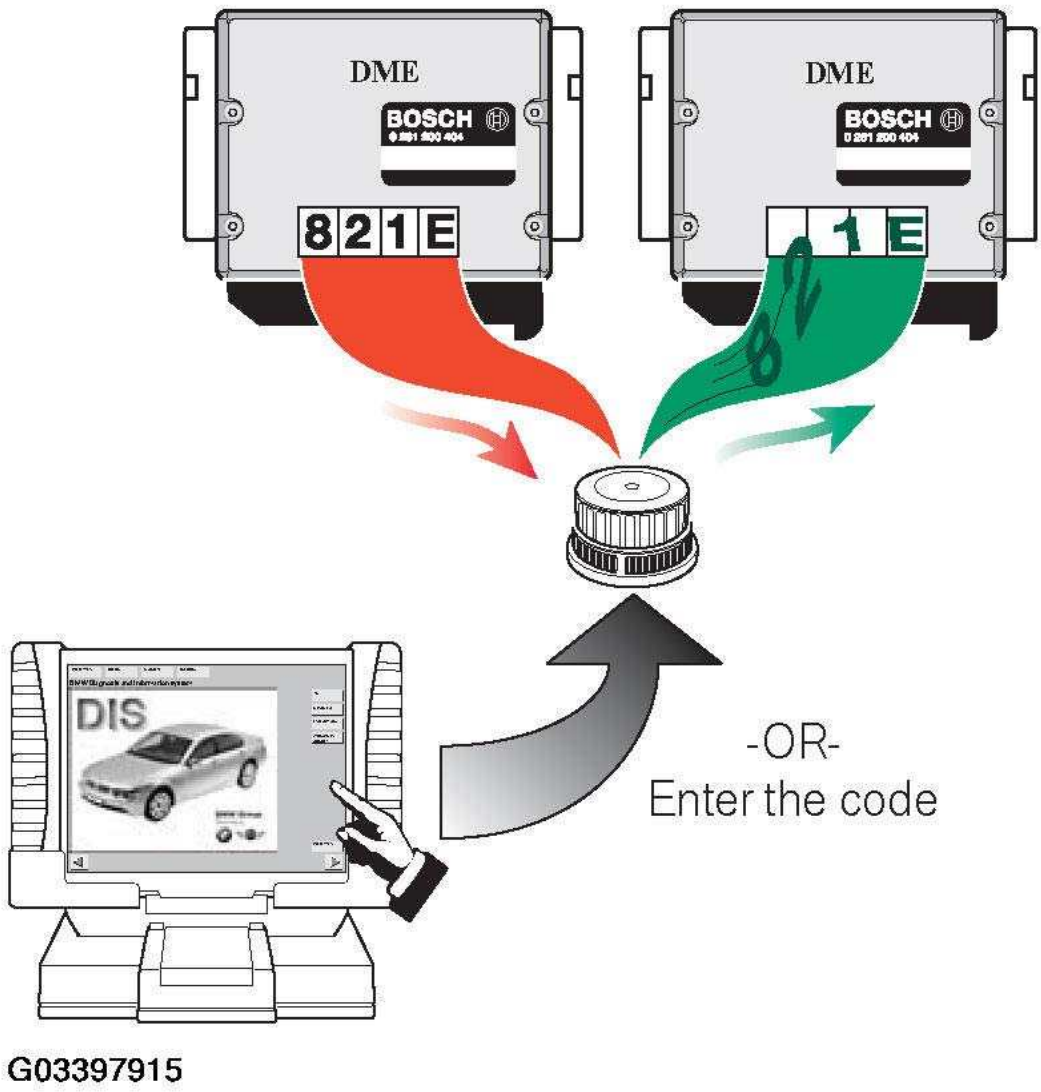


Fig. 61: Entering Variant Code Into Control Module
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: M1.X DME control modules can only be coded up to eight (8) times. The GT1/DISplus will display the remaining number of times the control module can be recoded.

If variant coding of an M1.3 control module for an M20 engine is not possible, the cause may be that Pin 18 (DME Code Link) of the 20 pin diagnostic connector may be backed out of the connector preventing communication between the tester and DME control module.

Variant Code Identification Display

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The variant code for a DME M1.X control module can be accessed in three ways:

- Electronically via DISplus or GT1:
  - DME Control Module Identification screen
  - Select "Programming" then "DME variant code", installed variant code is displayed.
- DME control module variant code label
- ***SI B13 02 90 (3009)***

The quickest and most accurate way to access the variant code of the installed DME is by viewing the DME Identification page using the DISplus or GT1.

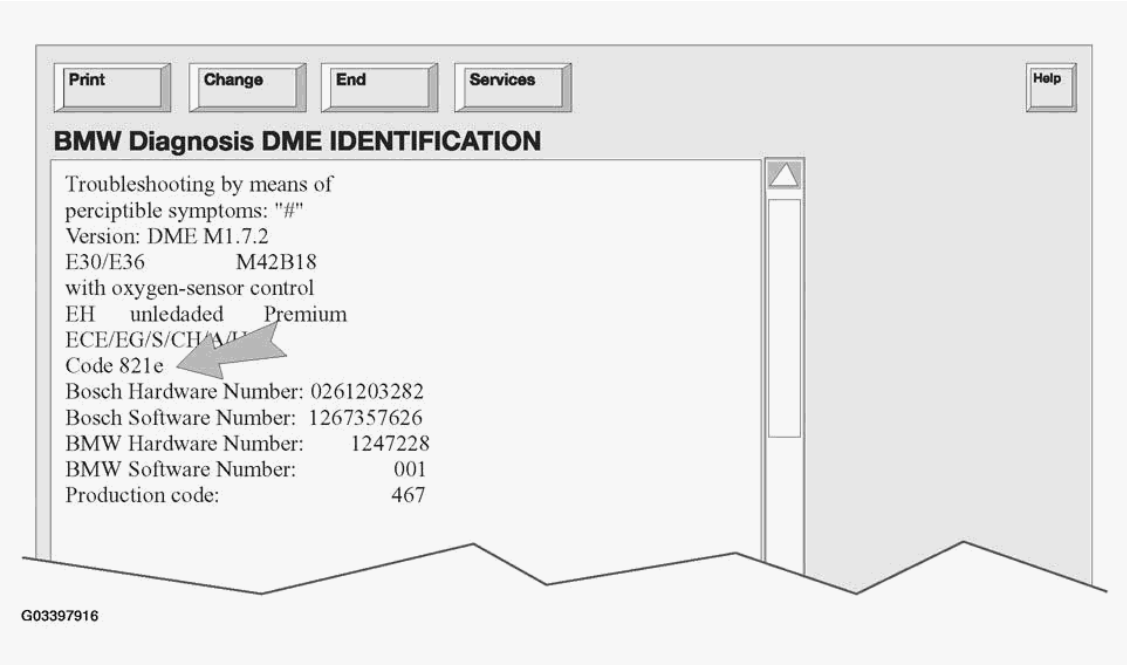


Fig. 62: Identifying DME Identification Page
Courtesy of BMW OF NORTH AMERICA, INC.

If a control module malfunction is suspected cross reference the BMW and Bosch part numbers in the display with the installed variant code. Problems can occur if:

- The correct variant code is installed in the wrong control module.
- An incorrect variant code is installed in the correct control module

Variant Code Structure

The four digit structure of the variant code consists of a 16 bit binary code which converts to a 4 digit hexadecimal code. Each hex character provides information pertaining to specific functions, characteristic maps and vehicle data.

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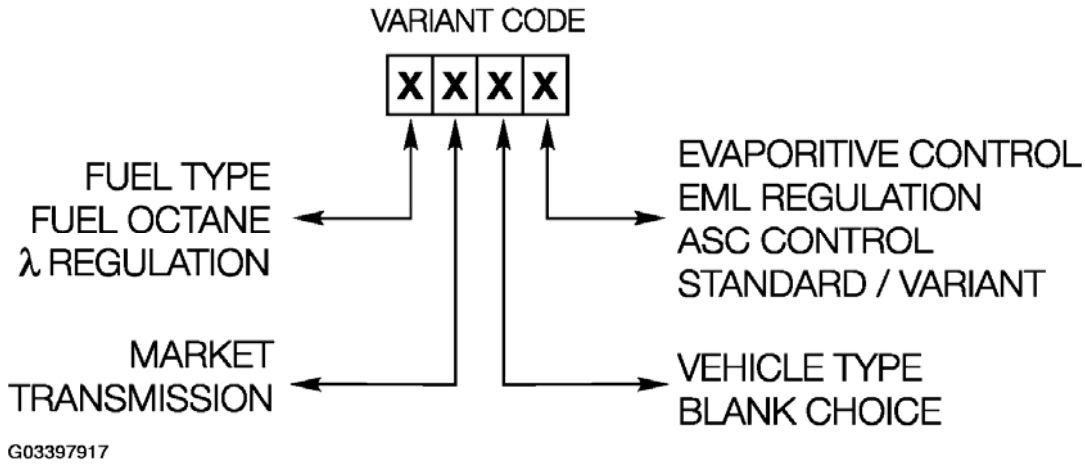


Fig. 63: Identifying Variant Code Structure
Courtesy of BMW OF NORTH AMERICA, INC.

The information from the variant code is used to define the operational data to be assigned to the operating program of the module.

Each hex digit has a binary equivalent that provides four 1's or 0's which results in a total of 16 bits of information (or choices) per hexadecimal digit.

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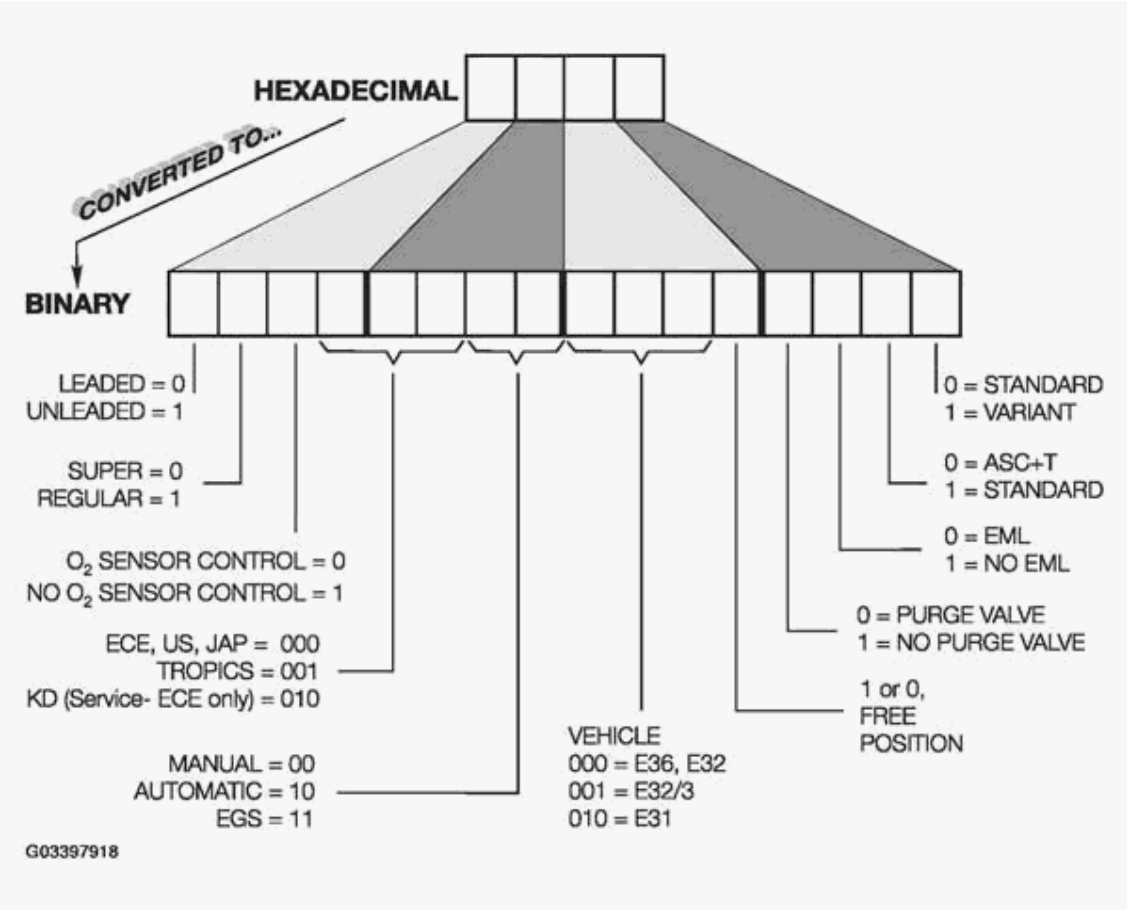


Fig. 64: Identifying Variant Code Information
Courtesy of BMW OF NORTH AMERICA, INC.

Under no circumstances should the variant code to be changed from the assigned number for the vehicle. Erratic engine operation and possible engine damage may result.

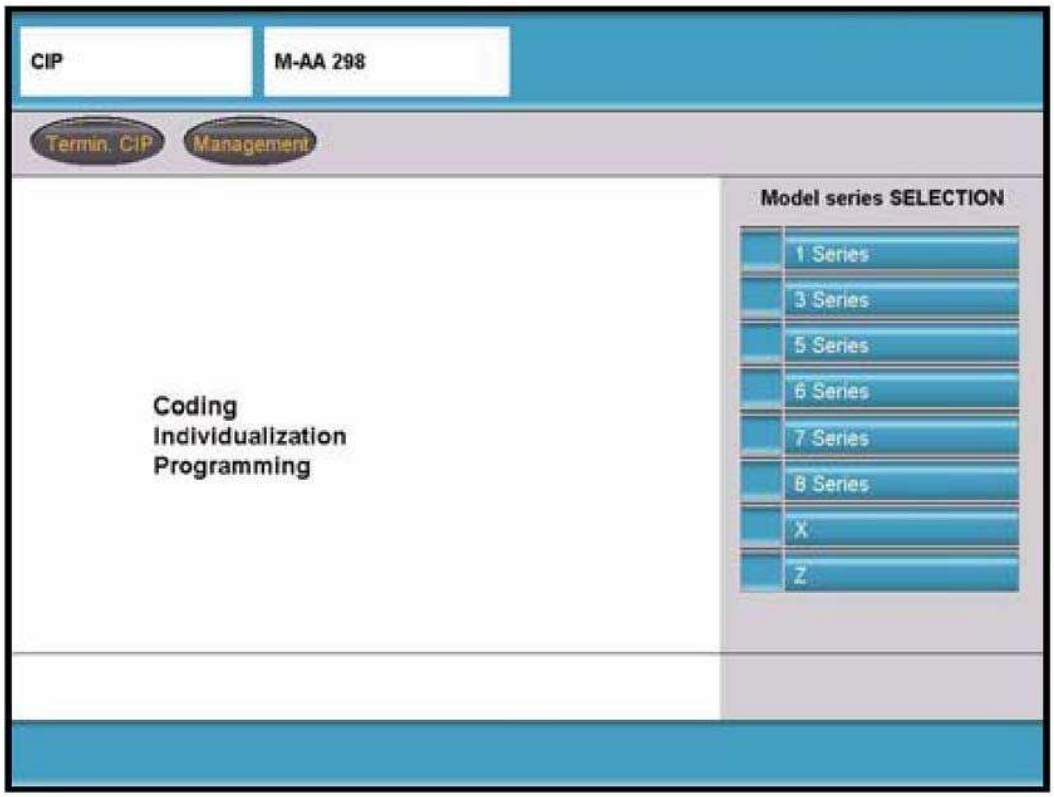
Variant Code Procedure

In the event that an M1.x control module needs to be replaced or recoded the process can be accessed through Progman with CIP 15.0 or higher.

To perform the procedure from CIP the Model series must be selected.

Then select the body (E32, E36 ...)

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Fig. 65: Selecting Model Series Selection Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Select: **"Progammierung"**

Advance screen to the right two times to enter the programming/variant coding selection screen.

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Fig. 66: Selecting Progammierung
Courtesy of BMW OF NORTH AMERICA, INC.

From the "Selection" screen:

Select: **"DME Variant Code"**

Select: **"Exchange Control Unit"**

Select: The Engine version installed on the connected vehicle to be coded Ex. "M40/42/43"

The following steps are based on the selection of "M40/42/43":

"M40/42/43 4-Cyl. has been selected ? Y/N"

Select: **"Y"**

"Is the vehicle fitted with a DME M1.7.3 (M43 engine from 9/95) ? Y/N"

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Select: **"N"**

Select: **1 "New Coding"**

Select: **1 "Adopt code from old control unit"** and follow the procedure indicated once selection is made.

OR

Select: **2 "Enter code manually"** (See **ENGINE CONTROL MODULE ECM/DME INFORMATION** for Variant Code) and follow the procedure indicated once selection is made.

If DME M1.X control module replacement is required, determine which method of variant coding you will need.

- Adopt variant code from existing control module
- Manual input of variant code from control module label

NOTE: For vehicles produced with the M42B19 engine (M1.7.2 Engine Control Module) a replacement EPROM was made available for vehicles produced 1/94-12/95 to address a service issue. Since the control module for this engine requires a variant code in order to assign the correct operating data to the program a variant code must still be assigned to the module upon installing the EPROM.

Adopt a Variant Code

The preferred method of coding a replacement module is by "Adopting" the code from the old module, since this method prevents accidentally entering the wrong code which may occur when trying to manually enter the code. If the control module cannot communicate on the diagnostic link the manual input method will be necessary (refer to **MANUALLY ENTERING A VARIANT CODE**).

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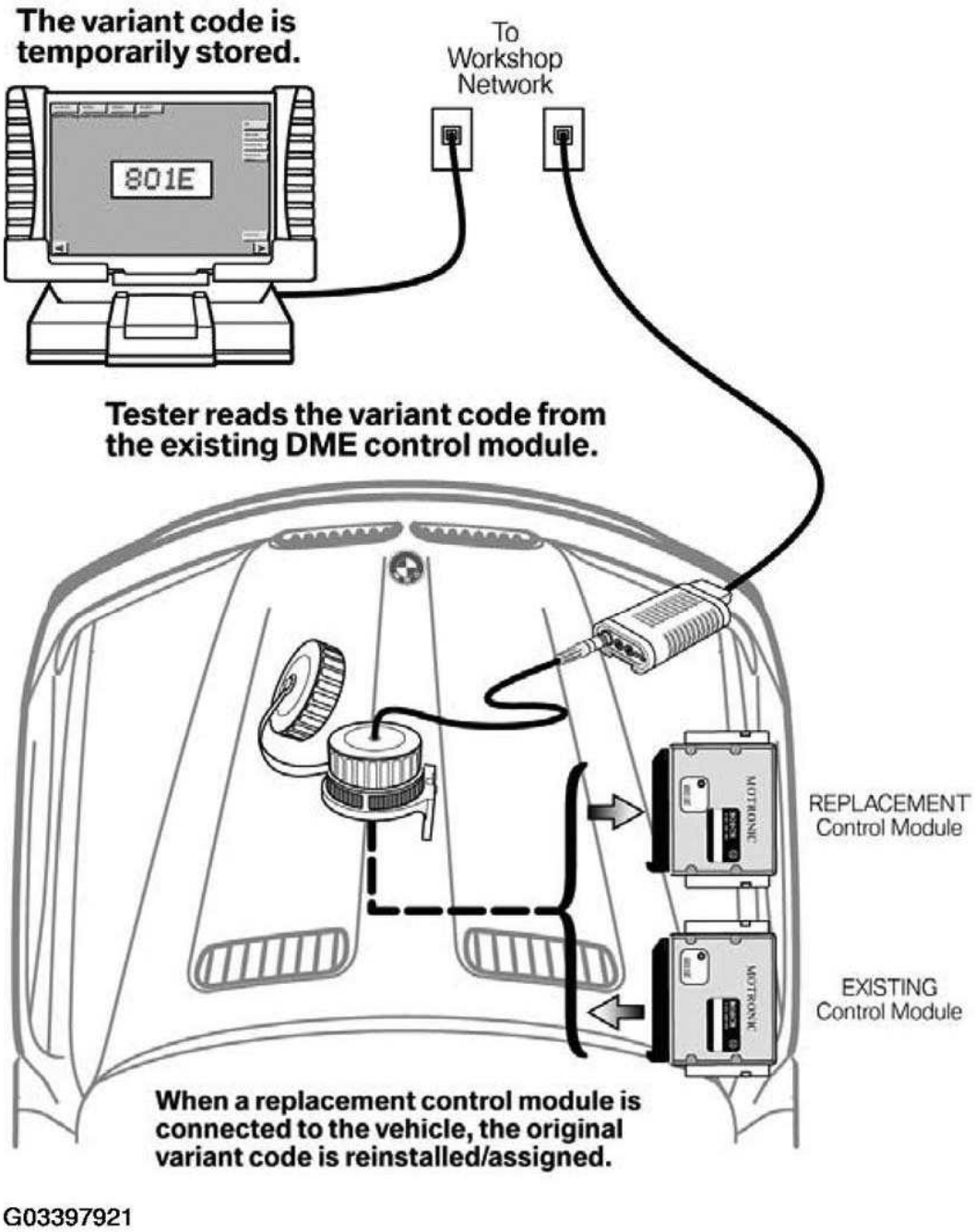


Fig. 67: Identifying Variant Code Adopting Chart
Courtesy of BMW OF NORTH AMERICA, INC.

Manually Entering a Variant Code

The process of manually entering a variant code should only be utilized when it is not possible to communicate

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with the Engine Control Module (DME) via the DISplus or GT1. The variant code to be entered can be taken from the label of the problem control module and checked against the listing of variant codes provided in ***SI B13 02 90 (3009)*** prior to entering the code into the new module.

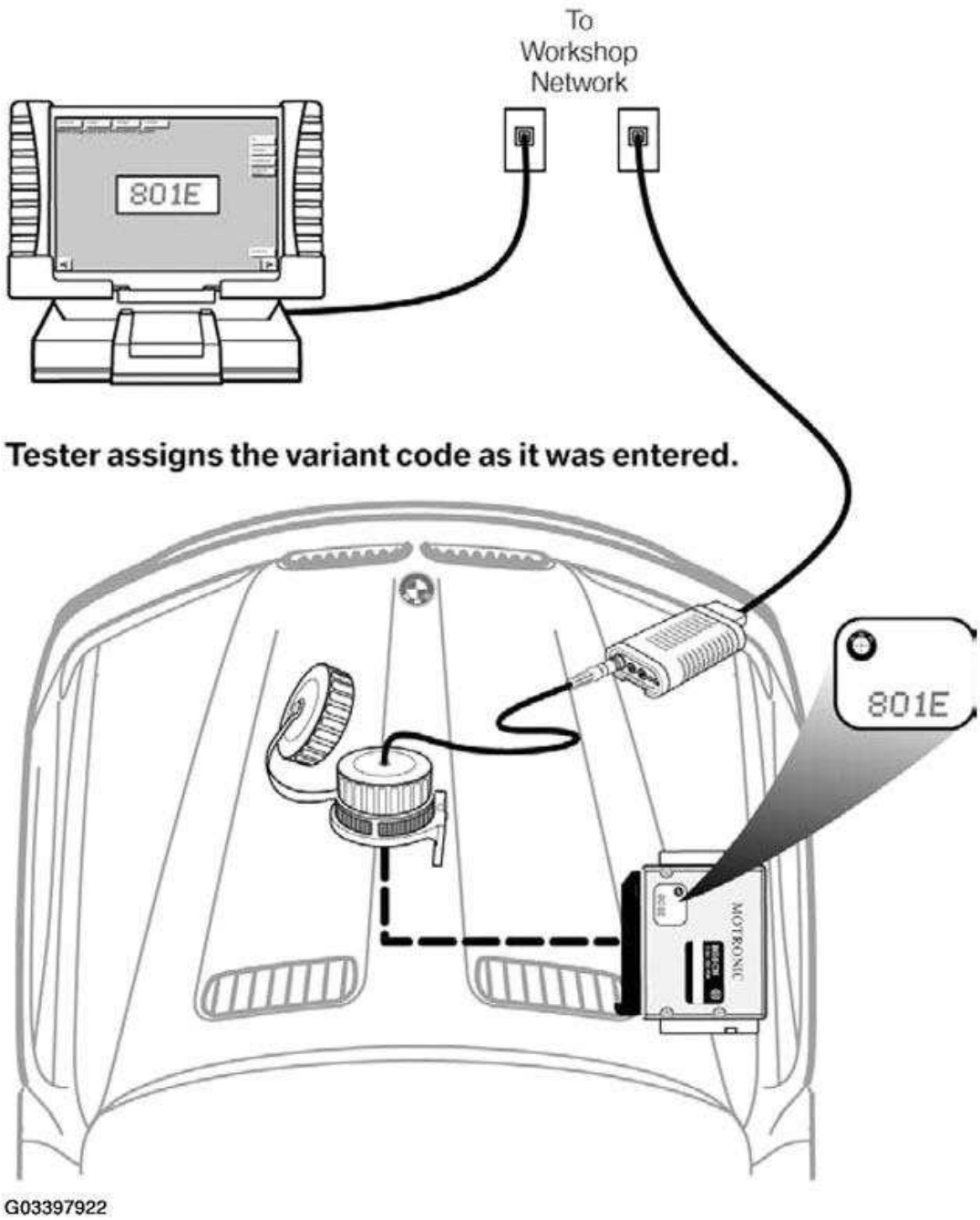


Fig. 68: Entering Variant Code
Courtesy of BMW OF NORTH AMERICA, INC.

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CODING CODE

Model: E32 and E34

Production: 10/90 - 9/91

CODING CODE (CODE NUMBER)

E32 and E34 vehicles produced from 9/90 to 10/91 were not ZCS compatible. For this limited range of production a coding code is required in order to properly code the following control modules:

- IHKR 2 & 3
- EDC III
- DWA

All other replacement control modules (except DME) within this production range are precoded at the factory.

The coding code is a single digit. Like variant coding, the code is entered via the DISplus/GT1/SSS. By entering a valid code into the module a set of operational data specific to the code entered is assigned to the operating program of that control module.

Code Number Identification

Along with the VIN, the Code number for the installed control module(s) is printed on a label, located on the underside of the fuse box cover.

Additional labels are available from the parts department under P/N 01 99 9 784 735

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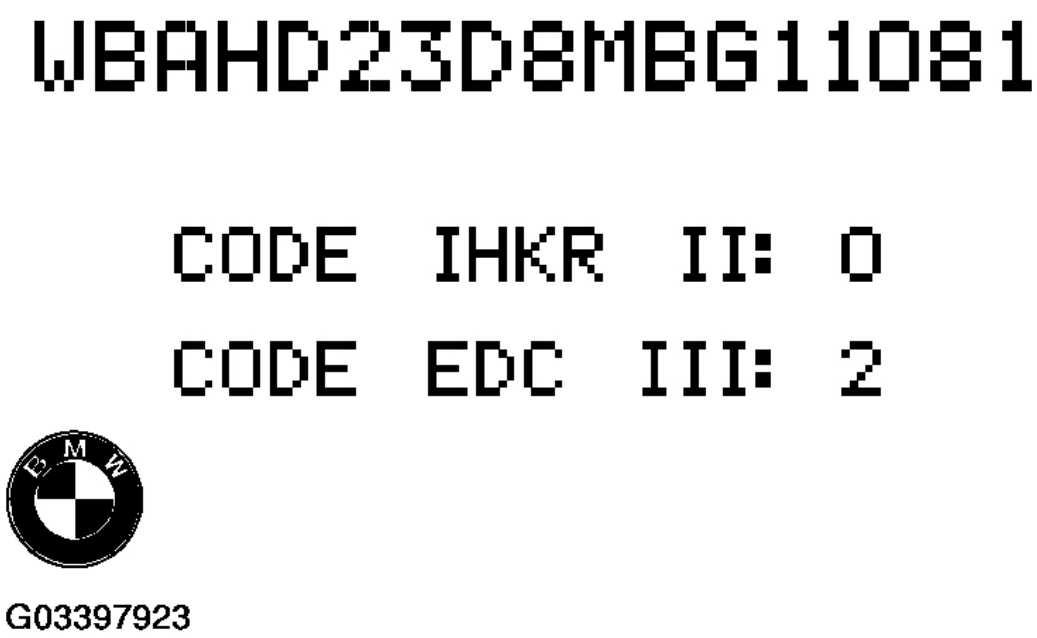


Fig. 69: Identifying Code Identification Number
Courtesy of BMW OF NORTH AMERICA, INC.

Coding Code Procedure

With the original module still installed in the vehicle, select the Coding/Programming function which can be accessed through Progman with CIP 15.0 or higher using the DISplus/GT1 or SSS.

1. From Progman establish a connection to the interface connected to the vehicle and access CIP

   To perform the procedure from CIP the Model series must be selected **(3 series, 7 series ...)**

   Then select the body **(E32, E36 ...)**

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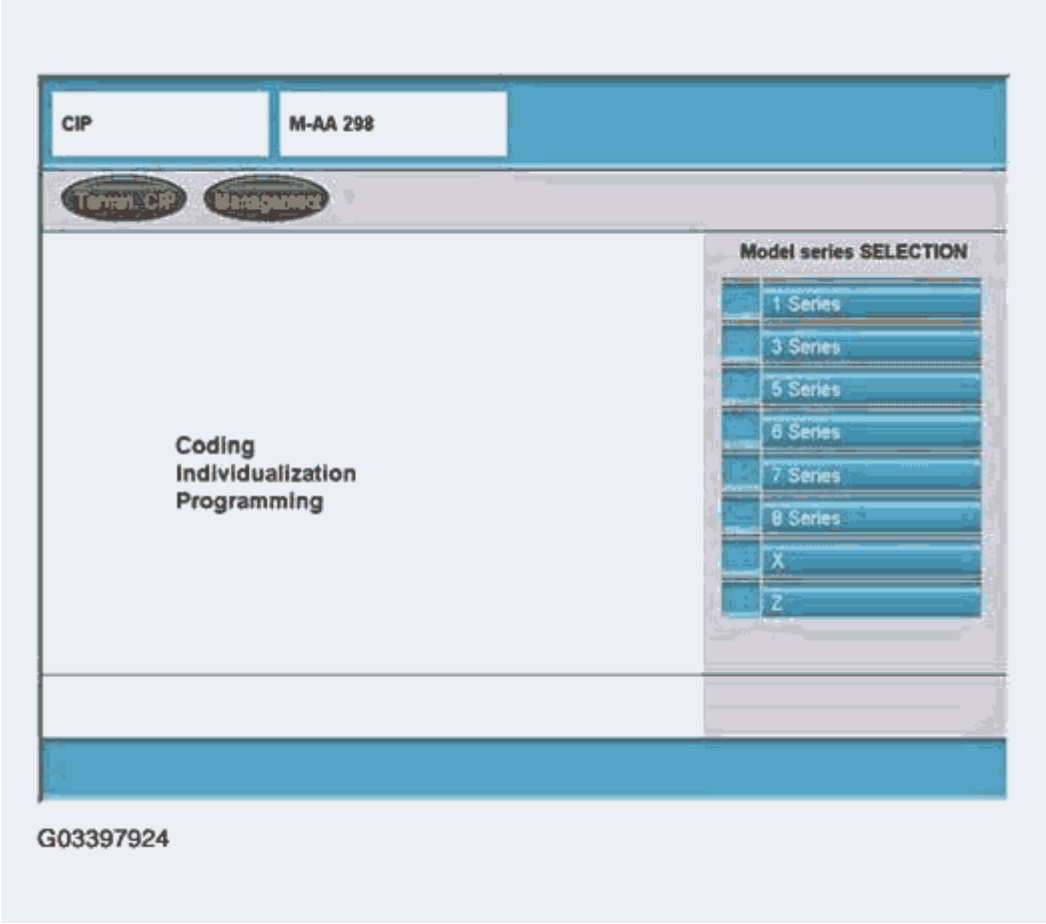


Fig. 70: Selecting Model Series Selection Menu
Courtesy of BMW OF NORTH AMERICA, INC.

2. Select **"Codierung ZCS/FA"**

   (Advance screen to the right two times to enter the selection screen.)

3. Select: Specific model series
4. Select: **"Recoding" or "Coding Code"**
5. Select: **"Replacement part"**

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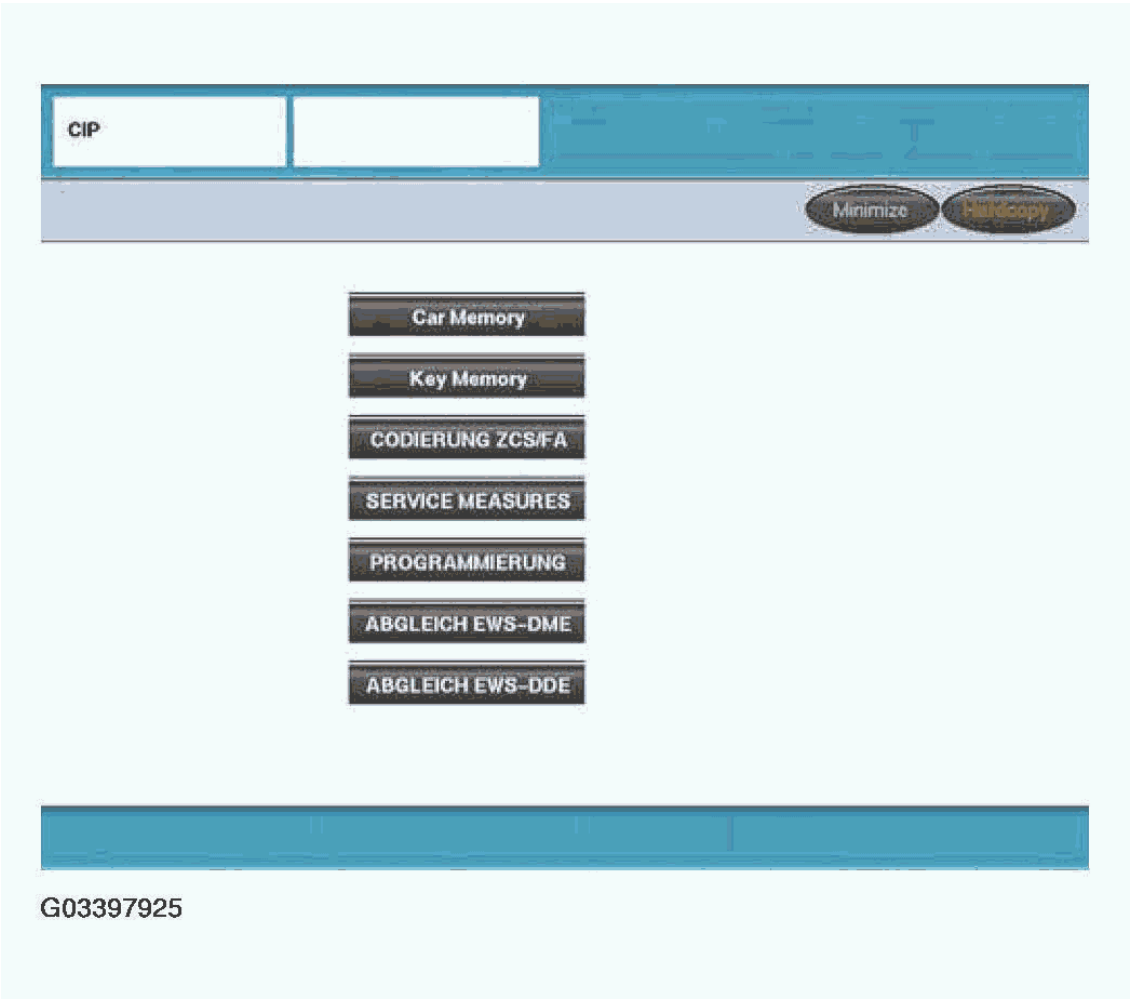


Fig. 71: Selecting Codierung ZCS/FA
Courtesy of BMW OF NORTH AMERICA, INC.

6. Select: Specific system/module to be coded
7. Turn off ignition and remove the old module, install new module and turn ignition on.
8. Advance the screen and enter **"0"** plus the number located on the label of the module
9. Confirm entry
10. 10. If the displayed number is correct confirm and coding will begin A message "Coding Complete" will be displayed when finished coding.

Ordering Pre-Coded Modules

Pre-coded control modules are available from the parts department and requires the following information:

- Part number "Basic Control Module"
- VIN of vehicle for which it is needed
- The "Code Number" indicated on the module

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Workshop Exercise

Access the initial start screen in CIP for performing the Coding Code procedure.

VEHICLE CODING INFORMATION

Model: All

VEHICLE CODING INFORMATION

Introduction

As part of an ongoing process to reduce the need for country, model and option specific control modules, BMW began to utilize a multi digit vehicle coding structure referred to as a Central Coding Key (ZCS) and later changed to a structure referred to as a Vehicle Order (VO/FA).

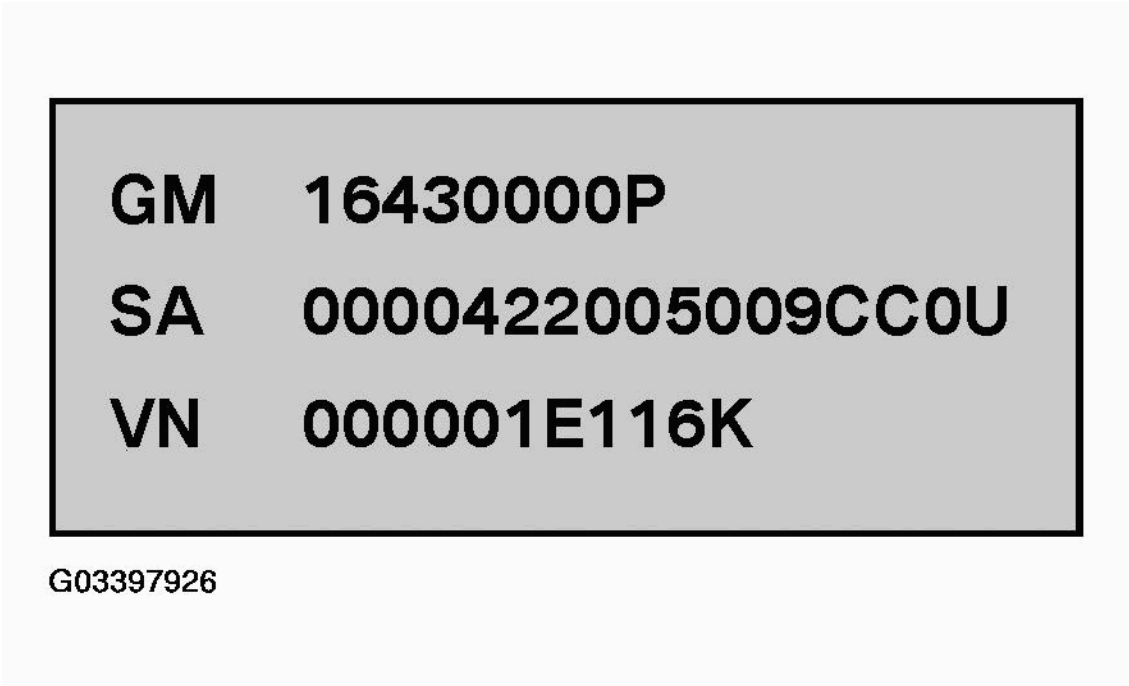


Fig. 72: Identifying Vehicle Coding Information Number
Courtesy of BMW OF NORTH AMERICA, INC.

The Central Coding Key (ZCS) is a unique 37 digit (originally a 48 digit) code that contains specific model, country variation and individual equipment/option information for a vehicle.

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 one or two control modules, depending on the model.

ZCS is often referred to as a "key" since it is able to automatically "unlock" or "activate" specific functions of a

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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.

As the number of options & accessories available for installation in a vehicle increased, an alternative to the ZCS code was introduced on 9/01 production E46 vehicles. The ZCS system was replaced with a system known as the Vehicle Order (VO/FA). The VO is a straight forward listing of vehicle specific information including a list of the option codes pertaining to the systems or equipment installed in the vehicle and is used in the same manner as the ZCS to properly code replacement or additional modules.

Regardless of which structure is utilized on a vehicle, 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.

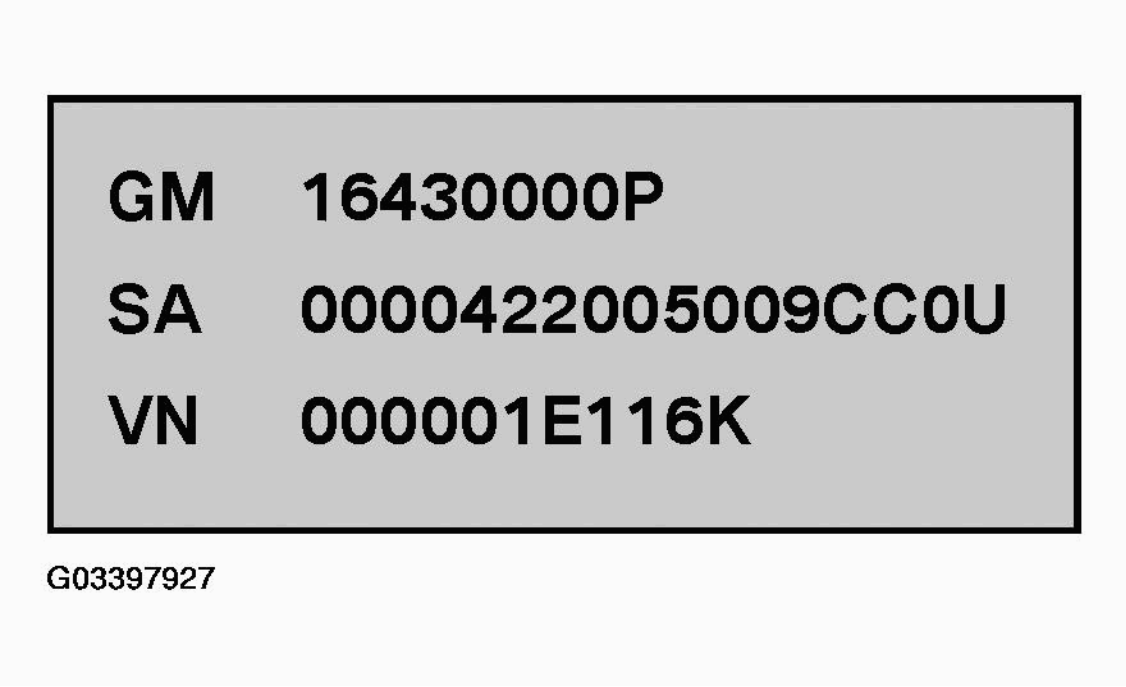


Fig. 73: Identifying ZCS Structure
Courtesy of BMW OF NORTH AMERICA, INC.

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:

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- Canadian market vehicle being moved to the US
- Retrofit installation of an accessory system (ie. CPT9000 phone system or BMW ULF system)

If a modification needs to be made to the ZCS structure and there is no information available in a service bulletin then the BMW 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 (E36, E38, E39 ...)
- Specific body style of the vehicle (Sedan, 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
- Phone 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 VN.

NOTE: In its original form the ZCS was displayed as a 48 digit code containing a fourth segment, the AM (Antriebsmanagement) which identified Powertrain management information specific to the vehicle, however this information was

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eliminated and was not needed for coding a control module.

FOUR DIGIT PORTION REPRESENTS VEHICLE BODY AND SPECIFIC BODY EQUIPMENT (COUPE, SEDAN, ROADSTER, SUNROOF, ETC,)

There are 4096 possible combinations of digits per model.

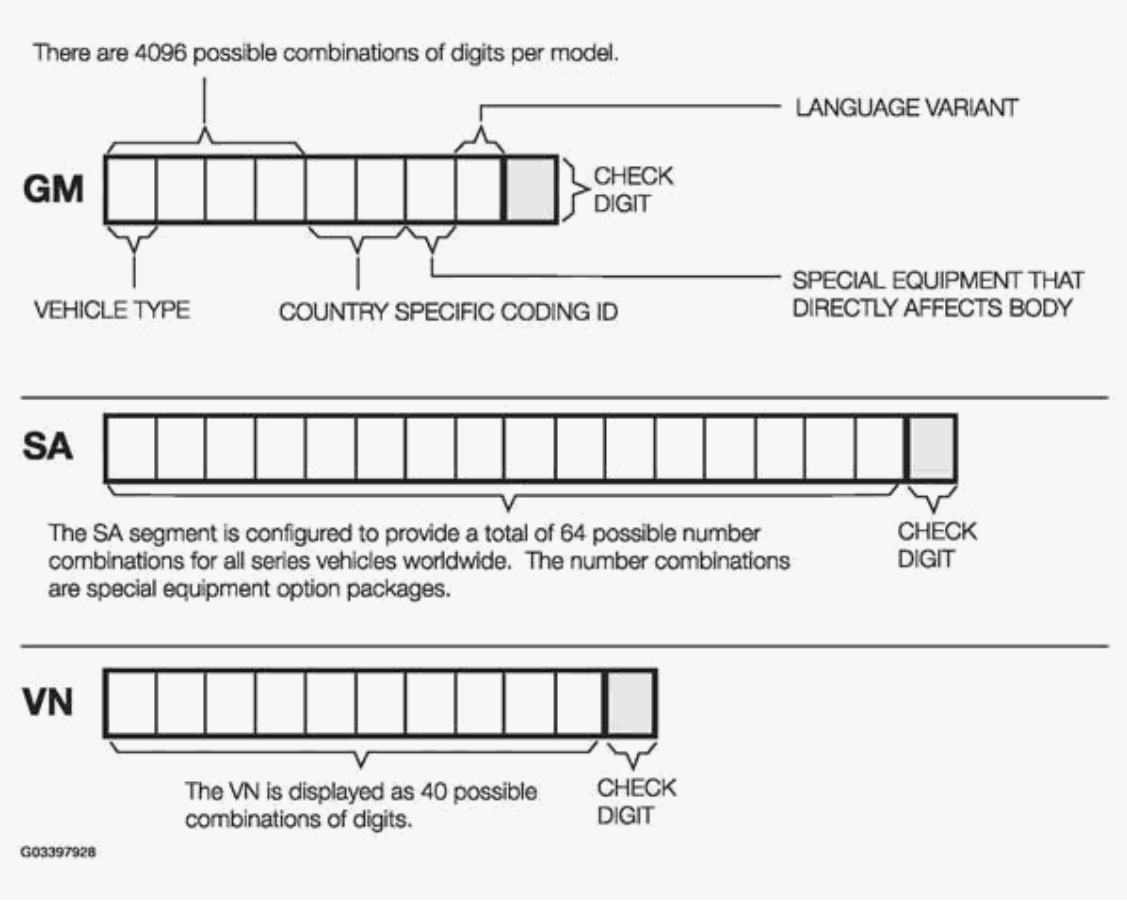


Fig. 74: Identifying ZCS Structure Information Chart
Courtesy of BMW OF NORTH AMERICA, INC.

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:

ZCS STORED LOCATION IN VEHICLE

Vehicle	Model	Module	Vehicle	Model	Module
E31	All	EKM	E39	All	Instrument Cluster/EWS
E32	All	Instrument	E38	All	Instrument

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		Cluster			Cluster/EWS
E34	All	Instrument Cluster	E46(1)	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	Instument Cluster/LSZ
(1) 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 the DISplus/GT1 or SSS using Progman with CIP 15.0 or higher and accessing the "Codierung ZCS/FA" function.

When coding a ZCS codable control module the coding program in CIP 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 storages, 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 DISplus/GT1 or SSS.

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.

ZCS Identification/Display

The ZCS information for a specific vehicle can be obtained by:

- Accessing the control module(s) that electronically stores the information, using the DISplus/GT1 or SSS
- Locating the ZCS label affixed in the vehicle

Accessing Stored ZCS Information

From Progman establish a connection to the interface connected to the vehicle and access CIP.

To perform the procedure from CIP the Model series must be selected **(3 series, 7 series ...).**

Then select the body **(E32, E36 ...).**

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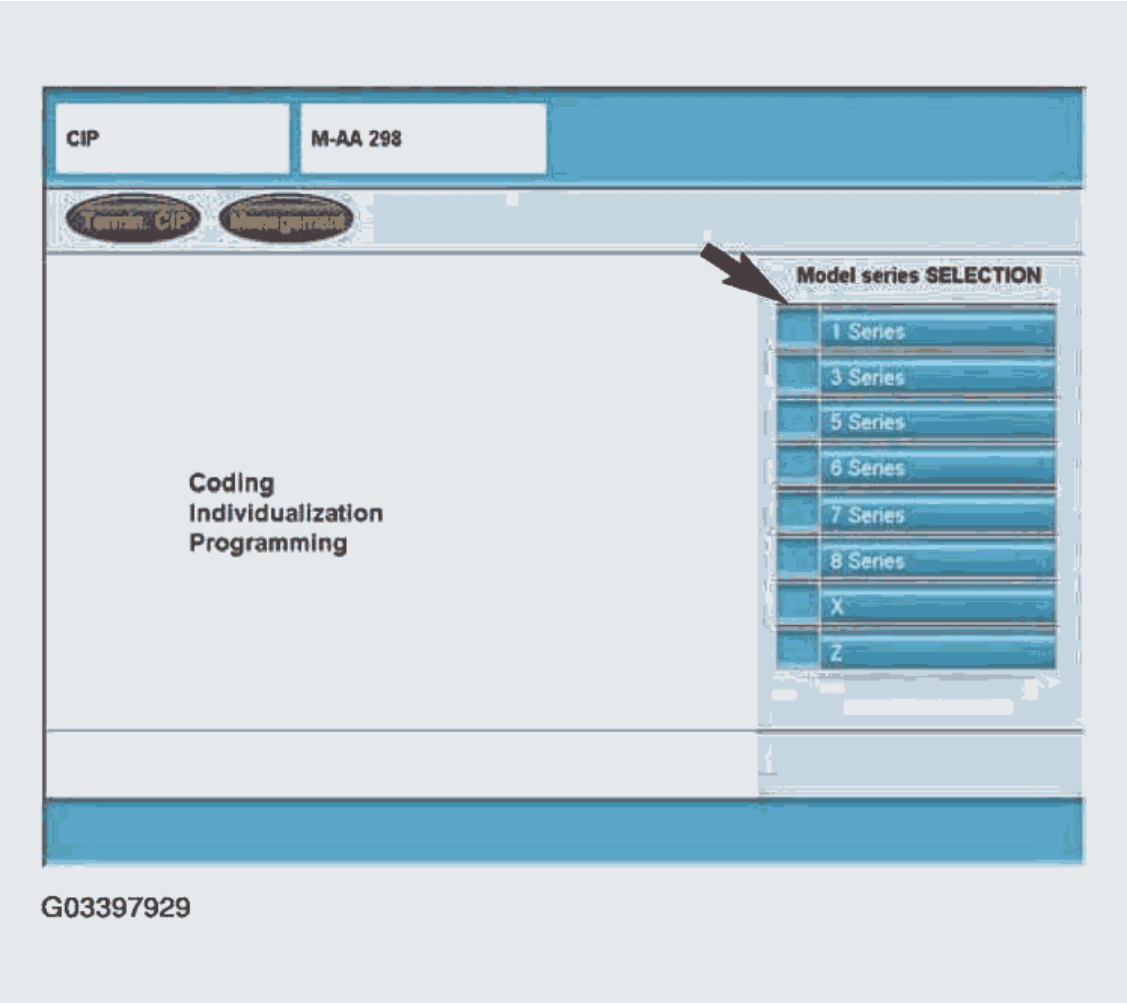


Fig. 75: Selecting Model Series Selection Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Codierung ZCS/FA".**

Then advance screen to the right two times to enter the vehicle series selection screen.

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Fig. 76: Selecting Codierung ZCS/FA
Courtesy of BMW OF NORTH AMERICA, INC.

Example:

Select vehicle series (i.e ***"E36 Series"*** *).*

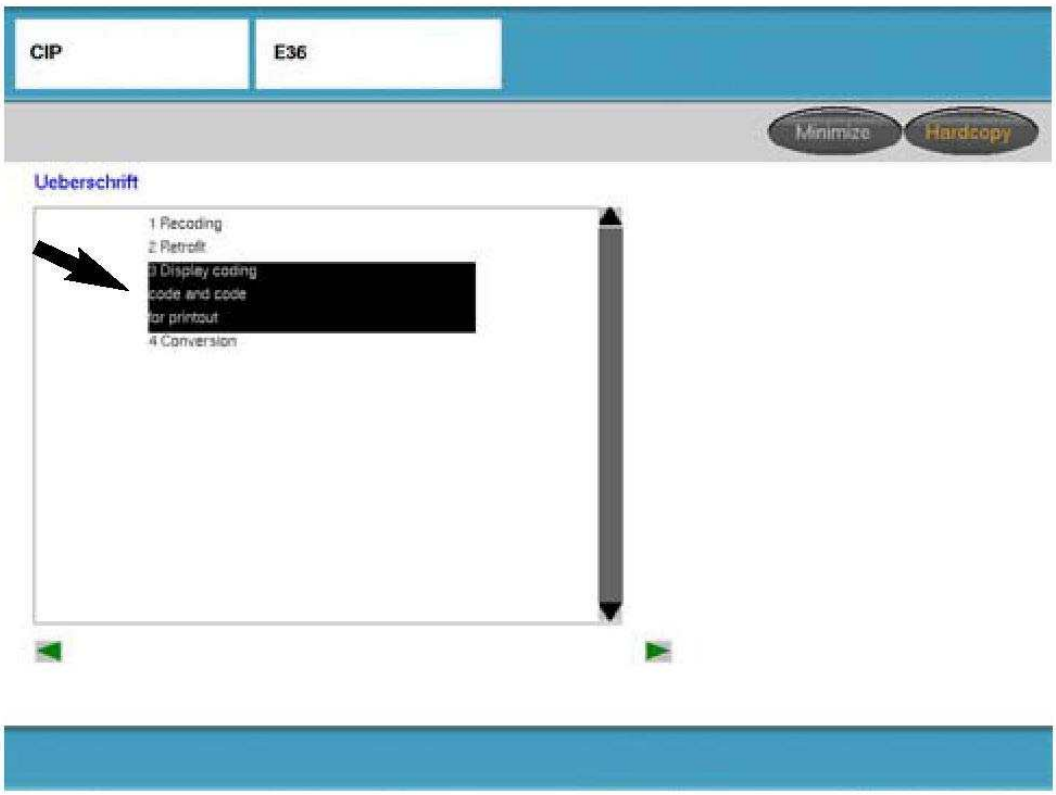
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Fig. 77: Selecting Vehicle Series
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Display coding code and code for printout".**

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Fig. 78: Selecting Display Coding Code And Code For Printout
Courtesy of BMW OF NORTH AMERICA, INC.

ZCS Information for vehicle is displayed along with the stored location.

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Fig. 79: Display ZCS Information For Vehicle Along With Stored Location
Courtesy of BMW OF NORTH AMERICA, INC.

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

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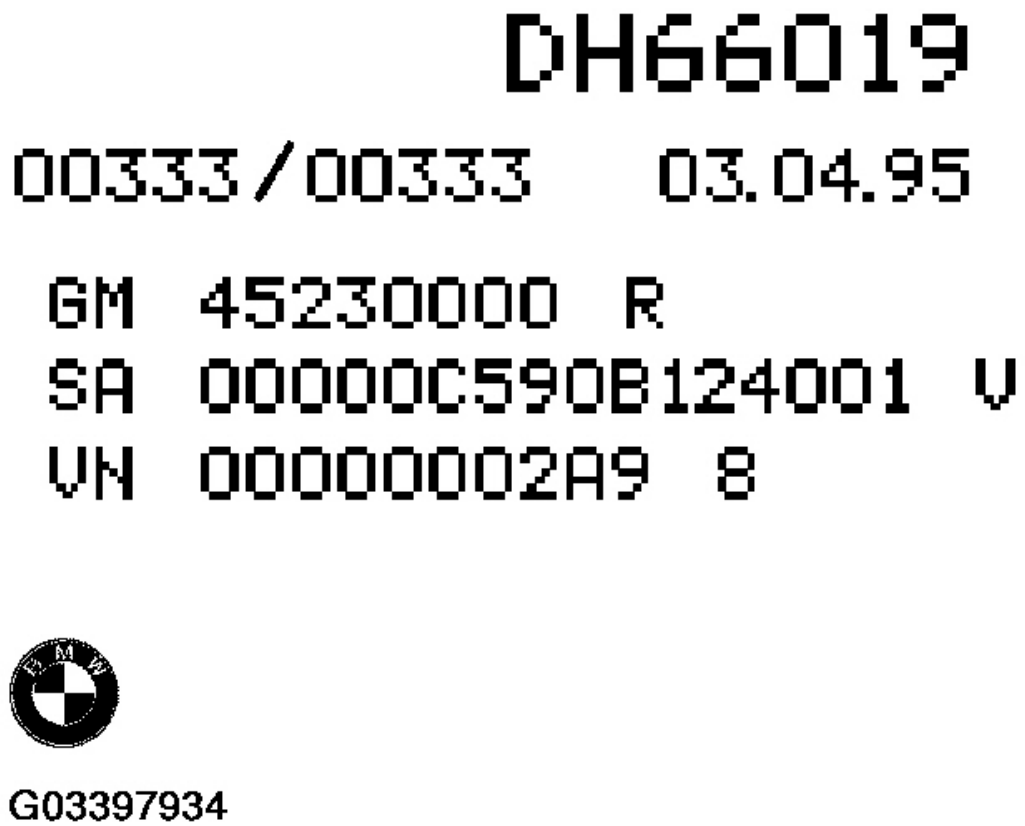


Fig. 80: Identifying Accessing ZCS Information Label
Courtesy of BMW OF NORTH AMERICA, INC.

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.

ZCS Codable Control Modules

Control modules located in a vehicle that are ZCS codable are listed/identified by the "Codierung ZCS/FA" function contained in CIP.

A list of the modules specific to the model can be accessed as follows:

From Progman establish a connection to the interface connected to the vehicle and access CIP.

To perform the procedure from CIP the Model series must be selected **(3 series, 7 series ...).**

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Then select the body **(E32, E36 ...).**

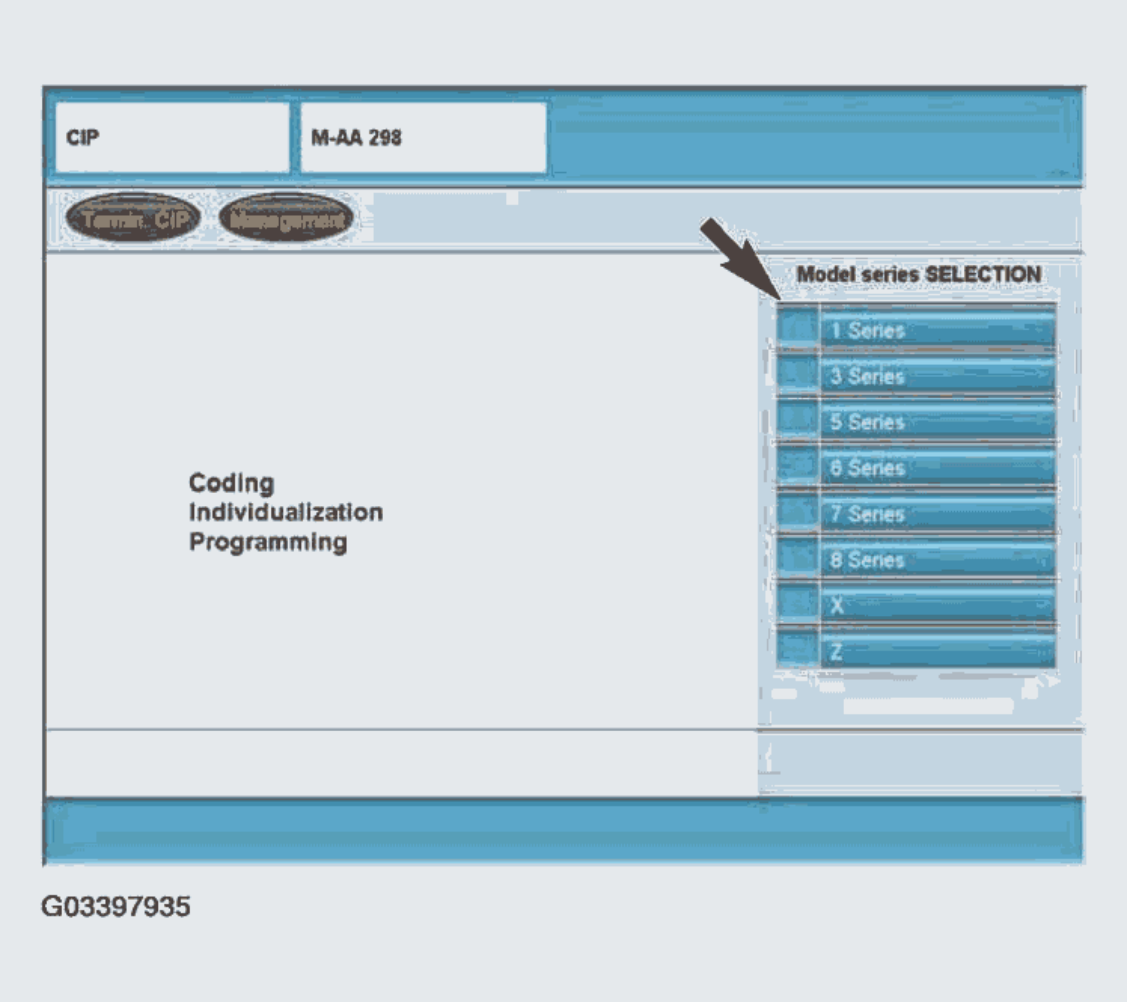


Fig. 81: Selecting Model Series Selection Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"CodierungZCS/FA".**

Then advance screen to the right two times to enter the vehicle series selection screen.

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Fig. 82: Selecting CodierungZCS/FA
Courtesy of BMW OF NORTH AMERICA, INC.

Example:

Select vehicle series (i.e **"E36 Series"**).

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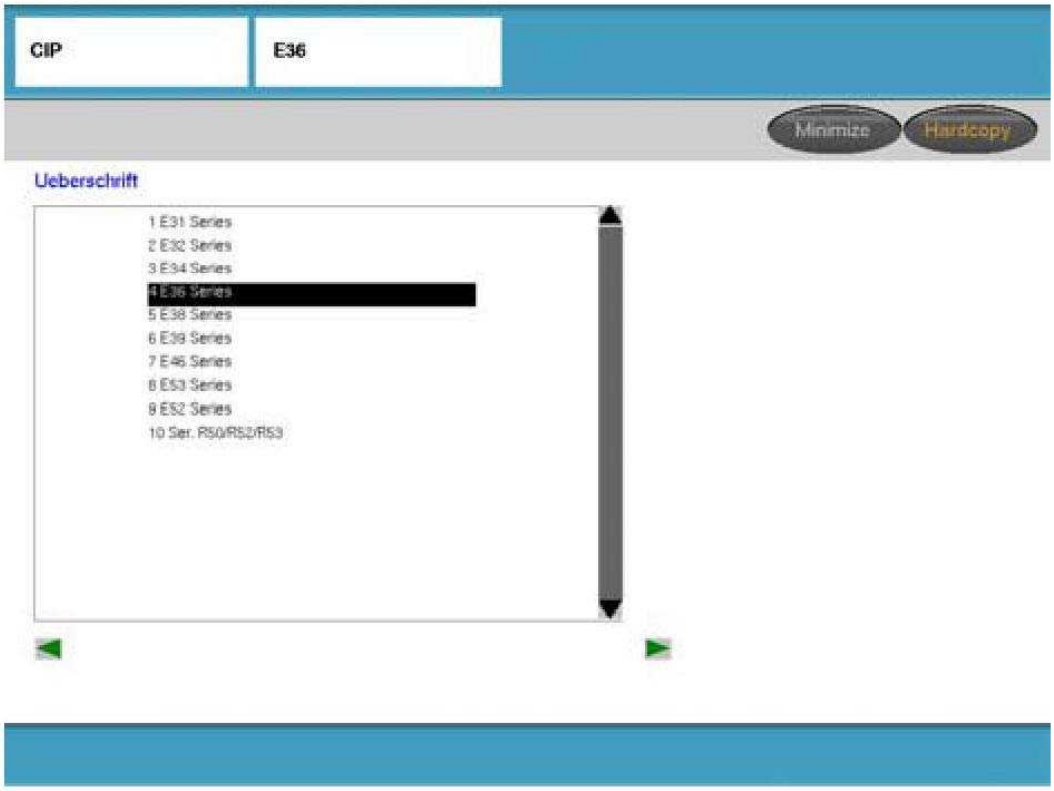


Fig. 83: Selecting Vehicle Series
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Recode".**

Then advance screen to the right.

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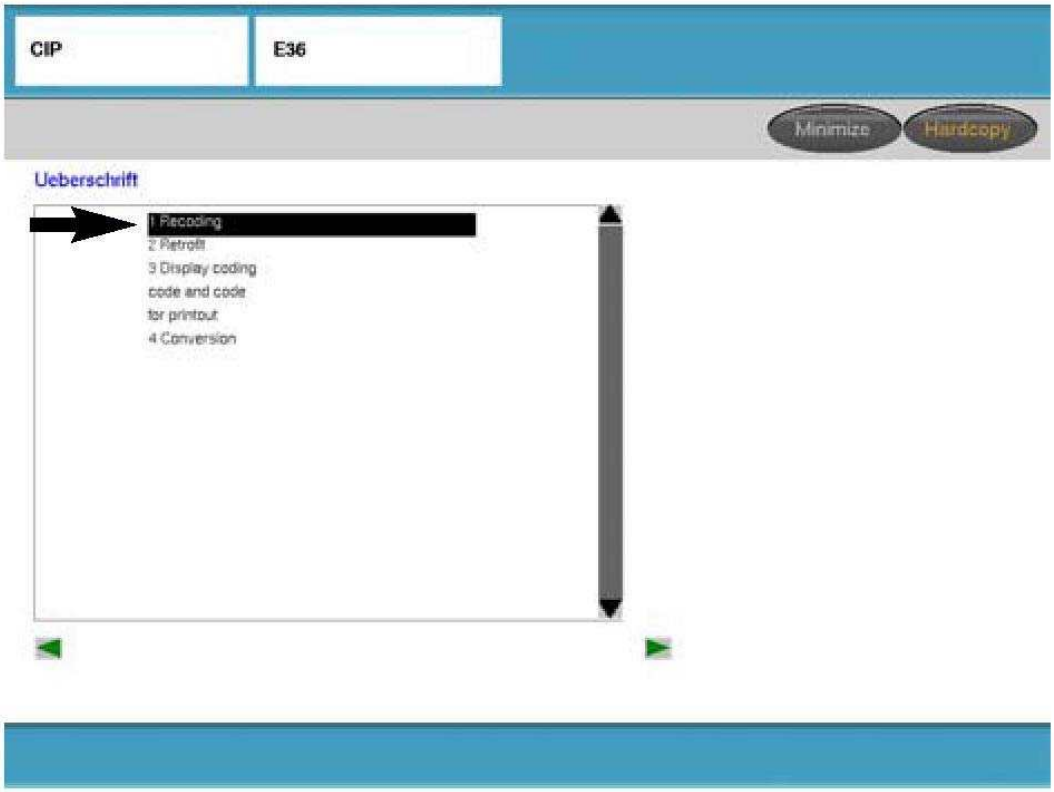


Fig. 84: Selecting Recode
Courtesy of BMW OF NORTH AMERICA, INC.

Displays control modules that are ZCS codable.

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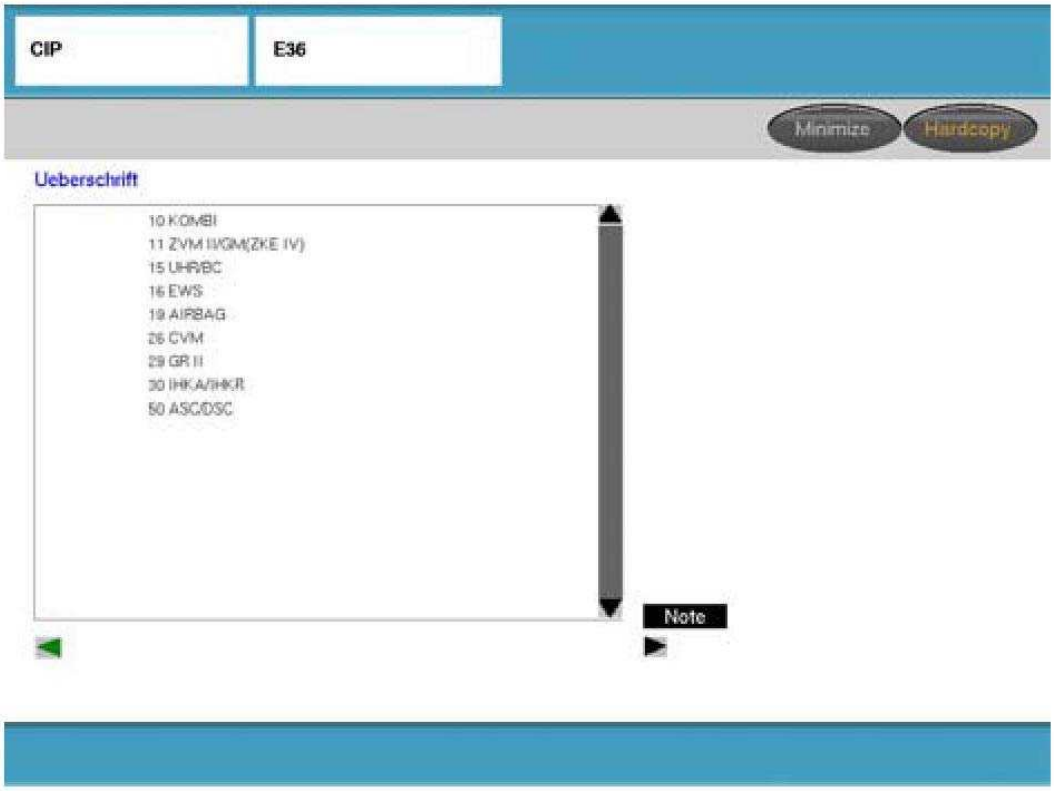


Fig. 85: [Displays Control Modules That ZCS Codable]
Courtesy of BMW OF NORTH AMERICA, INC.

Workshop Exercise

Access the ZCS coding information on an E36, E39, E46 or E53. and identify where the information is stored.

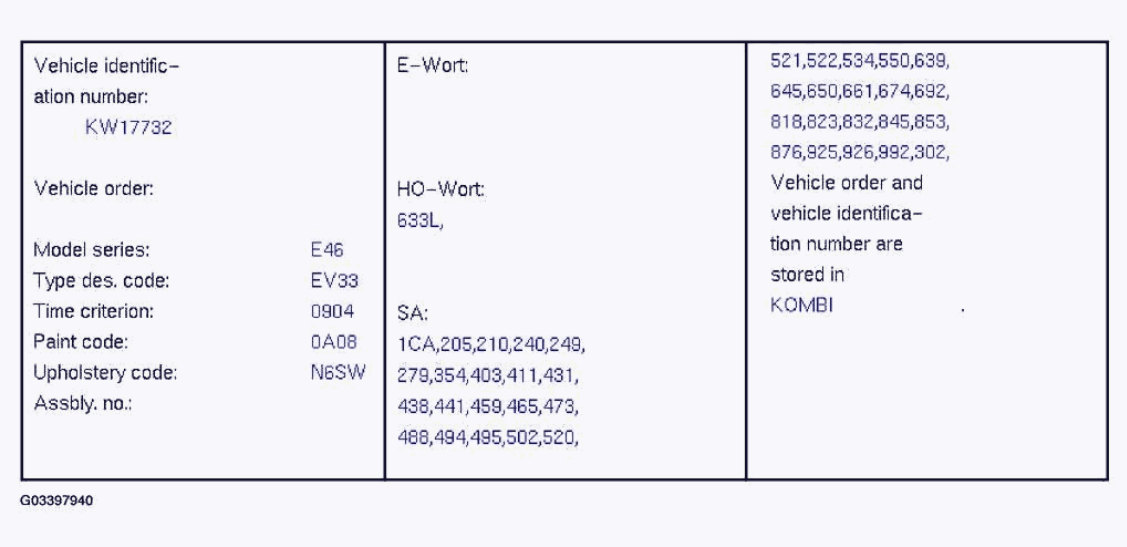
Determine which modules in an E36, E39, E46 or E53 are codable.

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:

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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 and vehicle identification number are stored in KOMBI .
Vehicle order:		HO-Wort: 633L,	
Model series:	E46		
Type des. code:	EV33		
Time criterion:	0904	SA:	
Paint code:	0A08	1CA,205,210,240,249,	
Upholstery code:	N6SW	279,354,403,411,431,	
Assbly. no.:		438,441,459,465,473,	
		488,494,495,502,520,	

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Fig. 86: Vehicle Order Chart (For E46 As Of 9/01 Production)
Courtesy of BMW OF NORTH AMERICA, INC.

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-B110+K639+OI11 +OI12
Vehicle data status:	E060-04-09-504
Target data status:	E060-04-09-504

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Fig. 87: Vehicle Order Chart (For New Models As Of 9/01 Introduction)
Courtesy of BMW OF NORTH AMERICA, INC.

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

Series Type - (E46, E65, E60, etc.)

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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.

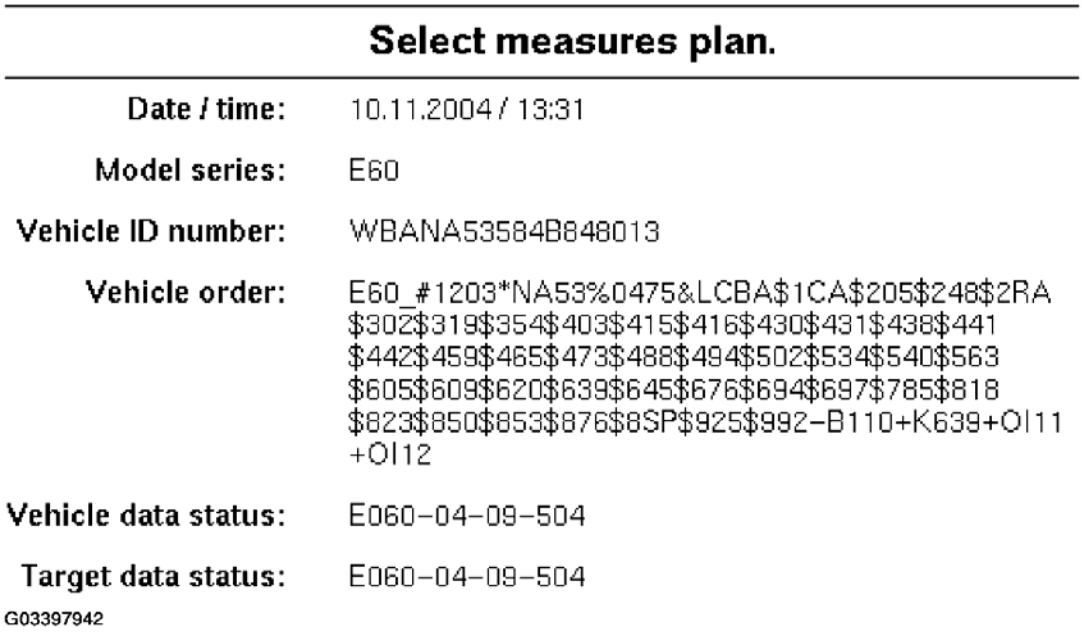
Installed Option/SA Codes - Listing of accessories & equipment options installed in the vehicle.

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*

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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-B110+K639+OI11 +OI12
Vehicle data status:	E060-04-09-504
Target data status:	E060-04-09-504

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Fig. 88: Identifying Select Measures Plan
Courtesy of BMW OF NORTH AMERICA, INC.

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

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2RA - LT/ALY wheels

EPROMS & EEPROMS

Model: E31/32/34/36/38/39

Production: All

INTRODUCTION

Early Engine and Transmission Control Modules used EPROMs (Electrically Programmable Read Only Memory device) to store operational programs and operating data specific for the application that they were used for. Since the operating program and associated data is installed at the factory during the vehicle assembly process updates could not be provided for vehicles once they were programmed and left the factory floor. In order to install a new or updated program (DME or TCM) the module needed to be replaced. Eventually it became possible to replace EPROMs and/or update them which dramatically reduced the cost of updating a module and a vehicle.

ENGINE CONTROL MODULE EPROM PROGRAMMING

With the introduction of M3.X & DME/ECM control modules it was no longer necessary to replace the entire control module in order to install updated engine operating programs and/or data.

ENGINE CONTROL MODULE EPROM PROGRAMMING DATA

M3.X	DME/ECM Version	Vehicle Application
	M3.1	E36 - 325i/is (up to 8/92)
		E34 - 525i (up to 8/92)
	M3.3	E31 - 840Ci (9/93 - 12/95)
		E32 - 740i/iL (9/92 - 8/94)
		E34 - 530i/it & 540i (3/93 - 12/95)
		E38 - 740i/iL (9/94 - 12/95)
	M3.3.1	E36 - 325i/is & M3 (as of 9/92)
		E34 - 525i/it (as of 9/92)

M3.x engine control modules allow EPROMs:

- To be removed & replaced
- Programmed or updated depending on control module version

M3.1 Engine Control Modules

Beginning with M3.1 DME/ECM control modules, BMW introduced the ability to program an EPROM using BMW diagnostic equipment. On the M3.1 control module the originally installed EPROM needs to be removed from the control module and a new partially blank EPROM installed in order to update the existing control module.

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For the M3.1 systems the replacement EPROM that is installed does not contain all the data necessary for the engine to operate, it is a "basic" EPROM that only contains some basic data referred to as "resident data" which helps identify the module and allows the diagnostic equipment to determine what program and associated data needs to be installed/loaded.

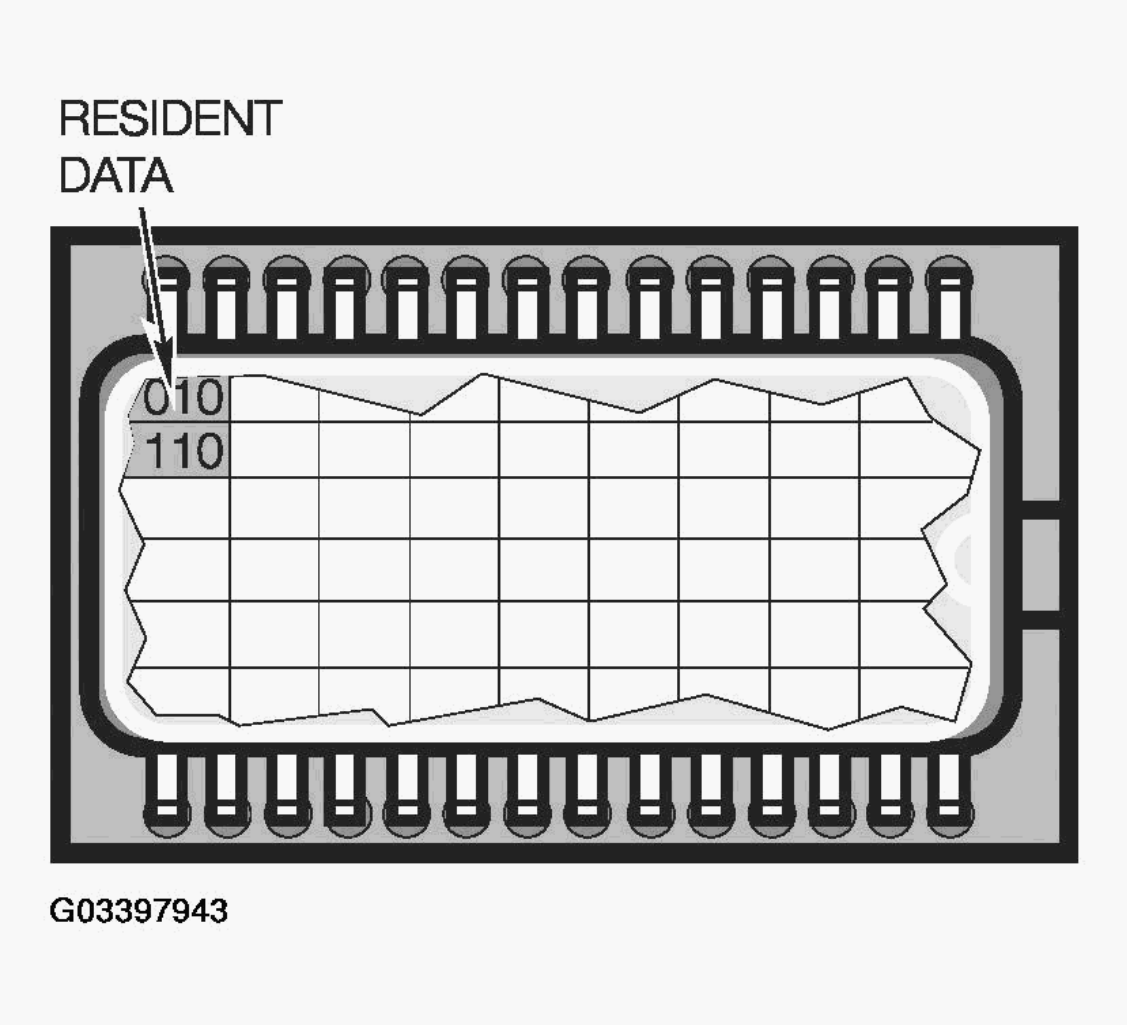


Fig. 89: Identifying EPROM Replacement Information (Basic State)
Courtesy of BMW OF NORTH AMERICA, INC.

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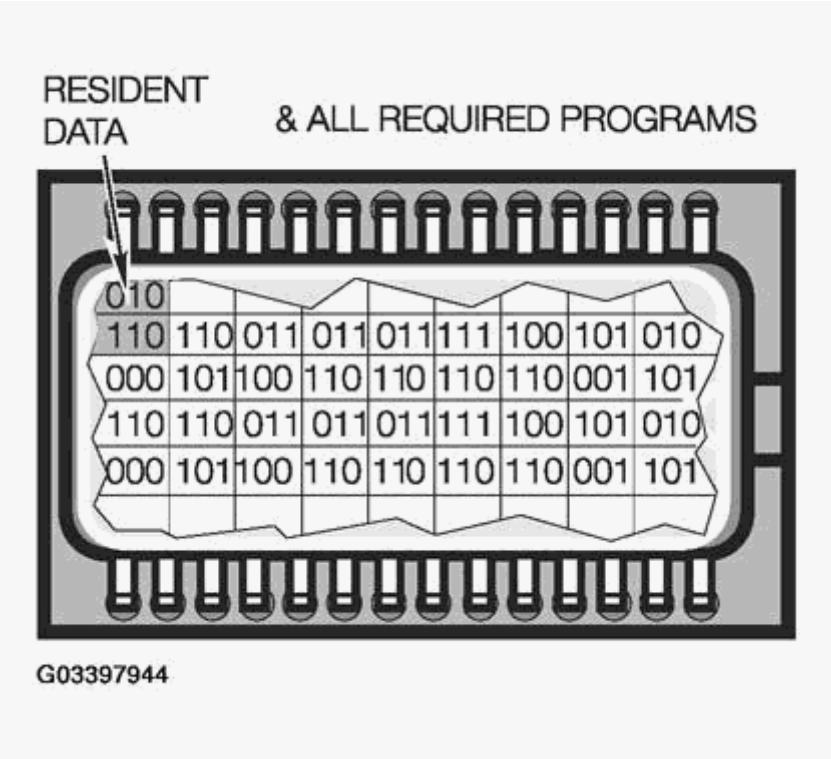


Fig. 90: Identifying EPROM Replacement Information (Programmed)
Courtesy of BMW OF NORTH AMERICA, INC.

M3.3 & M3.3.1 Engine Control Modules

As later versions of engine control modules (M3.3 & M3.3.1) were introduced it was not always necessary to replace the EPROM in order to perform an update to the module. The EPROMs installed on the newer systems are larger and allow additional information to be loaded without having to install a new EPROM. In the event that the size of the update exceeds the space available on the installed EPROM or an update was previously performed, then the installed EPROM will need to be replaced.

THE UPDATE CANCELS THE OLD FUNCTIONS CHARACTERISTICS AND ADDS THE UPDATED FUNCTION TO THE EPROM

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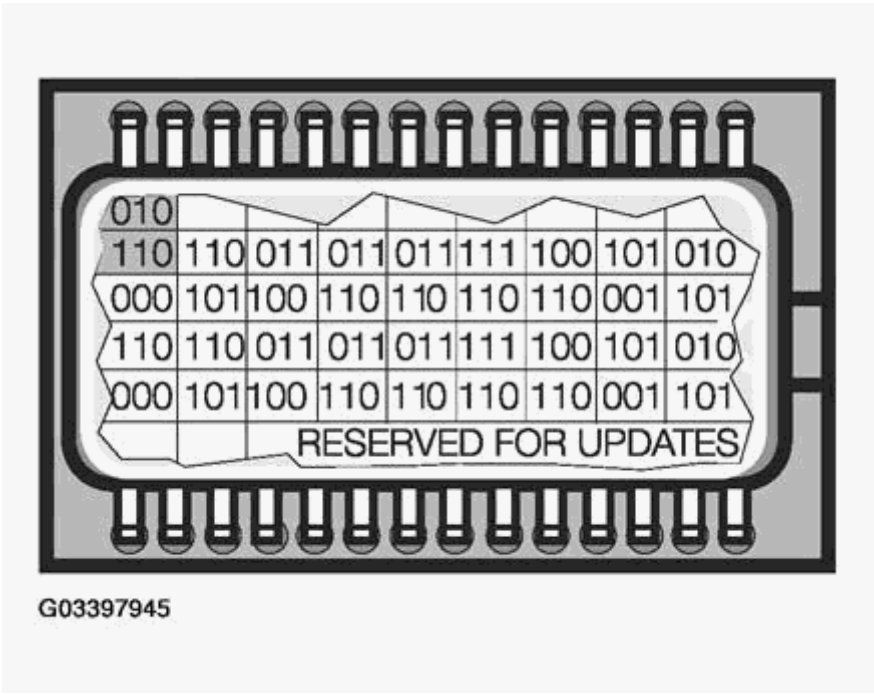
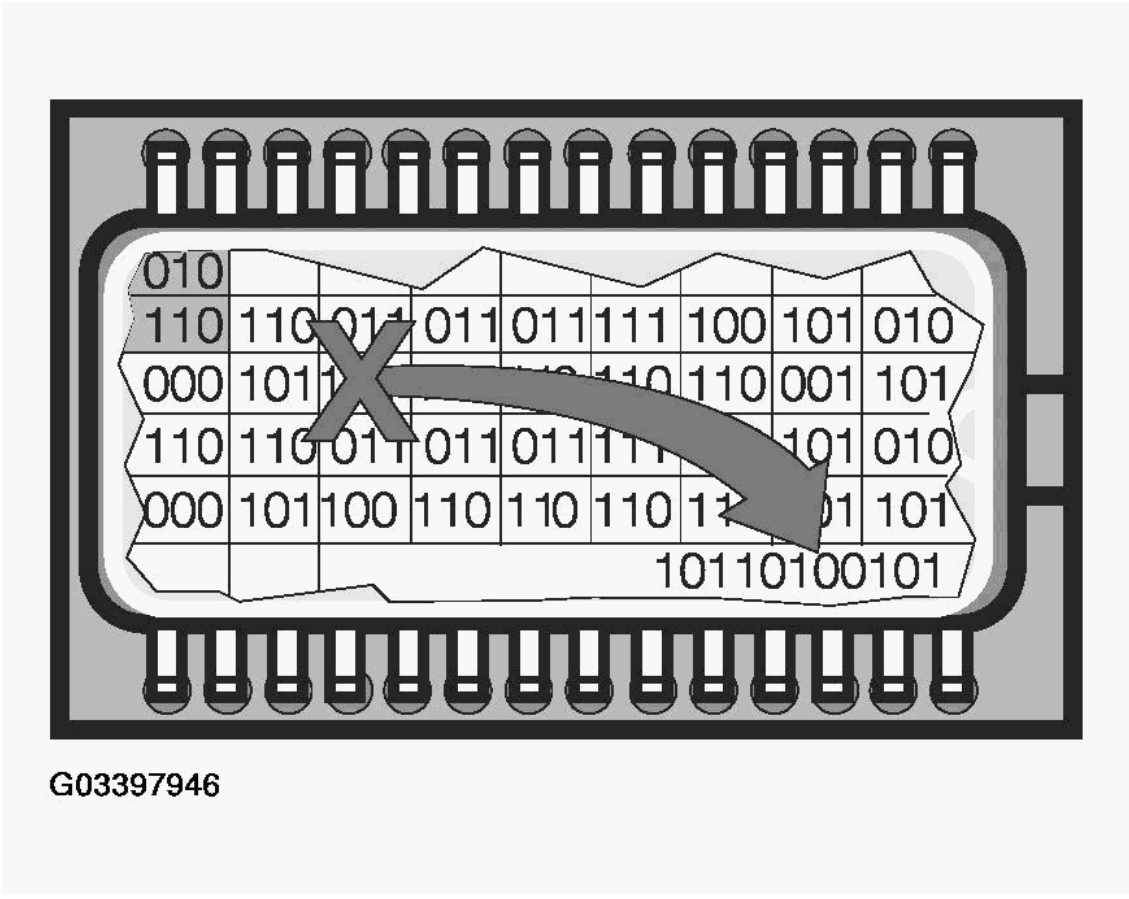


Fig. 91: Identifying EPROM Before Update
Courtesy of BMW OF NORTH AMERICA, INC.



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Fig. 92: Identifying EPROM After Update
Courtesy of BMW OF NORTH AMERICA, INC.

For the M3.3 & M3.3.1 systems the replacement EPROM that is installed does not contain all the data necessary for the engine to operate, it is a "basic" EPROM that only contains some basic data referred to as "resident data" which helps identify the module and allows the diagnostic equipment to determine what program and associated data needs to be installed/loaded.

ENGINE CONTROL MODULES FLASH (EEPROM) PROGRAMMING

At the end of 1995 new variations of DME/ECM control modules were introduced that no longer contained a removable EPROM but instead contained a soldered in EEPROM. An EEPROM is an E lectrically E rasable P rogrammable R ead O nly M emory device, which means 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 newer technology, these 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 control modules listed identify when EEPROMs were first introduced into the DME/ECM:

CONTROL MODULES INFORMATION DATA (DME/ECM)

DME/ECM Version	ENGINE	Vehicle Application
M5.2	M44	E36 - 318i/iA (as of 12/95) E36 - Z3 (as of 1/96)
	M62	E39 - 540i/iA (as 3/96) E38 - 740iLA (as of 12/95) E31 - 840iCA (as of 1/96)
MS41.1	M52	E36 - 328i/iA (as of 10/95) E39 - 528i/iA (as of 2/96)
MS 41.2	S52	E36 - M3 (as of 1/96)

The utilization of EEPROMs within the Engine Management Systems continues to be used today, and has expanded into other control modules as well.

TRANSMISSION EPROMS

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Beginning with vehicles produced in the early 1990's the Transmission EPROM can be replaced on some vehicles in order to address customer complaints that would normally be addressed by having to replace the Transmission Control Module (TCM). Service EPROMs are available for the following systems:

TRANSMISSION CONTROL MODULE (TCM) INFORMATION DATA

TCM Version	Engine	Application
EGS 1.27	M70B50	E31 - 850iA (1/90 - 9/91)
EGS 1.29	M70B50	E31 - 850iA (9/91 - 12/91)
EGS 4.16	M42B18	E36 - 318iA/isA/iCA/itA (12/92 - 12/95)
	M50B25	E36 - 325iA/iSA/iCA (10/91 - 9/95)
		E34 - 525iTA/iA (9/90 - 12/95)
EGS 7.30	M60B30	E34 - 530iA (3/93 - 8/93)
AGS 7.32	M60B30	E34 - 530iA (9/93 - 6/95)
EGS 9.20	M60B40	E34 - 540iA (3/93 - 8/93)
		E32 - 740iA/iLA (9/92 - 9/94)
		E31 - 840CiA (9/93 - 9/94)
AGS 9.22	M60B40	E34 - 540iA (9/93 - 5/96)
		E38 - 740iA/iLA (9/94 - 5/95)
		E38 - 750iLA (1/95 - 6/95)

TRANSMISSION CONTROL MODULE FLASH (EEPROM) PROGRAMMING

The introduction of newer generation Transmission Control Modules introduced with the M44, M52 and M62 engines at the end of 1995, brought with it the ability to "flash" program this module as well. By being able to electrically erase and install a new program and or data stored on the EEPROM, it no longer becomes necessary to replace the chip to get an updated transmission program installed.

The technology used on the Transmission Control module is the same as explained in the section "**ENGINE CONTROL MODULES FLASH (EEPROM) PROGRAMMING** ".

WHEN IS EPROM REPLACEMENT AND/OR PROGRAMMING NECESSARY?

The program and or data of an engine or transmission control module only needs to be updated or replaced if:

- The control module is replaced with a non programmed/basic module.
- A Service Action, Recall or customer concerns have resulted in the release of a new/updated program or revised operational data.

The programming procedure of the diagnostic equipment will identify if:

- a DME EPROM needs to be replaced or can be updated
- a control module (DME or Transmission) can still be programmed or needs to be replaced if the reprogramming limit of 13 times has been reached

How A Replacement EPROM Or Control Module Is Determined

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DME/ECM EPROM

As mentioned previously on the M3.1 Engine Control Modules the EPROM needs to be replaced whenever an update is to be performed. On M3.3 and M3.3.1 Control Modules the EPROM's for these modules generally have enough additional space to add/load one update. However, if the update that needs to be installed is too large, then the installed EPROM needs to removed and a Basic EPROM reinstalled. The diagnostic equipment (DISplus, GT1 or SSS) contains a program within CIP that will determine the part number of the replacement EPROM or control module that needs to be installed.

For some control module variations there is more than one replacement EPROM available.

Example: An M3.1 DME has three different hardware versions:

Bosch Hardware Number 0 261 200 402

Bosch Hardware Number 0 261 200 403

Bosch Hardware Number 0 261 200 405

This requires three different replacement EPROM's, however one EPROM is not necessarily specific to one hardware version.

TCM

Regarding the replacement EPROM for Transmission Control Modules there are specific Service Bulletins which identify various situations that can be addressed by replacing the EPROM in the control module. The replacement transmission EPROM does not require any type of programming after being installed, as it already contains all the program and operational data.

If an early version Transmission Control Module, for vehicles prior to 1996 model year, is replaced it generally also does not need to have the EPROM replaced as the required program is already installed.

Programming Procedure

Within CIP is a procedure that requires the selection of the model/series whenever a/an:

- EPROM needs to be updated/replaced
- EEPROM needs to be updated
- Control module needs to be replaced

Then select "Programming" - "DME Programming" or "EGS Programming" and follow the steps given in the respective SIB.

Workshop Exercise - SIB Look-up

Detailed information pertaining to updates and replacements is provided in:

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SI B12 08 95(4274) - DME EPROM replacement

SI B12 08 94(4117) - M50 DME EPROM Update

SI B12 07 94(4116) - M50 DME Programming Update,

SI B12 09 94(4132) - M60 DME EPROM Update

SI B 12 07 95(4273) - M60 DME EPROM Needs Replacement

SI B12 05 96 - Programming Flash Control Modules (DME)

SI B2404 96 - EPROM Replacement Application Chart

SI B24 05 95 - EGS/AGS EPROM Replacement

Plus additional situation/complaint specific Service Bulletins available on the TIS website.

Determination Process for DME EPROM

In the event a DME EPROM, a control module or the program of a control module needs to be updated or replaced the program contained within CIP will provide the information necessary to perform the specific task. A program within CIP is used to determine the correct replacement part numbers (EPROM, Control Module or software update) to be installed.

For earlier production vehicles there are two ways to perform this process:

- "automatic" determination

  or

- "manual" determination.

The automatic determination is the preferred method as it is faster and mistakes made during data entry into the tester are avoided. For newer production vehicles that utilize EEPROMs/Flash programming the determination process is done automatically as part of determining a measures plan (refer to **CIP** section or more information).

Automatic Determination

In order to determine which EPROM needs to be installed there is a special procedure that is executed as part of the "Exchange EPROM" process. The procedure will "automatically" determine the correct replacement EPROM or control module part number, based on the "Basic part number" and "Programmed part number" stored on the installed EPROM, if the EPROM is not damaged.

The procedure is run automatically if "YES" is selected for the answer to the question Is old EPROM still installed.

During the automatic determination process the tester compares the part numbers stored in the EPROM of the

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currently installed DME control module with a list of possible replacement part numbers contained in the program of the tester.

The comparison is done to determine if the tester can "recommend" a replacement EPROM or control module part number.

Manual Determination

If the EPROM is damaged then the "Basic part number" and "Programmed part number" indicated on the label of the control module that is located on the cover of the module must be entered "manually" via the touch screen on the tester so that the replacement part numbers can be determined.

This procedure is followed if "NO" is selected for the answer to the question "Is old EPROM still installed?"

During a manual determination you will need to:

- Enter the part number for a basic (programmable) control module.
- Enter the VIN number of the vehicle.
- Enter the part number of a programmed control module

Once the correct numbers are entered, the tester searches a "master list" for the proper replacement part number and will display either that part number or the message "no substitute found."

Regardless of which process is used if the replacement part does not match the part number displayed and "expected" by the program on the tester, programming will not occur. You need to obtain the proper replacement part.

At no time during the determination or programming process should you turn off the ignition, disconnect the control module or tester/interface.

Once the EPROM is programmed by way of the "Automatic" or "Manual" determination process it contains the operating program for the engine and the associated operational data or characteristic maps. In the event a basic replacement control module is installed, the EPROM installed in the control module will be programmed in the same manner.

NOTE: The EPROM in a basic replacement module does not need to be replaced since it only contains the "resident data" and nothing else.

PROGMAN

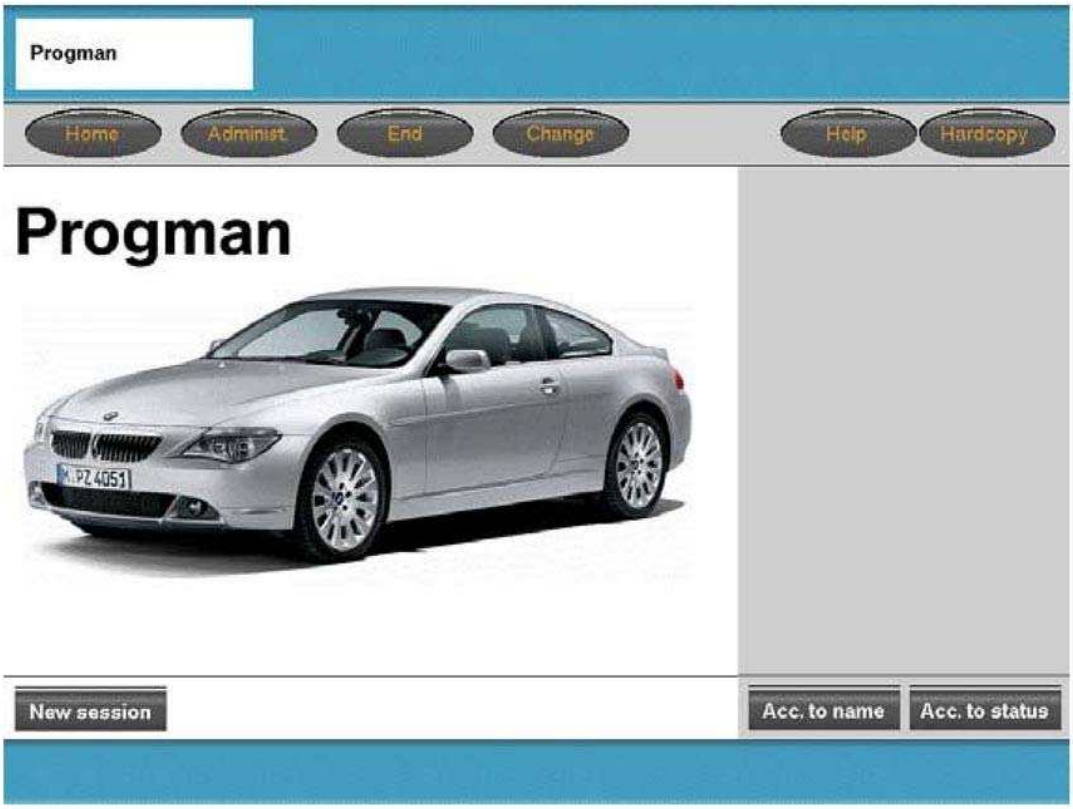
Model: All

Production: All

PROGMAN INTRODUCTION

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With the release of CIP 15.0, BMW released a new software program known as Progman.



G03397947

Fig. 93: Identifying New Software Program Known As Progman
Courtesy of BMW OF NORTH AMERICA, INC.

Progman is a software package that operates with Windows XP Embedded to manage:

- Administration & assignment of OPPS/OPS/Diagnostic heads plus network configuration/addressing.
- Installation/loading of new data updates via Jetstream.
- Activation of a Coding, Individualization or Programming request from a GT1 to an SSS via a multiconsole/multisession feature.
- Coding, Individualization or Programming of older vehicles via the SGC/UNIX application.
- Coding, Individualization & Programming functions of CIP.

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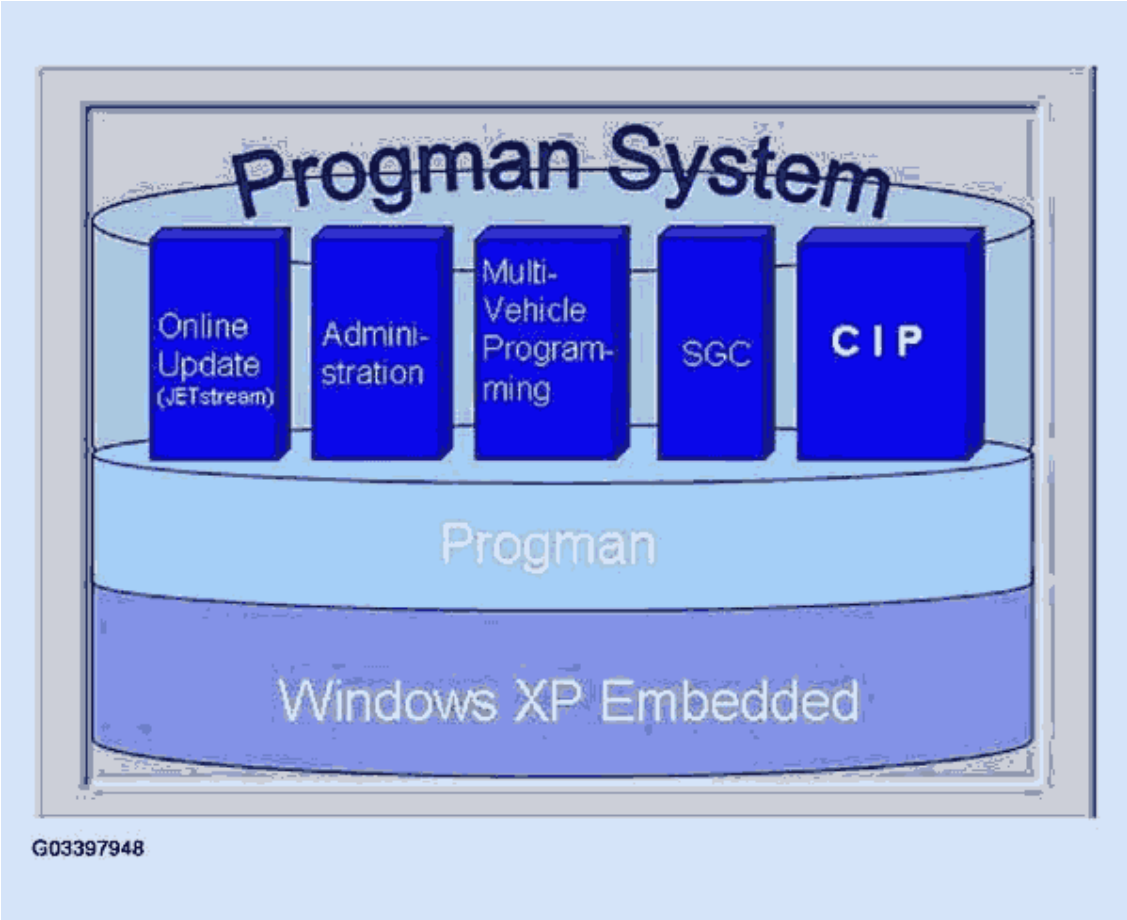


Fig. 94: Identifying Program System With Windows XP Embedded
Courtesy of BMW OF NORTH AMERICA, INC.

Progman

The new prog ramming man agement tool utilizes a new operating system (Windows XP Embedded) to manage the programming processes that can be initiated via the SSS.

Progman utilizes Windows XP Embedded which will serve as the basis for all further programs required for programming applications. No changes can be made to the operating system of this Windows variant and it can be used only in connection with the corresponding hardware (Software Service Station).

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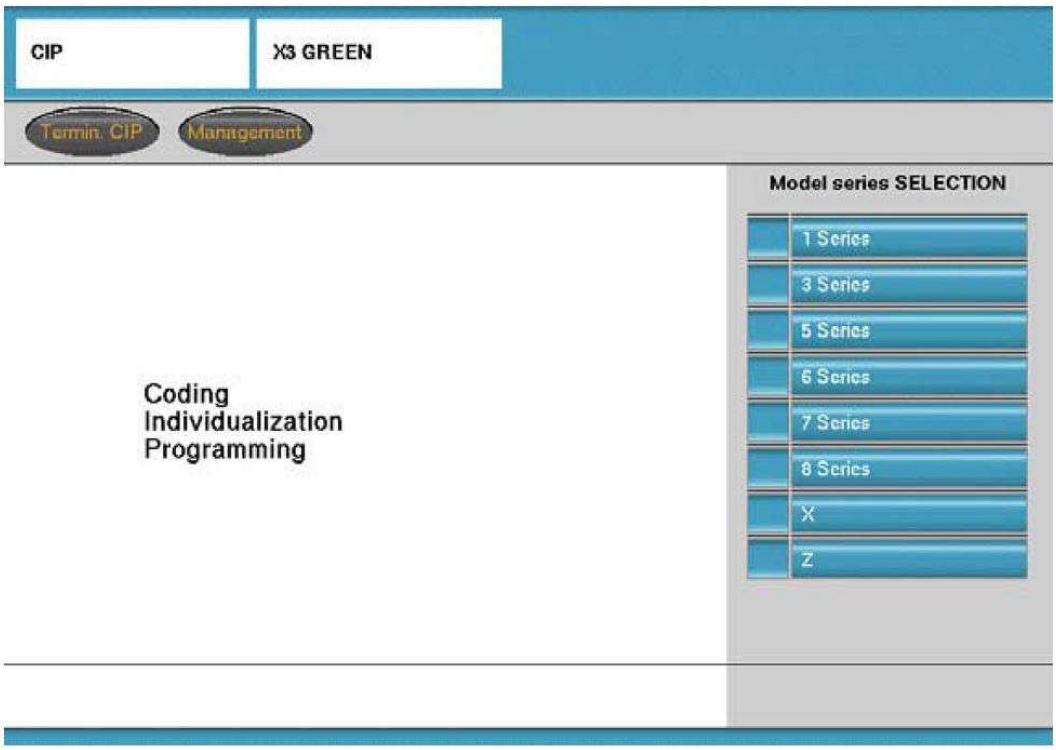


Fig. 95: Display Model Series Selection Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Progman incorporates all Coding, Individualization & Programming functions that were previously part of the DIS CD for E31/32/34/36/38/39/46/52 & E53, which operates under the old SGC/UNIX application, into the CIP application.

Since CIP is incorporated into Progman, it will now contain all Coding, Individualization & Programming functions. CIP will be used to launch the SGC/UNIX application for the older vehicles as well as launch the Windows XP based application for Coding and Programming the newer vehicles.

In the future the E36/38/39/46/52/53 applications will be converted/integrated directly into CIP and be based on Windows XP Embedded. The structure for the E31/32/34 will not be changed and will remain SGC/UNIX based.

Administration

The administration tool provides the same setting options as before however, Progman adds additional features/capabilities:

- Ability to view and select accessible "Interfaces" (Diagnostic Head, OPPS, OPS...)

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- Configure interfaces
- Adjust SSS and network specific settings
- View available SSS units and select a specific unit
- Select language specific to each SSS

JETstream

JETstream is the application that provides online data updates for Coding and Programming data. The feature allows the SSS to be up to date on the current/new vehicle data regarding coding and programming information prior to the release of an update DVD. The application can be configured to automatically search for online updates at a specific time (ex. after normal shop hours every night) and install any updates found at a specific time/point in the systems operation cycle.

In order for this feature to work the SSS must:

- Be located on the workshop network
- Be connected to BMW via a network connection
- Have the correct network specific data entered in the "Network" mask
- Have the host/domain name and IP address of the BMW server entered in the "Online Service" mask
- Have the "Automatic Online Update" feature active

Multiconsole/Multisession

Since the SSS is the primary Coding and Programming system, coding and programming tasks can be "transferred" to the SSS from any GT1 located on the workshop network. In order to monitor the tasks assigned to a specific SSS a menu of active jobs is displayed via Progman and can be accessed by any GT1 or SSS on the network.

MULTICONSOLE/MULTISESSION FUNCTION

Multiconsole	The multiconsole function makes it possible to control programming procedures both via the Software Service Station as well as via the BMW diagnosis systems GT1.
Multisession	The multisession function makes it possible to program several vehicles simultaneously.

This function allows the GT1 to be remote terminals for the SSS with respect to Coding and Programming and once a task is transferred to an available SSS, the GT1 can be used to diagnose another vehicle and/or transfer another coding/programming task to an SSS.

CIP

The Coding, Individualization and Programming application that has been used previously since the introduction of the E65 continues to operate the same as before. The only major change is that all of the Coding and Programming functions for the older vehicles (E31/32/34/36/38/39/46/52 & E53) that was only available on

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the DIS CD for use on DISplus and GT1 has been incorporated into CIP.

Prior to CIP15.0 SGC/Unix functions for Coding, Individualization & Programming were incorporated into DIS CD VXX.X.

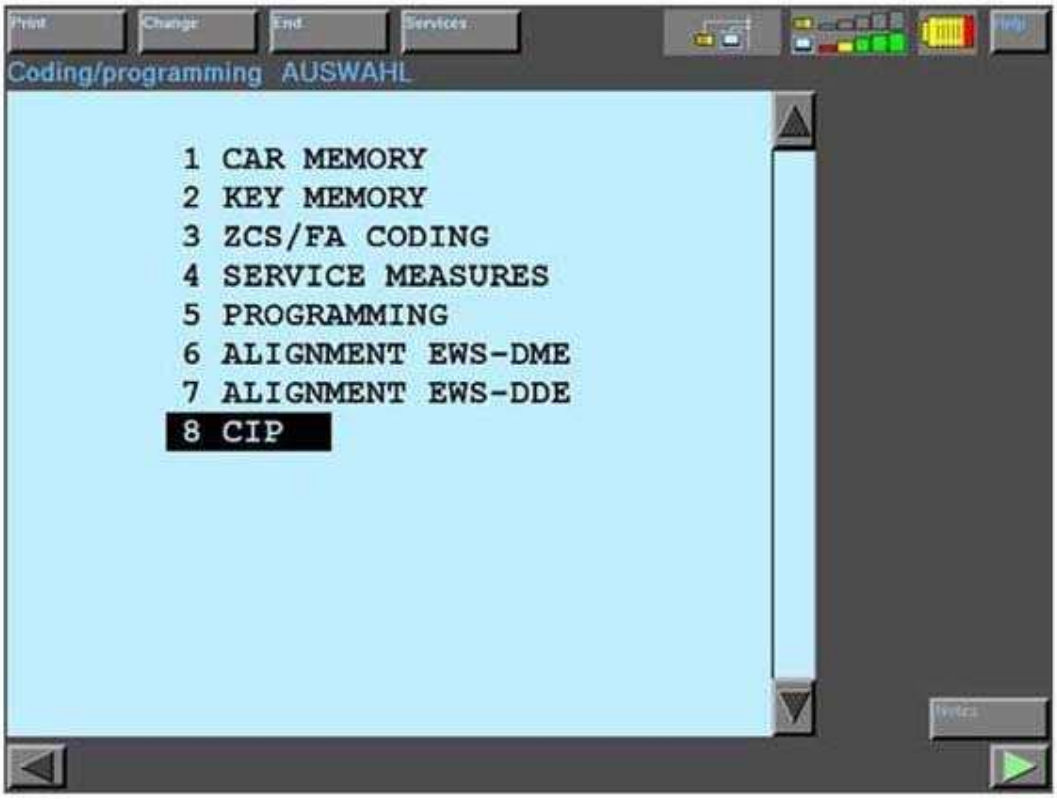


Fig. 96: Display Coding, Individualization And Programming Application (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

As of CIP 15.0 SGC/Unix functions for Coding, Individualization & Programming are incorporated into CIP.

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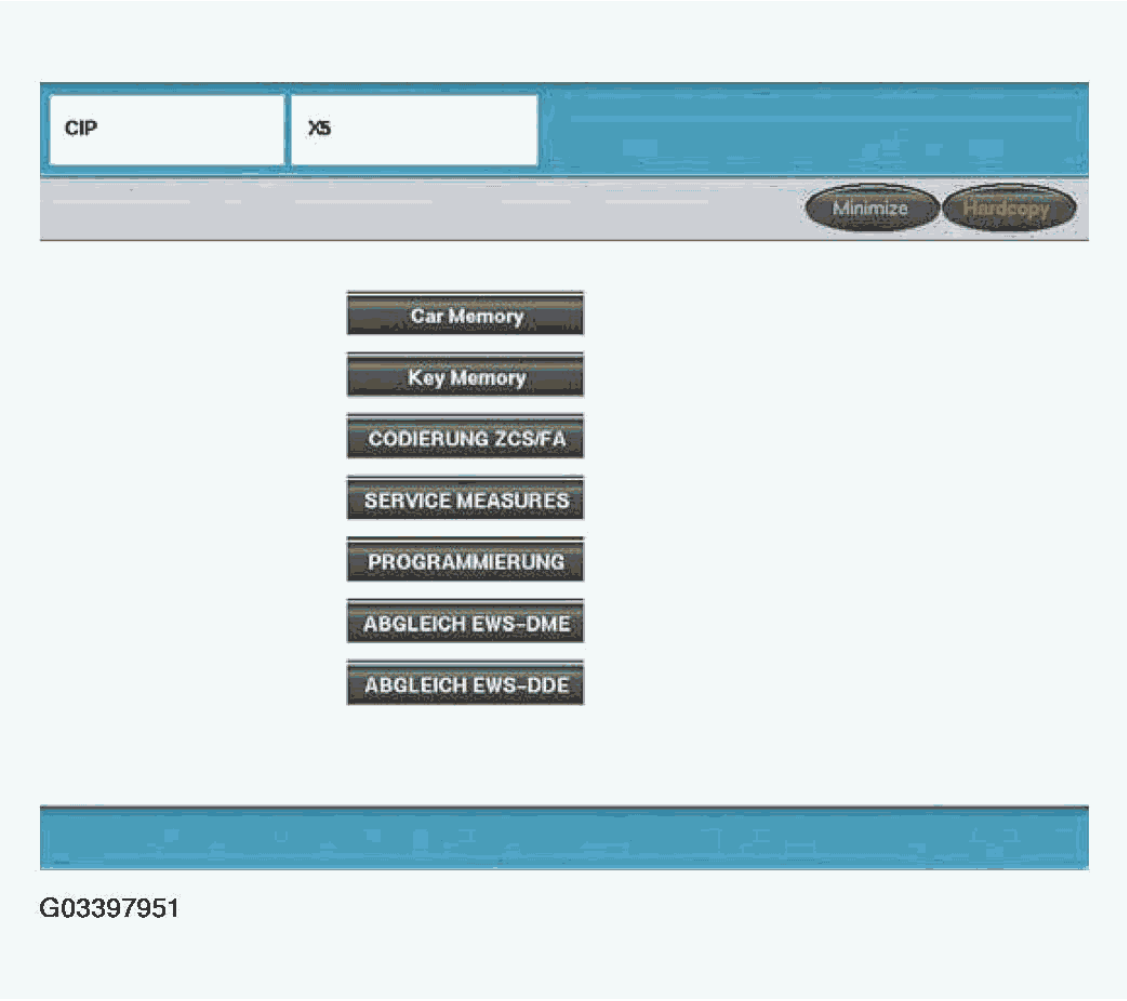


Fig. 97: Display Coding, Individualization And Programming Application (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

WHAT WILL PROGMAN DO FOR ME?

Progman allows the GT1 to be released from the task of Programming and Coding vehicles. The GT1 will be capable of performing vehicle diagnosis while the SSS is used to Program and Code a vehicle(s).

Example: *Given a workshop with 10 active workstalls (CORA) and equipped with 2-GT1's, 1-DISplus, 1-SSS, 3-Diagnostic Heads, 1 OPPS Head, 2-OPS Heads*

Before Progman (CIP 15.0)

CIP INFORMATION BEFORE PROGMAN (CIP 15.0)

Device	# of MOST-bus equipped Vehicles able to be Programmed at one time	# Vehicles able to be Diagnosed while another is being Programmed
GT1	1	0
GT1	1	0

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DISplus	0	1
SSS	1	0
TOTAL	**3**	**1**

With Progman (CIP15.0)

CIP INFORMATION WITH PROGMAN (CIP 15.0)

Device	# of MOST-bus equipped Vehicles able to be Programmed at one time	# Vehicles able to be Diagnosed while another is being Programmed
GT1	0	1
GT1	0	1
DISplus	0	1
SSS	5	0
TOTAL	5	3

By installing CIP 15.0 on all of the GT1's and SSS's, Progman can be accessed via any GT1 or SSS but is controlled/operated by the Software Service Station (SSS) only. Since the SSS controls/runs Progman, it will be the only device able to code and program vehicles, the GT1 will be viewed as a remote terminal for Progman.

With the introduction of Progman, parallel programming of up to five vehicles can be performed. The vehicles to be programmed do not need to be the same model series nor have the same data status or be connected at the same time.

GETTING STARTED WITH PROGMAN

Progman is launched from the GT1 whenever the Coding/Programming function is selected. On the SSS Progman is always active as this is the only program installed on the system.

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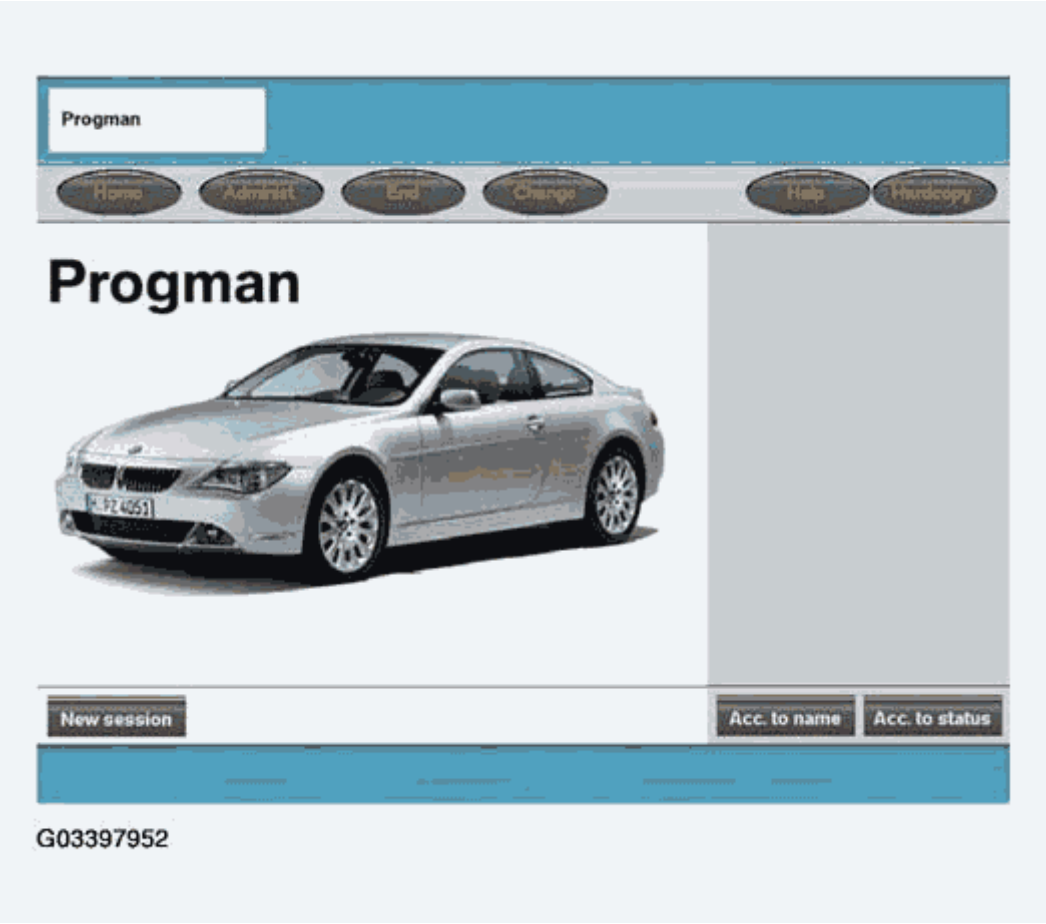


Fig. 98: Display Progman System
Courtesy of BMW OF NORTH AMERICA, INC.

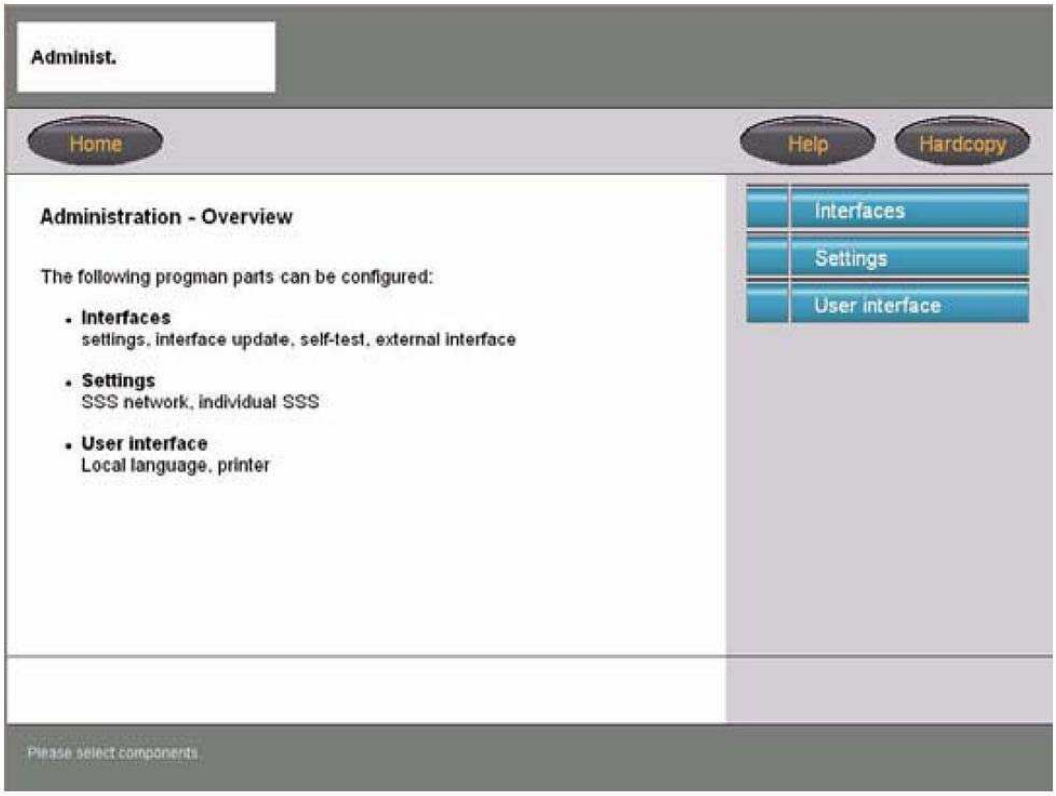
From the main menu screen in Progman the administration features for system configuration can be accessed or a new session can be started. By selecting "Help" a more detailed document explaining Progman can be accessed.

ADMINISTRATION

In order to insure initial system setup selecting "Administration" will bring up a new screen which explains the menu selections available on the right side.

At this point Interfaces, Settings or User Interface can be selected.

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Fig. 99: Display Administration Overview
Courtesy of BMW OF NORTH AMERICA, INC.

Interfaces

By selecting "Interfaces" an overview of all available and/or connected interfaces is obtained along with information pertaining to the status of the interface, device name, software level and IP address.

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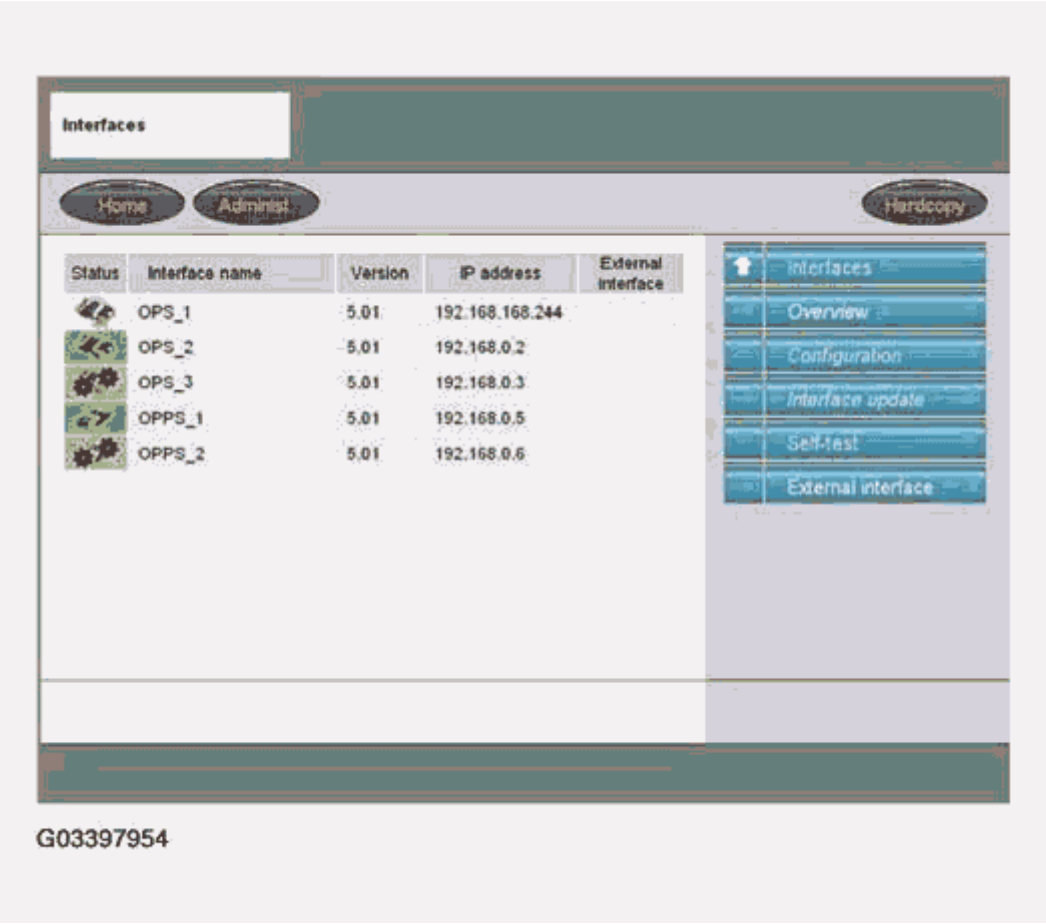


Fig. 100: Display Status Of Interface, Device Name, Software Level And IP Address
Courtesy of BMW OF NORTH AMERICA, INC.

Explanation of Status Indicators

Symbol Description

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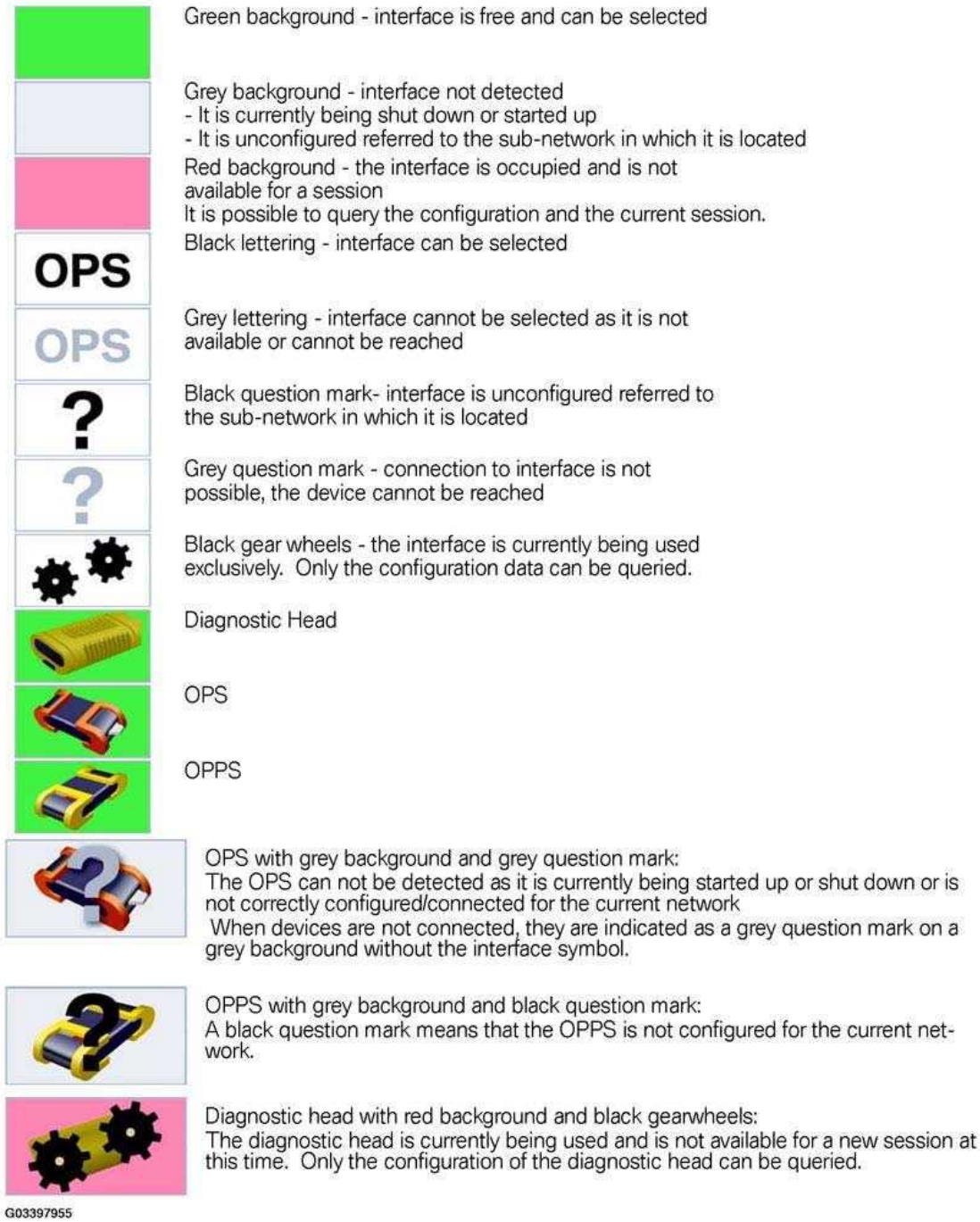


Fig. 101: Identifying Interfaces Status Indicators Explanation
Courtesy of BMW OF NORTH AMERICA, INC.

Examples of Possible Combinations

Interface Name

An interface name can be freely assigned to each interface so as to simplify definition of the interface in the

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workshop. The name used should be helpful in locating/identifying the particular interface if necessary.

Version

The firmware version indicates the software level currently installed on the selected interface (OPPS/OPS/ diagnostic head). It is recommended that the version on the interface be the same as that of the SSS it is being used with.

IP Address

The IP address (internet protocol address) is a unique and specifically assigned address for each device in the workshop network. This address consists of a number block which is normally structured as follows.

Example: *192.168.100.10*

The IP addresses must be structured so that each device in the network is distinguished from all the others and must be exclusive to that device and not shared among other devices connected to the network.

External Interface

This column indicates whether the current interface is an external interface. External interfaces are located in external subnetworks and can be used in connection with this Software Service Station.

Overview

If an interface is selected and items on the right of the screen in the menu listing are selectable (not grey) then additional information can be accessed for that device.

In this example "Overview", "Interface update", "Configuration" and "Self-test" are available.

If a device is not correctly configured for the network certain selections may not be available for that device.

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Fig. 102: Display Interfaces Name, Version And IP Address
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: The Interface list does not automatically update as devices are utilized or freed up. The only way to update the list is to select "Overview".

Configuration

Configuration provides information for the device selected pertaining to:

- Interface Name
- Gateway
- IP Address
- IP Subnet Mask

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Fig. 103: Display Interfaces Configuration Information (1 Of 3)
Courtesy of BMW OF NORTH AMERICA, INC.

Interface Name

The specific name assigned to the device (Ex. Blue A). The name used should be helpful in locating/identifying the particular interface if necessary.

IP Address

A specific four segment number assigned exclusively to the device. The number represents the address of the device on the network and is necessary when communicating with other devices located on the network.

Gateway

This information identifies the four segment address of the component located on the network responsible for communicating from the current network to another network. If the there is no address in this location then a connection to any devices outside of the current network can not be established.

IP Subnet Mask

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This information is used to define which segment of the four segment IP address specifically identifies the device and which identify the specific network.

Example: *255.255.255.0*

Indicates that the first three segments (255.255.255) identify the specific network that the device is located on. The last segment (0) indicates that this is the segment that will identify the specific device.

NOTE: The network and device address information must be entered exactly as defined by the network administrator for your facility, otherwise the devices can not be accessed.

After entering the necessary information and continue is selected, Progman will run a check on the values/information entered and will indicate if the information is acceptable.

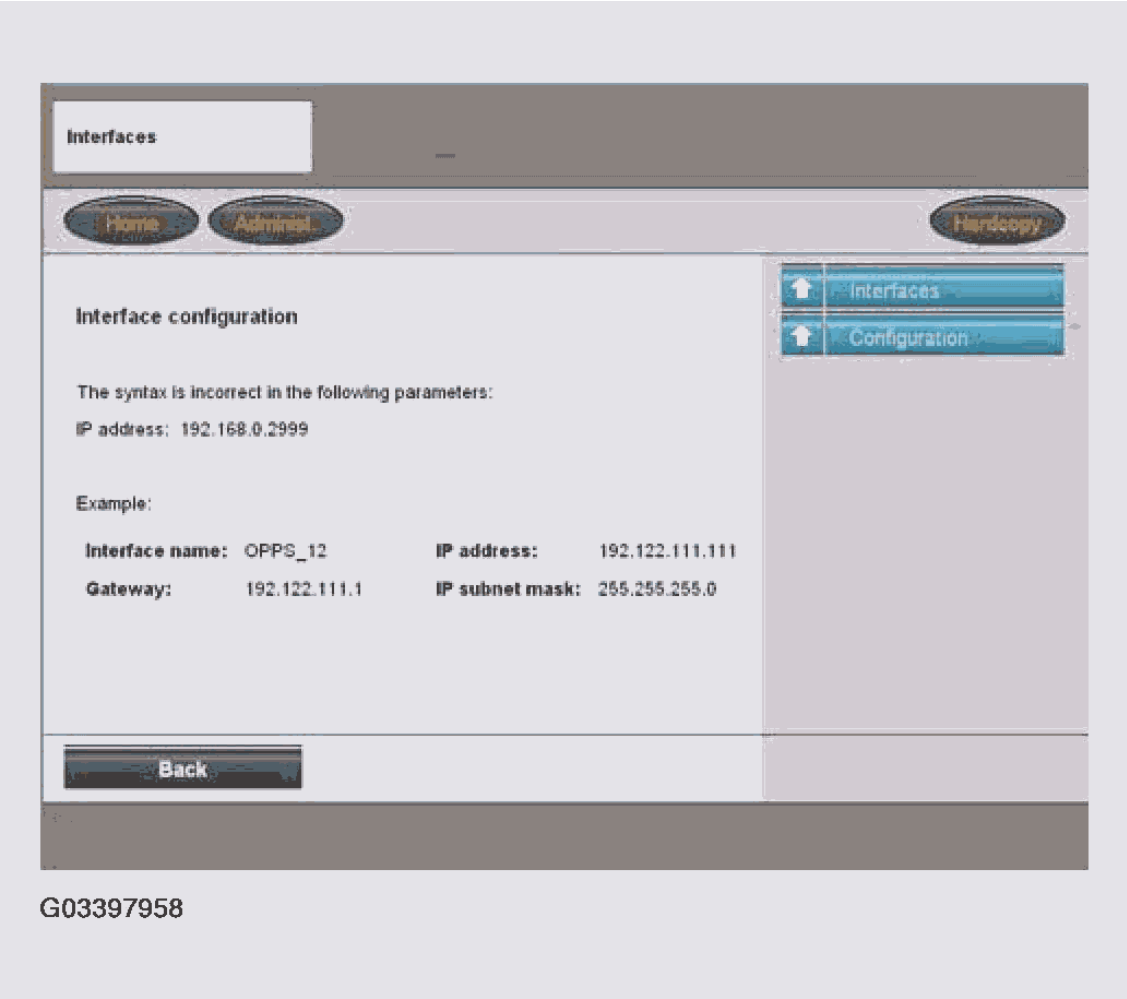


Fig. 104: Display Interfaces Configuration Information (2 Of 3)
Courtesy of BMW OF NORTH AMERICA, INC.

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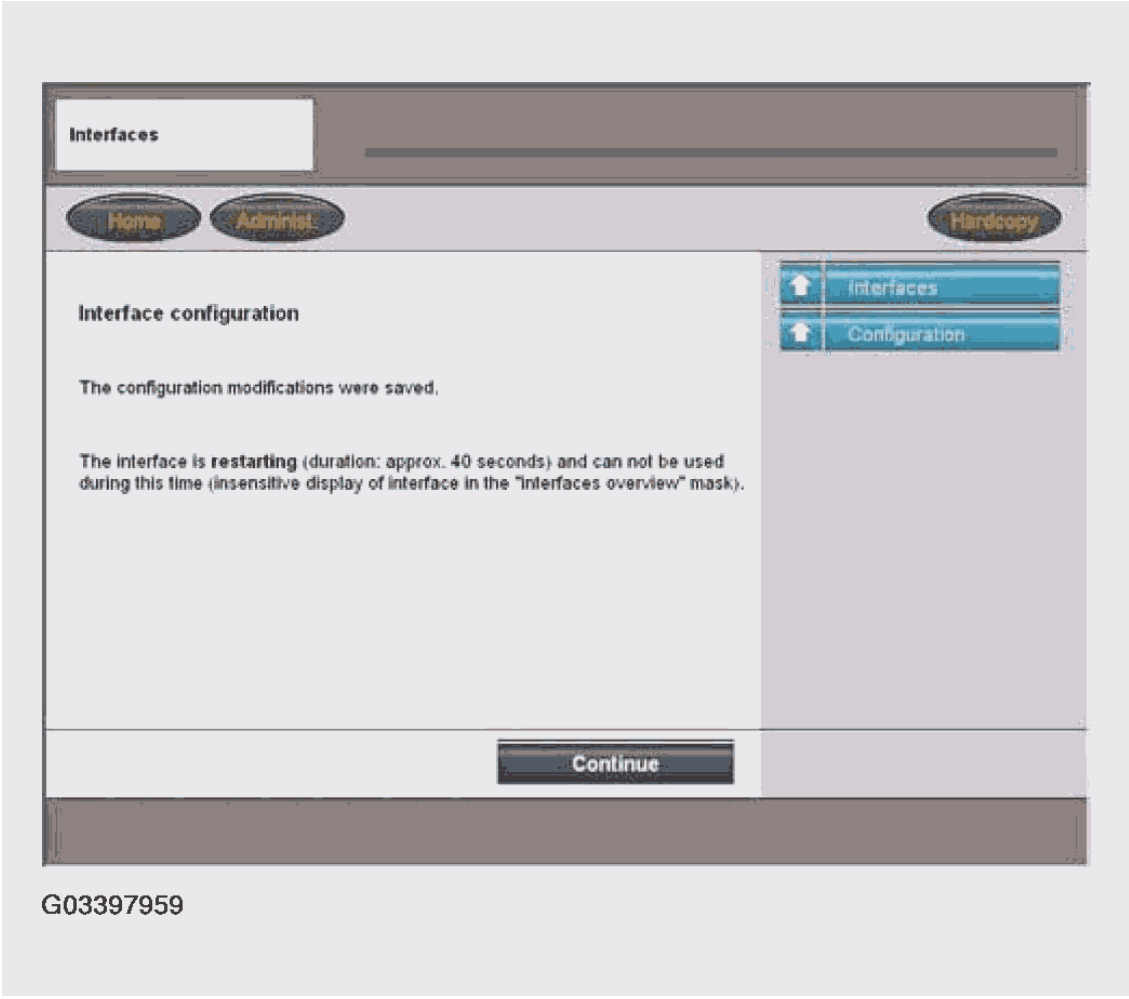


Fig. 105: Display Interfaces Configuration Information (3 Of 3)
Courtesy of BMW OF NORTH AMERICA, INC.

Interface Update

Interface update can only be selected if the selected interface is not being used by another device (interface symbol has a green background).

This function allows the firmware of the interface to be checked against the version of the SSS.

It is recommended that the version of the SSS and the Interface be at the same level to reduce susceptibility to errors and system conflicts.

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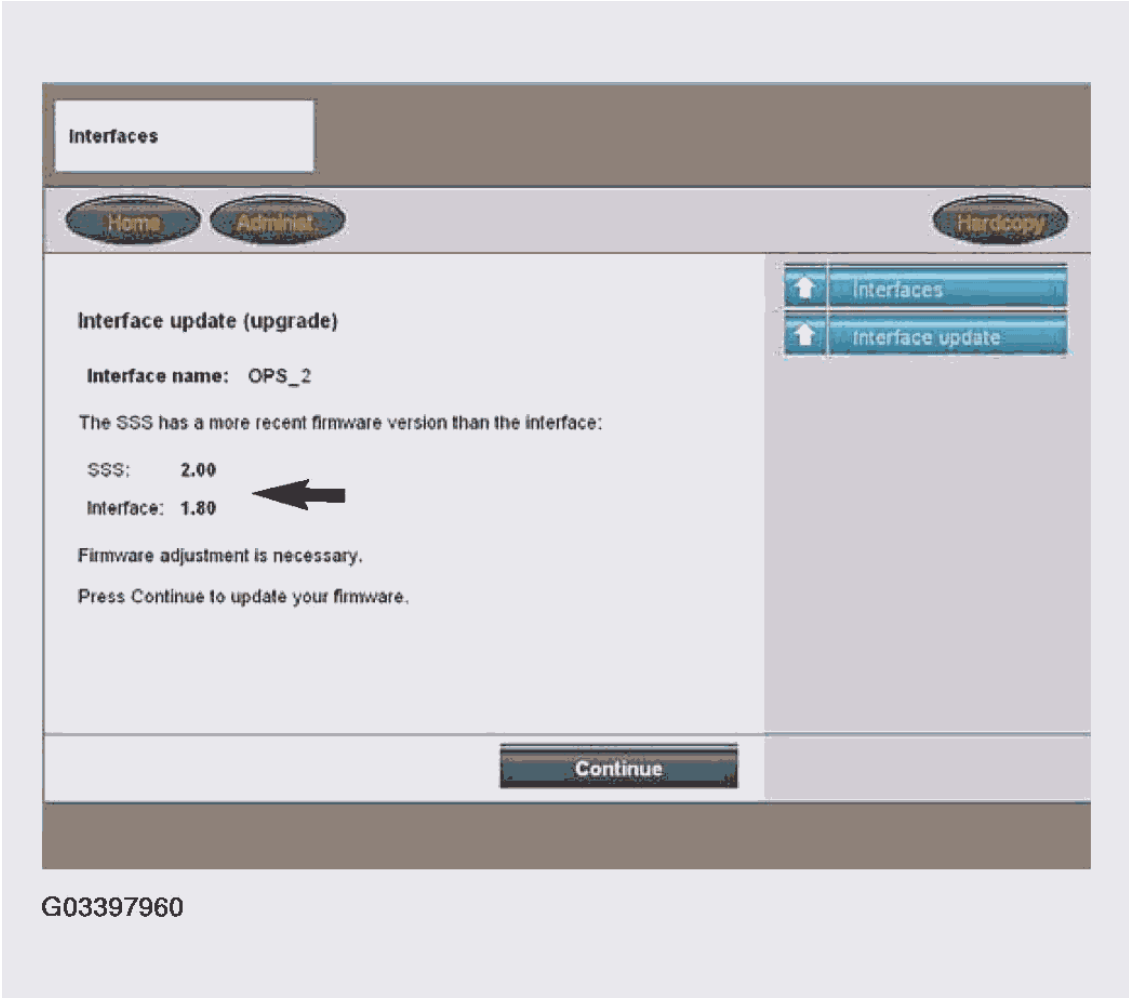


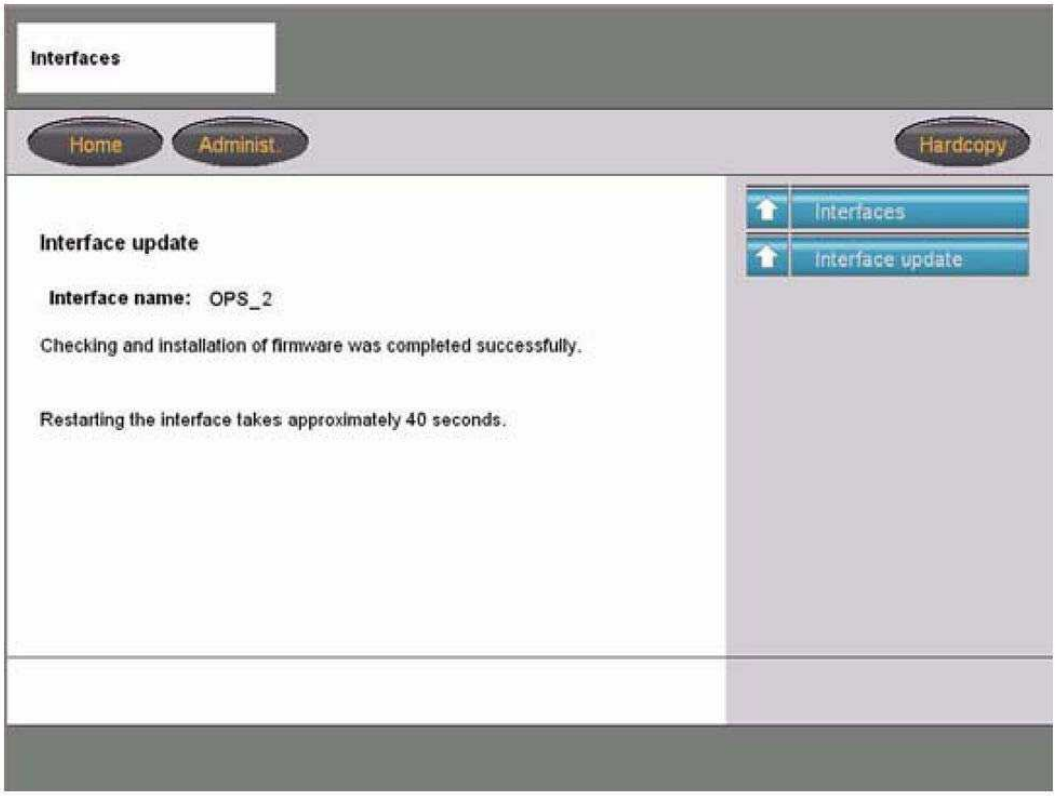
Fig. 106: Display Interface Update Information (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

The SSS will check which firmware version is installed in the interface and then searches for the newest available version on the SSS. Depending on the result of the search, Progman will make a recommendation as to what action should be taken.

- If both versions are equal no action is required.
- If the version on the SSS is newer then Progman will suggest updating the version on the interface.
- If the version on the SSS is older, Progman is able to change the version on the interface to the older one.

Once the update is successfully completed a corresponding message is displayed.

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Fig. 107: Display Interface Update Information (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Updating Interface after Initial Install

After the initial installation of Progman with CIP 15.0, the firmware installed on the interfaces that will be used with Progman must first be updated. If the firmware level of the interface is not at a predefined level then it will not be recognized/identified within the Progman application, thereby not allowing a connection to the interface. This update only needs to be performed when an interface is used for the first time with Progman.

Using the GT1 update the firmware in the interface.

Select the interface

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Fig. 108: Selecting Interface
Courtesy of BMW OF NORTH AMERICA, INC.

With a connection to the interface established a message should be displayed indicating that the firmware in the head needs to be updated, perform the update by selecting the "Diagnostic head Update" button.

After the update is complete select "Quit connecting".

Access Progman and verify that the interface is recognized

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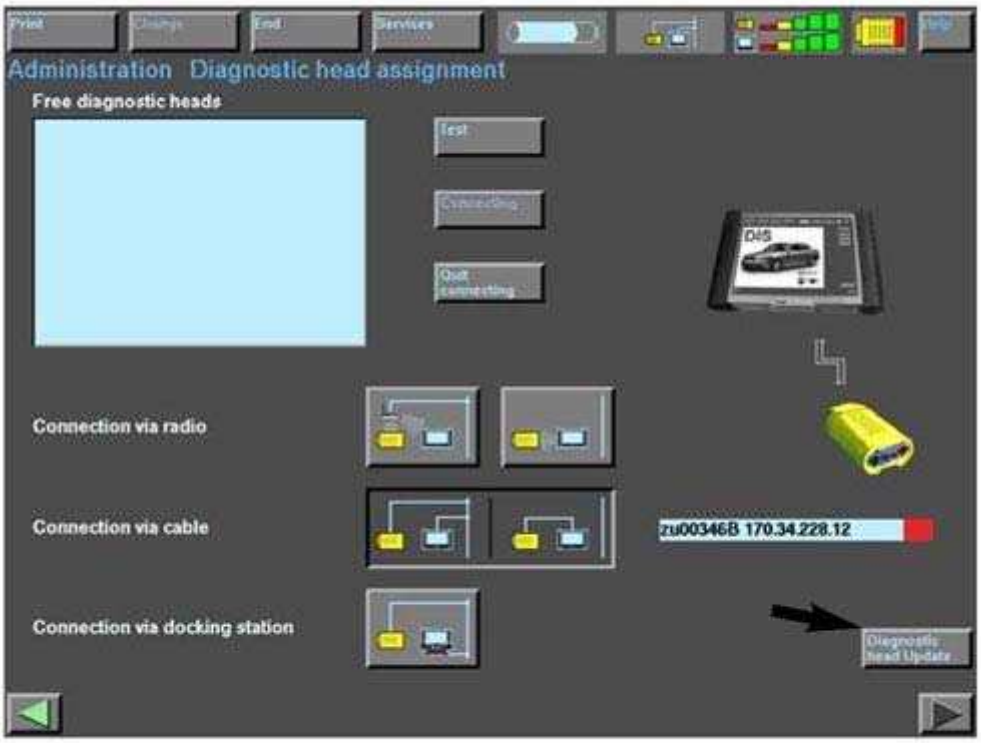


Fig. 109: Selecting Quit Connecting Button
Courtesy of BMW OF NORTH AMERICA, INC.

From Progman the firmware level of the interface should also be checked and updated if necessary. Progman does not automatically inform the user if the firmware of the interface needs to be updated.

Updates to the interface are checked and performed by selecting the specific interface from the list, located under "Administration" - "Interfaces", then selecting "Interface Update" (refer to previous page for additional information).

Self-Test

Self-test can only be selected if the selected interface is not being used by another device (interface symbol has a green background).

Depending on the interface selected a test loop must be attached to the interface.

- For opps use test loop 663124 and 663131
- For OPS use test loop 663124
- For Diagnostic Head, no test loop is needed

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External Interface

An external interface is an interface that is not automatically detected by Progman or is not contained in the subnet of the workshop network, such an interface can be added manually to the list of available interfaces or removed using this function. In order to add an interface the I/P address of the interface must be entered.

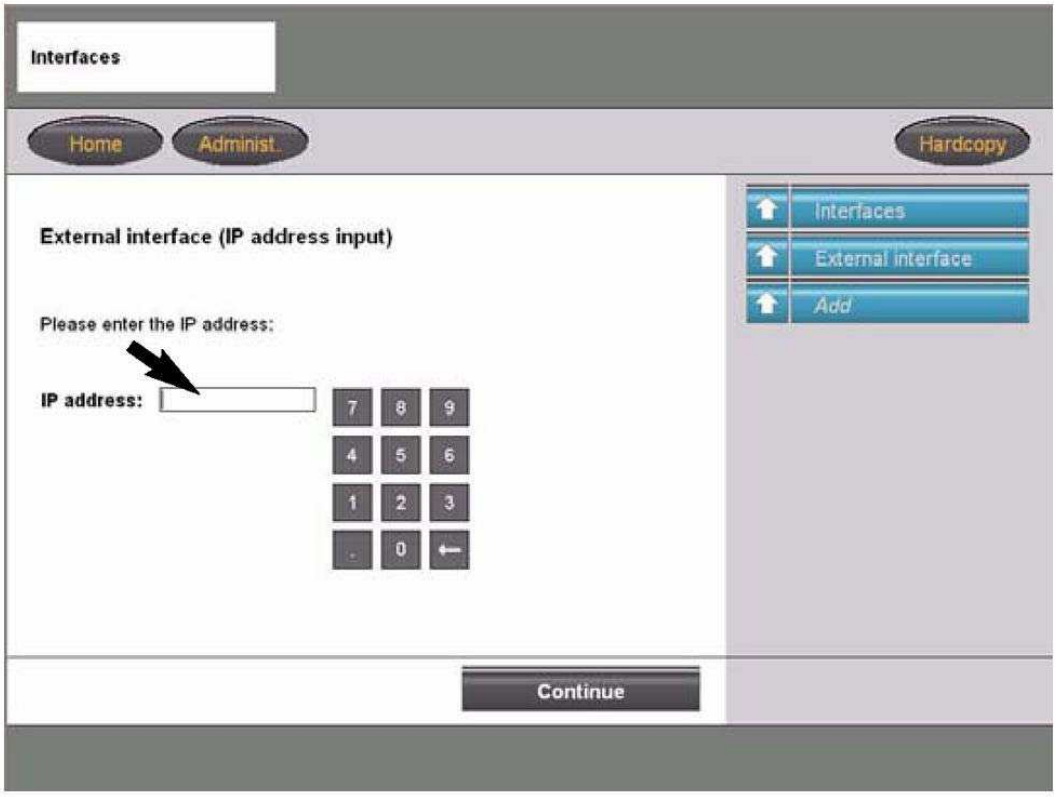


Fig. 110: Display Interfaces Menu For Entering IP Address
Courtesy of BMW OF NORTH AMERICA, INC.

Example: *The dealer has two separate service facilities each with its own network, an external interface can be connected to a vehicle located within one network and accessed by a GT1 or SSS located in the other network in order to Code/Program the vehicle.*

Settings

From the Administration screen the "Settings" tap allows access to information specific to a selected/specific SSS.

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Fig. 111: Display Administration - Settings Tap
Courtesy of BMW OF NORTH AMERICA, INC.

Overview

The overview tap provides a listing of all SSS's that are located on the network.

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Fig. 112: Display SSS Overview Menu (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

The Overview screen provides information pertaining to:

- Operating status of a particular SSS

Ready (Green) = Usable

Full use of SSS is possible

Limited (Yellow) = Usable

The number of possible sessions is limited (Ex. a download of a new update is in progress)

Not Ready (Red) = Maintenance

No new sessions are possible (Ex. an update is currently being installed)

- Number of active sessions on each SSS
- The CIP version installed on each SSS

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Upon selecting a particular SSS additional menu selections are possible.

The selected SSS is highlighted in a blue frame and all items are possible for the selected SSS are active in the menu.



Fig. 113: Display SSS Overview Menu (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Operating Status

This menu item provides a more detailed status information for specific SSS then the Overview table.

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Fig. 114: Display SSS Operating Status Menu
Courtesy of BMW OF NORTH AMERICA, INC.

The name of the SSS is displayed with a colored background indicating the status of the selected SSS.

Green = Ready **Yellow** = Limited **Red** = Maintenance

Additional status information is also displayed:

MAC address - Media Access Control address is an unchangeable and unique address for identification of a network device.

Serial Number - Serial number of specific SSS

Operating Status - Provides detailed information about the current operation of the SSS

Sessions - Indicates the number of currently active/started CIP sessions.

Interfaces - Indicates how many interfaces are connected to the specific SSS

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Online Service - Indicates whether the online update is activated on the SSS

From this location it is also possible to change the operating status of the SSS, as long as the selected SSS is currently in the "Ready" status, plus **this is also the recommended location from which the SSS should be restarted or shutdown using the buttons at the bottom of the screen.**

Network

The Network function allows network configuration information specific to the SSS to be entered, these settings should have been set during the initial installation of Progman/CIP15.0.

NOTE: Maintain a copy of the system configuration information, in the event information gets disturbed, printout a copy and keep in a binder along with information for DISplus, GT1 and the interfaces.



Fig. 115: Display Network Configuration Menu (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Information that can be entered is similar to the information needed to configure an interface. The following information must be entered to correctly configure the SSS to the network:

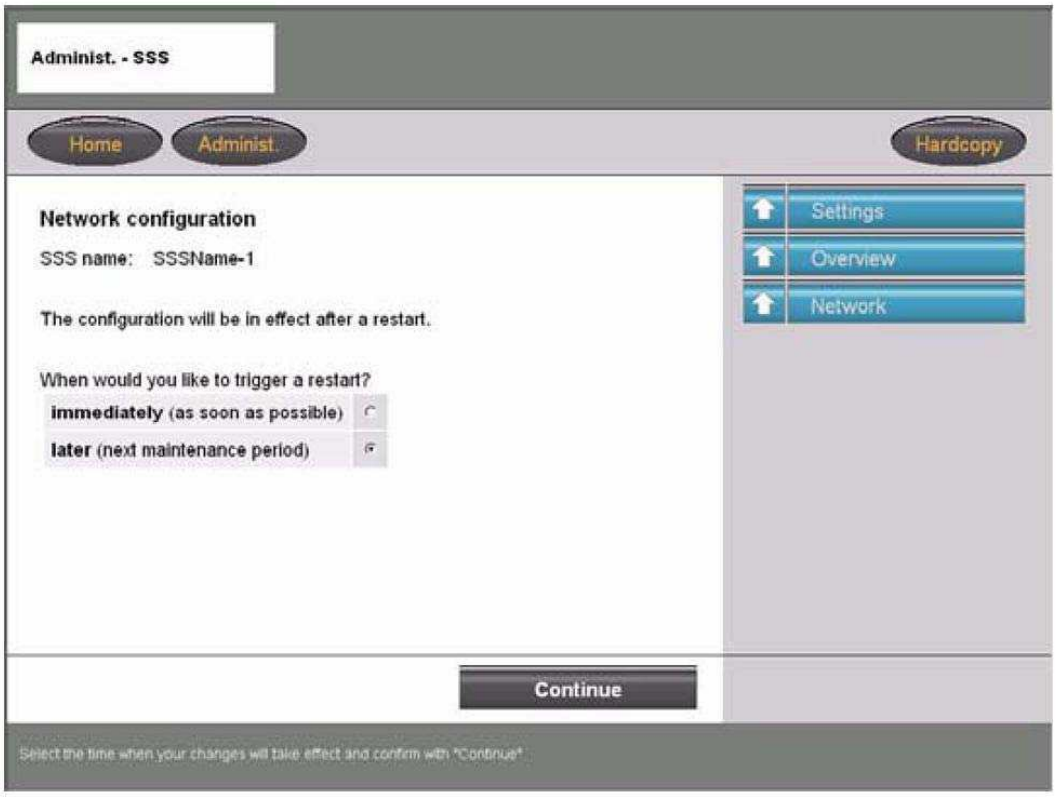
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- Assign a name specific to the SSS
- Gateway Address
- IP Address specific to SSS
- Information pertaining to the IP subnet mask

Any changes that are made to the configuration are saved by selecting continue and will go into effect once the SSS is restarted.

NOTE: Restart immediately means that Progman checks the current status of any sessions that are still active and once the sessions are complete the system will restart.

Restart later indicates that Progman will wait until the end of the day (specified under "Operating Times") to check and restart the system.



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Fig. 116: Display Network Configuration Menu (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

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Installation

The Installation tap is selected when updates need to be installed either by a way of a new CIP DVD or checking for new online updates (Automatically or Manually). The updates that can be installed pertain to the Progman application as well as updated vehicle data files for utilization by CIP.

The table provides an overview of the software program and version currently installed.

The selection/activation of Automatic online updates via the BMW server is selected from this screen.

"DVD update" can be selected whenever a new CIP DVD needs to be installed.

"Online update" allows a manual check for online updates to be initiated.



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Fig. 117: Display Installation Menu
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: It is recommended that the Automatic Online Update feature be activated to insure that needed Program and Coding updates are received in a timely

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manner. When new updates are made available they are downloaded and installed after the normal operating times of the workshop as specified under "Operating Times".

"Display status" provides information pertaining to the installation of the latest update.

Information pertaining to an erroneous installation of an update is displayed in the messages section.

NOTE: If frequent error messages are displayed contact your service provider for assistance and have available a copy of the error messages that have been received.



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Fig. 118: Display Installation - Status Menu
Courtesy of BMW OF NORTH AMERICA, INC.

FASTA

The FASTA function assures that vehicle operation and service data from the diagnostic and programming devices are sent to BMW. With Progman if data is available it is transmitted automatically every five minutes

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This function shows if any data is available for transfer and when it will be sent.

By selecting "Send data" (manual send) make sure that no sessions are currently running on the SSS as this will lengthen the data transmission process.

It is preferred that the automatic transfer process be utilized.



G03397973

Fig. 119: Display FASTA Function Menu
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: In order for FAST data transmission to be possible the correct BMW server address must be entered in the "Online Service" menu.

Date and Time

In this function the current date and time must be entered. An automatic correction for daylight savings time to standard is made automatically.

Operating Times

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The normal operating time of the workshop/service facility is entered in this function. The time is used to establish a maintenance period for the SSS. The end of normal operating time signals Progman to start executing/installing any online updates that may be available.

User Interface

Under this menu language settings specific to the individual SSS and printer configuration information can be set.

Example: If the language of the SSS is set to German then all information displayed on the SSS will be in German, however it does not mean that the GT1 will also display the text in German when accessing Progman and "connecting" to that SSS.

Workshop Exercise - Configuration Check

1. Check/access network configuration information for:
    - SSS
    - DISplus
    - GT1
    - Interfaces (Opps, OPS & Diagnostic Head)
2. Check firmware level of interface's via SSS.

STARTING A PROGRAMMING OR CODING SESSION WITH PROGMAN

In order to start a session in Progman the Diagnostic, OPPS or OPS head that will be selected can not be connected to the DISplus or GT1.

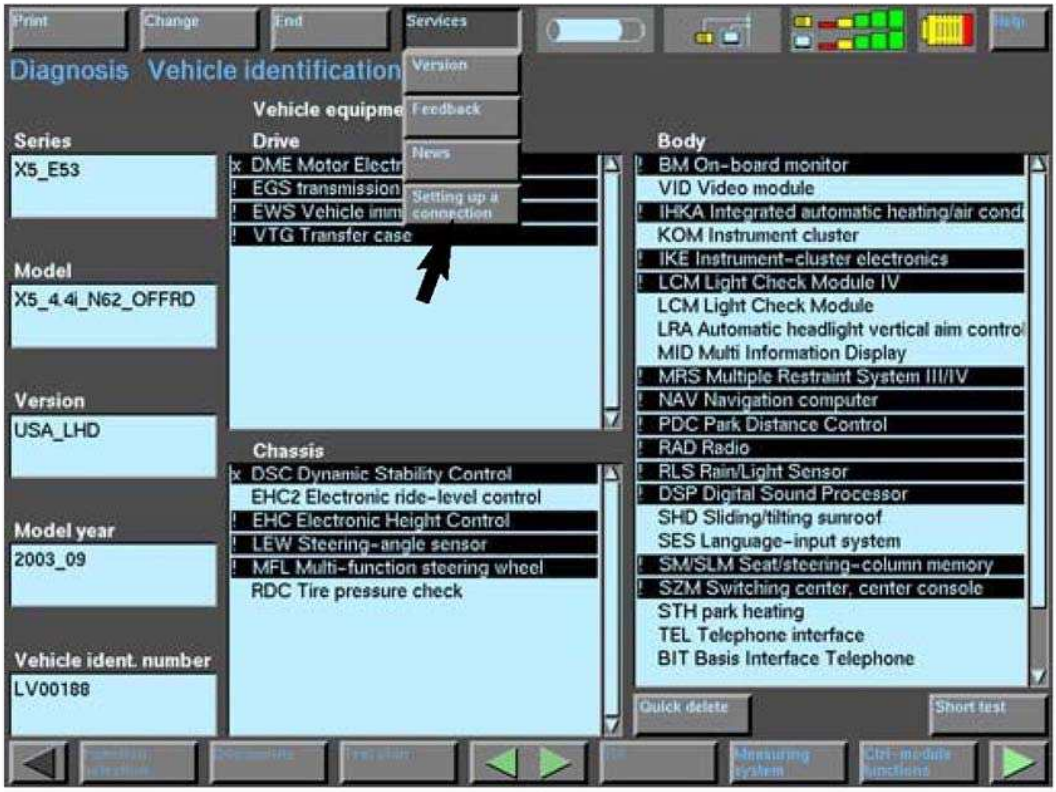
Disconnecting From Interface To Be Used By Progman

If the vehicle to be programmed was previously being diagnosed using a diagnostic head with the GT1, then the connection with the head must be broken before that head will be recognized by Progman.

Select "Service"

Select "Setting up a connection"

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Fig. 120: Selecting Service And Setting Up Connection Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select "Quit connecting"

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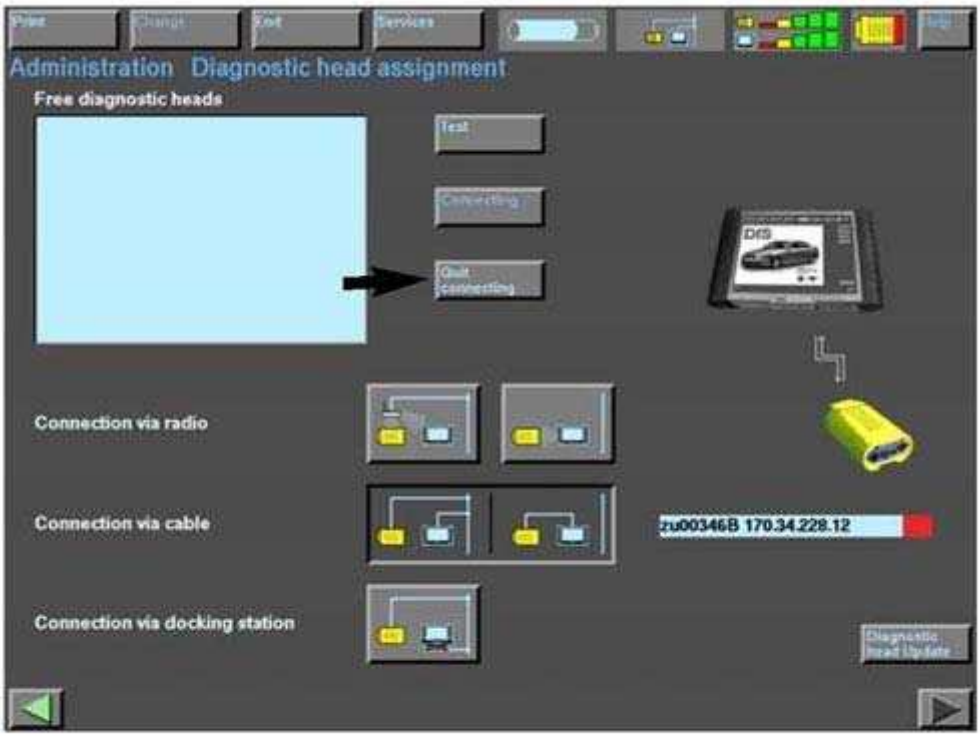


Fig. 121: Selecting Quit Connecting Button
Courtesy of BMW OF NORTH AMERICA, INC.

The selected head is free/disconnected

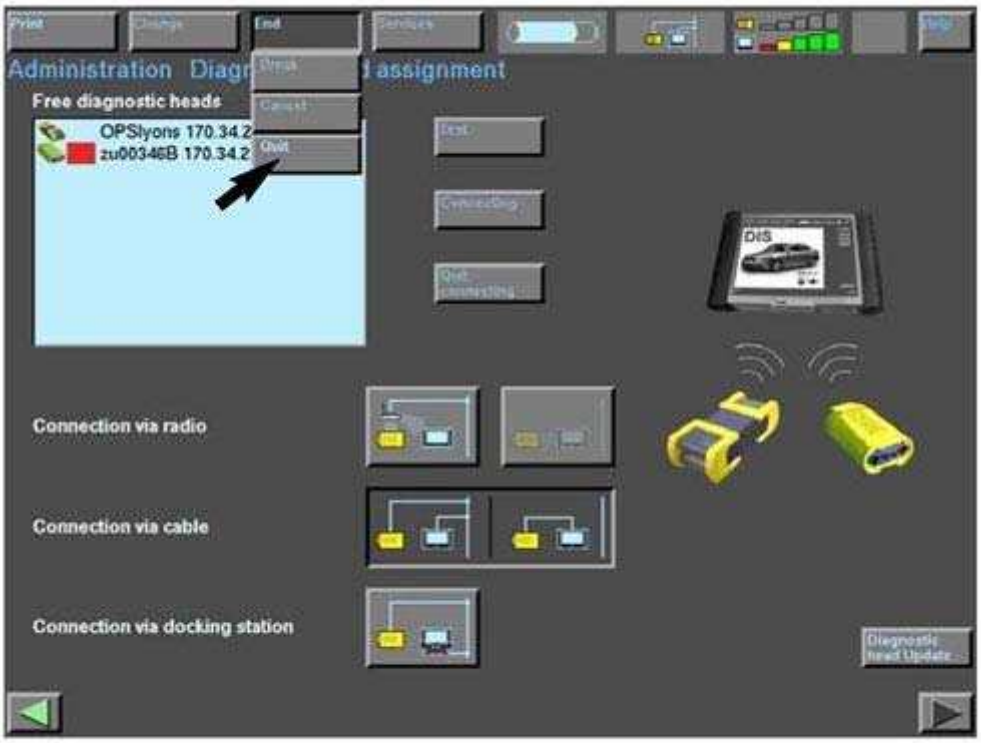
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Fig. 122: Display Free Diagnostic Head Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Select "End"

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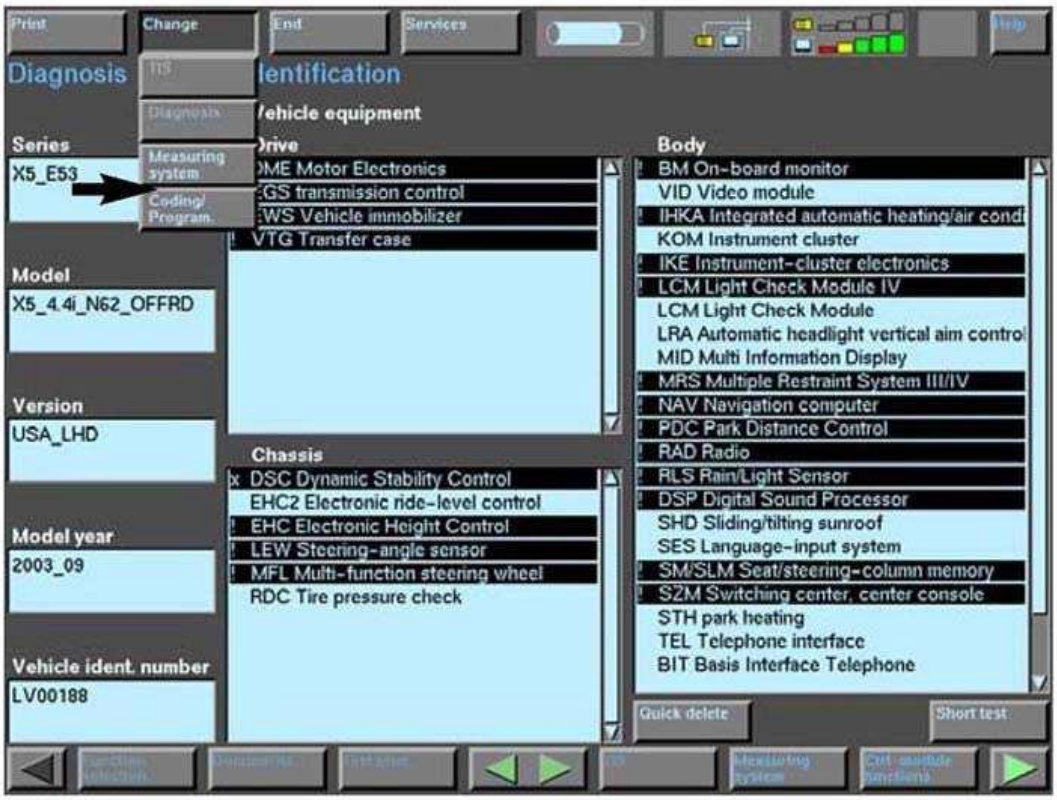
G03397977

Fig. 123: Selecting End Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select "Change"

Select "Coding/Program"

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G03397978

Fig. 124: Selecting Change And Coding/Program Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select available SSS

Select "Continue"

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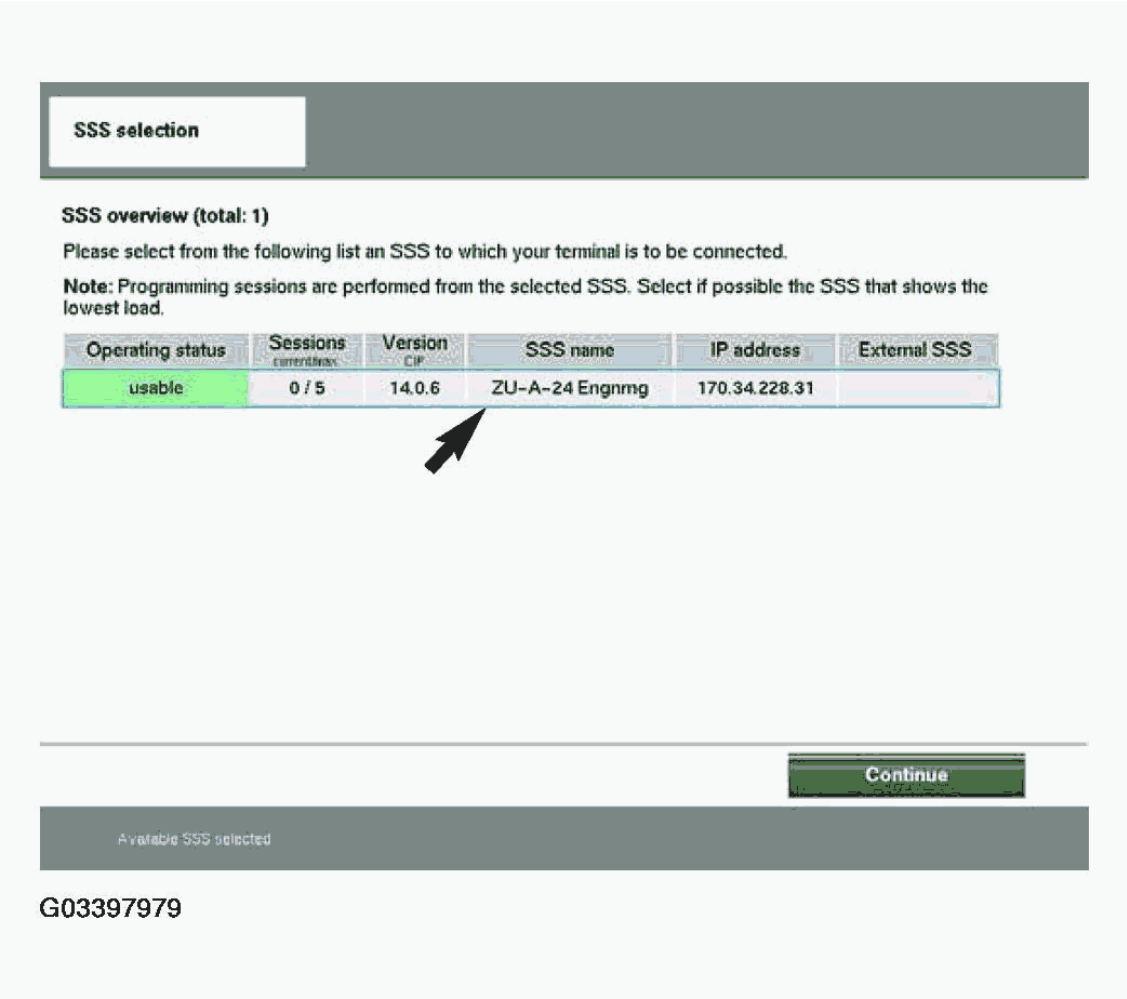


Fig. 125: Selecting Continue Button
Courtesy of BMW OF NORTH AMERICA, INC.

Starting A Session With Progman

Select "New Session"

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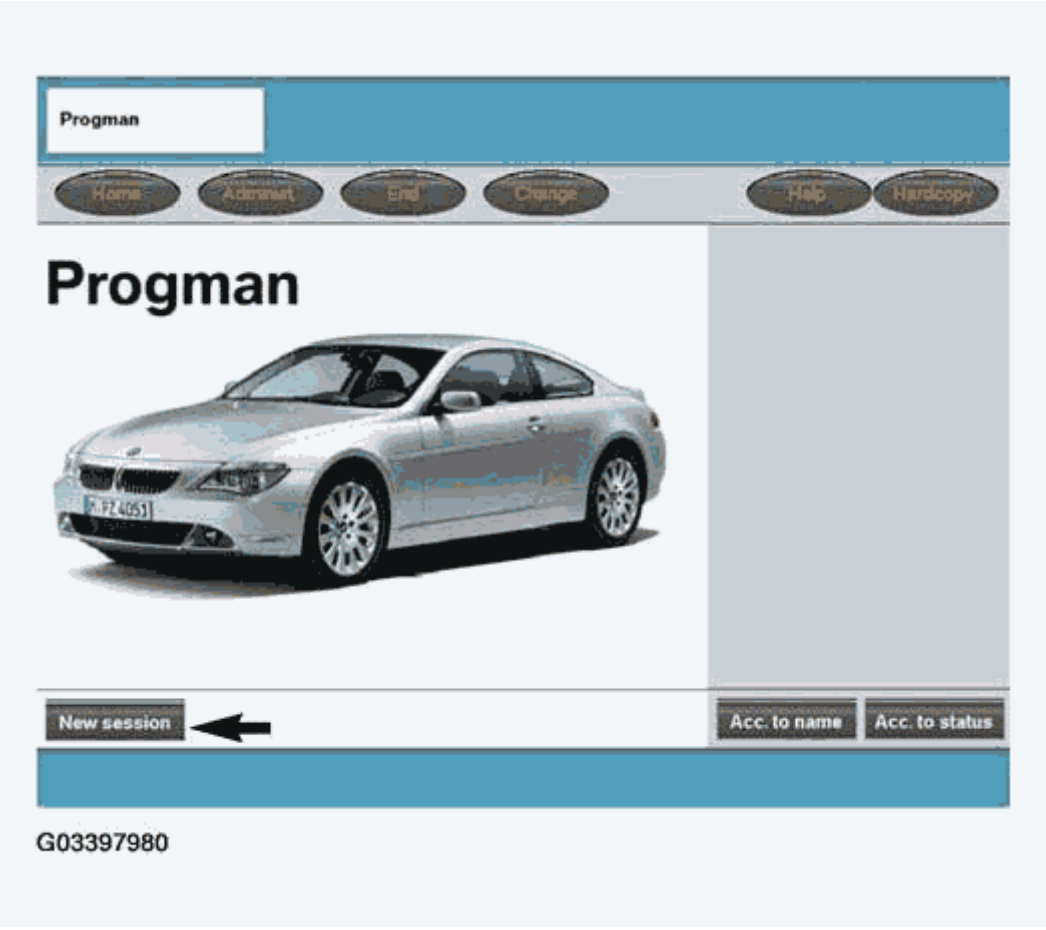


Fig. 126: Selecting New Session Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select the desired interface

Select "Continue"

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Fig. 127: Display Interfaces Name, Version And IP Address
Courtesy of BMW OF NORTH AMERICA, INC.

Under "Description" enter information that will identify the vehicle to which the interface is connected (Ex. VIN or Model type, Service hat #, Vehicle color, Bay location, etc.)

Select "Continue"

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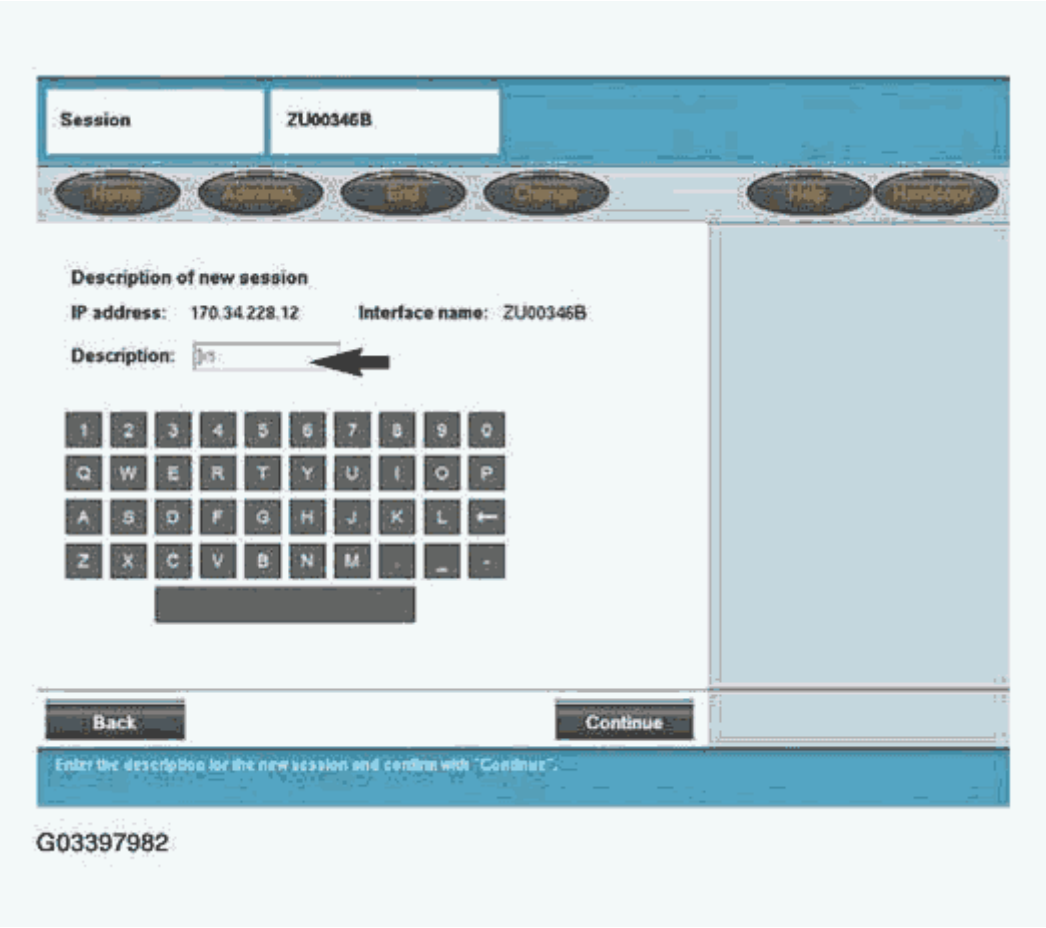


Fig. 128: Entering Information In "Description" About Vehicle To Which Interface Connected
Courtesy of BMW OF NORTH AMERICA, INC.

Access CIP Functions For E31E32/E34/E36/E38/E39/E46/E52/E53

Select desired model series

For this example an E53 - X5 is being used, therefore select "X"

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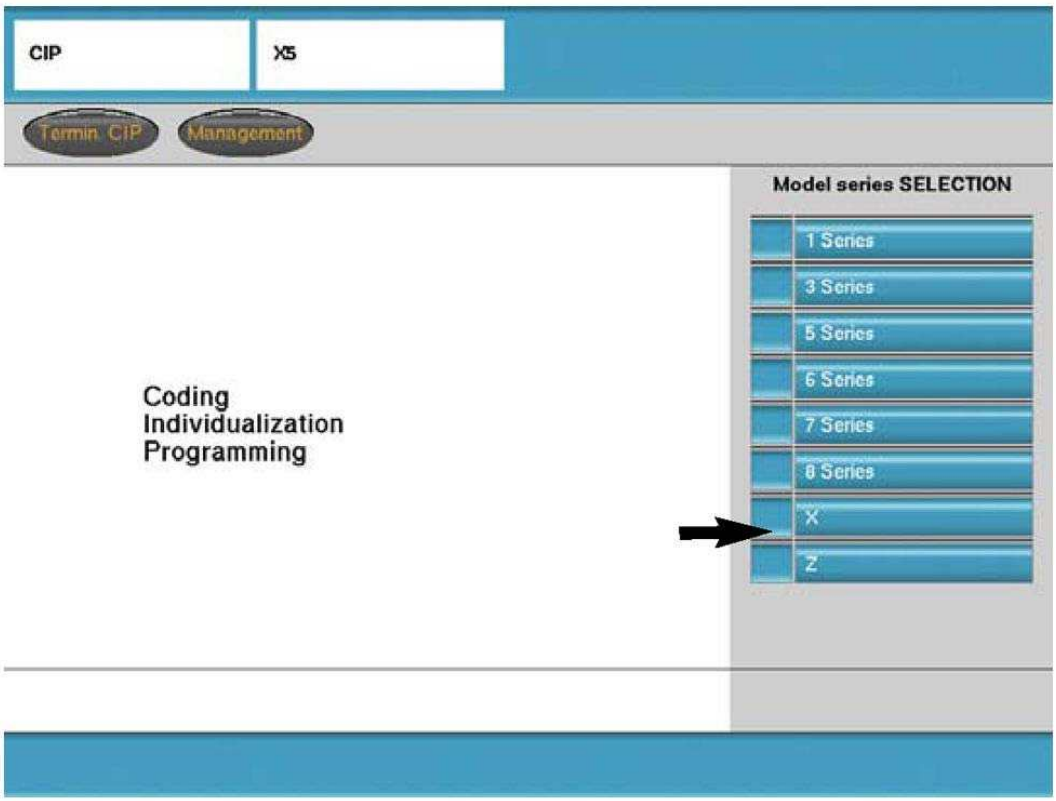


Fig. 129: Selecting "X" Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select "E53"

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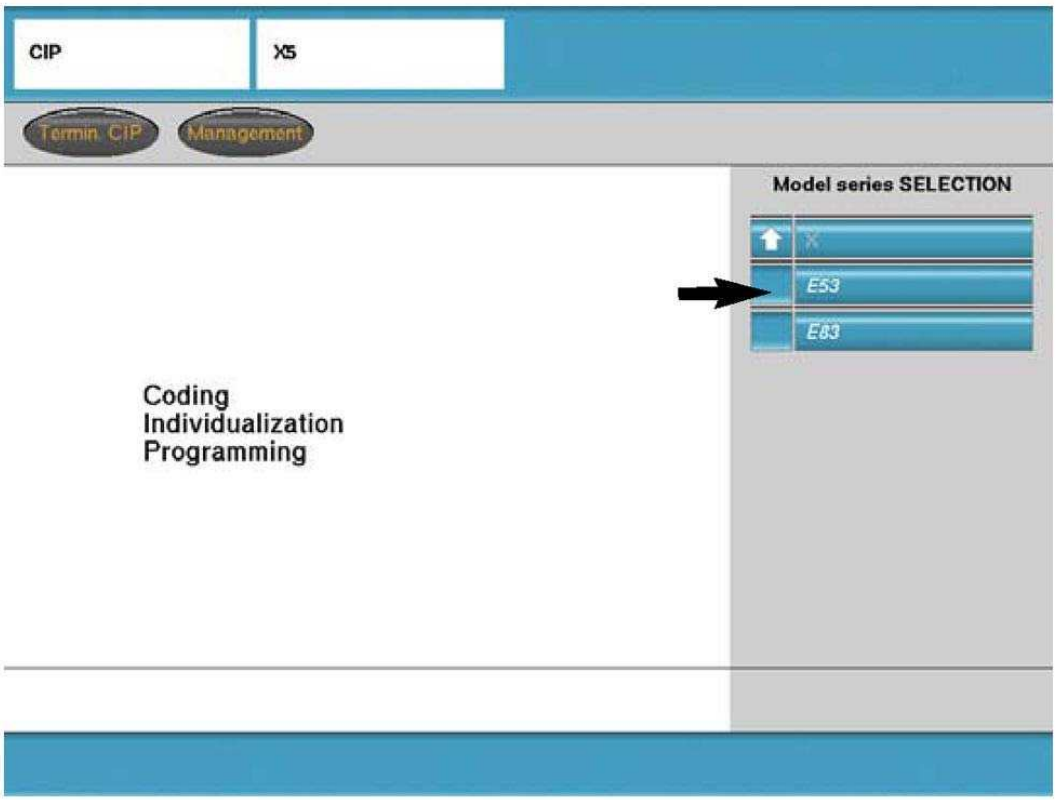


Fig. 130: Selecting "E53" Button
Courtesy of BMW OF NORTH AMERICA, INC.

The screen now displays the SGC/Unix screen previously accessed via the DISplus/GT1 when coding and programming was selected.

At this point select the desired function and proceed as stated in the respective Service Information Bulletin for the procedure being performed.

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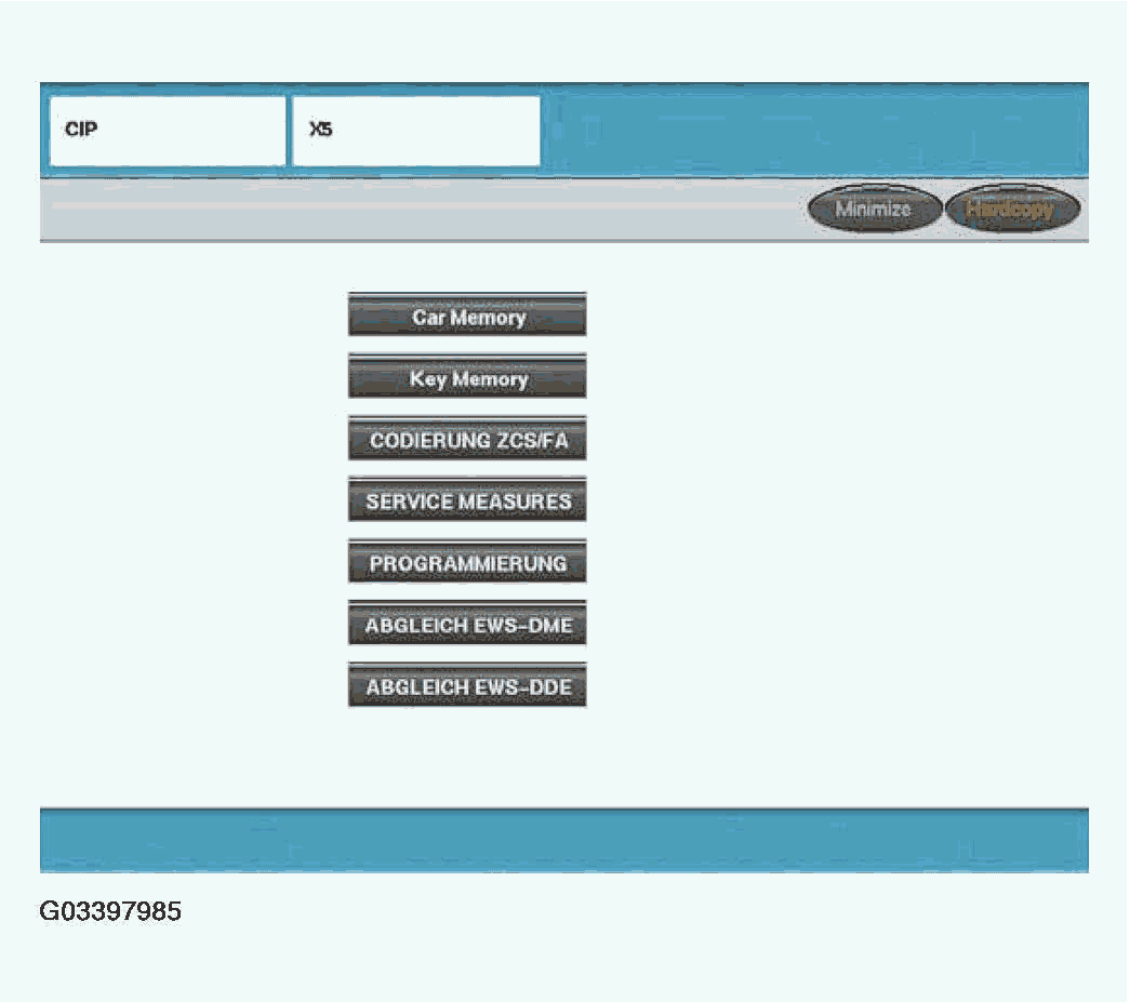


Fig. 131: Displaying SGC/Unix Screen
Courtesy of BMW OF NORTH AMERICA, INC.

Access CIP Functions For E60/E62/E63/E64/E65/E83/E85...

Select desired model series

For this examples an E60 is being used, therefore "5 Series" is selected

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Fig. 132: Selecting 5 Series Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select E60

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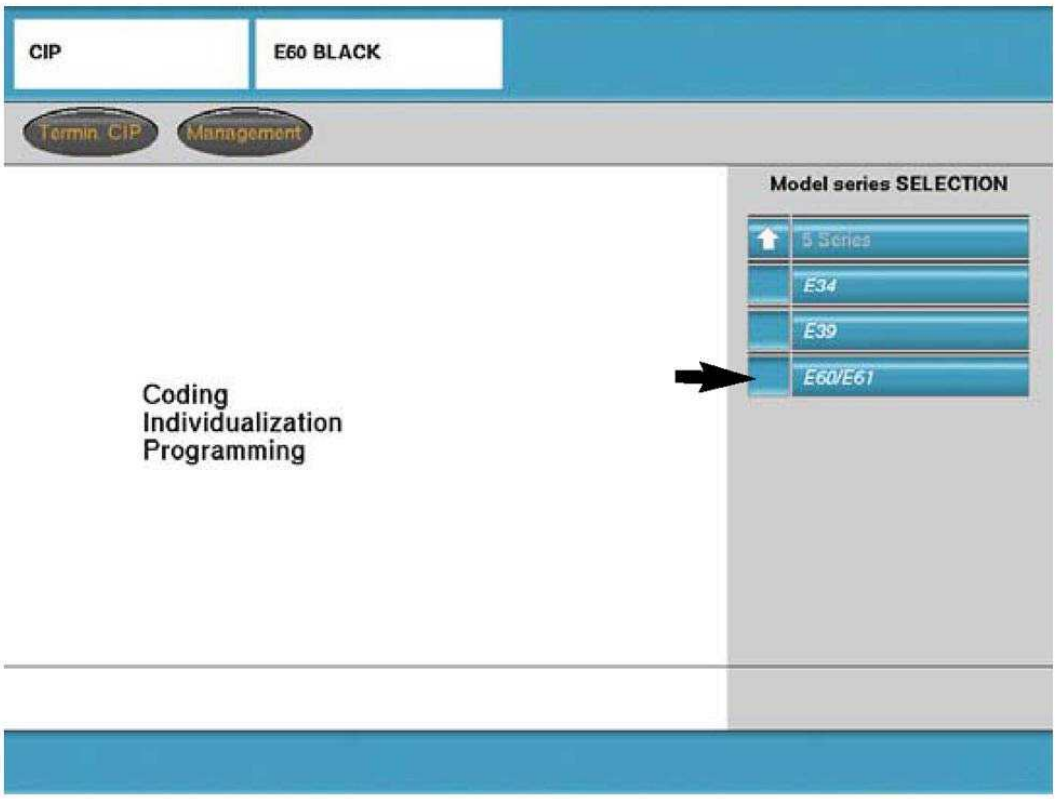


Fig. 133: Selecting E60/E61 Button
Courtesy of BMW OF NORTH AMERICA, INC.

CIP is determining the vehicle order for the vehicle being accessed.

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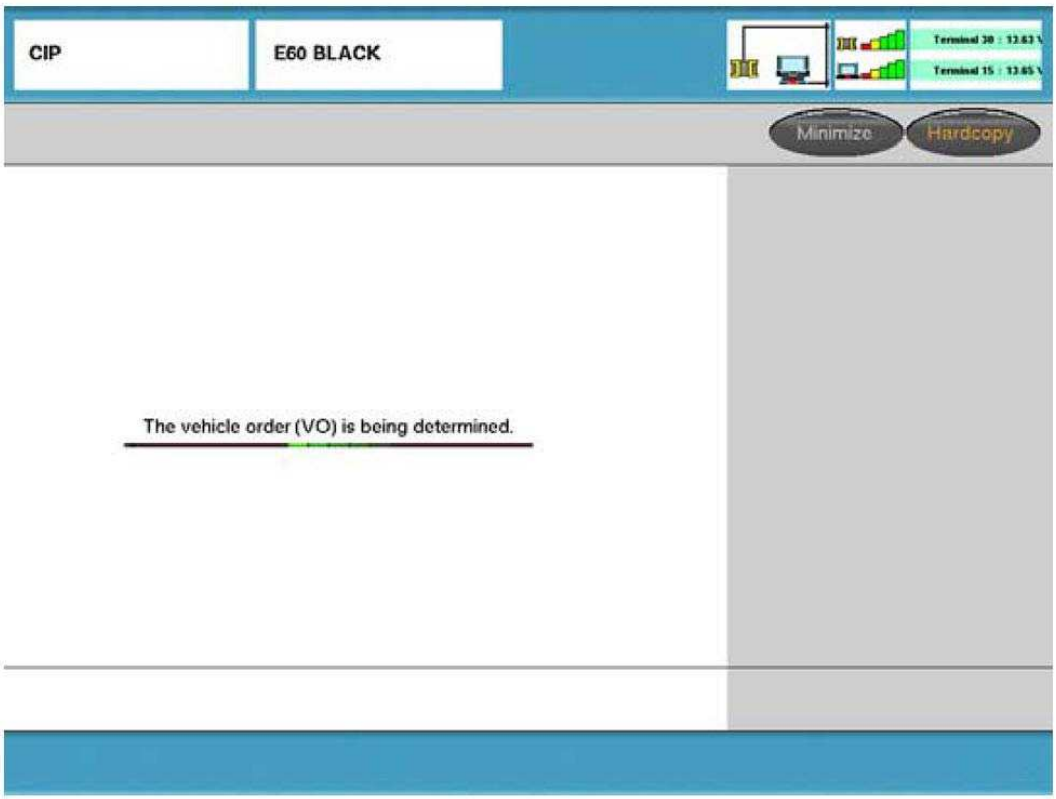


Fig. 134: Display Vehicle Order (VO) Determined
Courtesy of BMW OF NORTH AMERICA, INC.

From this screen select the desired function.

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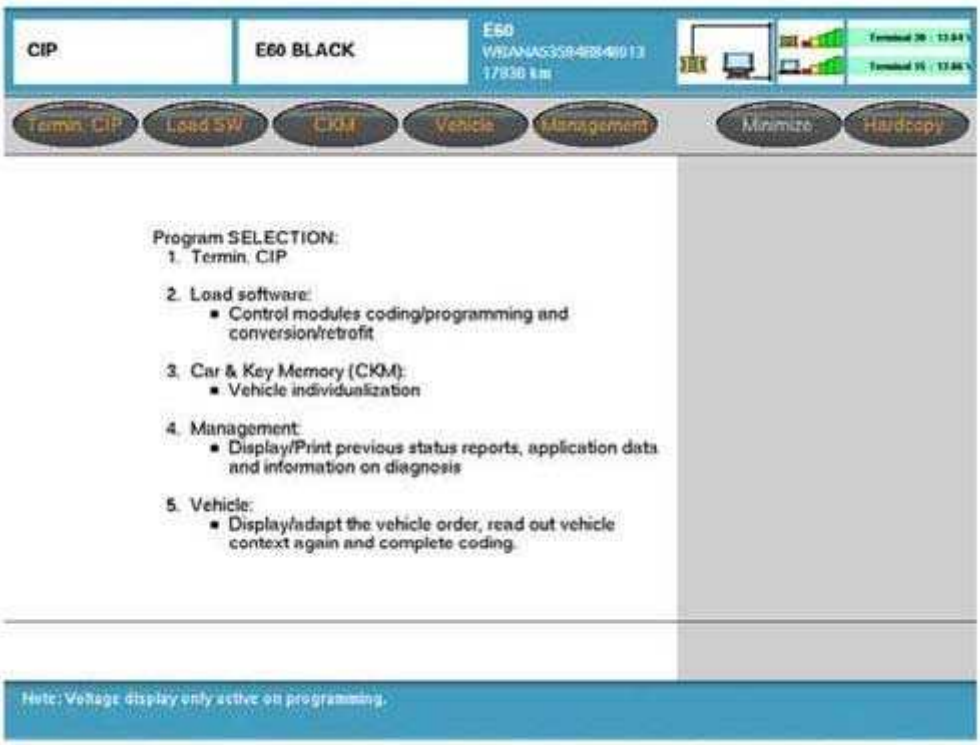


Fig. 135: Selecting Desired Function
Courtesy of BMW OF NORTH AMERICA, INC.

Return To Progman "Home" Screen

Select "Minimize"

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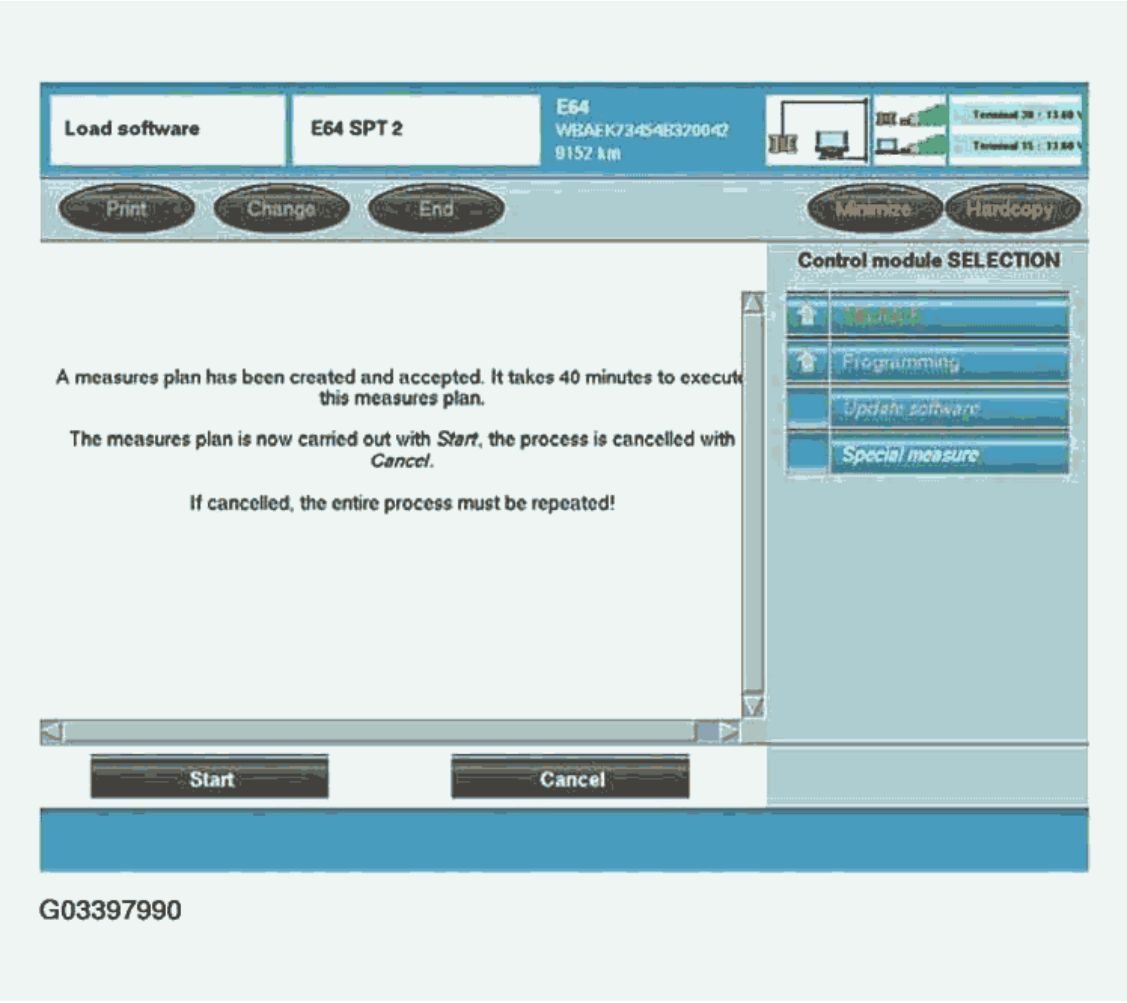


Fig. 136: Selecting Minimize Button
Courtesy of BMW OF NORTH AMERICA, INC.

The Progman "Home" screen is displayed, from here a new session can be started or a current session reviewed.

If using a GT1 a change to diagnostics can also be made.

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Fig. 137: Display Progman - Home Screen (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Progman "Home" Screen Session Status

The Progman "Home" screen displays all sessions that are running on a particular SSS and allows any of the sessions to be reviewed.

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Fig. 138: Display Progman - Home Screen (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Explanation of session status indicators:

1 - Black text with white background indicates that session is running and does not require any input, the status of the session can be reviewed.

2 - Grey text indicates a session is active/in progress and is currently being accessed or reviewed by another user. This session can not be accessed by an additional user.

3 - Orange text indicates that input is required before program can continue, this session should be accessed and reviewed to provide required input.

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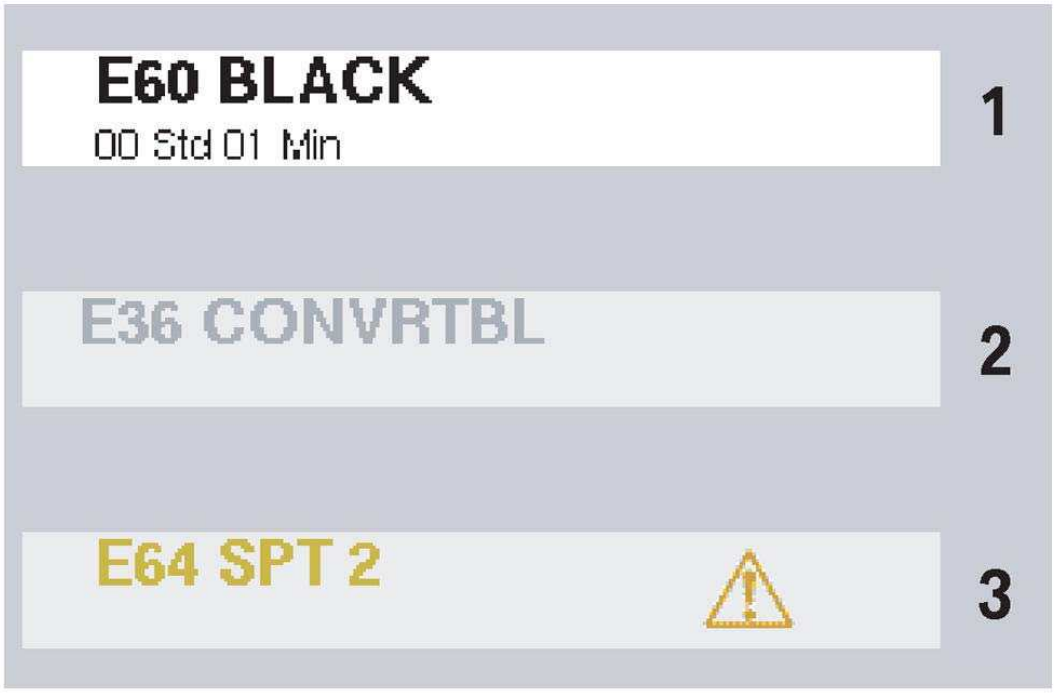


Fig. 139: Display Session Status Indicators Explanation
Courtesy of BMW OF NORTH AMERICA, INC.

Going From Progman To Diagnosis On GT1

If using a GT1 it is possible to switch from Progman to a diagnostic function.

From the Progman home screen select "Change"

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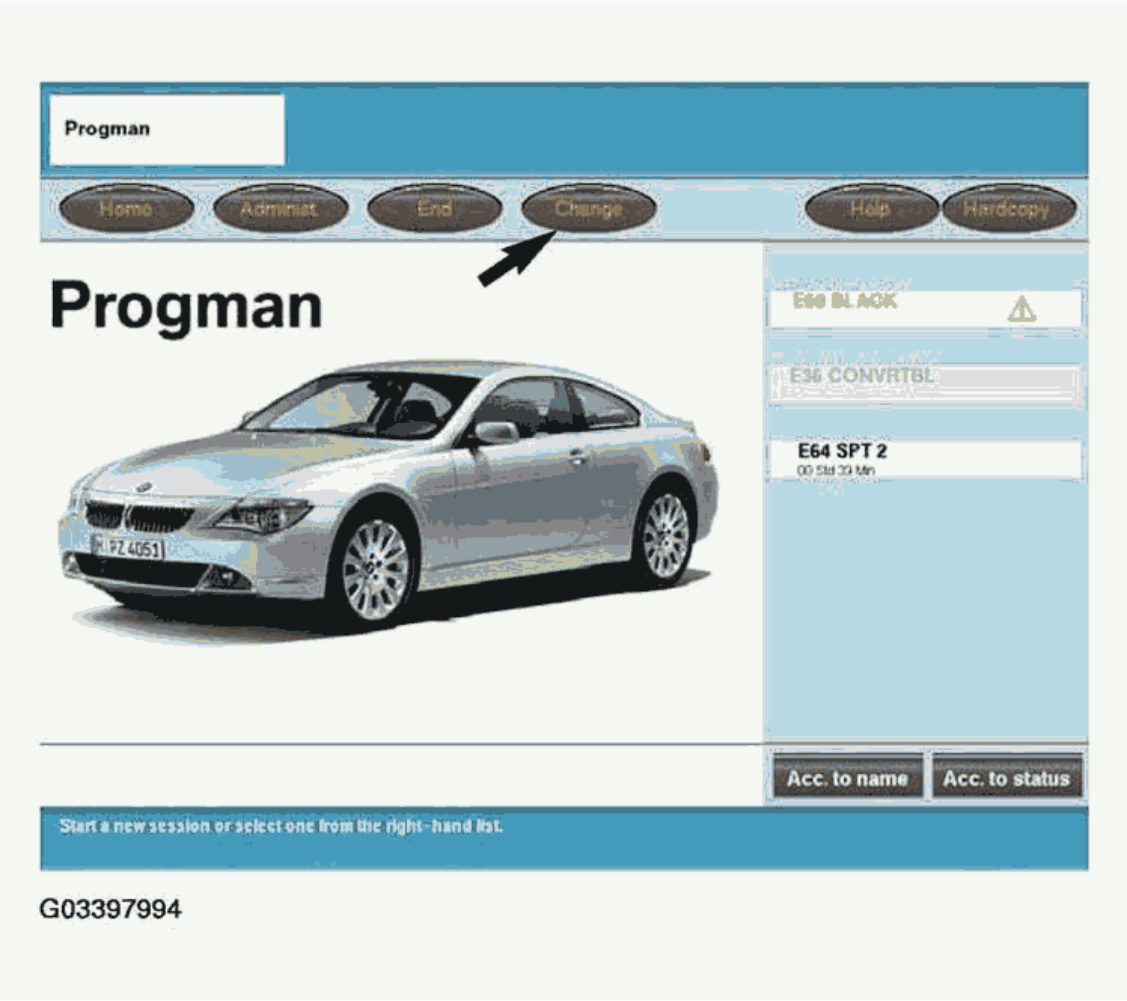


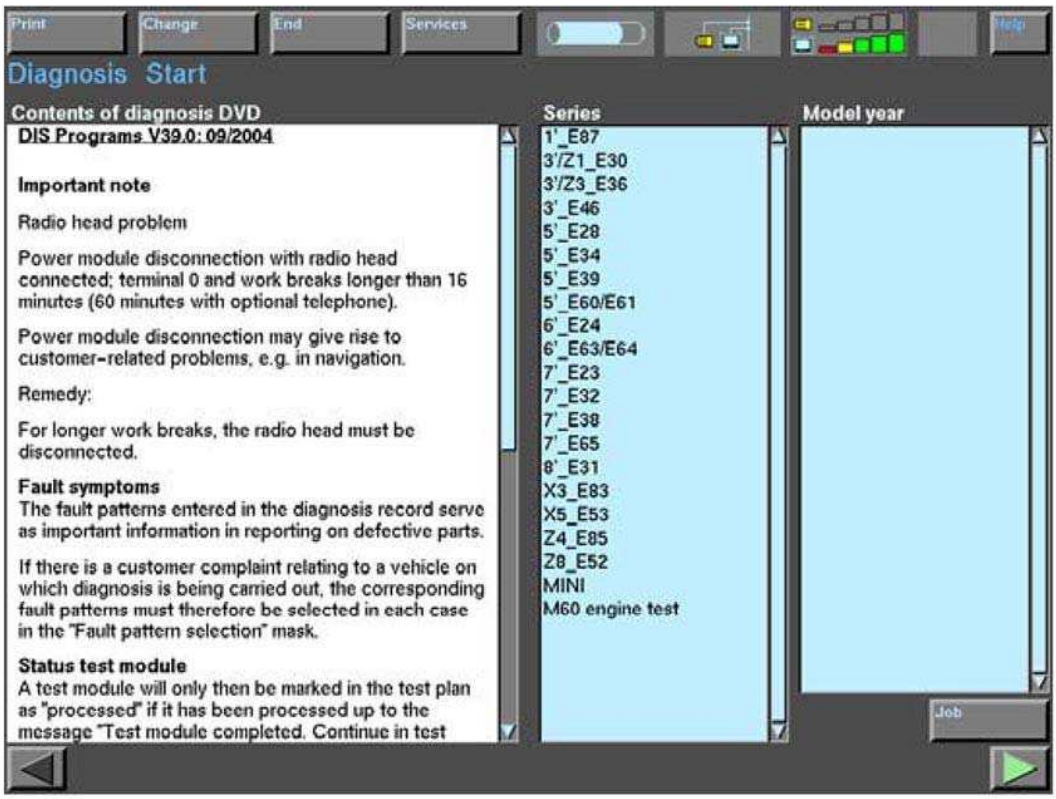
Fig. 140: Selecting Change Button
Courtesy of BMW OF NORTH AMERICA, INC.

The GT1 will switch to diagnostics and a new diagnostic session can be started by connecting to an available interface, if nothing was previously active.

Or

If a diagnostic session was previously active then the system will return to that point, prior to having switched over to Progman.

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Fig. 141: Display Diagnostic Start Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Going From Diagnosis To Progman On GT1

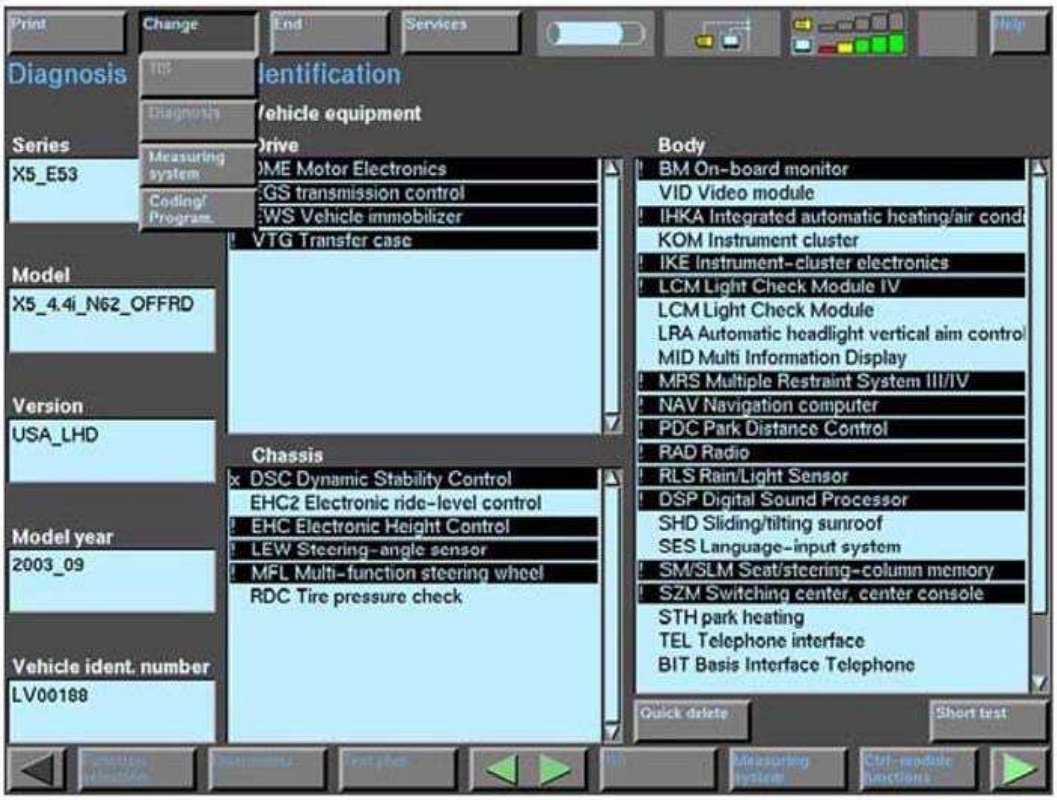
If using a GT1 it is possible to switch from a diagnostic function to Progman to check the status of an active session.

From the diagnostic screen:

Select "Change"

Select "Coding/Program"

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Fig. 142: Selecting Change And Coding/Program Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select the SSS on which the session is to be checked

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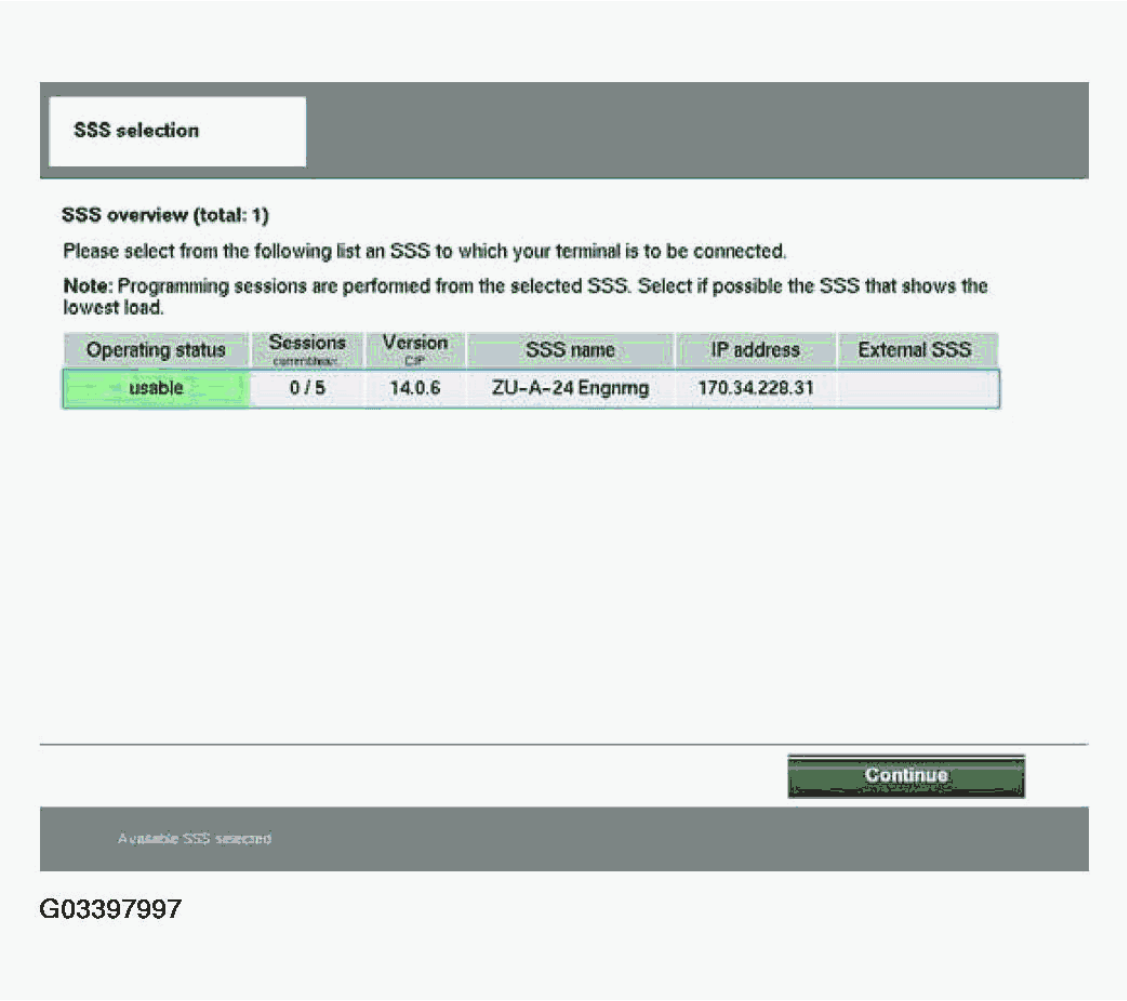


Fig. 143: Selecting SSS
Courtesy of BMW OF NORTH AMERICA, INC.

The GT1 will switch to the Progman session.

Select the session to be checked.

Example:

The E64 SPT 2 session is highlighted in orange, which indicates that a user input is required.

Select "E64 SPT 2"

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Fig. 144: Selecting E64 SPT 2
Courtesy of BMW OF NORTH AMERICA, INC.

The status information for the selected session states that it is "Waiting for user action"

Select "Continue" to view/access the session

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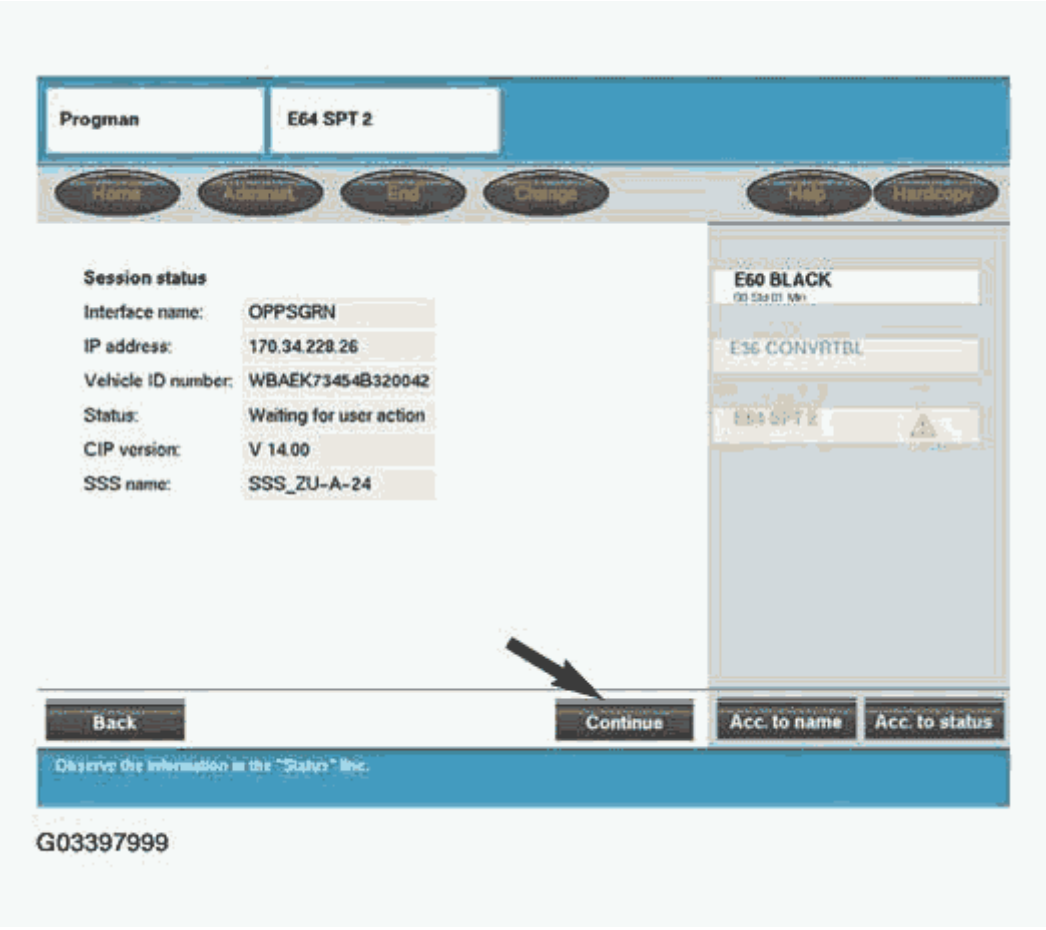


Fig. 145: Selecting Continue Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select "Start" to initiate/carryout the measures plan

Or

Select "Cancel" to end the process and return to the previous module selection screen of CIP.

Or

Select "Minimize" to return to the home screen of Progman.

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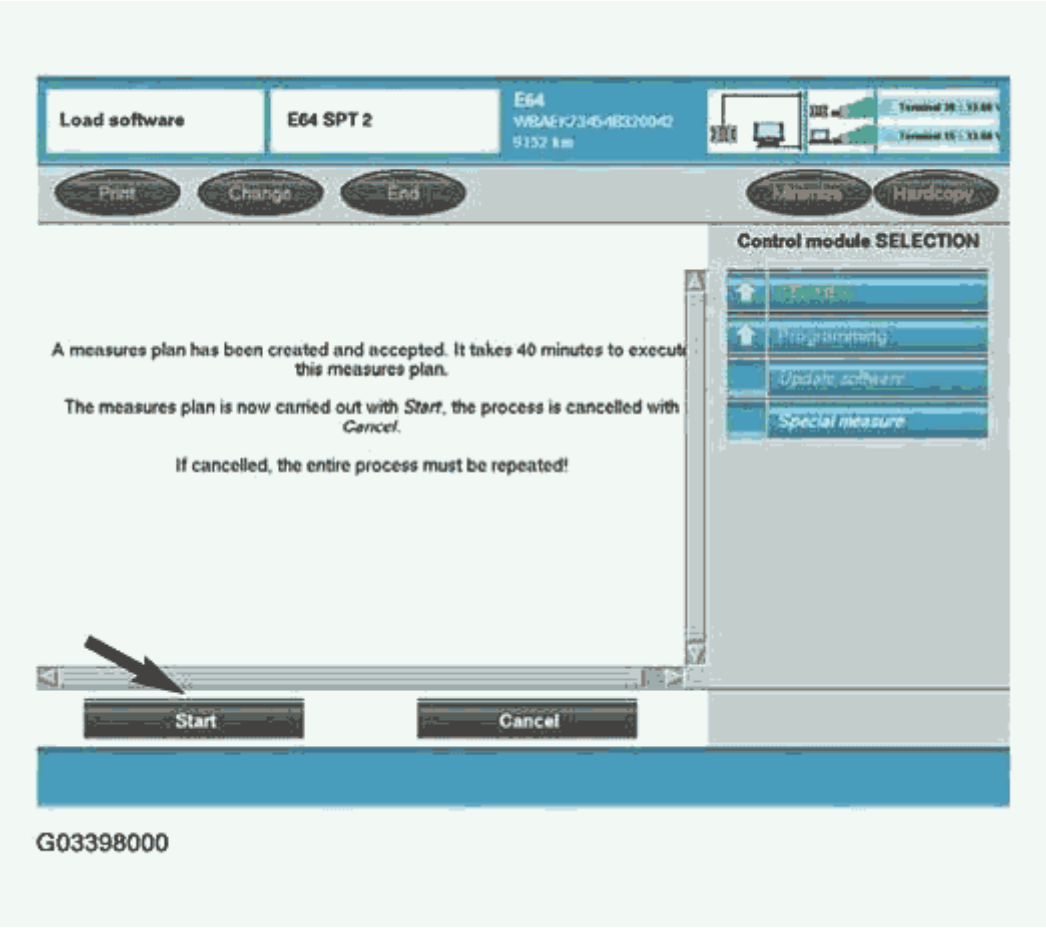
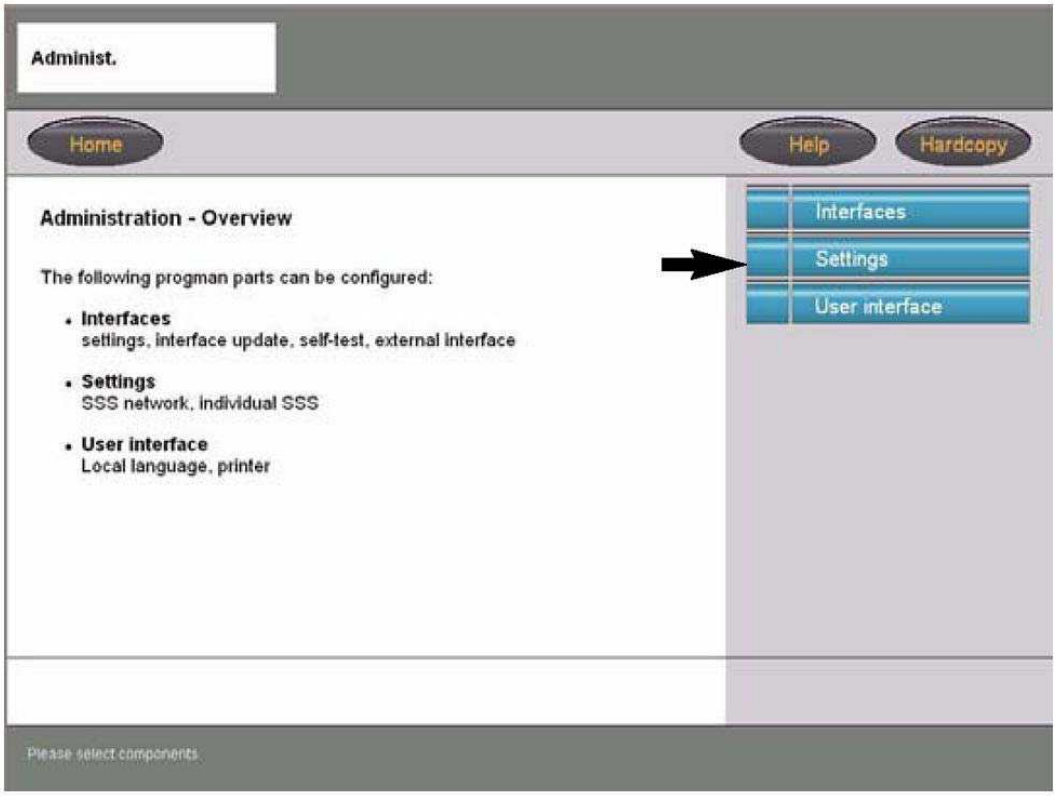


Fig. 146: Selecting Start Button
Courtesy of BMW OF NORTH AMERICA, INC.

SHUTTING DOWN THE SSS

After selecting "Administ." on the Progman Home screen select "Settings".

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Fig. 147: Selecting Setting Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select "Overview"

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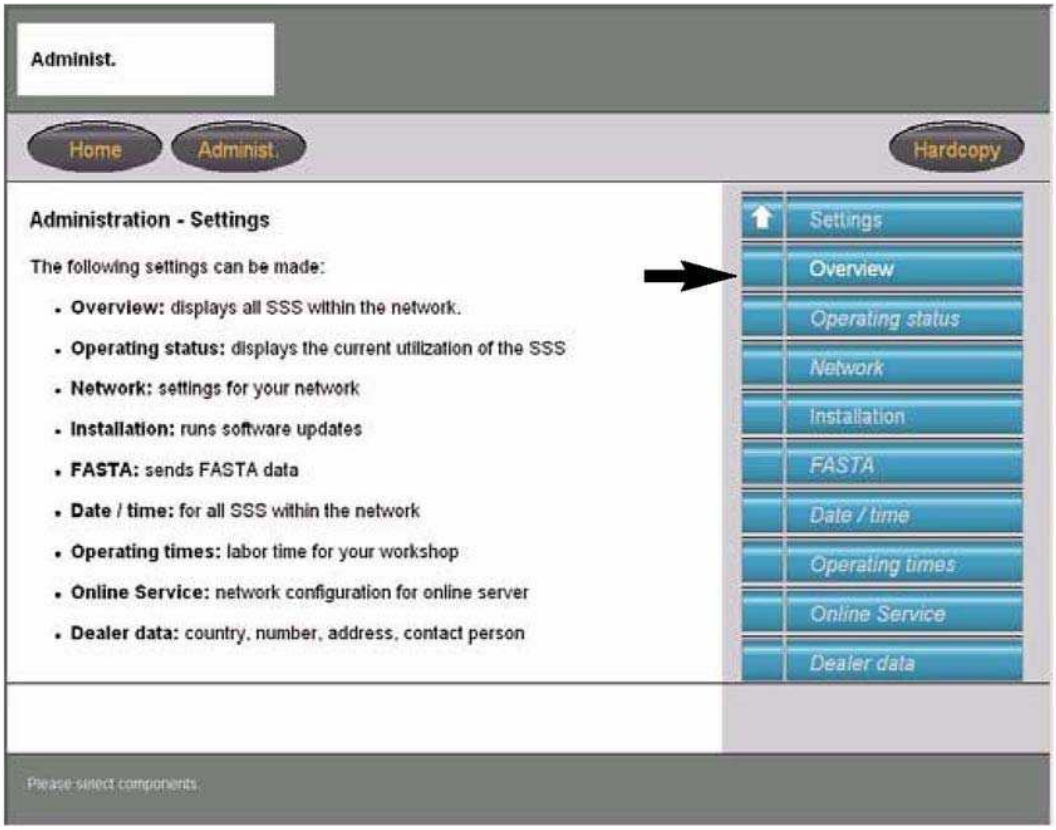


Fig. 148: Selecting Overview Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select the specific SSS to be shutdown

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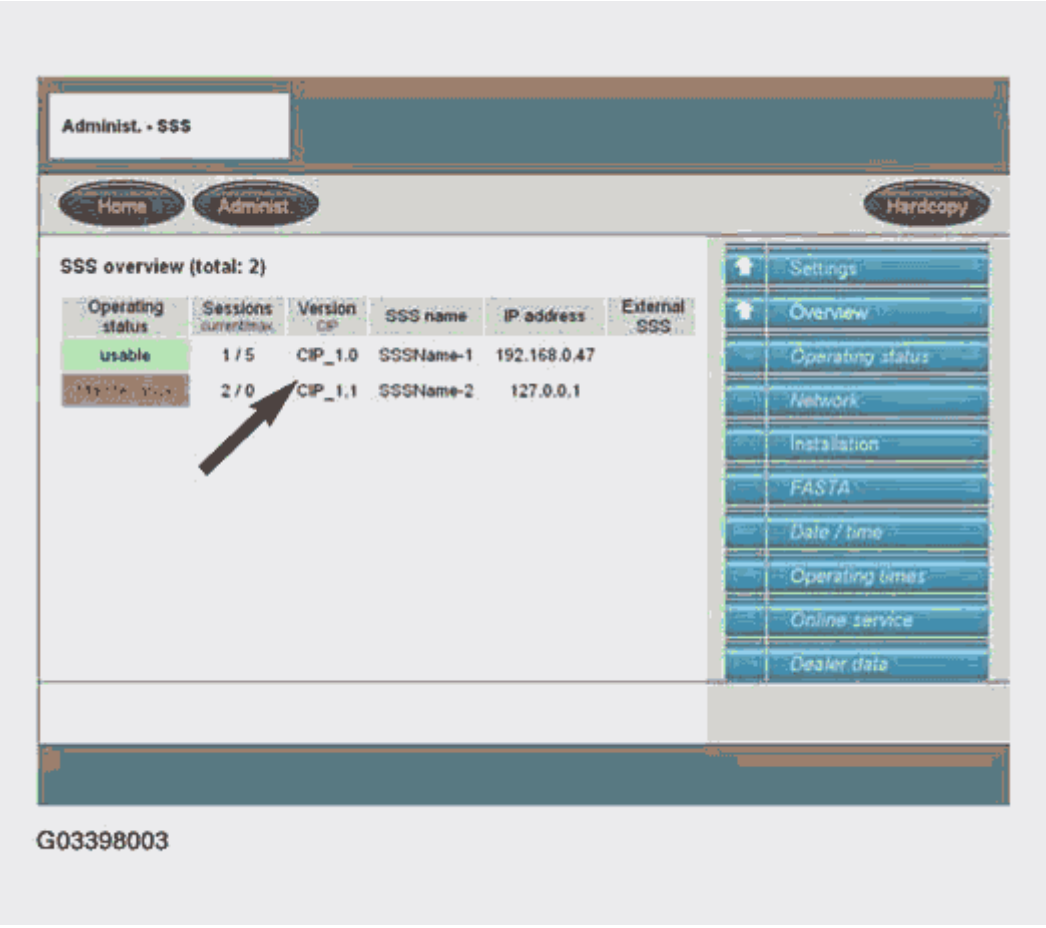
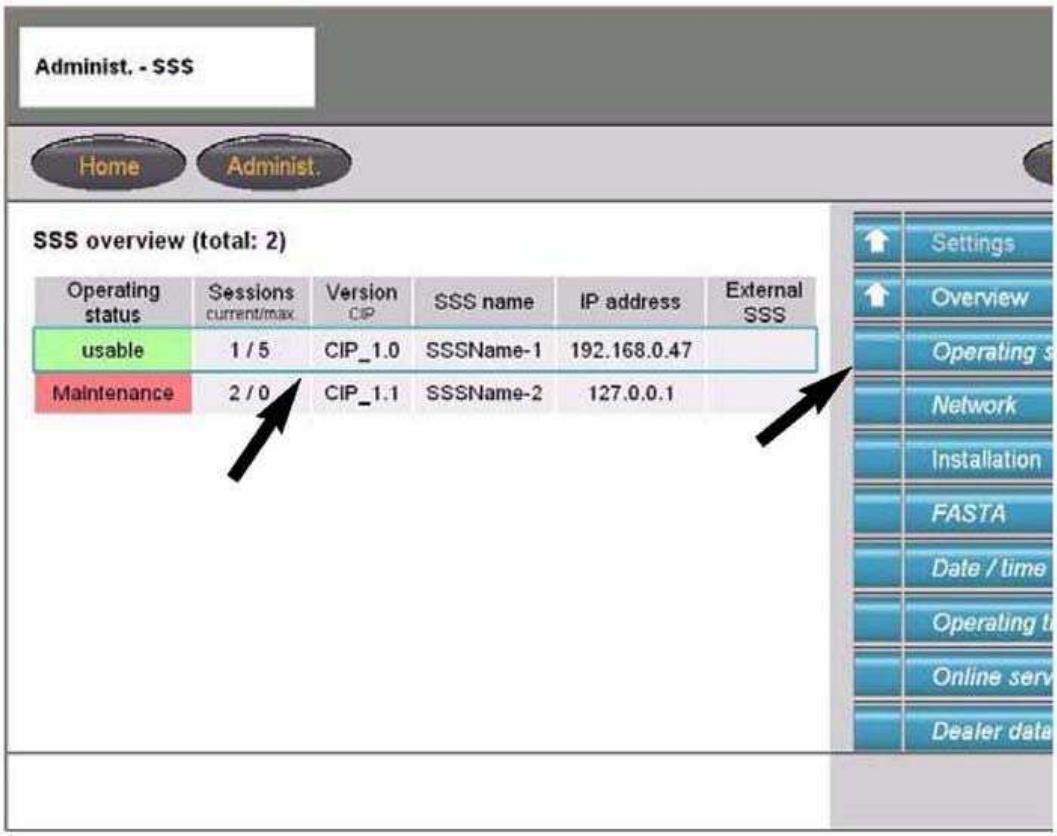


Fig. 149: Display SSS Overview Menu
Courtesy of BMW OF NORTH AMERICA, INC.

After selecting the specific SSS, select "Operating Status".

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Fig. 150: Selecting Operating Status Button
Courtesy of BMW OF NORTH AMERICA, INC.

This is the only location from which the SSS should be restarted or shutdown using the buttons at the bottom of the screen.

Selecting "Restart" will switch the SSS off and then back on.

Selecting "Switch off" will turn the SSS off.

NOTE: The on/off button located directly on the computer should not be used to turn OFF the SSS.

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Fig. 151: Display SSS Operating Status
Courtesy of BMW OF NORTH AMERICA, INC.

Workshop Exercise - Access CIP & ZCS

1. Access CIP for an E60.
2. Access ZCS functions to obtain the central coding key on an E53 or Vehicle order on an E46.

CODING, INDIVIDUALIZATION & PROGRAMMING (CIP)

Model: All

Production: All

CODING, INDIVIDUALIZATION & PROGRAMMING

Introduction

With the introduction of the E65 in 2001, BMW not only introduced a vehicle loaded with the latest technology

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but also introduced a new way of performing vehicle coding and programming. In order to code and program an E65, a software program commonly referred to as CIP was introduced. The acronym CIP stands for **C** oding, **I** ndividualization & **P** rogramming and with the introduction of Progman & CIP 15.0 it has become the sole software tool for coding and programming vehicles.

Initially CIP was developed for use on the E65/E66 and newer models but has since been expanded to include all vehicles produced prior to the introduction of the E65 that utilize a an SGC/UNIX programming structure.

The intention of the CIP program 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 (equipped with a MOST bus). 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, the CIP software 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 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.

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

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"Measures plan" as shown below.

Vehicle data status: E060-04-09-503

Target data status: E060-04-09-55

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.*

Measures Plan

A measures plan is generated by CIP to identify what if any control modules need to be updated in order to bring a vehicle up to the latest integration level or data status. The measures plan also identifies the part number of the old/installed programmed control module and also what the new part number will be after the update is performed.

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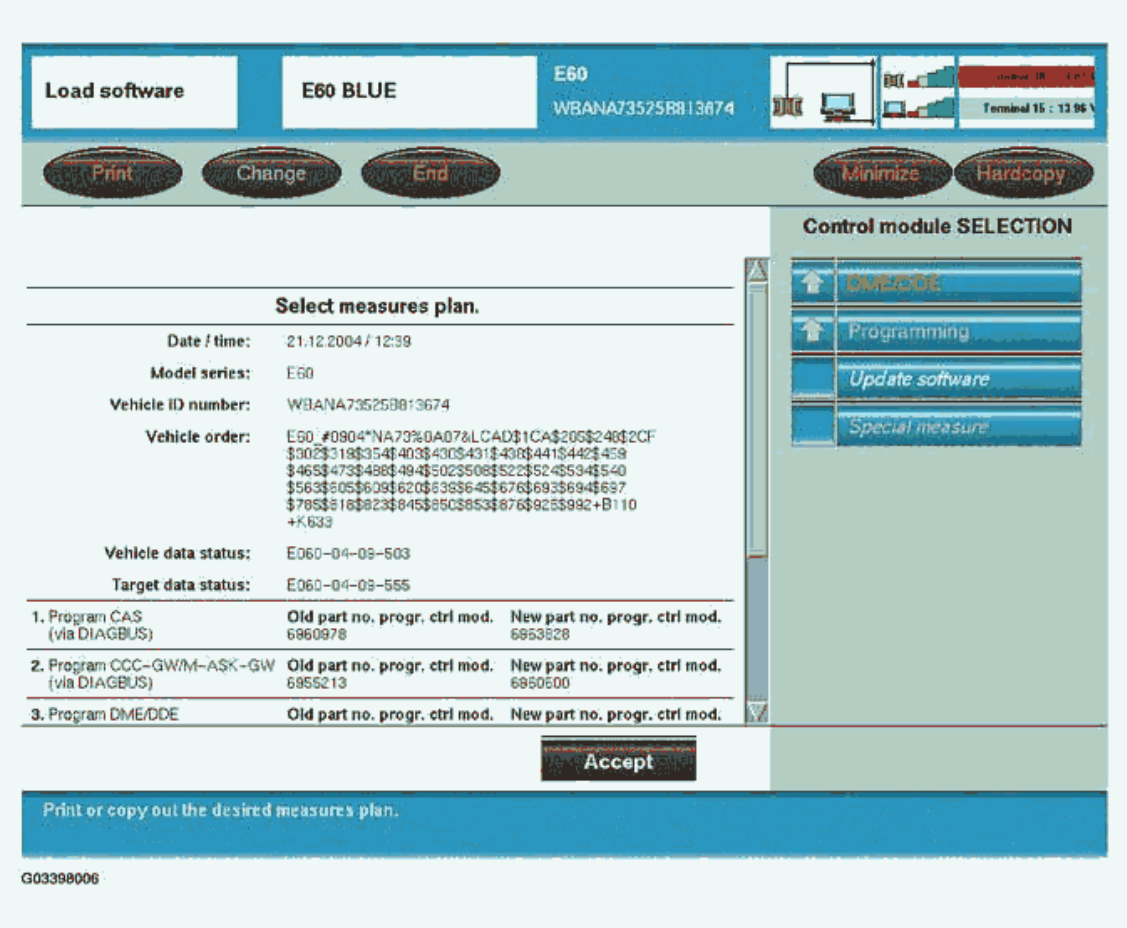


Fig. 152: Display Select Measures Plan Screen
Courtesy of BMW OF NORTH AMERICA, INC.

By accepting the defined plan all modules that are listed will be updated "automatically".

IMPORTANT: Whenever a measures plan is defined it should always be printed out before proceeding in order to document the work performed, by attaching it to the repair order.

NOTE: An all inclusive status report or measures plan is only generated for vehicles equipped with a MOST-bus, to ensure compatibility. For all other vehicles a measures plan is generated only for the module selected to be updated (i.e. DME, TCU, EGS...) no evaluation of the other modules in the vehicle is made.

Initial CIP Screen

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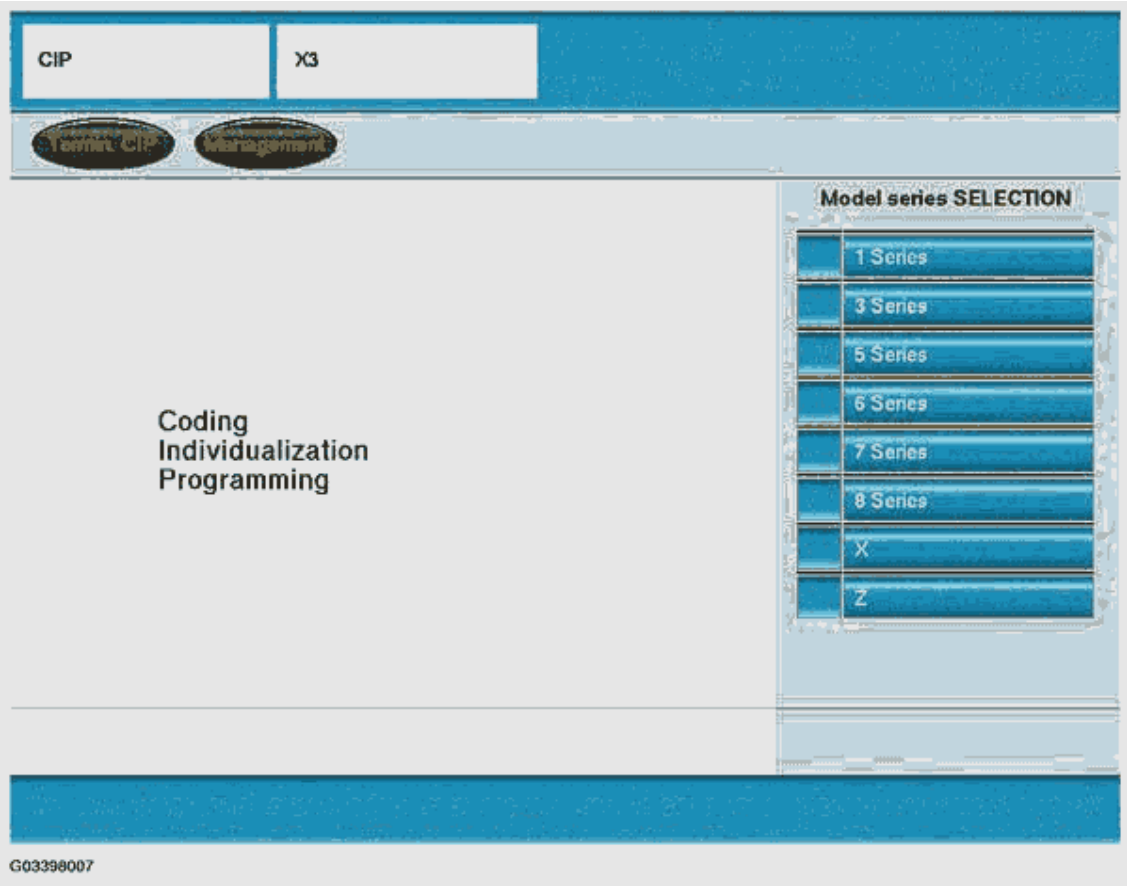


Fig. 153: Display Initial CIP Screen
Courtesy of BMW OF NORTH AMERICA, INC.

From the initial CIP screen select the model for which a coding or programming session is to be performed.

CIP Main Selection Screen

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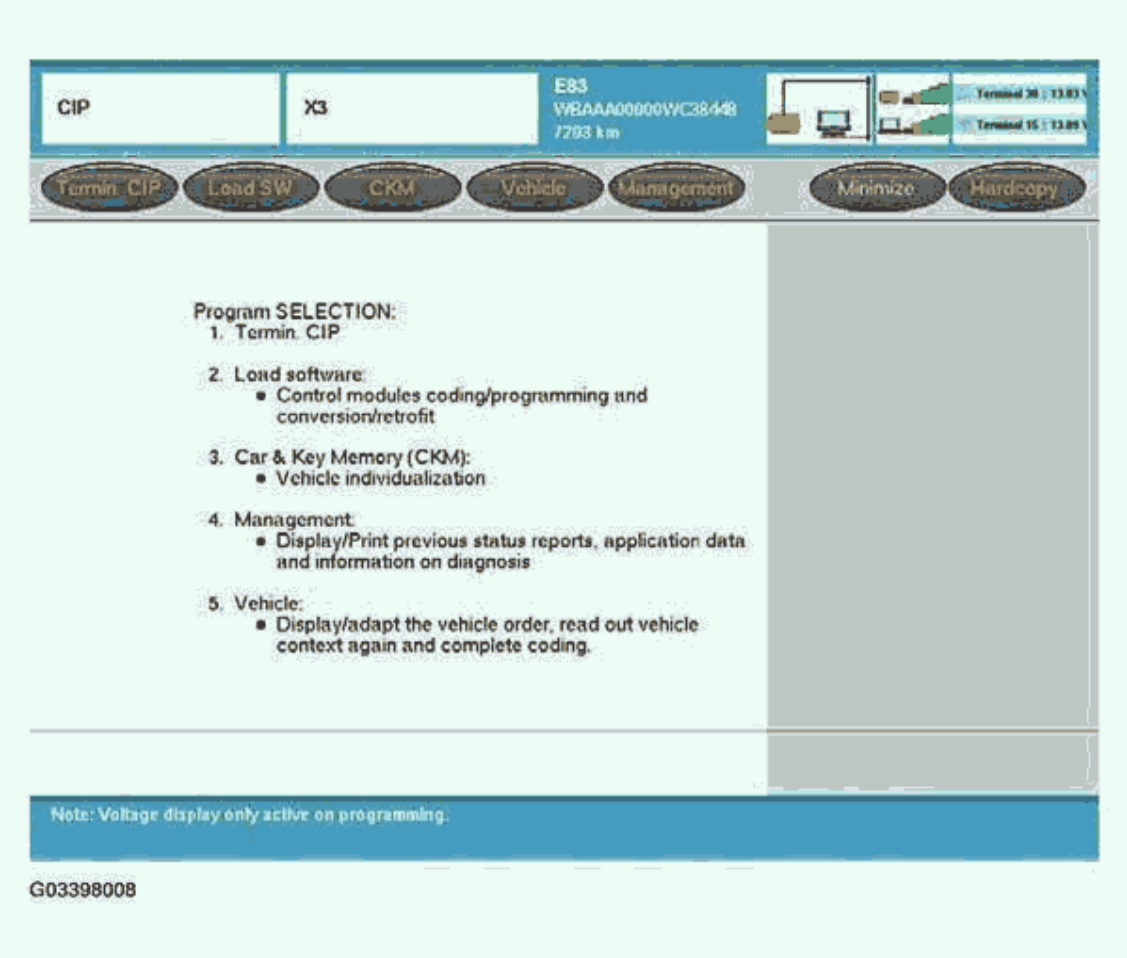


Fig. 154: Display CIP Main Selection Screen
Courtesy of BMW OF NORTH AMERICA, INC.

Selection of CIP functions/options:

Termin. CIP - End the CIP program and return to Progman home screen

Load SW - Load software function to be selected if:

- Control module has been replaced
- Retrofit process is to be carried out
- Vehicle software is to be updated
- Coding/programming of one or more module(s) is to be performed

CKM - Vehicle and Key Memory/Individualization allows various driver selectable features (such as drive way locking, seat memory, central locking/unlocking, daytime running lights etc.) to be coded to the vehicle or individual keys.

Management - Provides the ability to:

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- display the current version of CIP installed
- print previously performed Service Measure Reports
- run a test on the software currently installed on system (SSS)

Vehicle - Allows access to:

- Vehicle Order
- Initialization
- Service Functions
- Complete vehicle coding

Control Module Replacement Yes/No

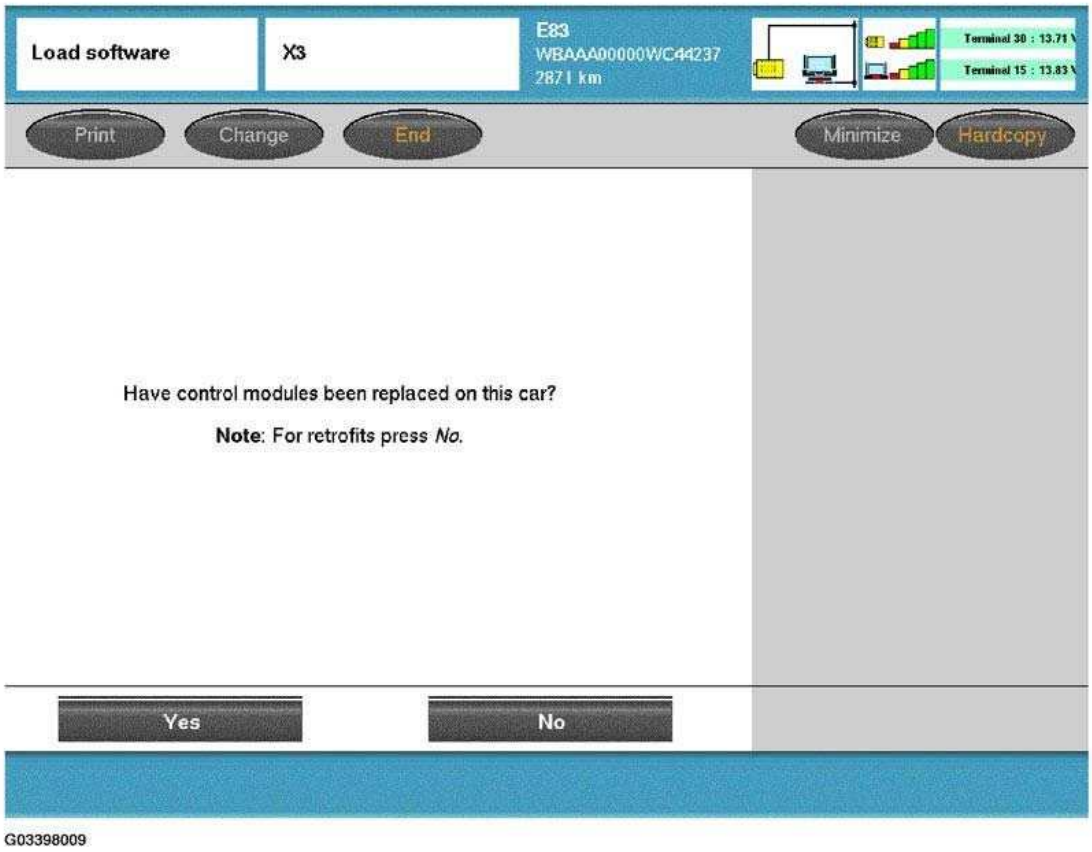


Fig. 155: Display Control Module Replacement Menu
Courtesy of BMW OF NORTH AMERICA, INC.

At this screen information is needed to determine which path is to be followed.

Answer **"Yes"** if:

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- A previously installed control module has been replaced.

Answer **"No"** if :

- No control module(s) has been replaced but an update on one or more modules needs to be performed.
- A retrofit needs to be performed on the vehicle (such as installation of CD player, ULF, phone cradle installation, activation of bluetooth, etc...).
- A control module for a new system/accessory is installed as part of a retrofit installation.

CIP FUNCTIONS - IF NO (NON MOST-BUS VEHICLES WITH VO)

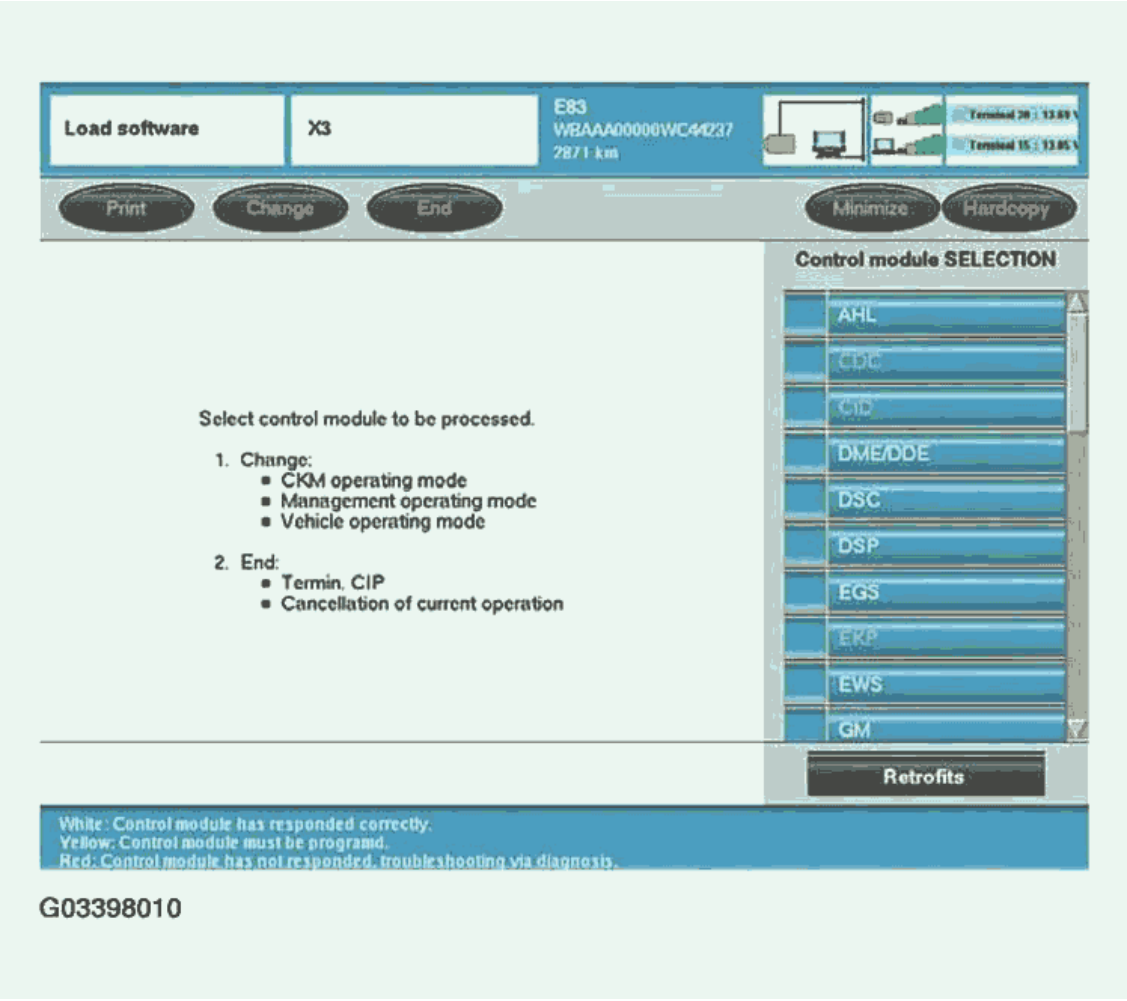


Fig. 156: Display Select Control Module Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Select the module to be reprogrammed

Or

Select **"Retrofits"** if an accessory function/feature is to be added or deleted.

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Example: *DME/DDE was selected on previous screen.*

Programming is selected if:

- Checking for availability of updated software for selected control module.
- It is known that updated software is available for the selected control module. Replacement is selected if a module was replaced.

EWS is selected if:

- Alignment of EWS & DME must be performed

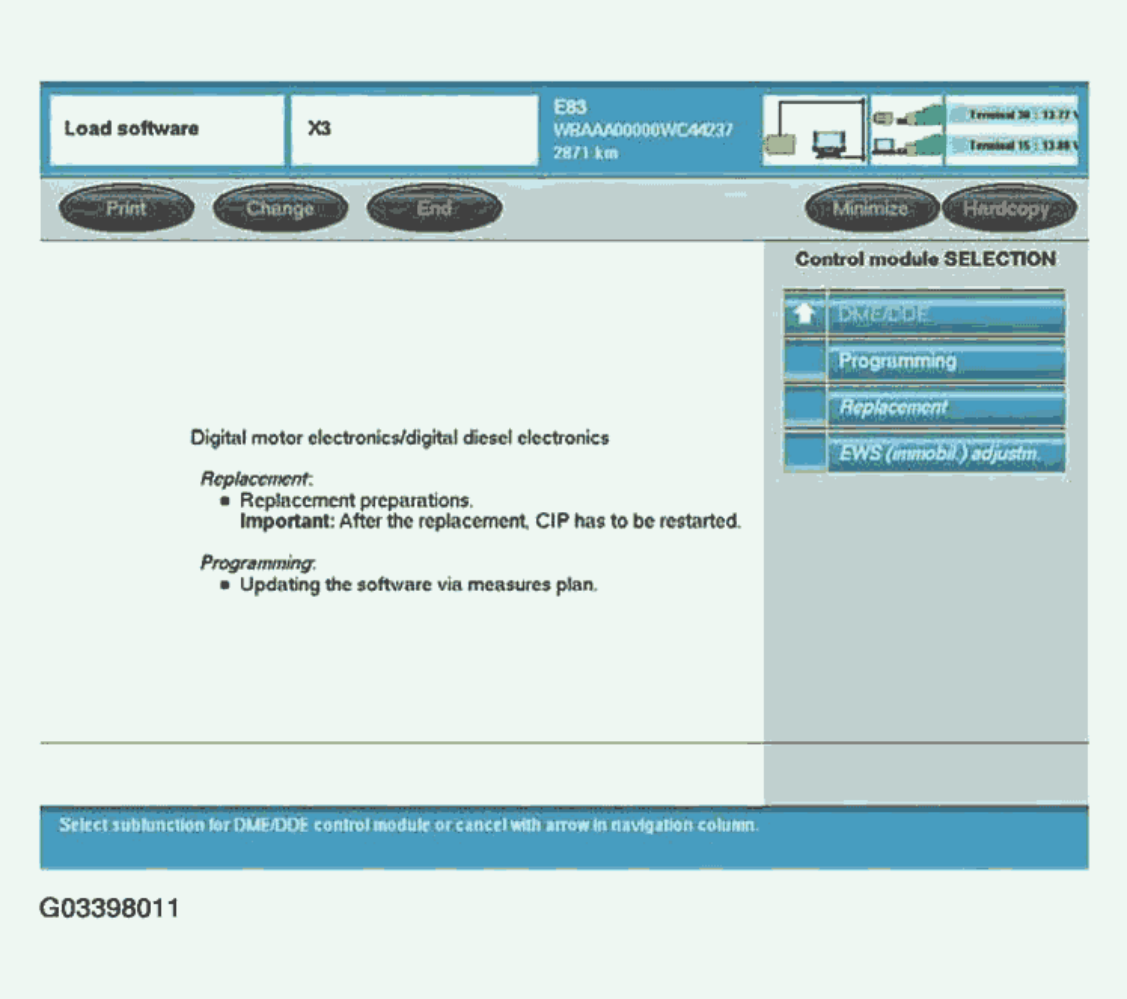


Fig. 157: Selecting Programming Button
Courtesy of BMW OF NORTH AMERICA, INC.

Example: *Programming was selected on previous Screen.*

Upon selecting **"Update software"** a measures plan will be generated that is specific to the module selected.

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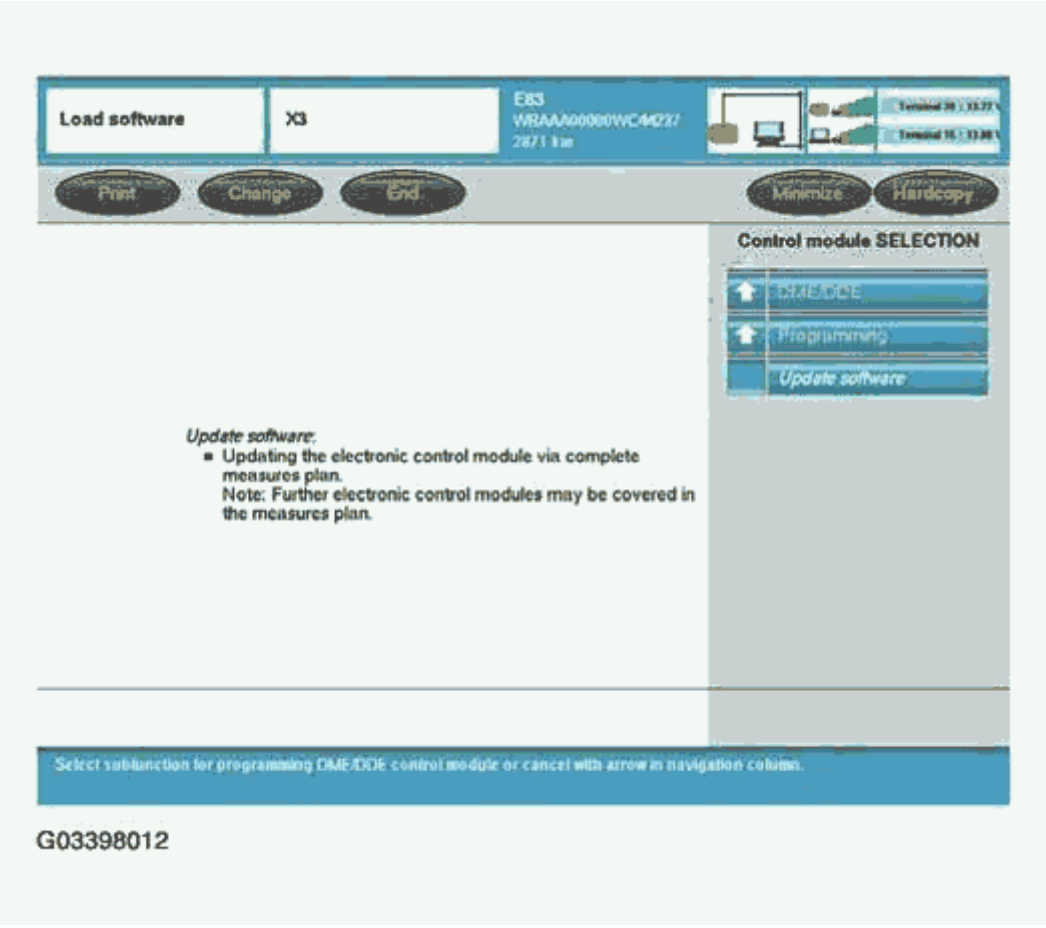


Fig. 158: Selecting Update Software
Courtesy of BMW OF NORTH AMERICA, INC.

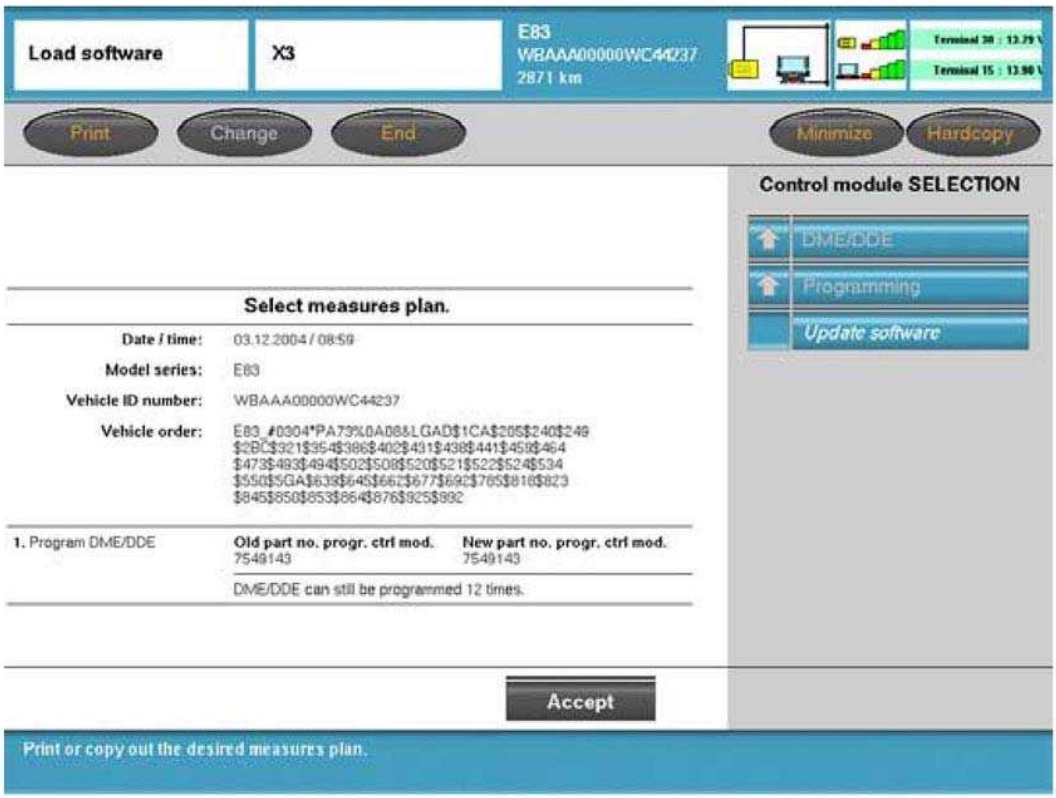
A measures plan for the selected system/module is displayed.

A measures plan identifies the programmed part number for the control module(s) installed:

- "Old part no. progr. ctrl. mod." - indicates p/n for software currently installed.
- "New part no. progr. ctrl. mod." - indicates the p/n if the module is updated, by accepting the displayed measures plan the module will be updated to the new number and software.

NOTE: The "update" does not need to be performed if the two part numbers are the same.

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Fig. 159: Display Select Measures Plan Screen
Courtesy of BMW OF NORTH AMERICA, INC.

On vehicles without a MOST-Bus, a "Measures plan" provides information on updates that are available for the selected control module. By selecting accept, only the module listed in the measures plan will be updated.

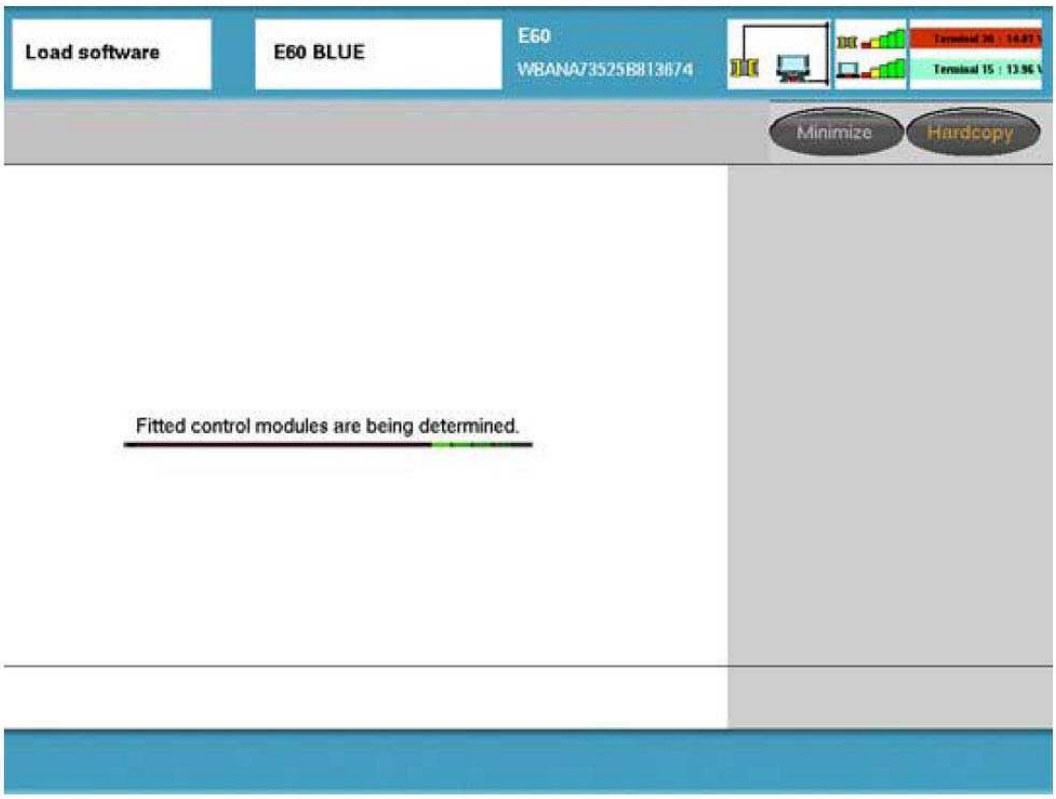
NOTE: Prior to selecting accept, printout a copy of the measures plan and attach it to the repair order to document the work performed.

IMPORTANT: If the measures plan identifies any control modules that will need to be replaced exit CIP.

CIP FUNCTIONS - IF NO (MOST-BUS VEHICLES)

After selecting **"No"** CIP evaluates the installed control modules to determine if any updates are required.

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Fig. 160: Display Fitted Control Module Determined
Courtesy of BMW OF NORTH AMERICA, INC.

Once the evaluation is completed and CIP determines that there are updates available a "Status report" is generated.

NOTE: Status report is similar to a measures plan.

The status report identifies the control modules for which an update is available and also indicates if the module will need to be reprogrammed or replaced.

Information is also provided indicating the current programmed part number and also what the number should be after an update is performed.

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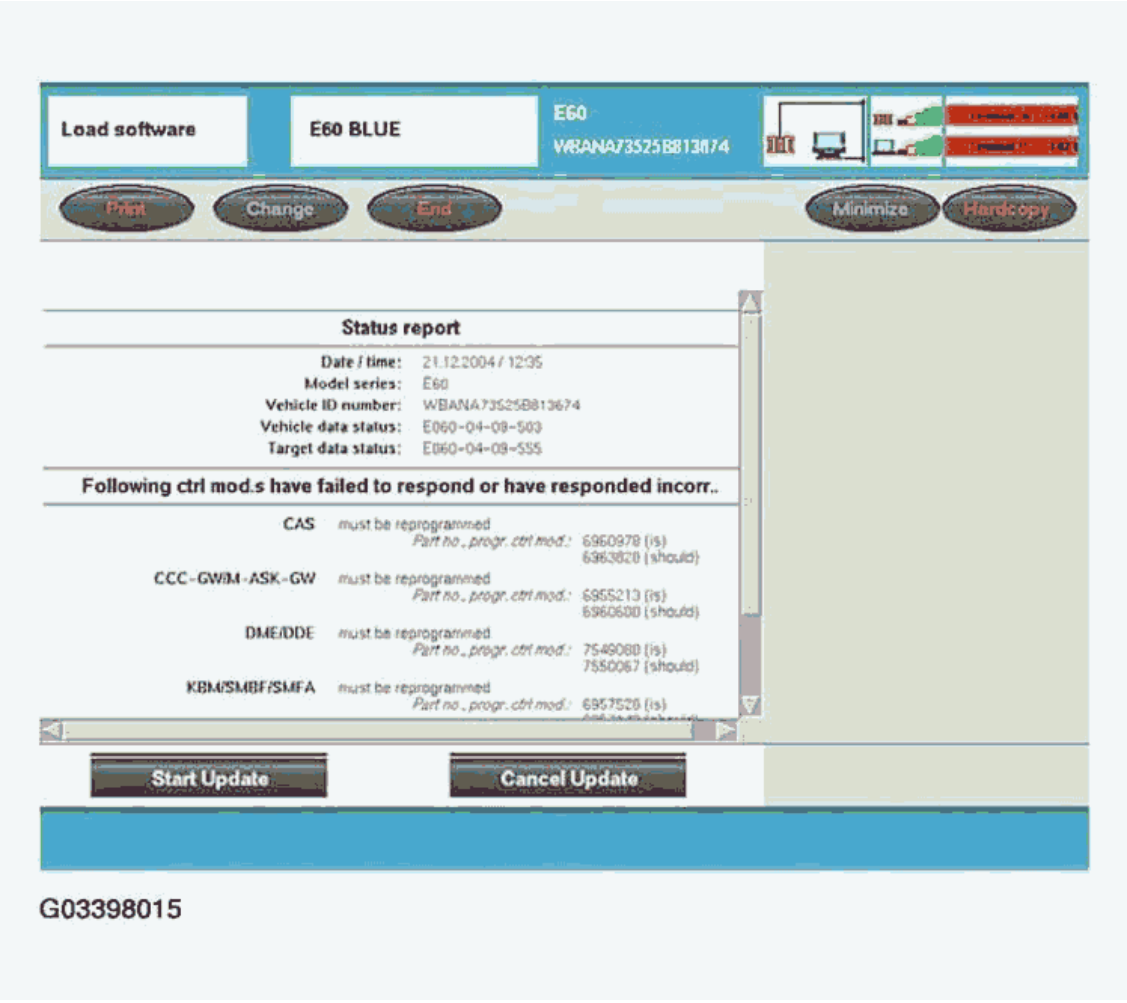


Fig. 161: Display Status Report
Courtesy of BMW OF NORTH AMERICA, INC.

If **"Cancel update"** is selected or if CIP determines that there are no updates needed or available for the vehicle then the "Control module selection" screen is displayed.

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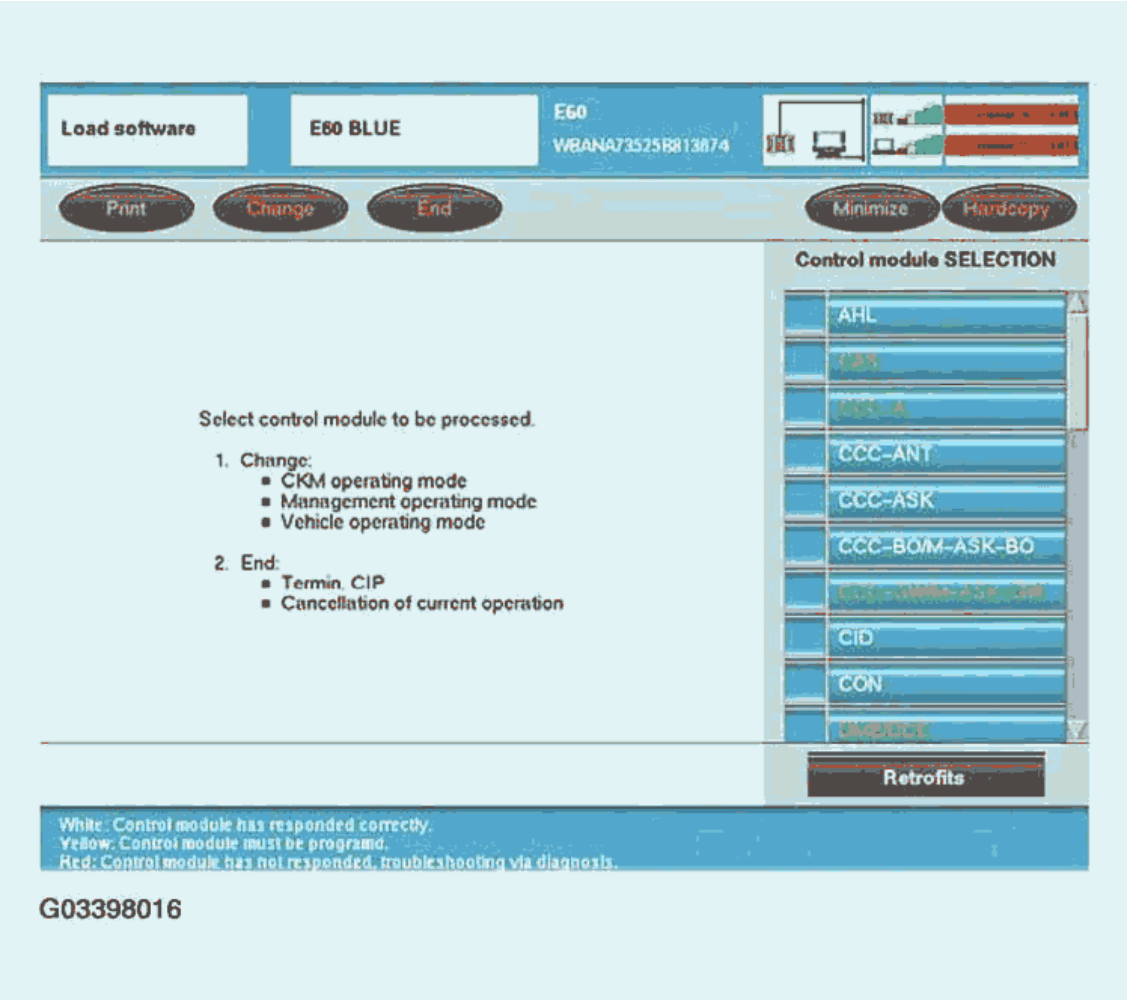


Fig. 162: Display Control Module Selection Screen (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

CONTROL MODULE SELECTION - PROGRAMMING - UPDATE SOFTWARE

From the "Control module selection" screen specific control modules can be selected for reprogramming.

Or

Select **"Retrofits"** if an accessory function/feature is to be added or deleted

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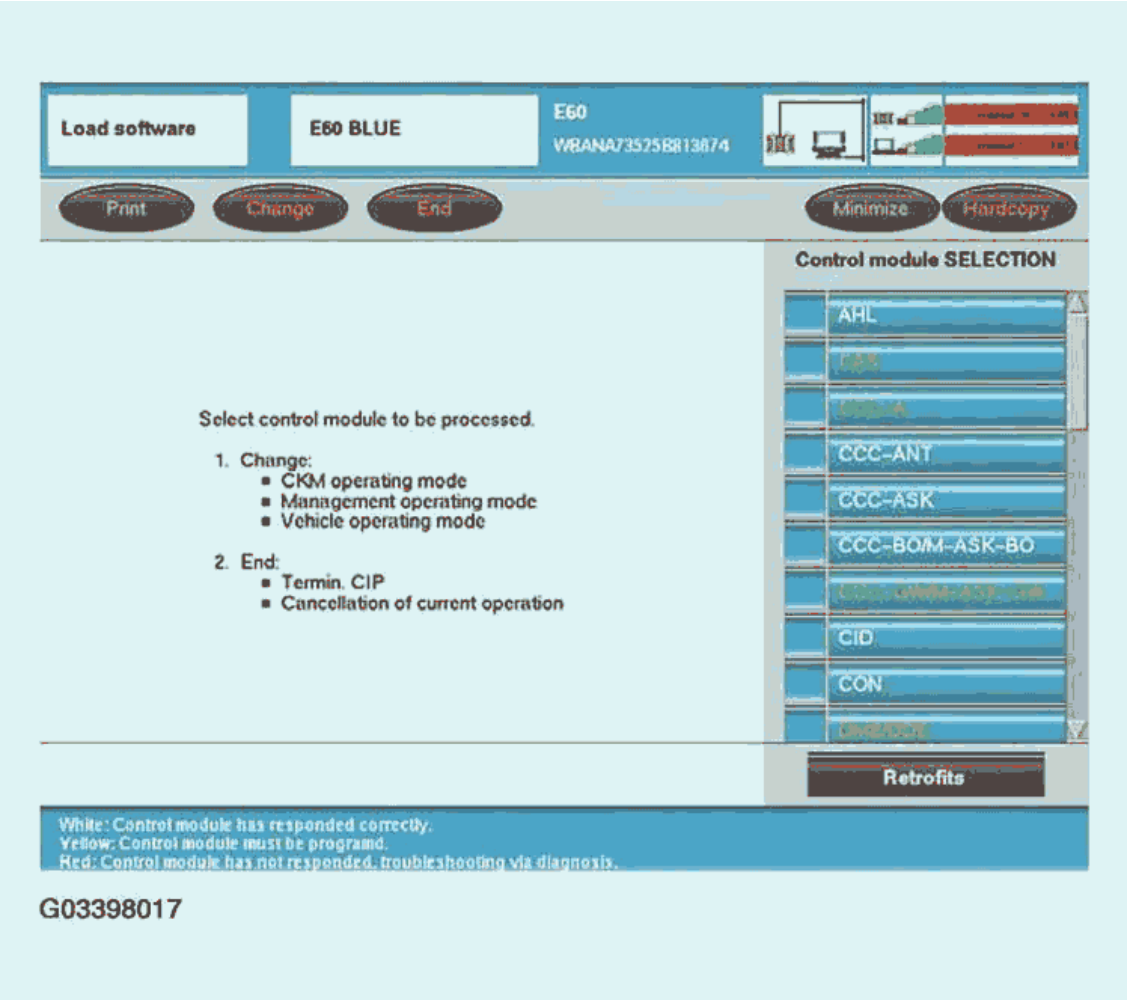
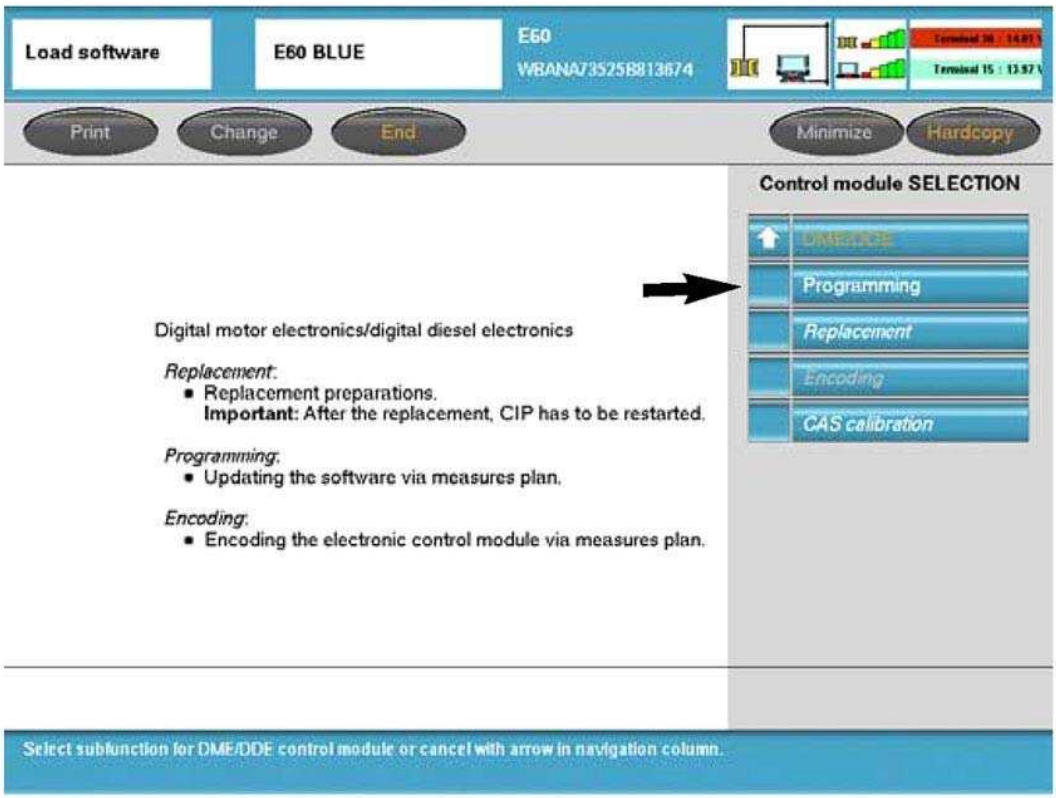


Fig. 163: Display Control Module Selection Screen (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Example: DME DDE is selected on the previous screen.

By selecting **"Programming"** the software of the selected module can be updated or a measures plan for all installed modules can be obtained and updated.

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Fig. 164: Selecting Programming Button
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting **"Update Software"** a measures plan will be generated that will indicate what updates if any are available not only for the DME but for all modules installed in the vehicle.

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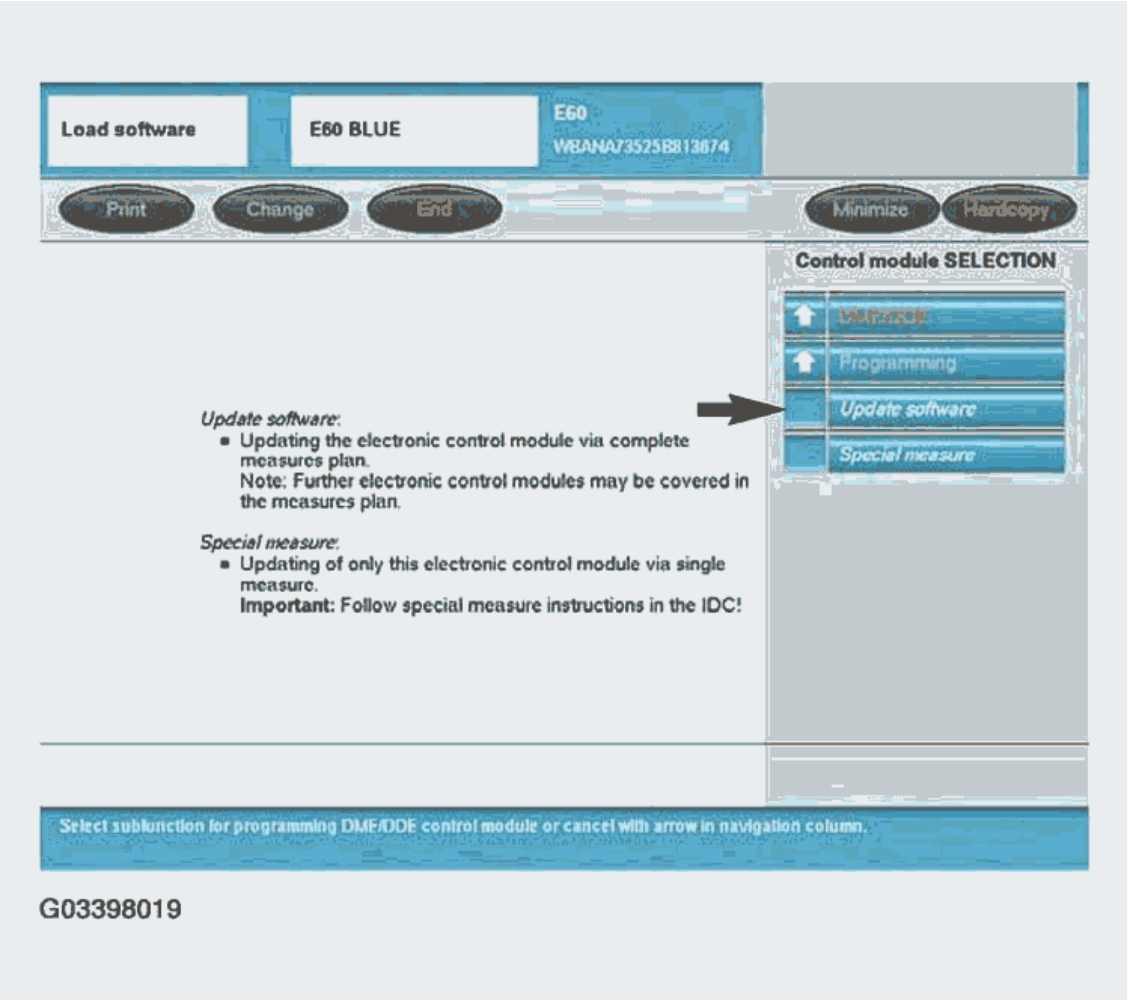


Fig. 165: Selecting Update Software Button
Courtesy of BMW OF NORTH AMERICA, INC.

A "Measures plan" provides information on updates that are available for all installed control modules. By selecting accept, all modules listed in the measures plan will be updated.

NOTE: Prior to selecting accept printout a copy of the measures plan and attach it to the repair order to document the work performed.

IMPORTANT: If the measures plan identifies any control modules that will need to be replaced exit CIP.

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Fig. 166: Display Select Measures Plan Table
Courtesy of BMW OF NORTH AMERICA, INC.

Control Module Selection-Programming-Special Measures

IMPORTANT: The "Special Measures" function is only to be used in the event that a control module(s) can not be programmed during the "Update Software" process that is executed as a result of a developed "Measures plan"/"Status report" or specific instructions are given in a Service Information Bulletin which require the use of special measures to update a module.

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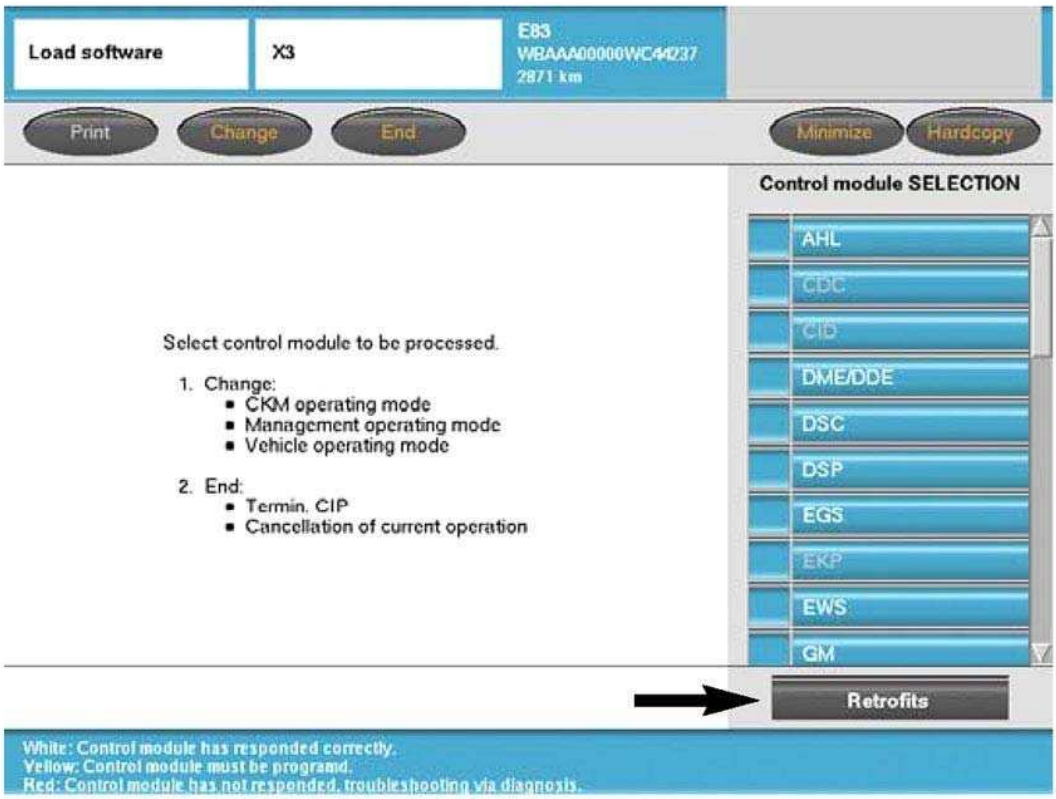
Fig. 167: Selecting Special Measure Button
Courtesy of BMW OF NORTH AMERICA, INC.

In the event that a control module(s) can not be programmed successfully the information will appear next to the specific module(s) in the final report, which is generated upon completion of an update or "Measures plan".

Retrofits

Select **"Retrofits"** to view a list of functions/features that can be modified or installed.

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Fig. 168: Selecting Retrofits Button
Courtesy of BMW OF NORTH AMERICA, INC.

The initial screen displays information pertaining to:

- Airbag activation/deactivation
- Telematics On/Off
- Language (setting control display/monitor language)
- Maintenance interval - reset/checking
- USA-Canada conversion
- Retrofits - listing accessories installed or available for installation.

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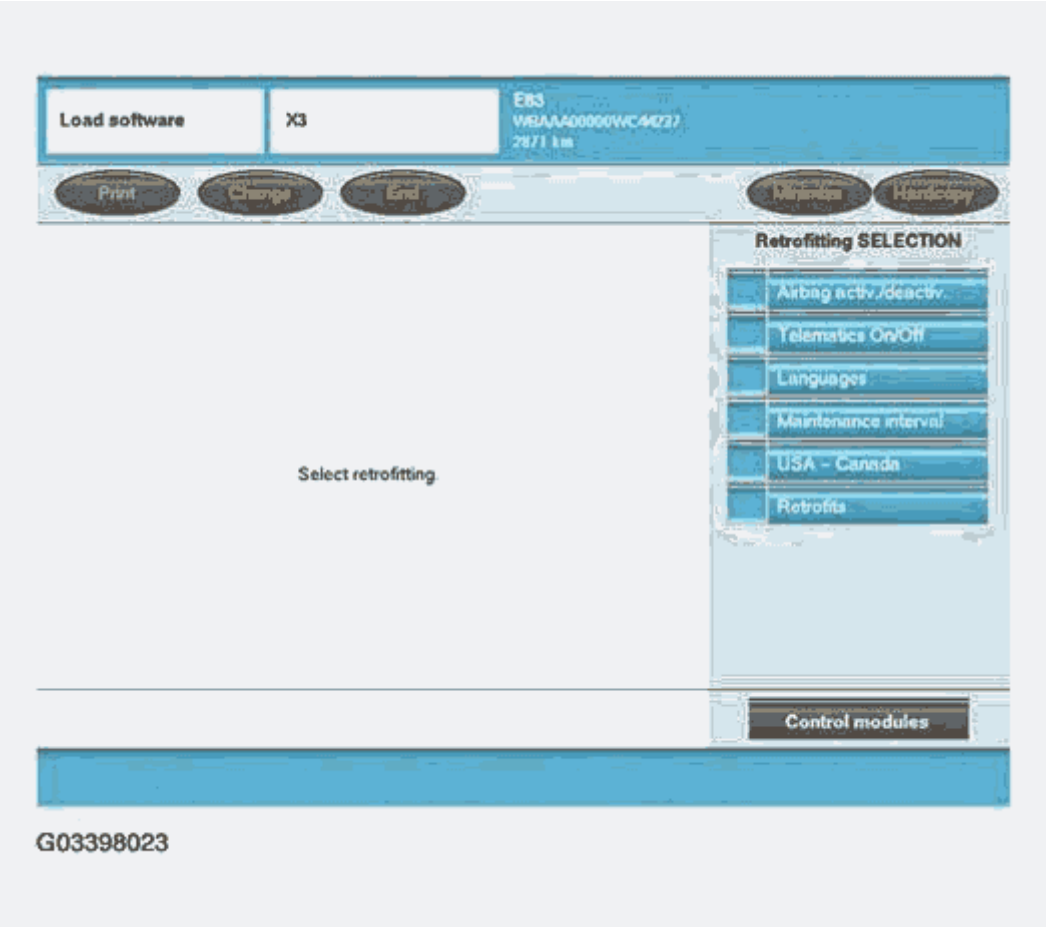


Fig. 169: Display Retrofitting Selection Screen
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting **"Retrofits"** on the previous screen a list of accessory systems available for installation is obtained.

NOTE: Some of the items listed may not be available as retrofits for US vehicles.

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Fig. 170: Display Add Retrofits
Courtesy of BMW OF NORTH AMERICA, INC.

Example: *ULF was selected on previous screen.*

If this system/module is installed the vehicle order will be modified to reflect the addition of this module/accessory to the vehicle by selecting **"Continue".**

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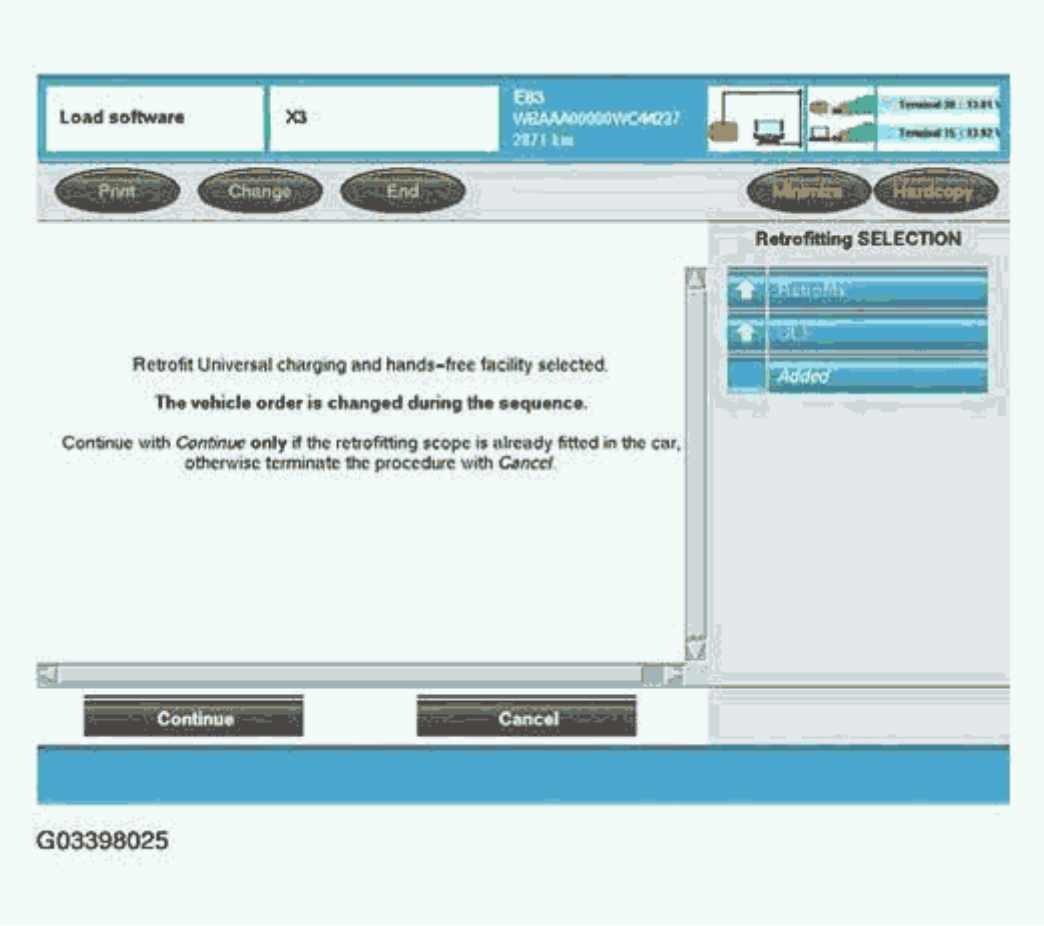


Fig. 171: Selecting Continue Button
Courtesy of BMW OF NORTH AMERICA, INC.

MANAGEMENT

"Management" can be selected from the main/initial CIP screen.

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Fig. 172: Selecting "Management" From Main/Initial CIP Screen (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Or

"Management" can be selected from the Main CIP Selection screen.

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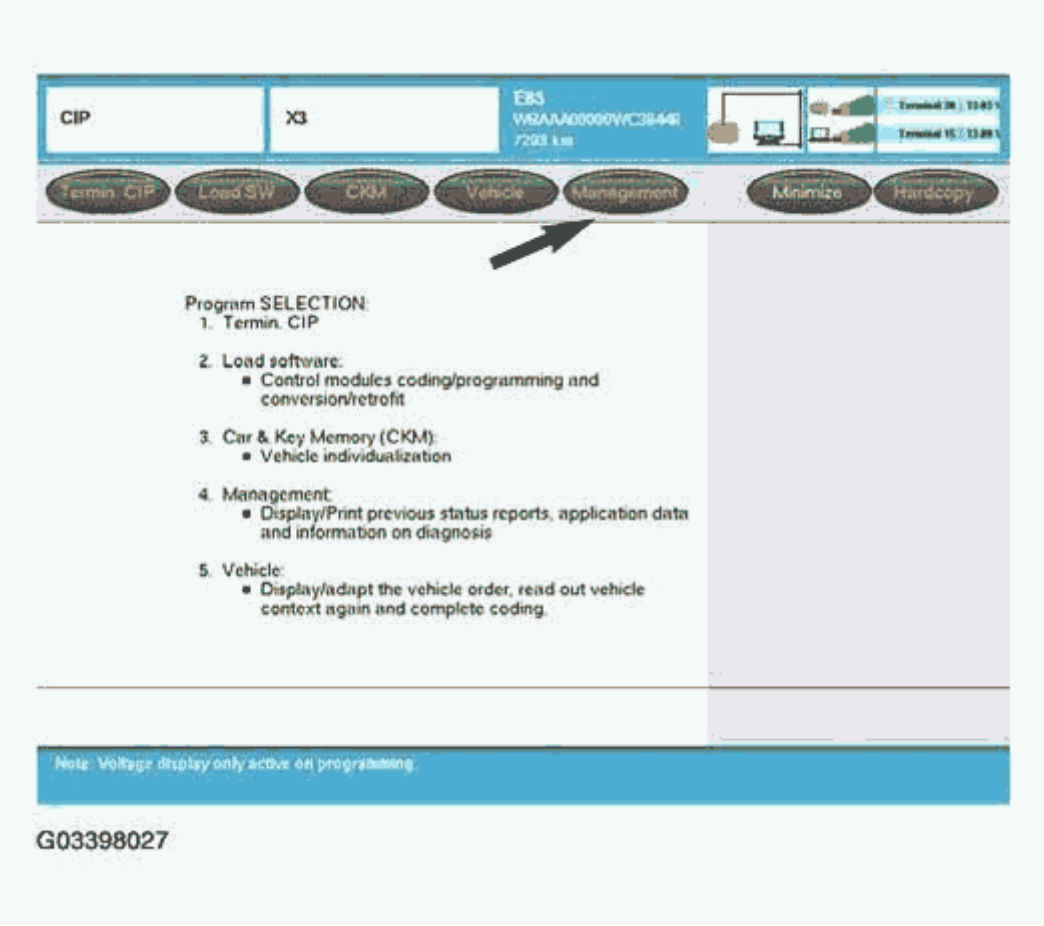


Fig. 173: Selecting "Management" From Main/Initial CIP Screen (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting "Management" the following functions can be accessed:

- Print previously performed Service Measure reports
- Display the current version of CIP installed
- Run a test on the software currently installed on the system (SSS)

Management - Reports

To access the most recently generated measures plans select **"Reports".**

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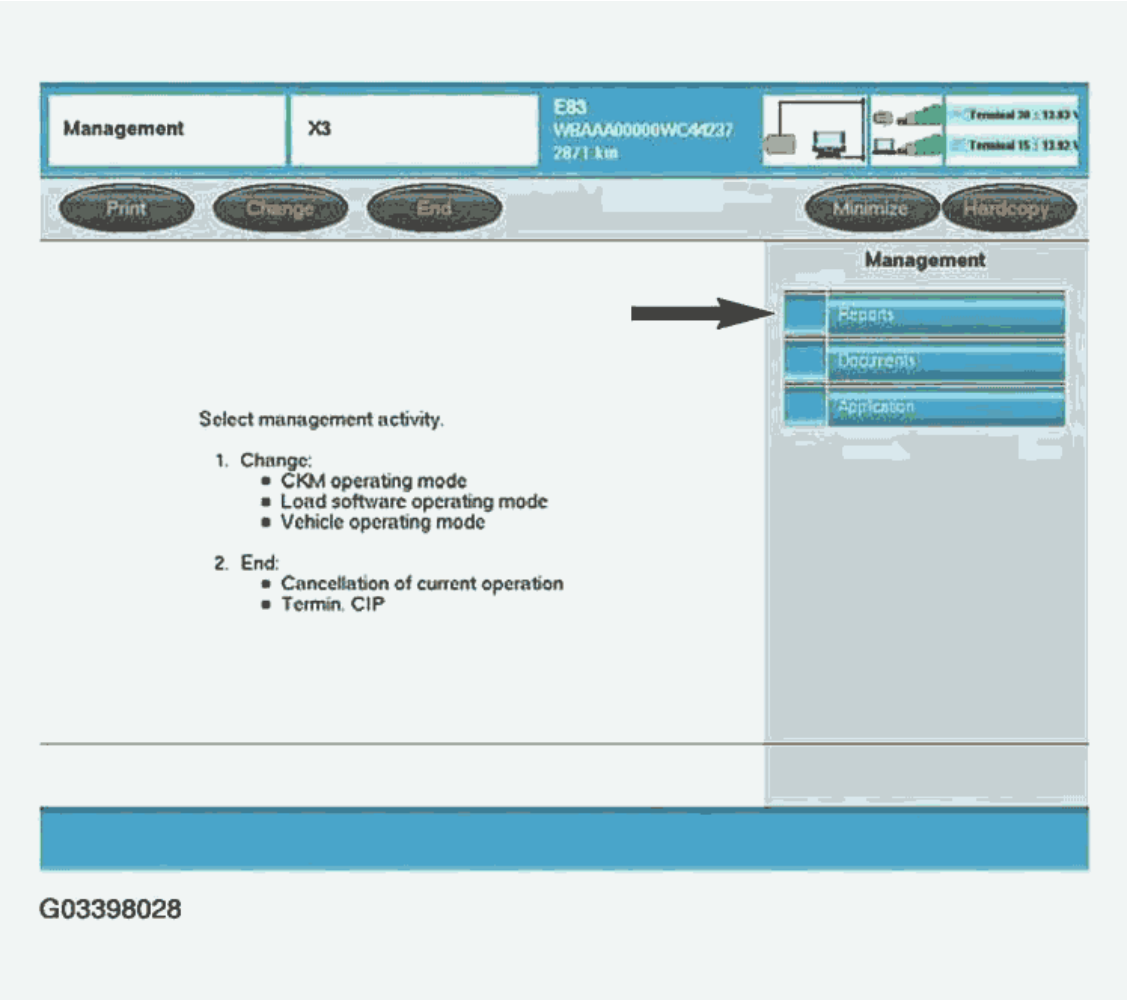


Fig. 174: Selecting Reports Button
Courtesy of BMW OF NORTH AMERICA, INC.

The 16 most recently generated measures plans can be accessed/viewed.

NOTE: The reports are not specific to the vehicle currently connected but are a cumulative listing of vehicles recently connected/accessed using CIP via a specific SSS.

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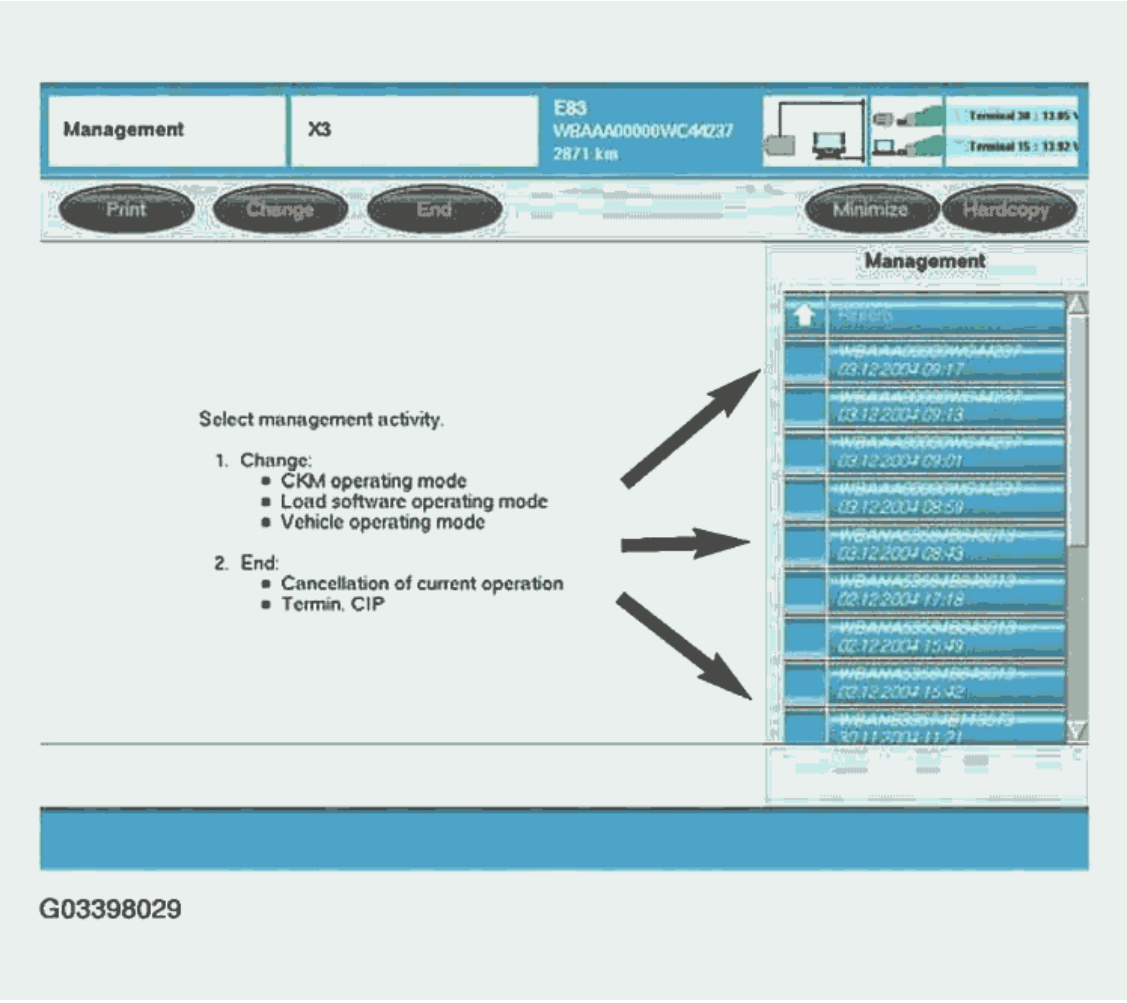


Fig. 175: Display Management Screen
Courtesy of BMW OF NORTH AMERICA, INC.

Management - Application - Test & Version

The "Application" function provides the ability to:

- Run a system test
- Determine information regarding the version of CIP currently installed

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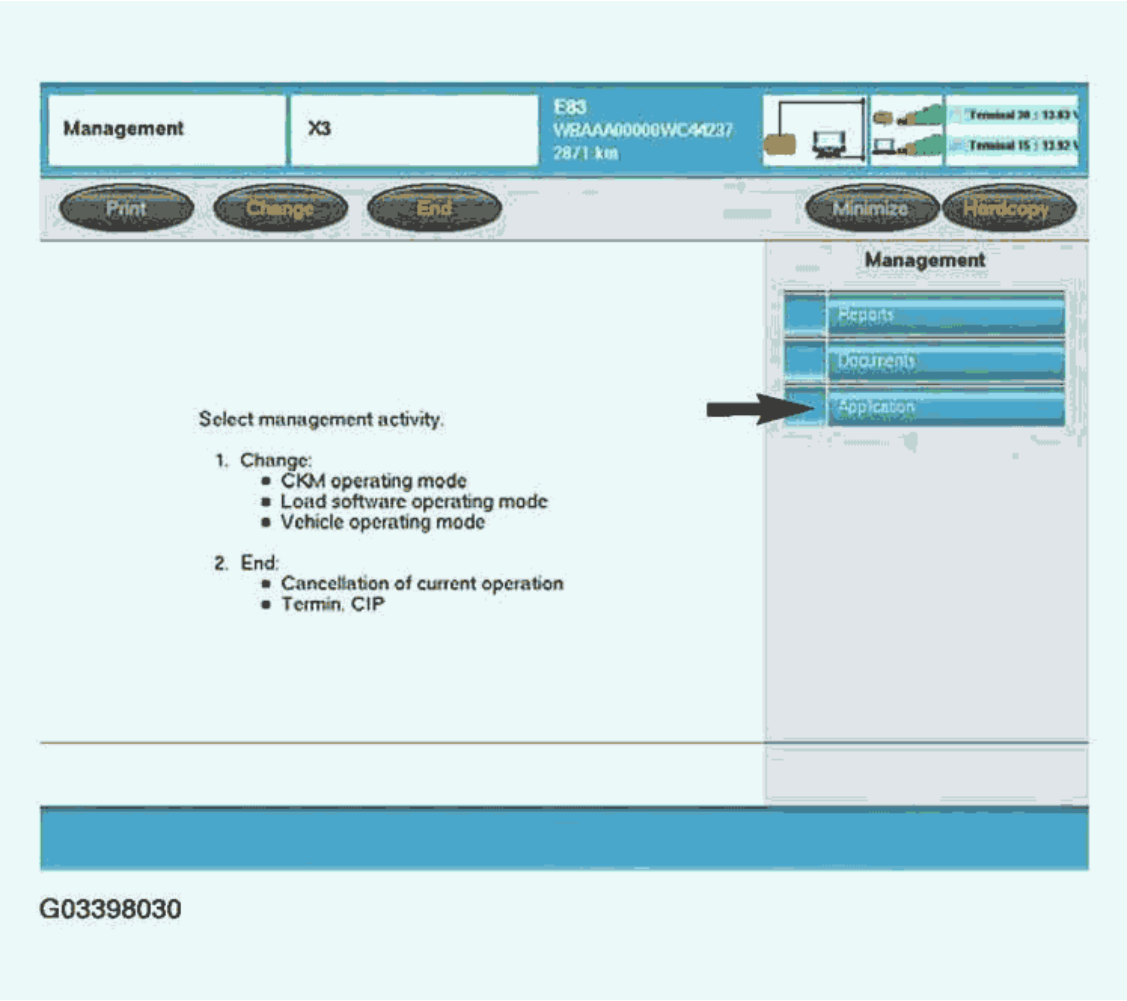


Fig. 176: Selecting Application Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Test"** if system files are to be checked.

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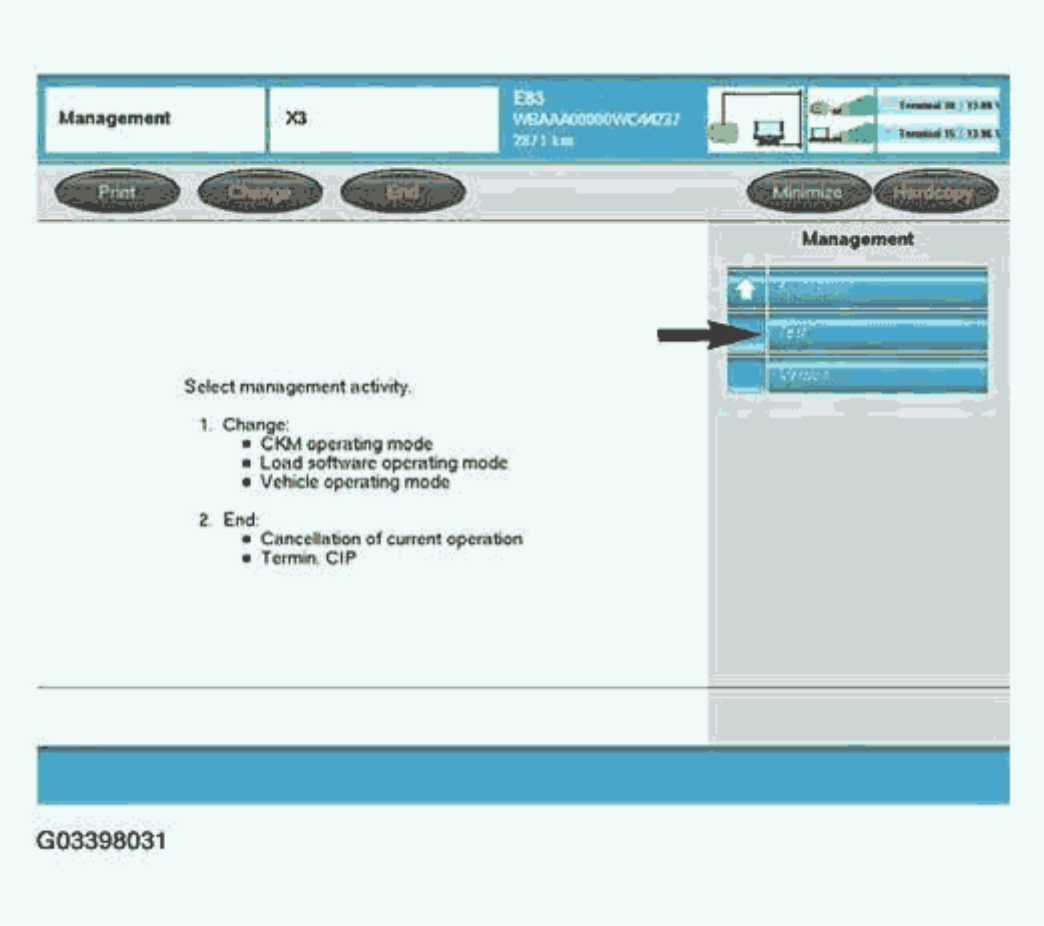


Fig. 177: Selecting Test Button
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting the **"Start"** button a brief test of the system files will be performed.

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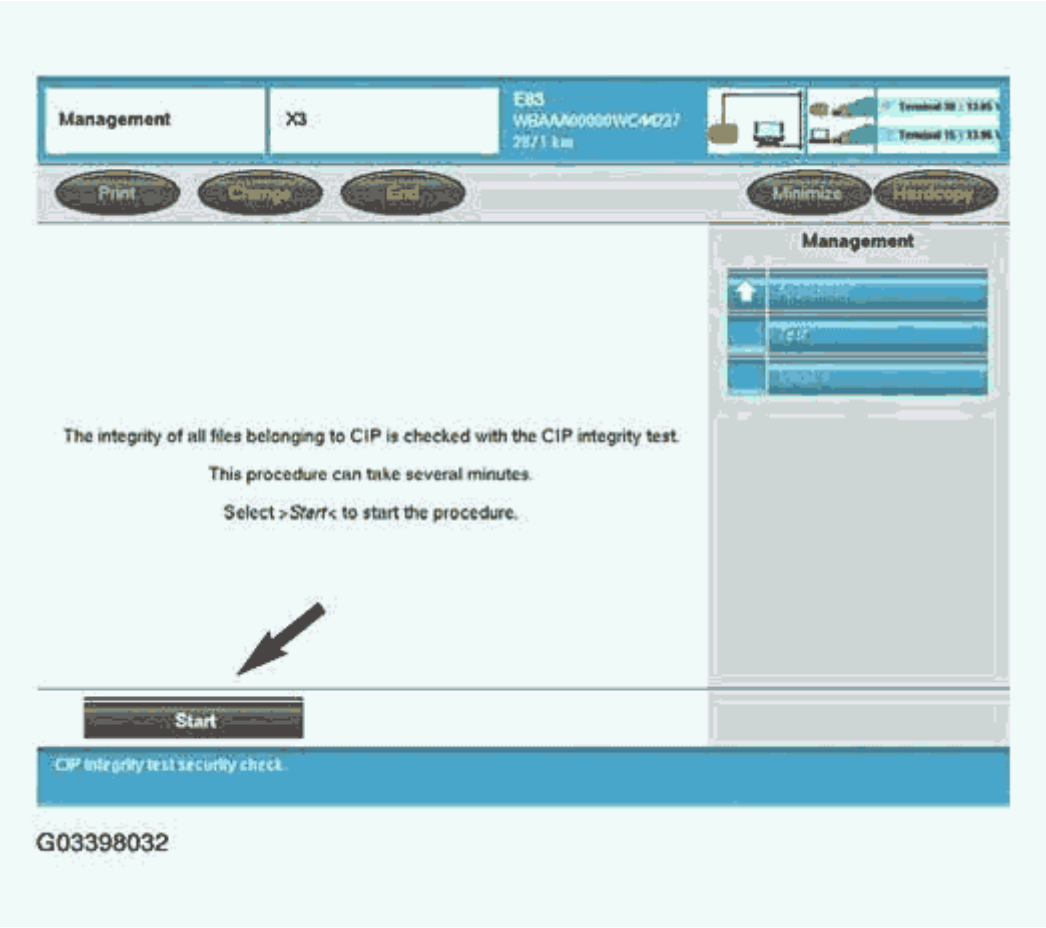


Fig. 178: Selecting Start Button
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting **"Version"** installed application information will be displayed.

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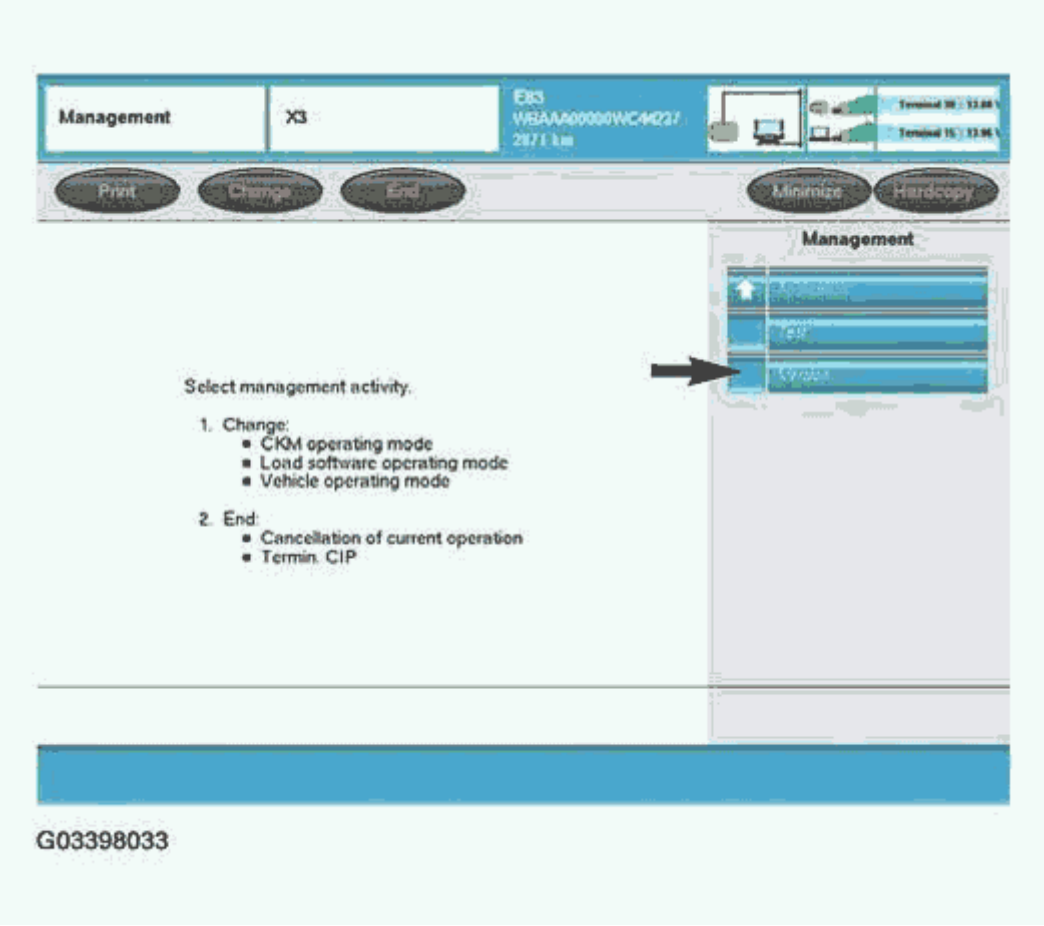


Fig. 179: Selecting Version Button
Courtesy of BMW OF NORTH AMERICA, INC.

A list of the various files/applications installed as well as their software levels is displayed.

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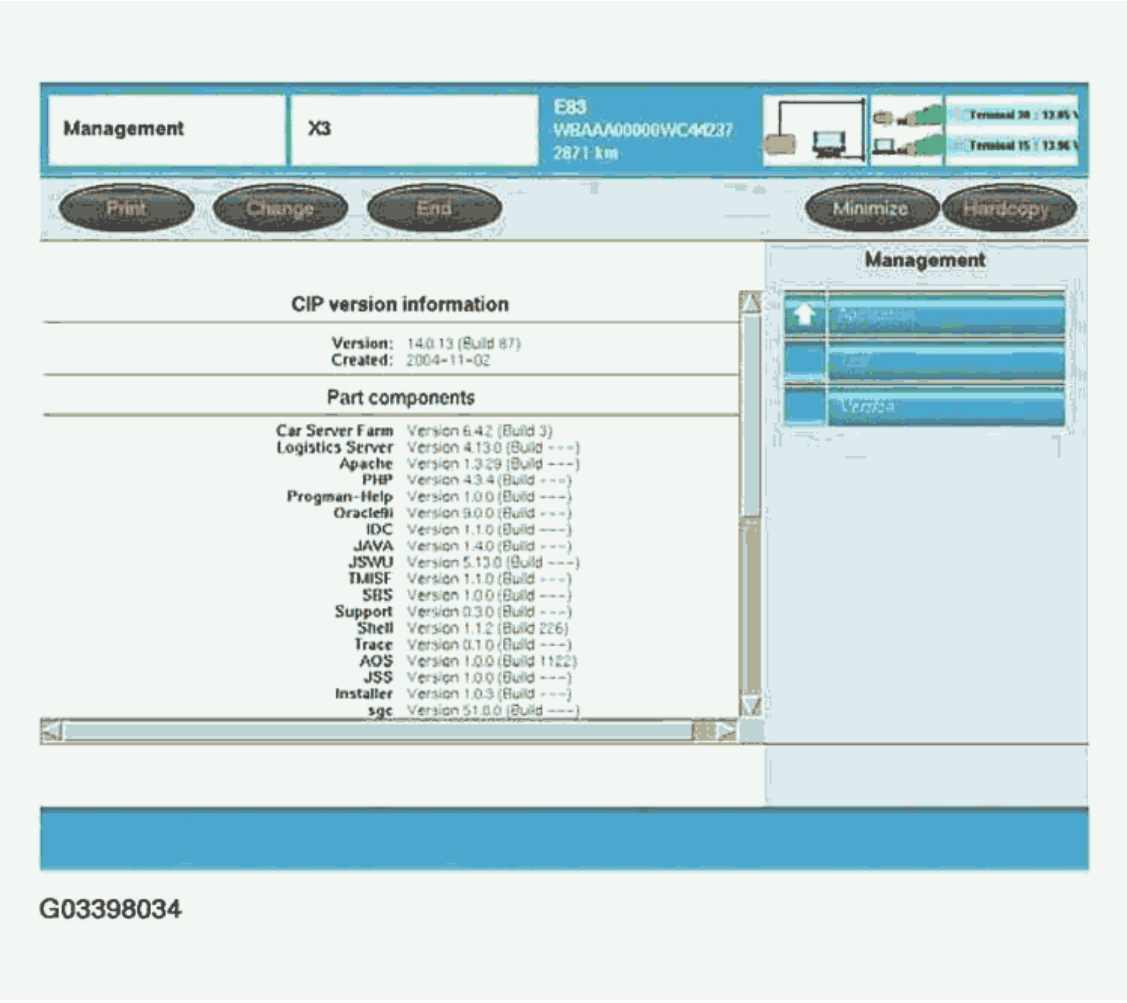


Fig. 180: Display CIP Version Information List
Courtesy of BMW OF NORTH AMERICA, INC.

VEHICLE

"Vehicle" can be selected from the main CIP selection screen to access additional functions:

- Vehicle order
- Initialization
- Service functions
- Complete encoding

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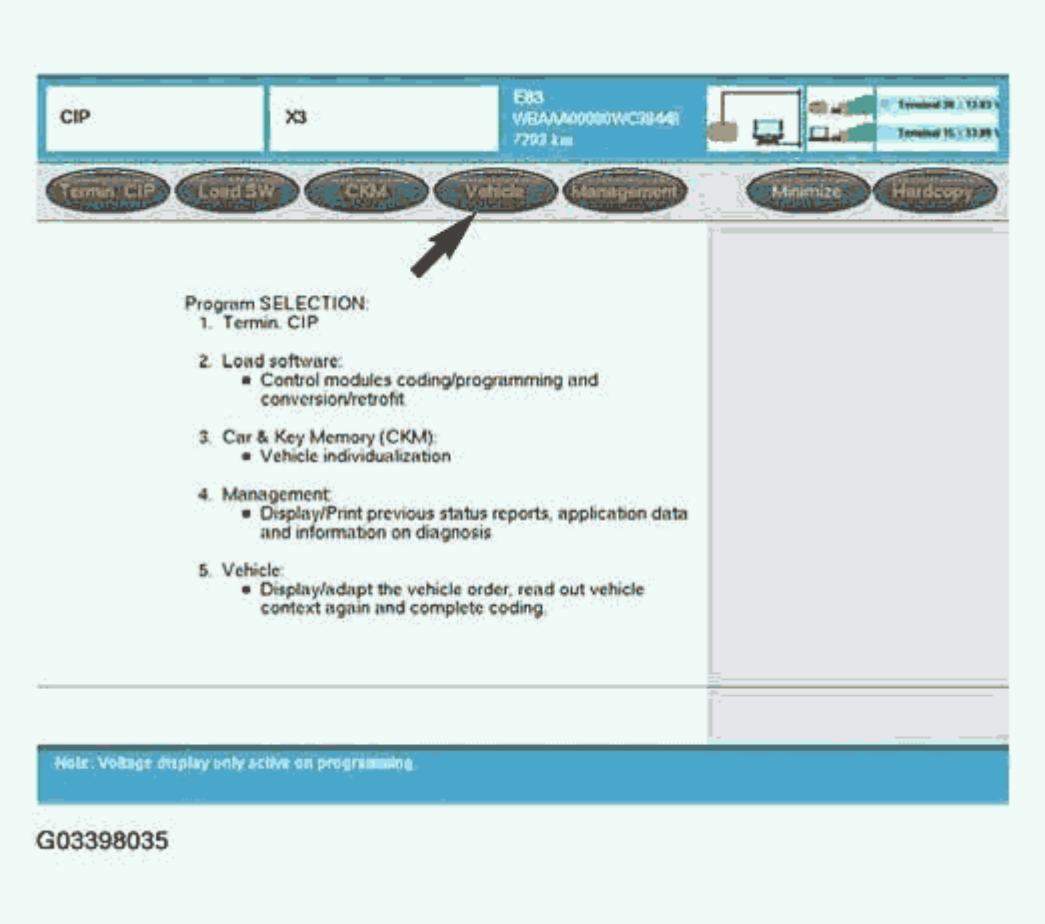


Fig. 181: Selecting Vehicle Button From Main CIP Selection Screen
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting "Vehicle" the following functions can be accessed:

- Vehicle Order
- Initialization
- Service functions
- Complete encoding

Vehicle - Vehicle Order

By selecting **"Vehicle order"** the ability to adapt/modify the vehicle order can be accessed.

NOTE: Changing the vehicle order may affect vehicle operation. Modifying the vehicle order should only be performed when directed to do so by the Technical Hotline, Service Information Bulletin or Aftersales Installation Instructions.

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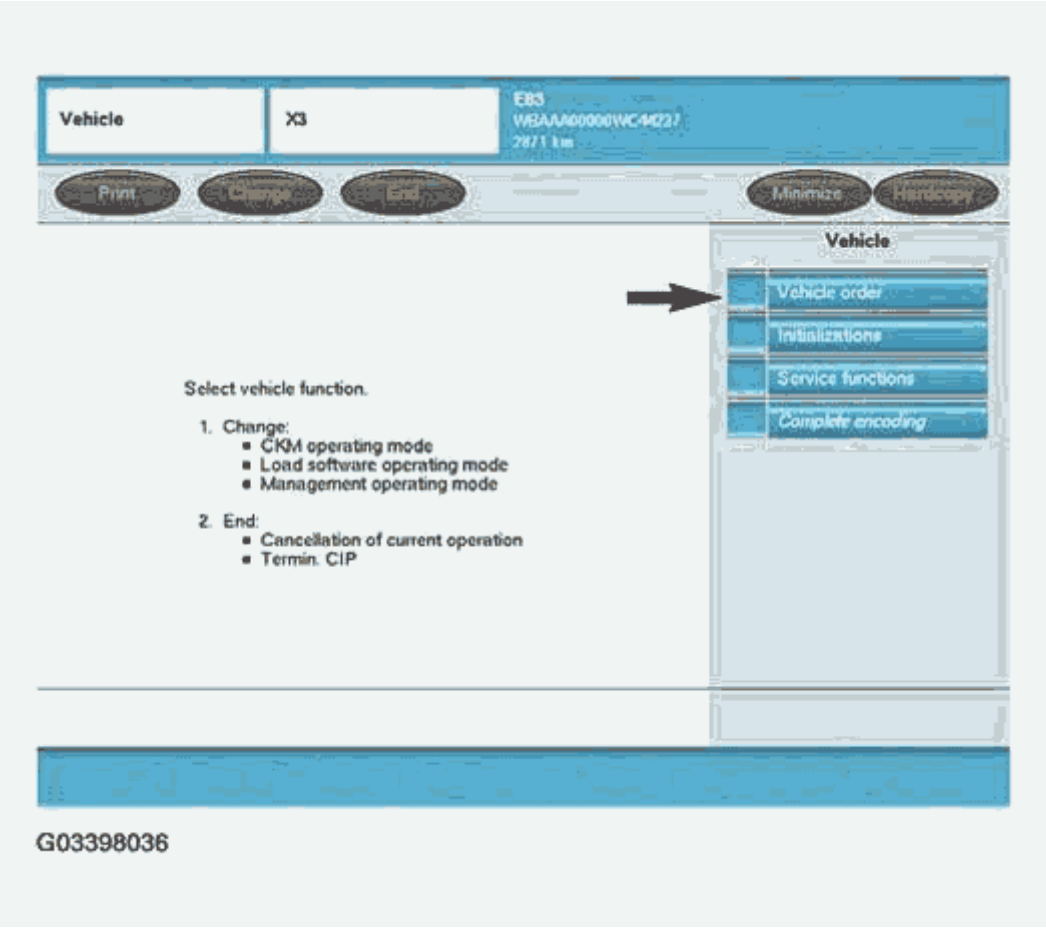


Fig. 182: Selecting Vehicle Order Button
Courtesy of BMW OF NORTH AMERICA, INC.

Selection of **"Adapt VO"** provides the ability to install a modified Vehicle Order file.

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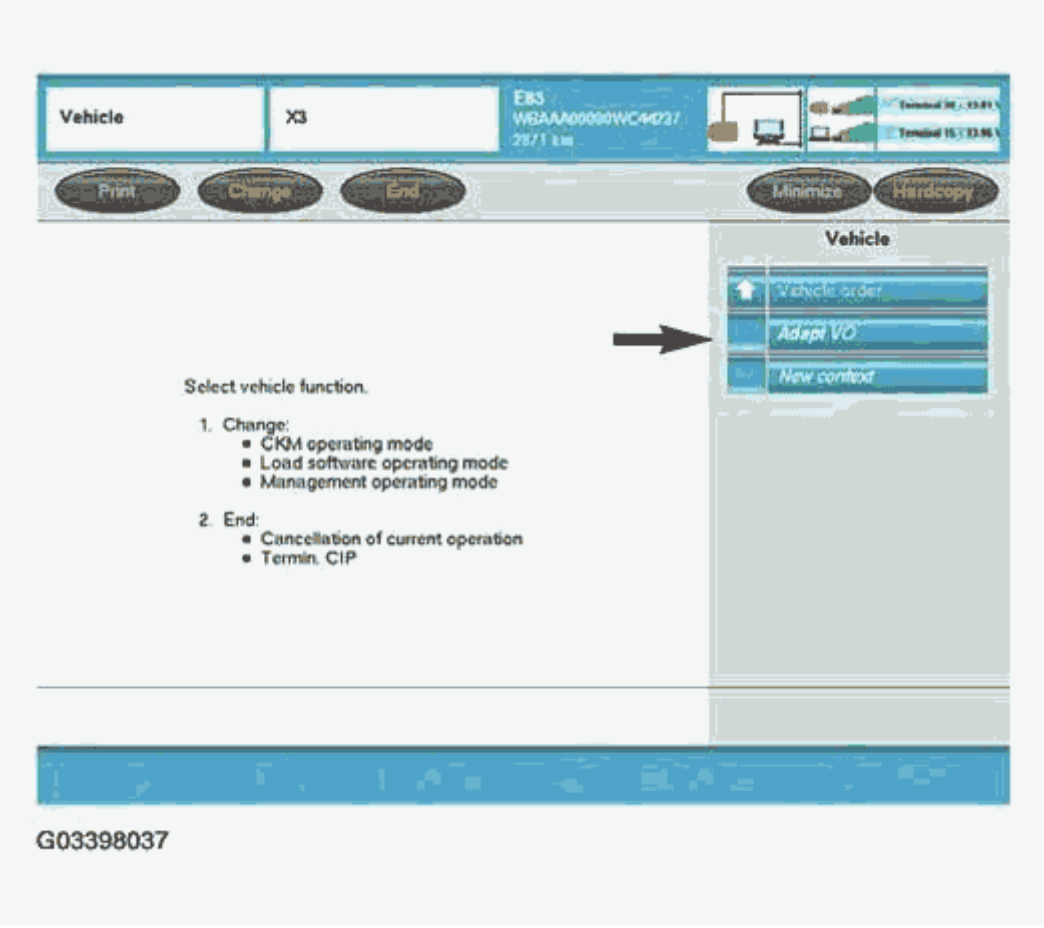
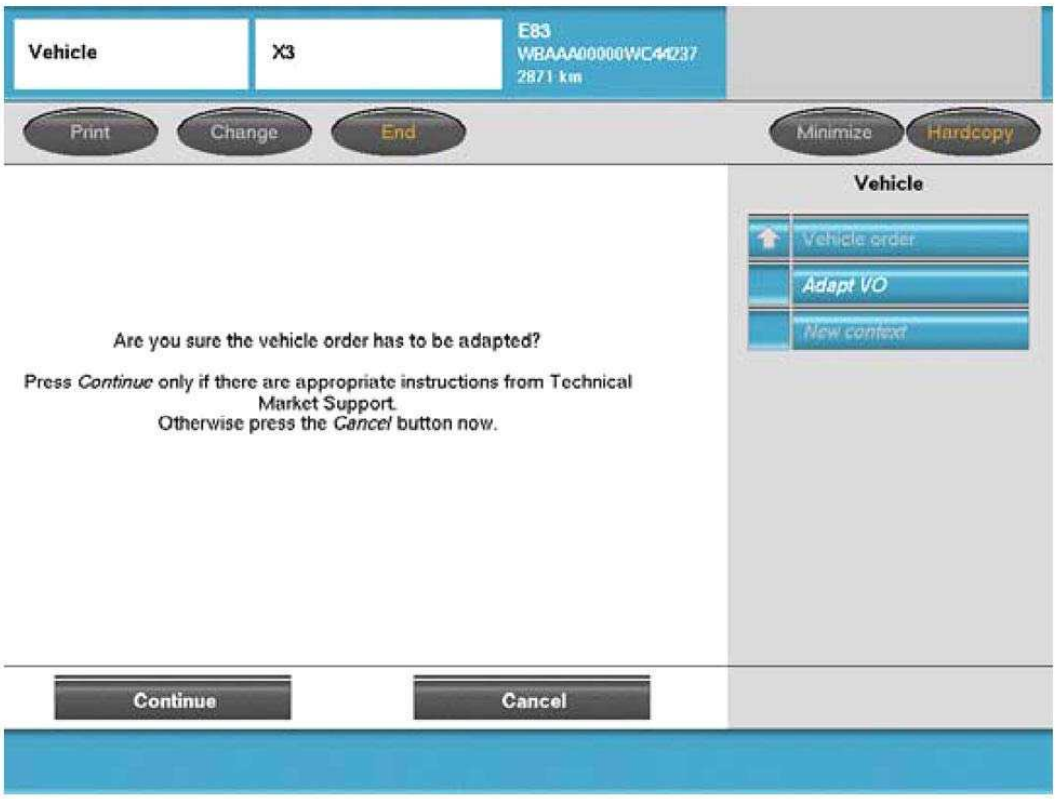


Fig. 183: Selecting Adapt VO Button
Courtesy of BMW OF NORTH AMERICA, INC.

Before selecting **"Continue"** a floppy disk (1.44) containing the modified/new vehicle order must be inserted into the disk drive of the SSS.

NOTE: The modified VO file is obtained from the Technical Hotline by submitting a PUMA case requesting a modified VO, the PUMA case should indicate what accessory/feature needs to be added or removed. The modified file will be sent via E-mail and must be copied on to a 1.44" floppy disk. Do not attempt to open the received file on a PC, as this may corrupt the data contained in the file.

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Fig. 184: Selecting Continue Button
Courtesy of BMW OF NORTH AMERICA, INC.

Vehicle - Initialization

The **"Initialization"** function provides access to three different functions:

- Start system time - Used to synchronize all modules contained on the vehicles byteflight bus.
- Delete fault memory
- CAS or EWS calibration

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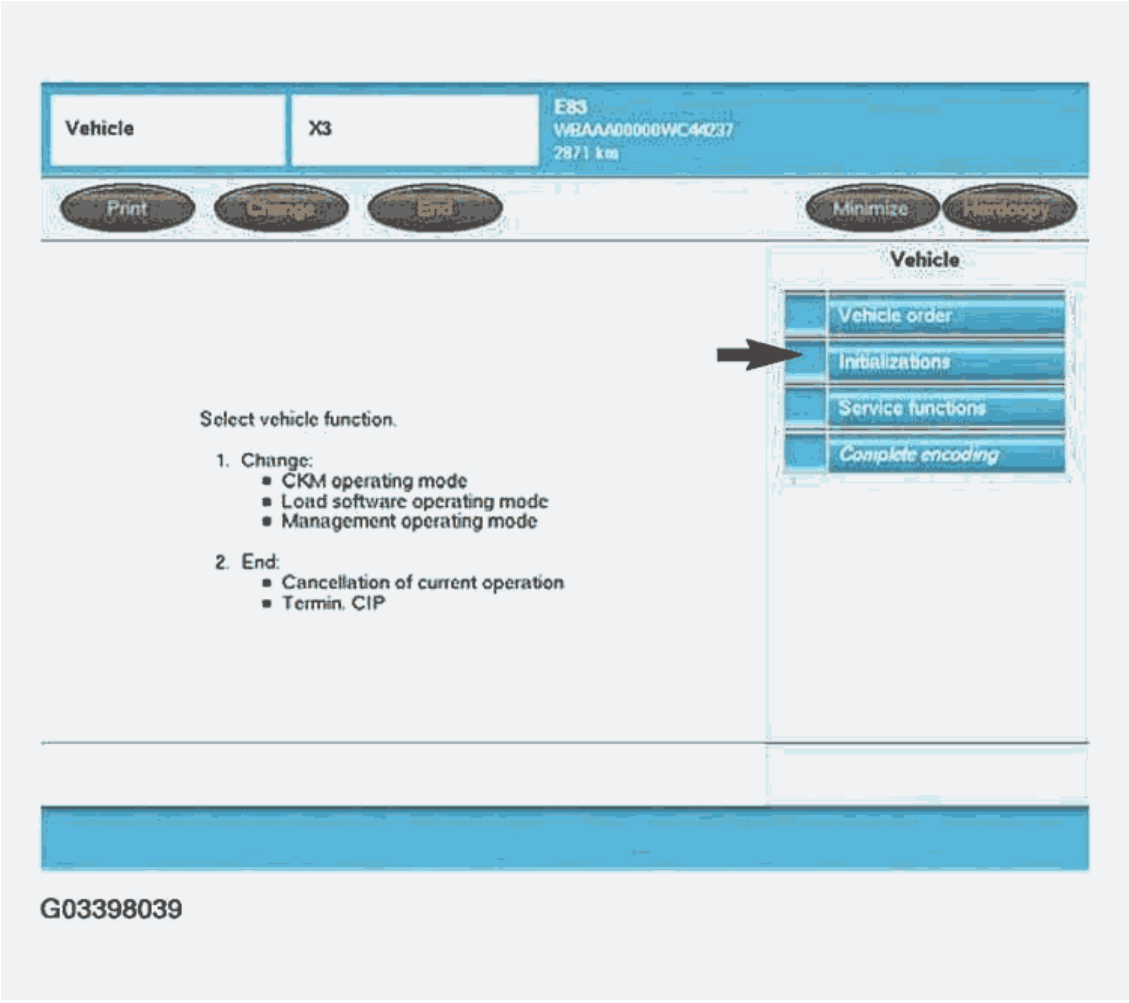


Fig. 185: Selecting Initialization Button
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting **"Delete fault memory"** the fault memory of all installed control modules will be cleared.

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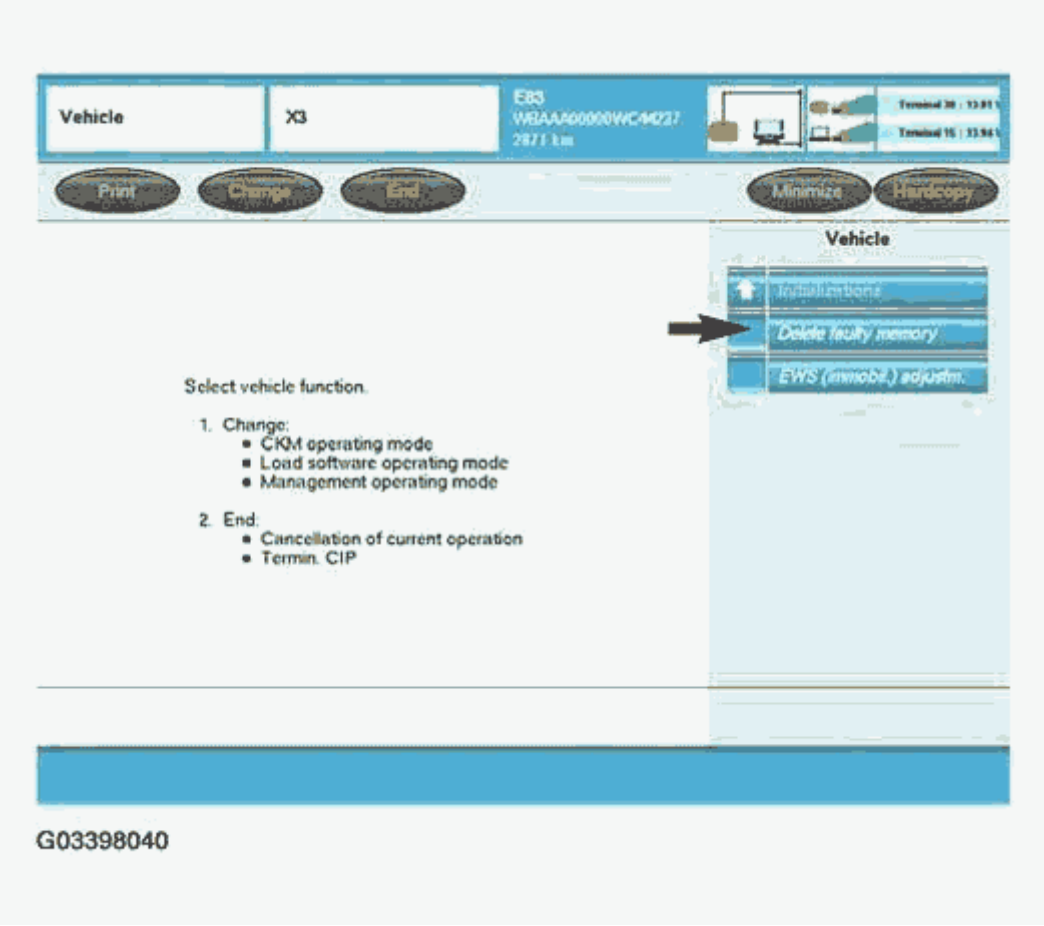


Fig. 186: Selecting Delete Fault Memory Button
Courtesy of BMW OF NORTH AMERICA, INC.

Displays a report pertaining to the clearing of the fault memory on all installed modules.

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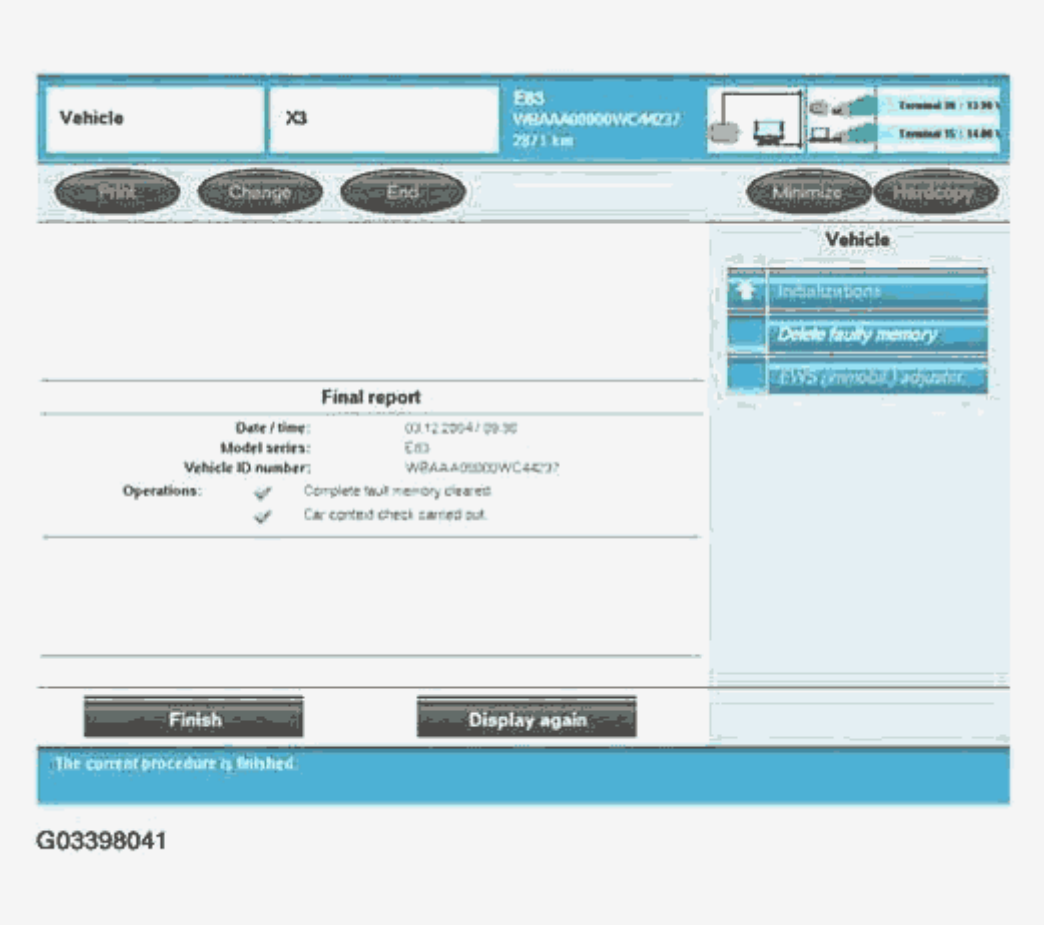


Fig. 187: Display Final Report
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting **"EWS adjustm."** or "CAS Calibration" the rolling code tables can be initialized.

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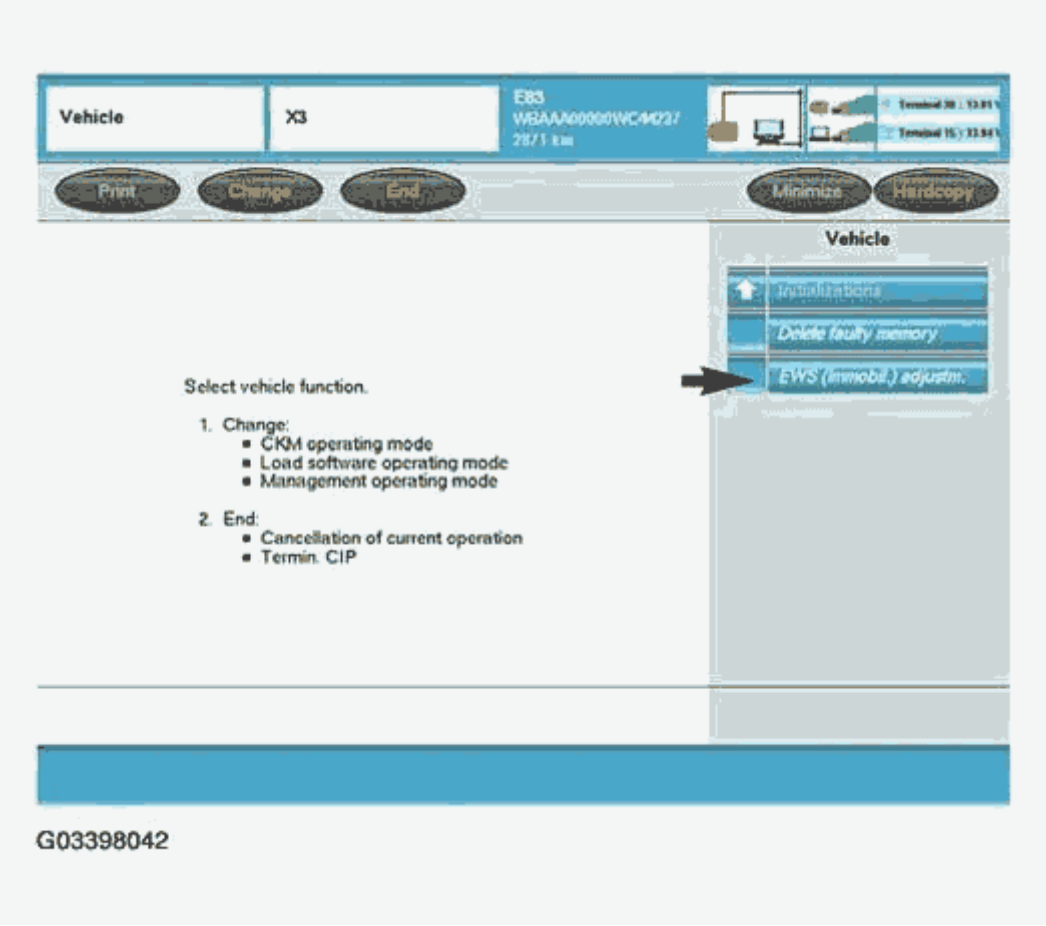


Fig. 188: Selecting EWS Adjustment Button
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting **"Yes"** the calibration/initialization of the rolling code tables in the DME and CAS or EWS modules will be carried out.

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Fig. 189: Selecting YES Button
Courtesy of BMW OF NORTH AMERICA, INC.

Vehicle - Service Function

The **"Service function"** feature provides access to various calibration functions.

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Fig. 190: Selecting Service Function Button
Courtesy of BMW OF NORTH AMERICA, INC.

Selecting **"LWS"** will provide the ability to calibrate the steering angle sensor.

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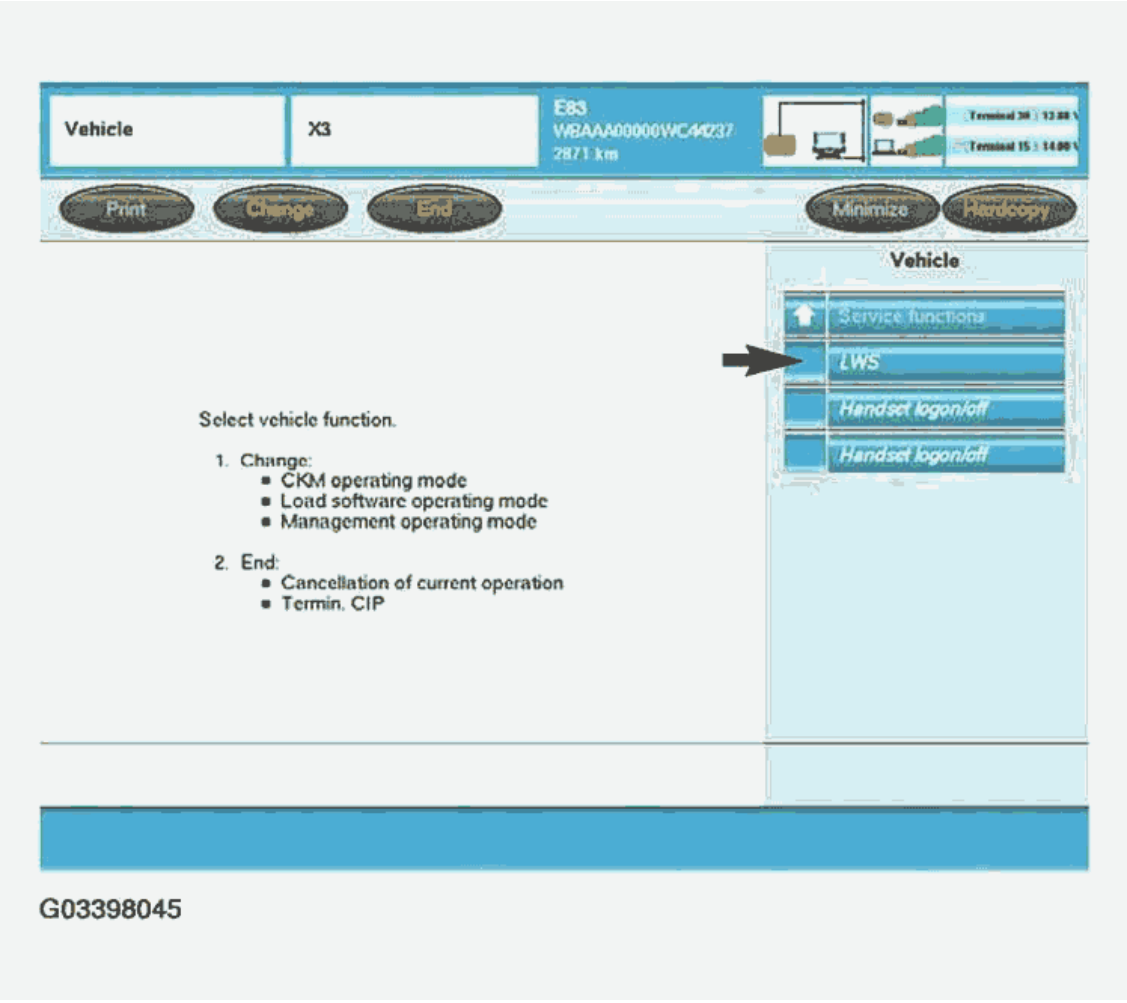


Fig. 191: Selecting LWS Button
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting continue the process to calibrate the steering angle sensor will be carried out.

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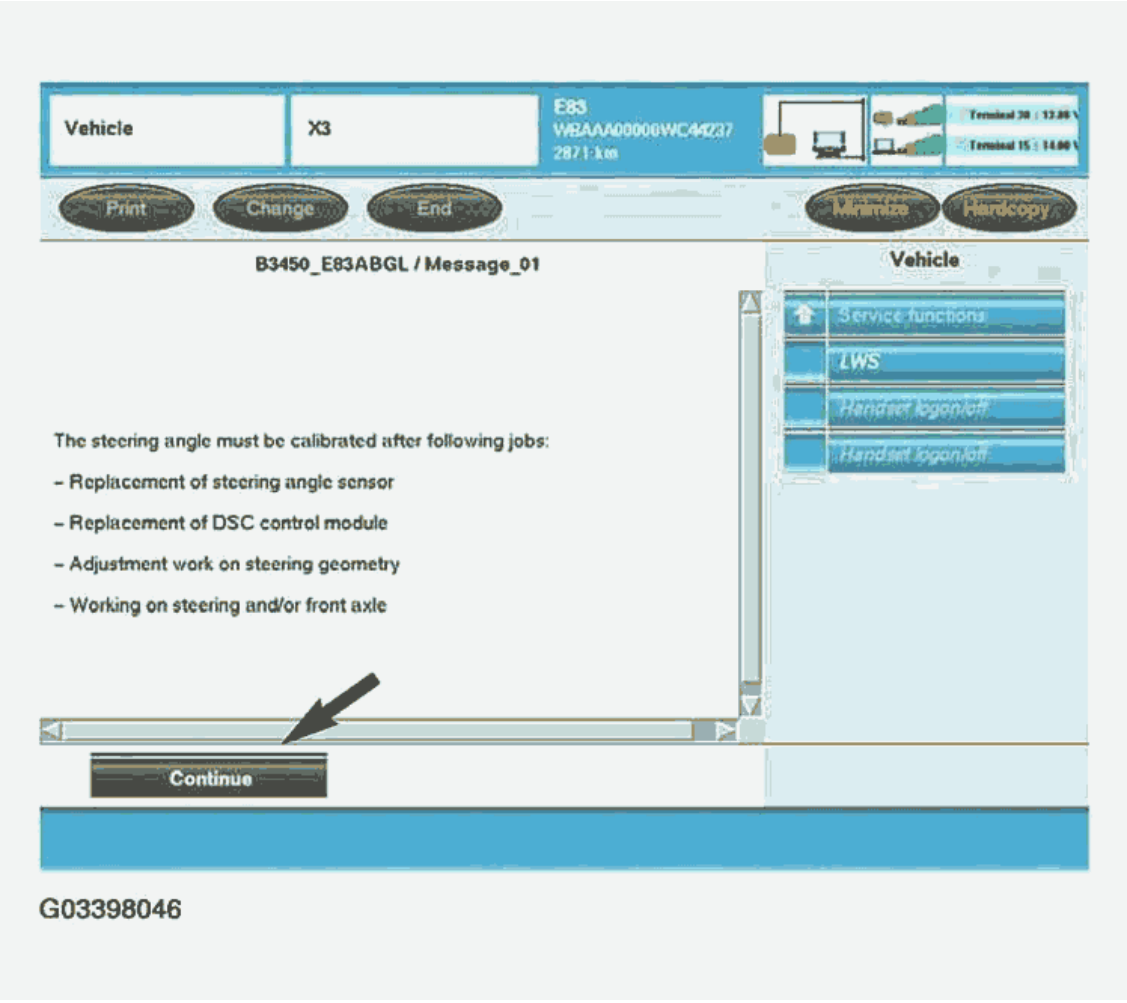


Fig. 192: Selecting Continue Button
Courtesy of BMW OF NORTH AMERICA, INC.

Vehicle - Complete Encoding

"Complete encoding" provides the ability to code/recode all control modules installed in the vehicle.

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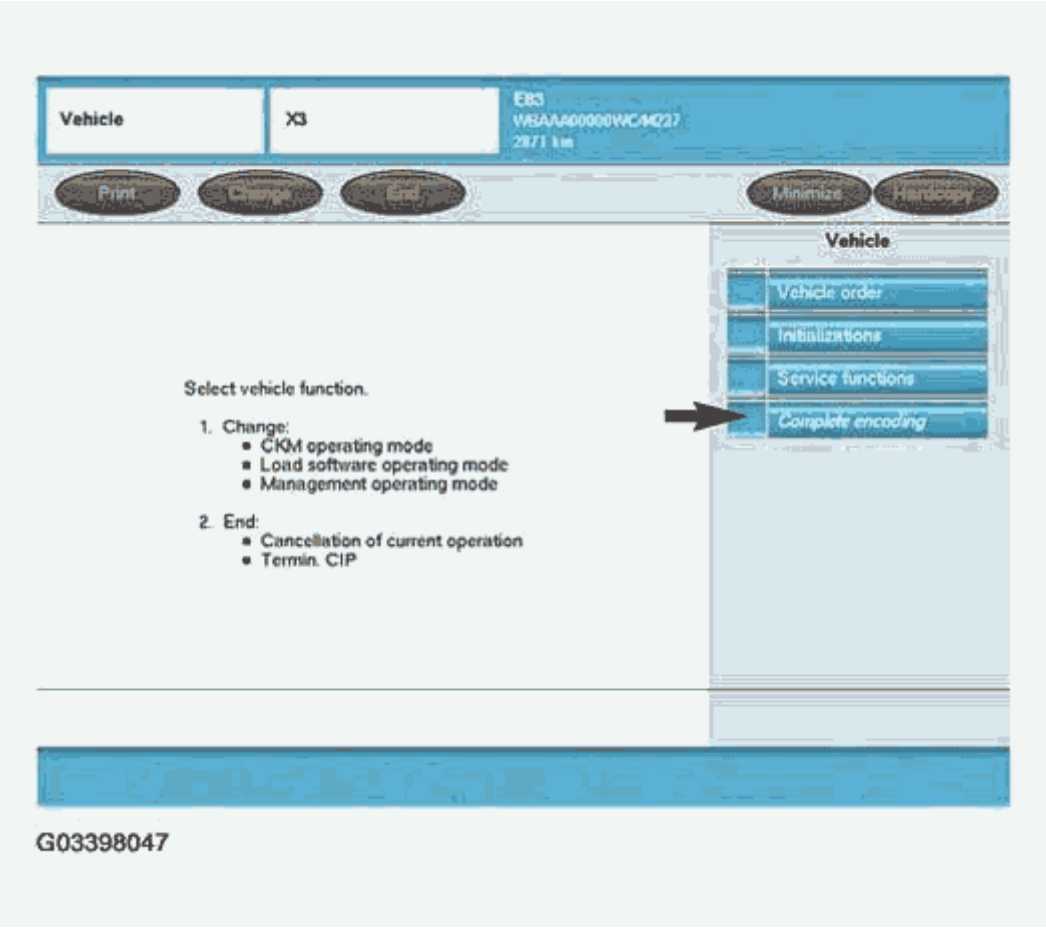


Fig. 193: Selecting Complete Encoding Button
Courtesy of BMW OF NORTH AMERICA, INC.

Recoding all the installed control modules may result in the loss of initialization or system settings such as radio station presets or seat/mirror memory.

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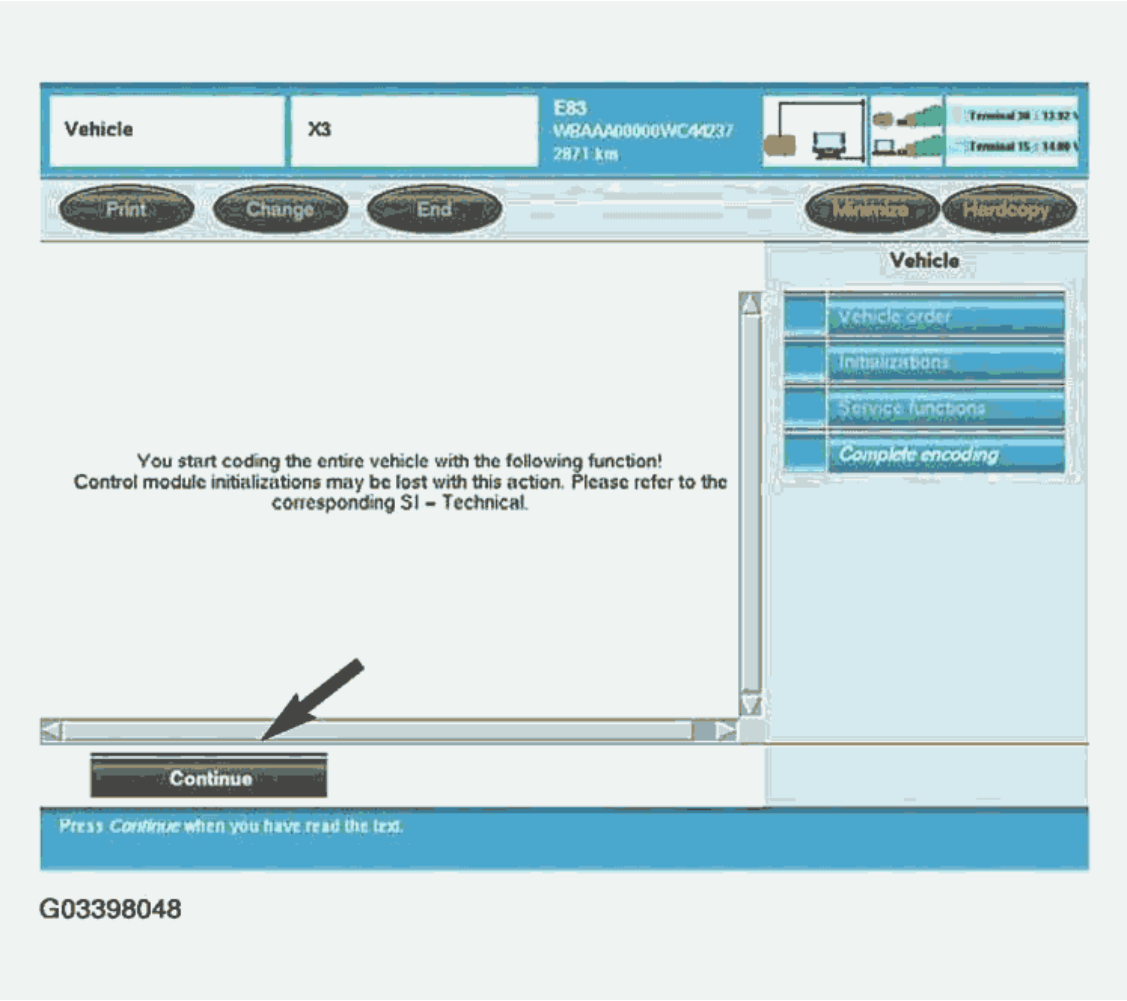


Fig. 194: Selecting Continue Button
Courtesy of BMW OF NORTH AMERICA, INC.

By selecting **"Yes"** all installed control modules will be recoded based on the information contained in the Vehicle Order.

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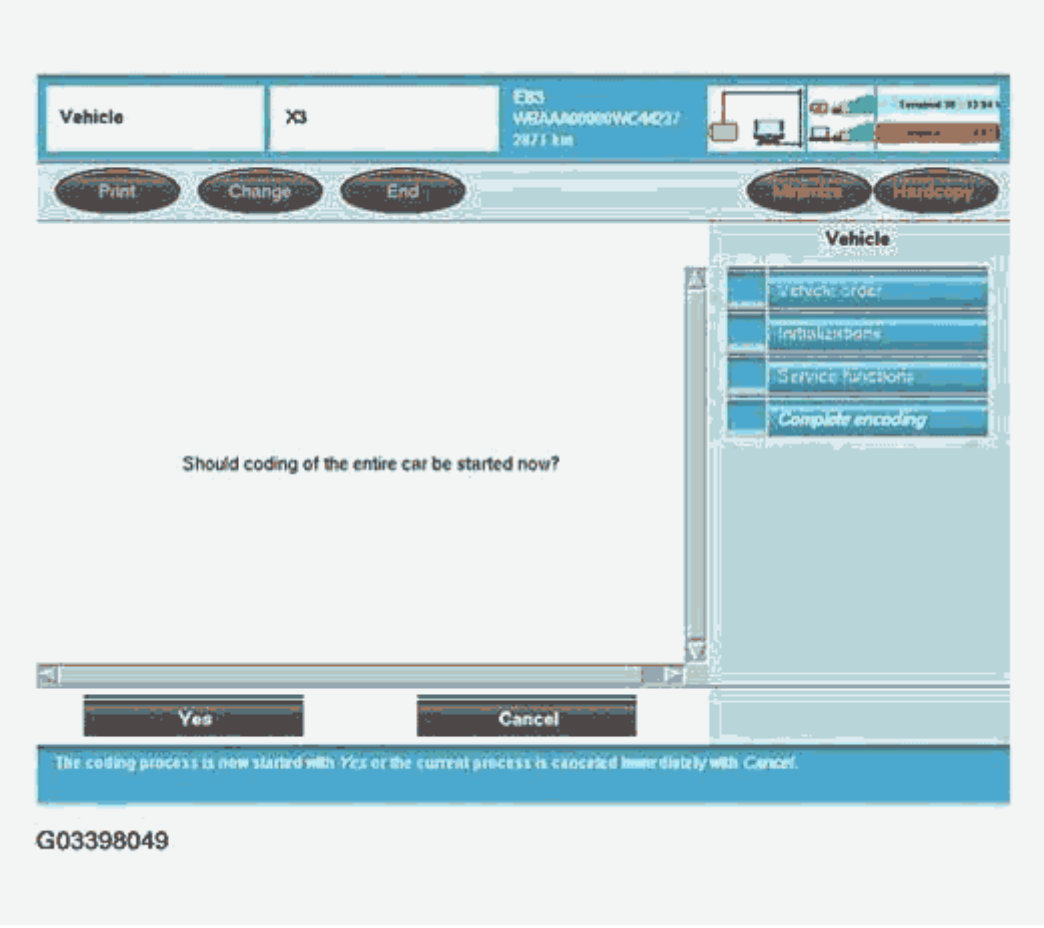
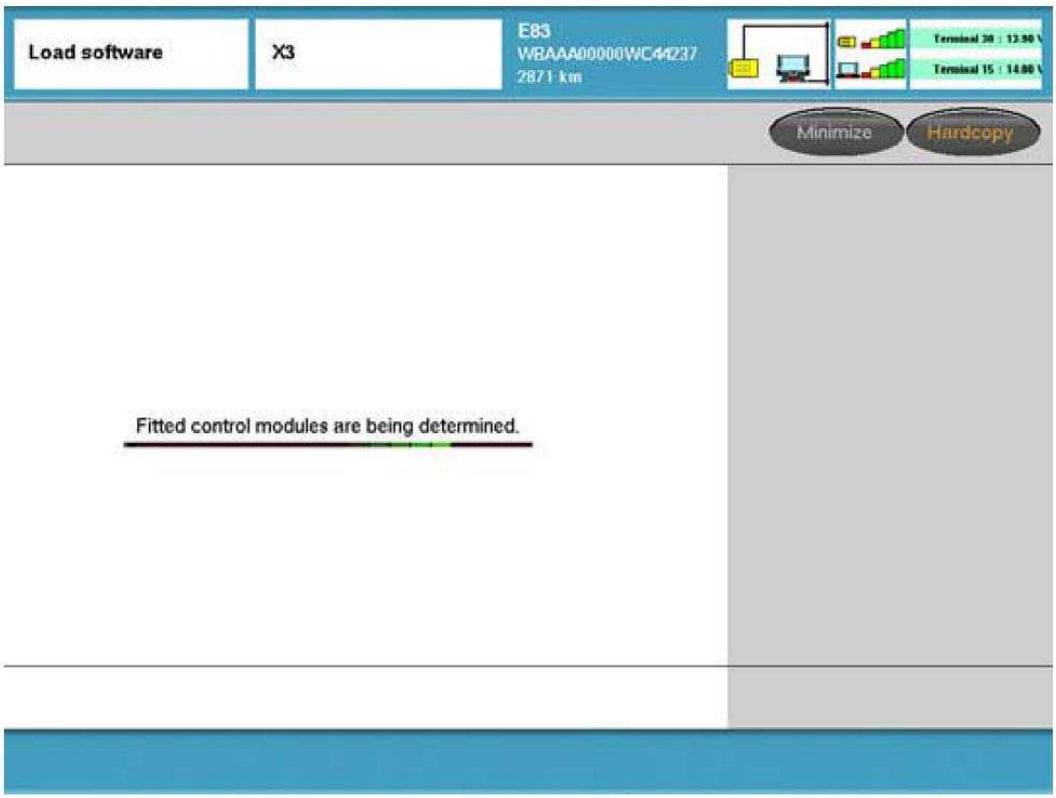


Fig. 195: Selecting YES Button
Courtesy of BMW OF NORTH AMERICA, INC.

CIP FUNCTIONS - IF YES

After selecting "Yes" on the Yes/No selection screen a determination/check of all installed control modules is performed.

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Fig. 196: Display Fitted Control Modules Determined Message
Courtesy of BMW OF NORTH AMERICA, INC.

Upon completing a check of the installed control modules, a list highlighting the installed control modules is displayed.

Select the control module(s) that were replaced and select continue.

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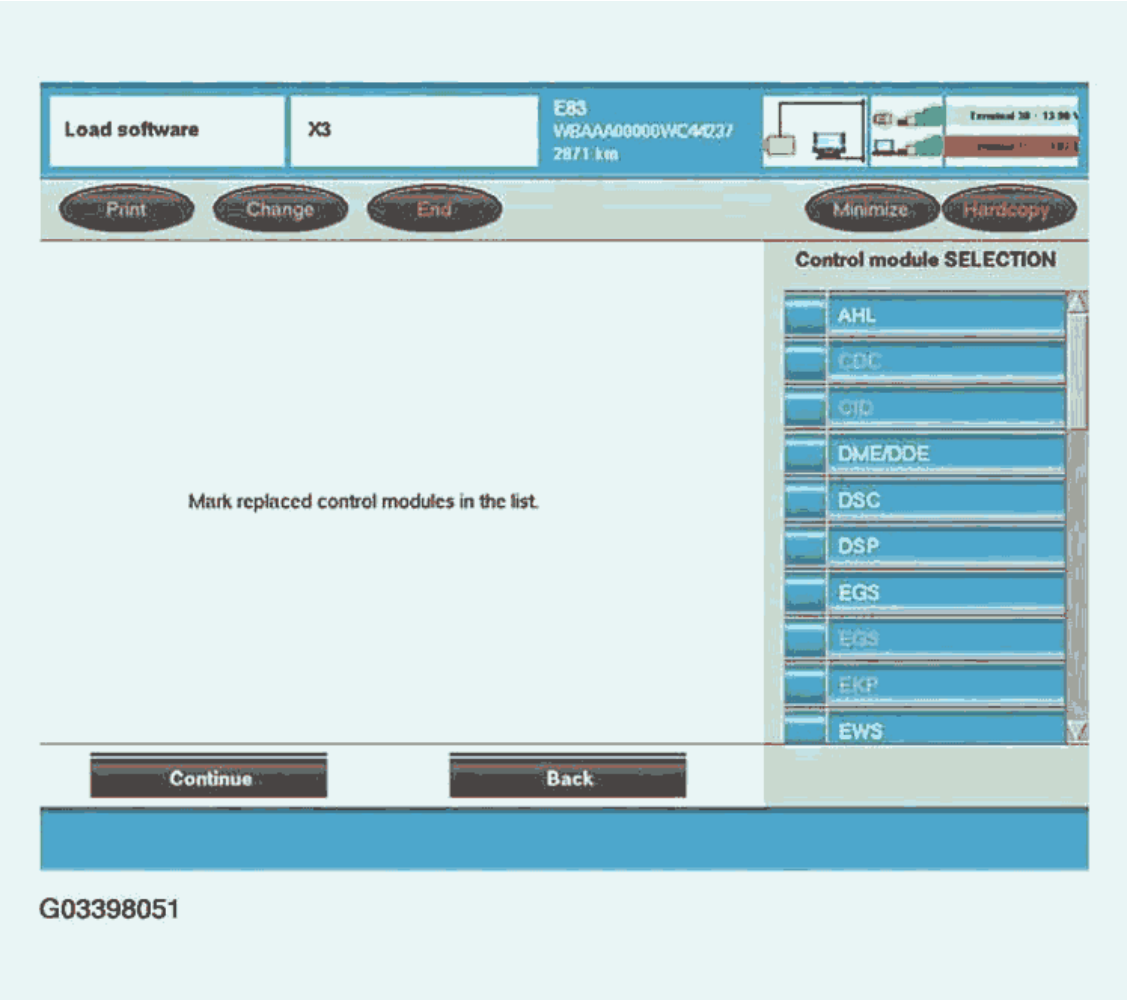


Fig. 197: Display Control Module Selection Screen
Courtesy of BMW OF NORTH AMERICA, INC.

After selecting the replaced module(s) and selecting continue a measures plan will be generated which compares the integration levels (actual vs. target) for not only the modules replaced but for all installed modules as well. If any of the installed control modules do not match the target level they will be updated along with the replacement modules.

CKM - INDIVIDUALIZATION (VEHICLE & KEY MEMORY)

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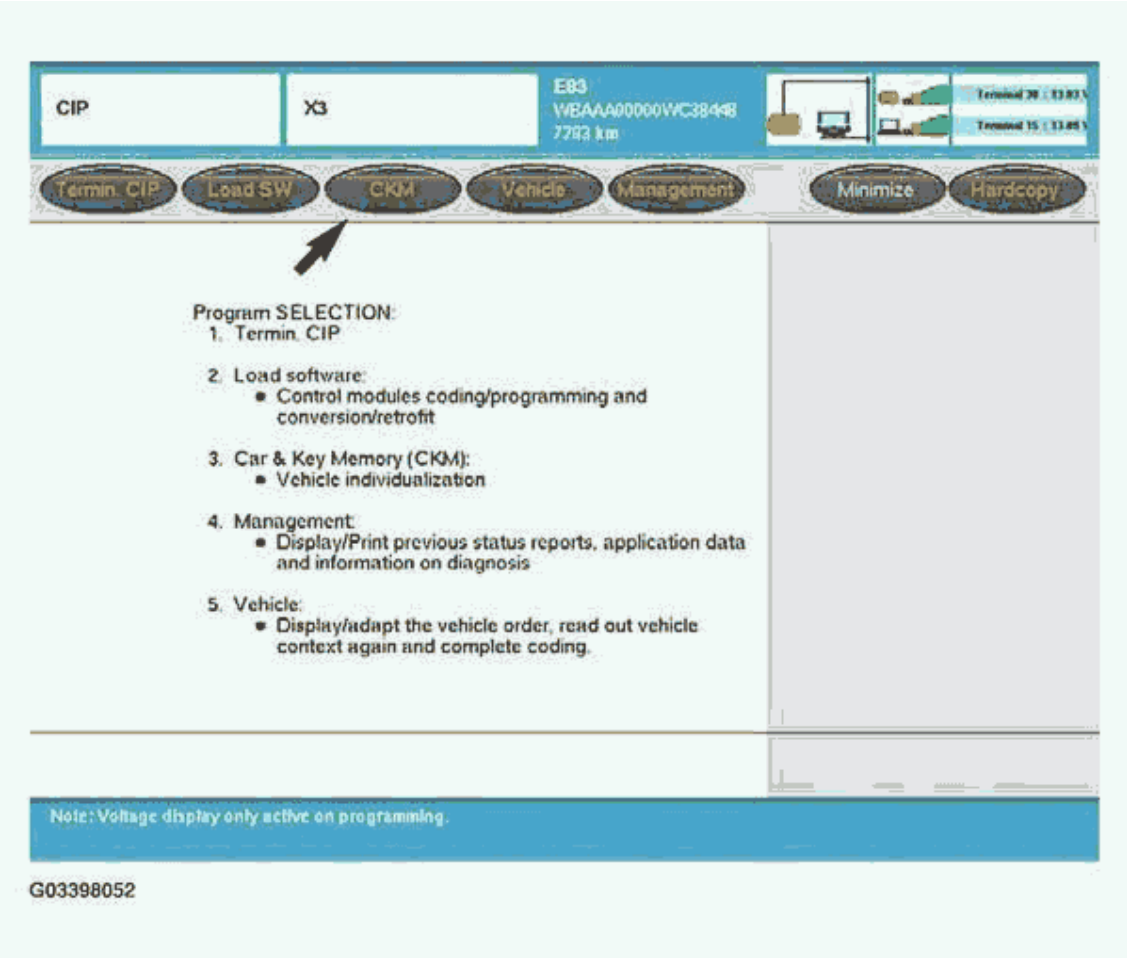


Fig. 198: Selecting CKM Button
Courtesy of BMW OF NORTH AMERICA, INC.

The CKM feature contained in CIP (for models produced as of the E65) provides the ability to "customize" certain vehicle and key functions to meet the specific preferences of the customer. It is important to note that the functions/features that can be "customized" will vary depending on model, equipment level and vehicle software level.

Upon selecting "CKM" a check of the current vehicle and key settings is made and displayed. The displayed settings list should be printed out and provided to the customer in order for them to select how the available functions should be set. The CKM function contained within CIP allows settings for both vehicle and keys to be made directly, the older version separates the key settings from the vehicle setting as different functions.

On older vehicles the Car Memory and Key Memory settings can be accessed via the SGC/UNIX function.

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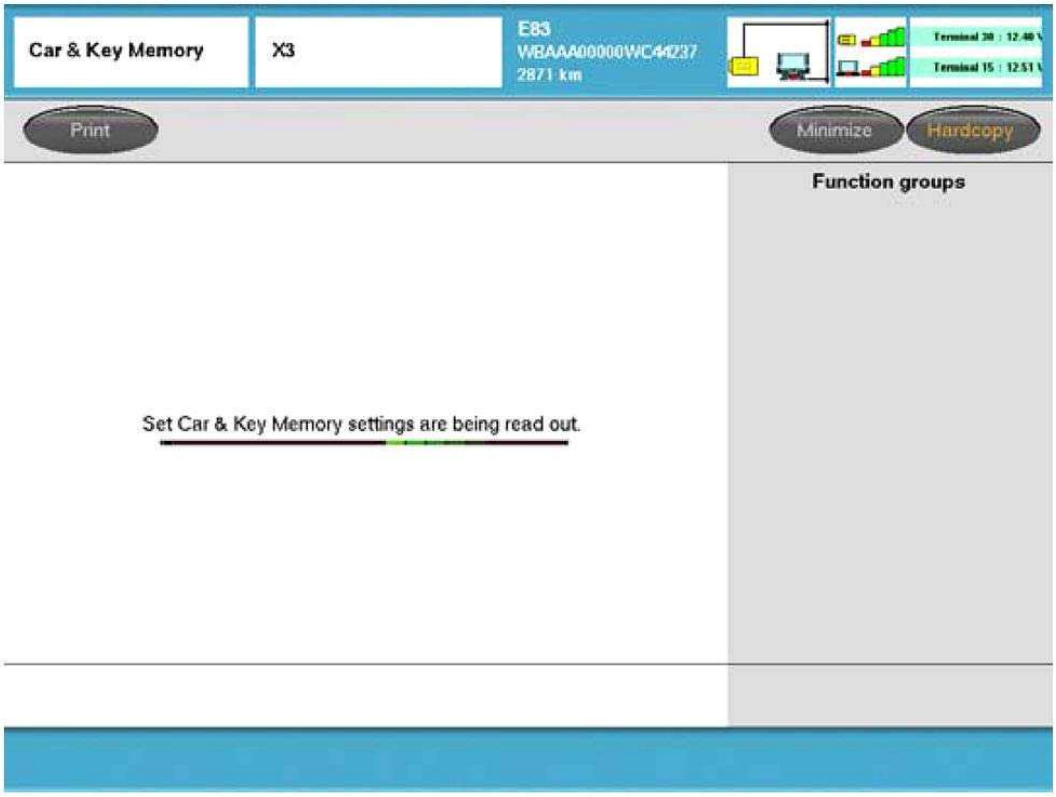


Fig. 199: Display Car Memory And Key Memory Settings Button
Courtesy of BMW OF NORTH AMERICA, INC.

Detailed information pertaining to CKM configuration is available in ***SI B09 03 98.***

Upon selecting **"CKM"** a check of the current vehicle and key settings is made.

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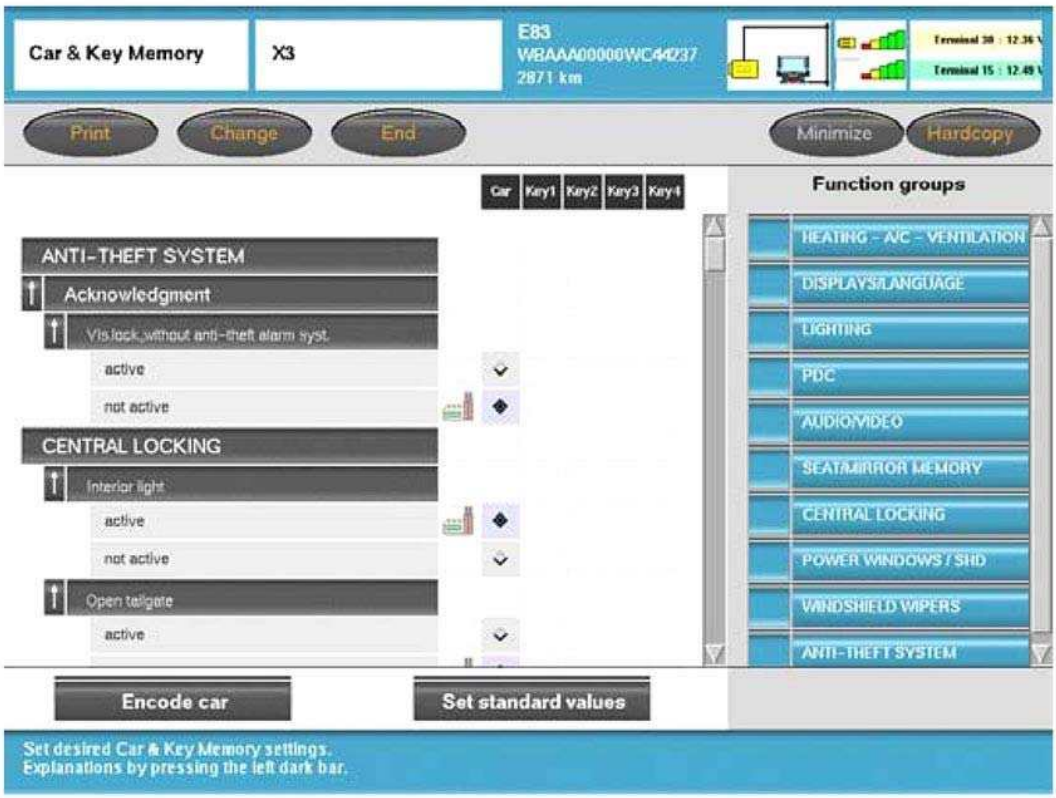


G03398054

Fig. 200: Selecting CKM Button
Courtesy of BMW OF NORTH AMERICA, INC.

Once the check is complete the current setting are displayed and can be printed out.

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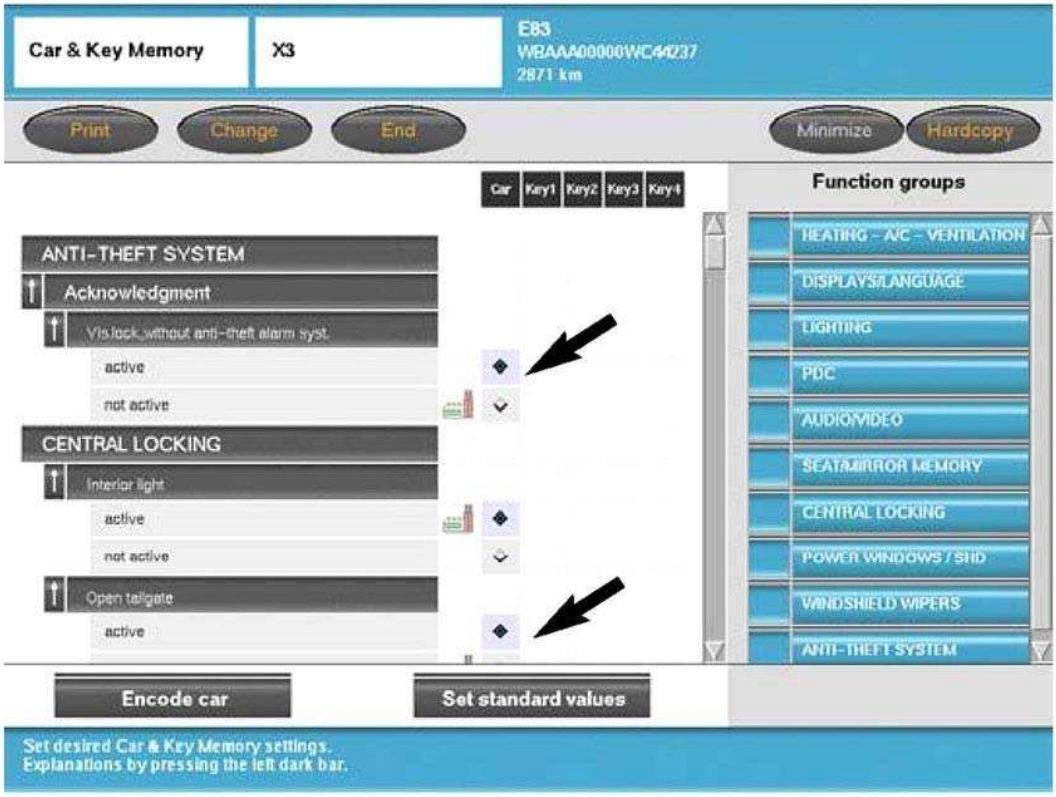
G03398055

Fig. 201: Display Current Setting Screen
Courtesy of BMW OF NORTH AMERICA, INC.

Changes to the current settings can be made by selecting the preferred function.

NOTE: Some preference settings can be made that are specific to the key being used.

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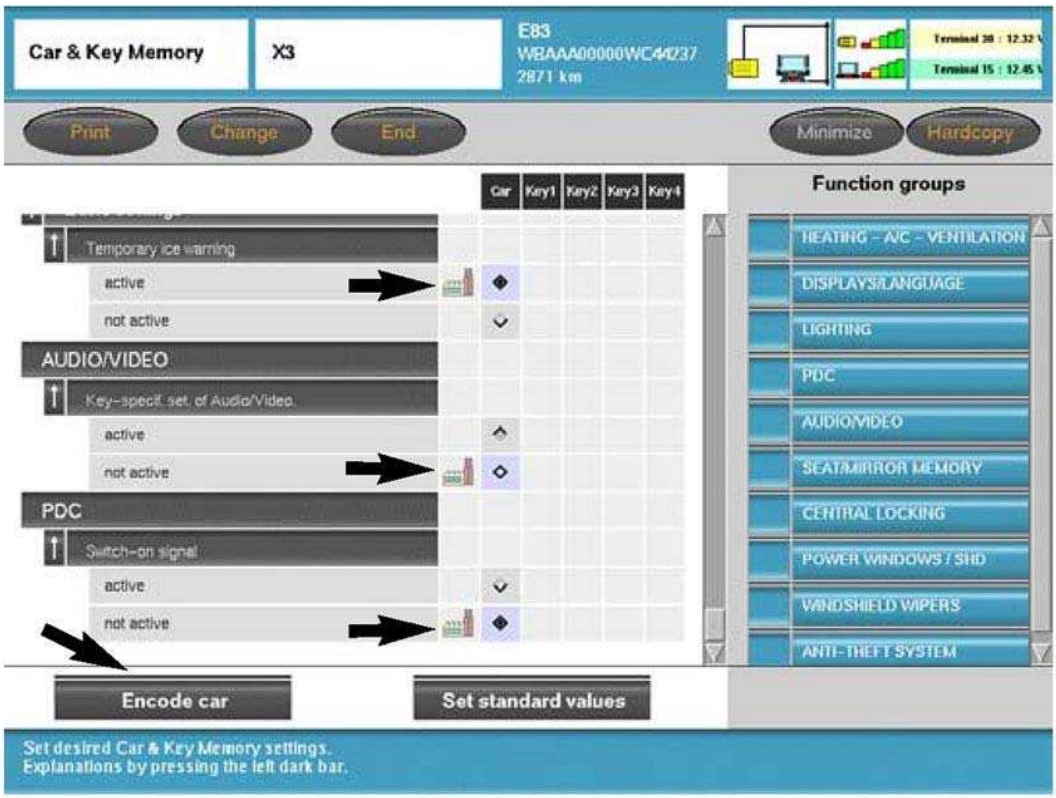
G03398056

Fig. 202: Selecting Preferred Function
Courtesy of BMW OF NORTH AMERICA, INC.

The factory default setting are identified by a "factory" symbol.

To except/code the new setting to the vehicle or key select **"Encode car".**

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Fig. 203: Selecting Encode Car Button
Courtesy of BMW OF NORTH AMERICA, INC.

To lock the changes to the vehicle and/or keys select **"Save".**

By selecting back additional changes can be selected or the function aborted.

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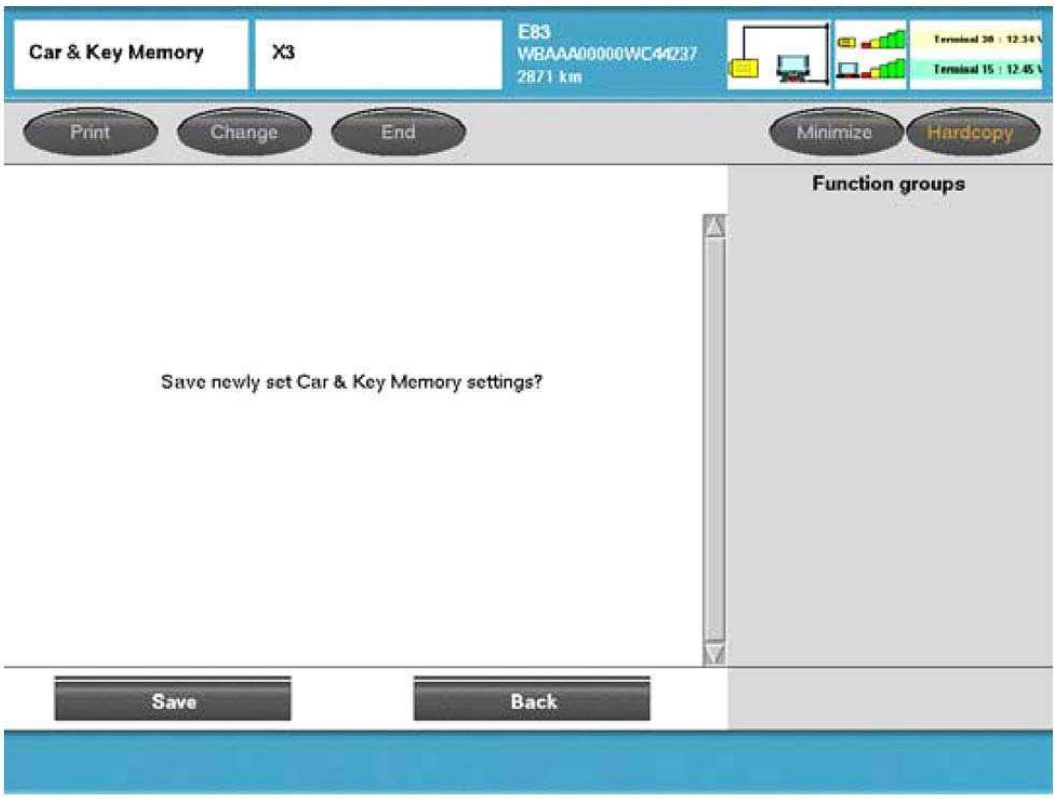


Fig. 204: Selecting Save Button
Courtesy of BMW OF NORTH AMERICA, INC.

Once the new values are stored/set a final report showing the new setting will be displayed. The report will also show if the effected modules did or did not accept the changes.

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Fig. 205: Display Final Report
Courtesy of BMW OF NORTH AMERICA, INC.

ZCS CODING PROCEDURE

The ZCS coding procedure can currently be performed with the DISplus using DIS CDs until DIS CD 42 is released at which time all SGC/Unix coding and programming functions will be available only via Progman using the GT1 or SSS.

There are two methods of encoding replacement control modules:

- Manual input of ZCS
- Automatic ZCS retrieval and coding

Coding Control Modules That Store The ZCS

On earlier production vehicles when replacing a control module that stores the ZCS code (i.e Kombi/Instrument Cluster) the information must be entered manually in order to code the replacement module. The ZCS code from the label located in the vehicle or a printout of the code stored in the module to be replaced must be entered into the new module.

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The control modules that store the ZCS and require manual input are:

- IKE - E38
- EKM - E31
- Instrument Cluster - E32/34 (After 9-91) & E36 (except 318ti and Z3 Roadster)
- EWS II - 318ti & Z3 Roadster

NOTE: As long as the defective EWS II control module can communicate with the coding equipment, automatic encoding is possible.

On later production vehicles where the ZCS information is stored in two modules, redundant data storage, the ZCS information to code the replacement module can be obtained from the second/backup module.

Vehicles which have redundant ZCS data storage are:

- E36 (Z3) - Instrument Cluster & EWS II as of 9/98
- E39 - Instrument Cluster & EWS II
- E46 - Instrument Cluster & LSZ
- E53 - Instrument Cluster & LSZ

NOTE: E46 changed from ZCS to a Vehicle Order (VO/FA) vehicle data structure in 9/01.

Manual Input of ZCS Data

From Progman establish a connection to the interface connected to the vehicle and access CIP.

To perform the procedure from CIP the Model series must be selected **(3 series, 7 series ...).**

Then select the body **(E32, E36 ...).**

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Fig. 206: Display Model Series Selection Menu
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Codierung ZCS/FA".**

Then advance screen to the right two times to enter the vehicle series selection screen.

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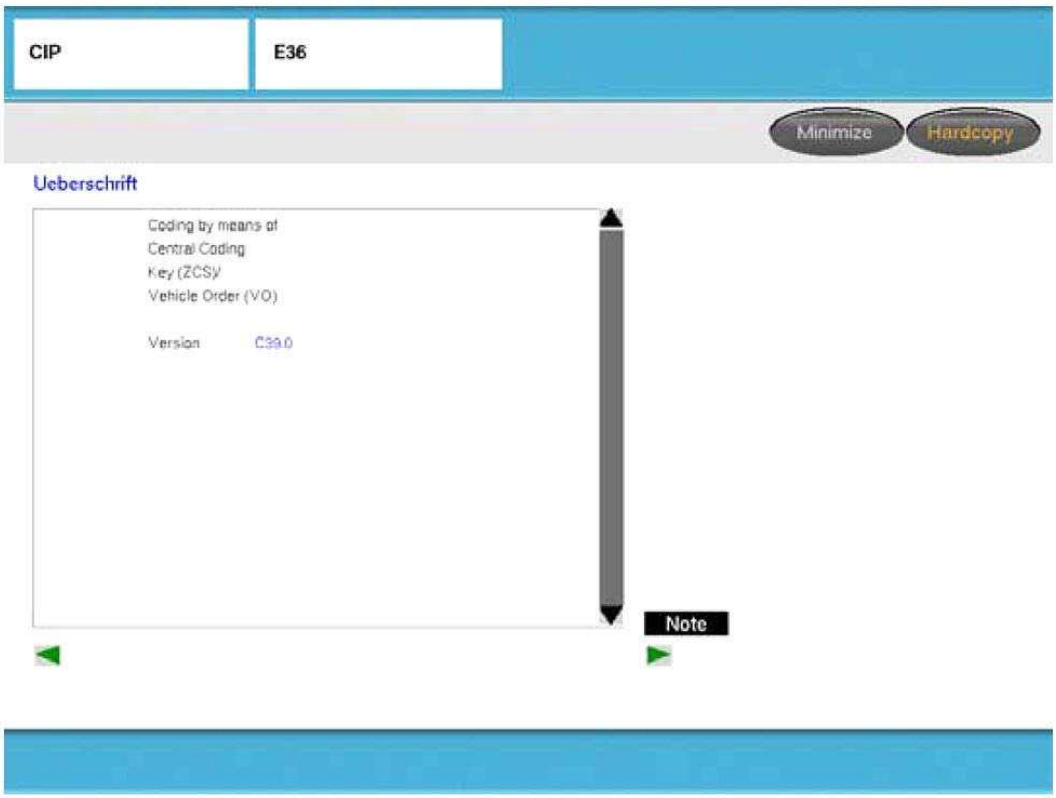
Fig. 207: Selecting Codierung ZCS/FA Button
Courtesy of BMW OF NORTH AMERICA, INC.

The version ID page is displayed.

Make sure it is the most up-to-date version of the software for the encoding procedure.

Press the right arrow.

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Fig. 208: Display Version ID Page
Courtesy of BMW OF NORTH AMERICA, INC.

Select vehicle series (i.e **"E36 Series").**

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Fig. 209: Selecting Vehicle Series
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Recoding".**

Then advance screen to the right.

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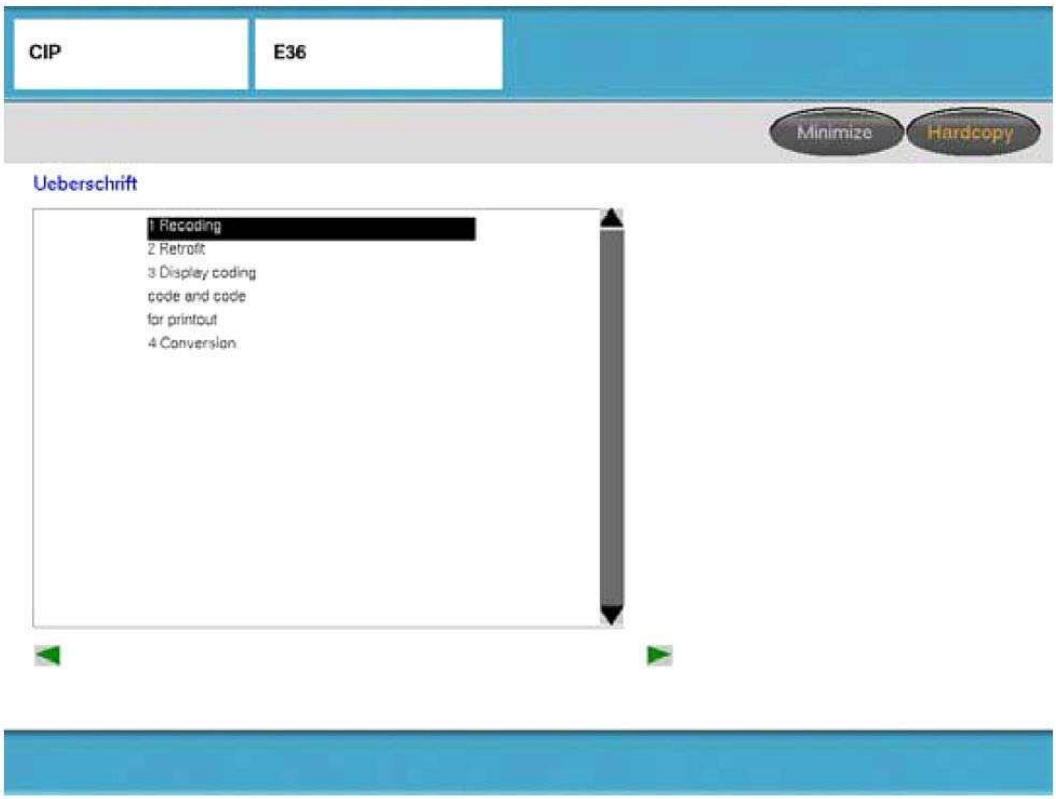


Fig. 210: Selecting Recoding Button
Courtesy of BMW OF NORTH AMERICA, INC.

Displays control modules that are ZCS codable.

Example:

Select **"KOMBI".**

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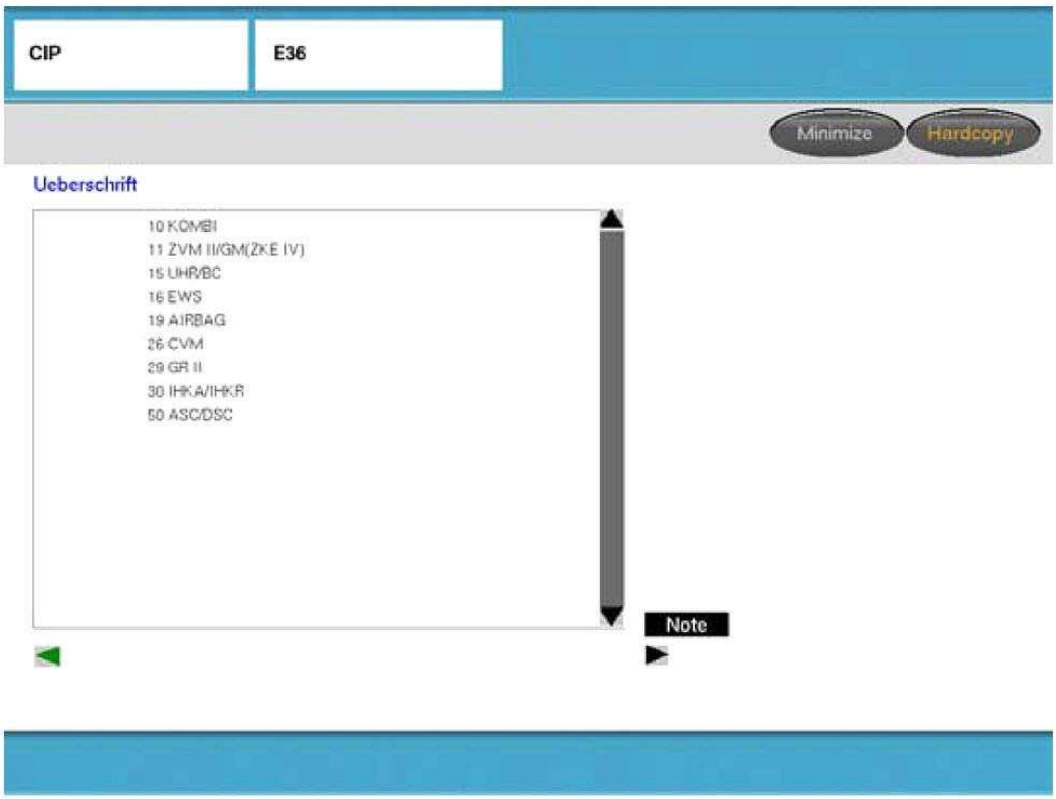


Fig. 211: Selecting COMBI Button
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Yes"** to recode KOMBI.

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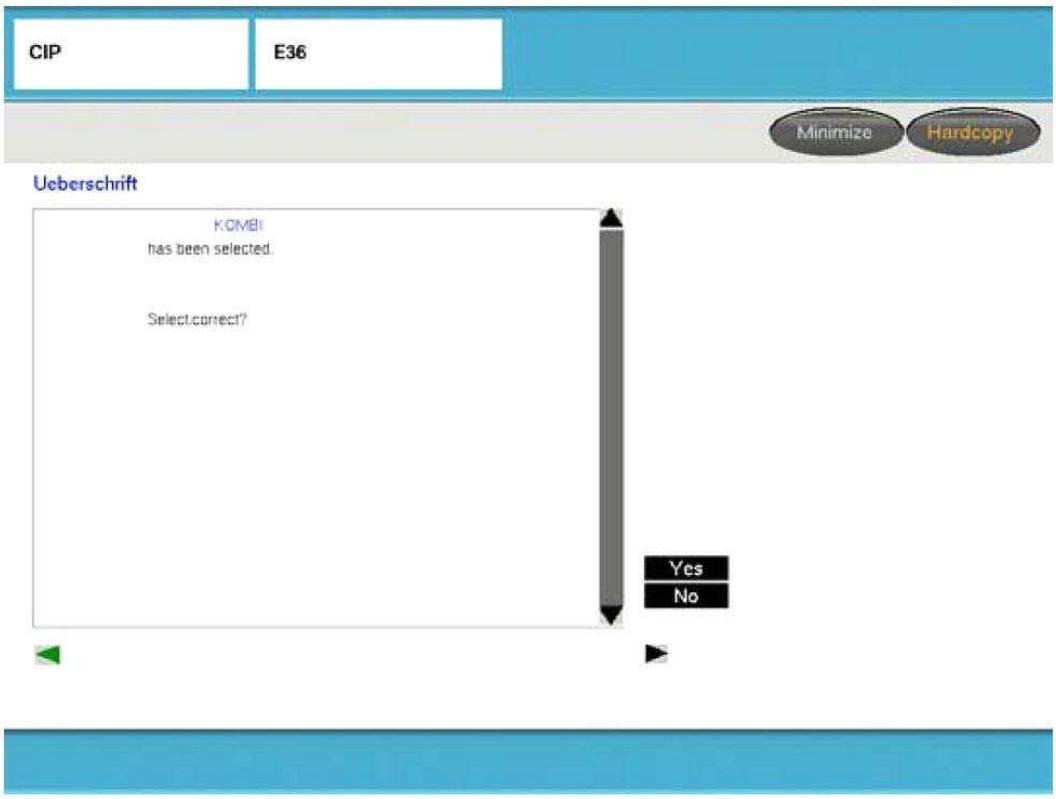
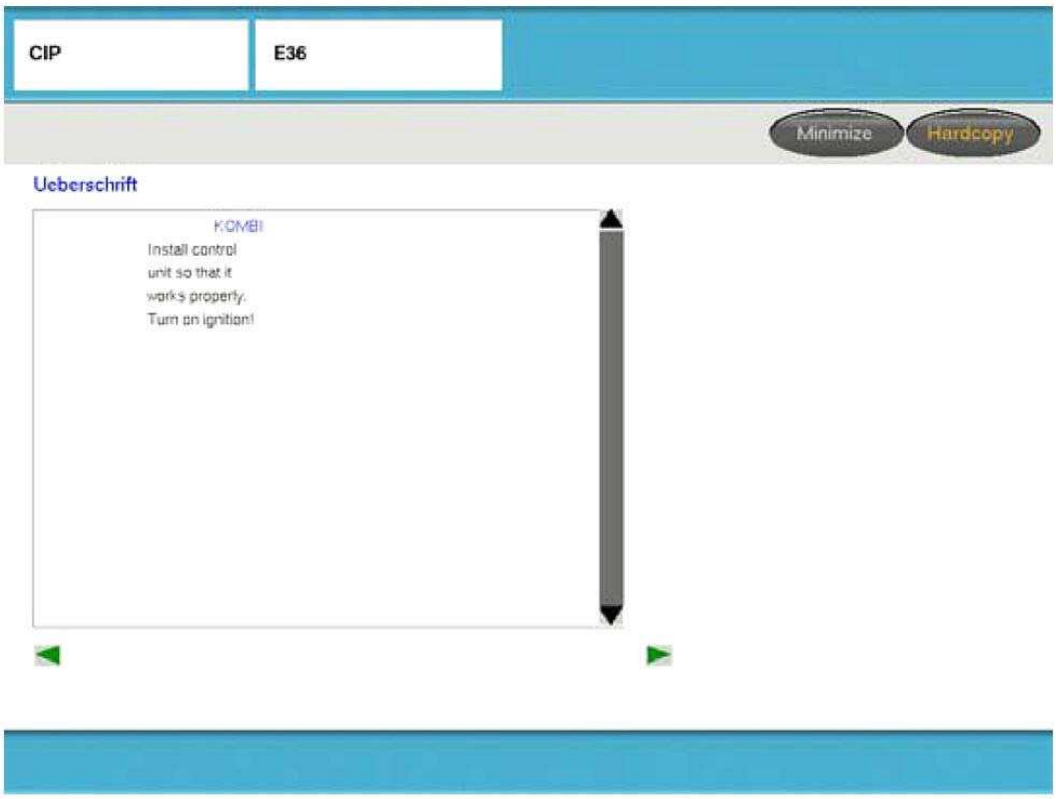


Fig. 212: Selecting YES Button
Courtesy of BMW OF NORTH AMERICA, INC.

Follow the instructions given on screen.

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Fig. 213: Display Instructions
Courtesy of BMW OF NORTH AMERICA, INC.

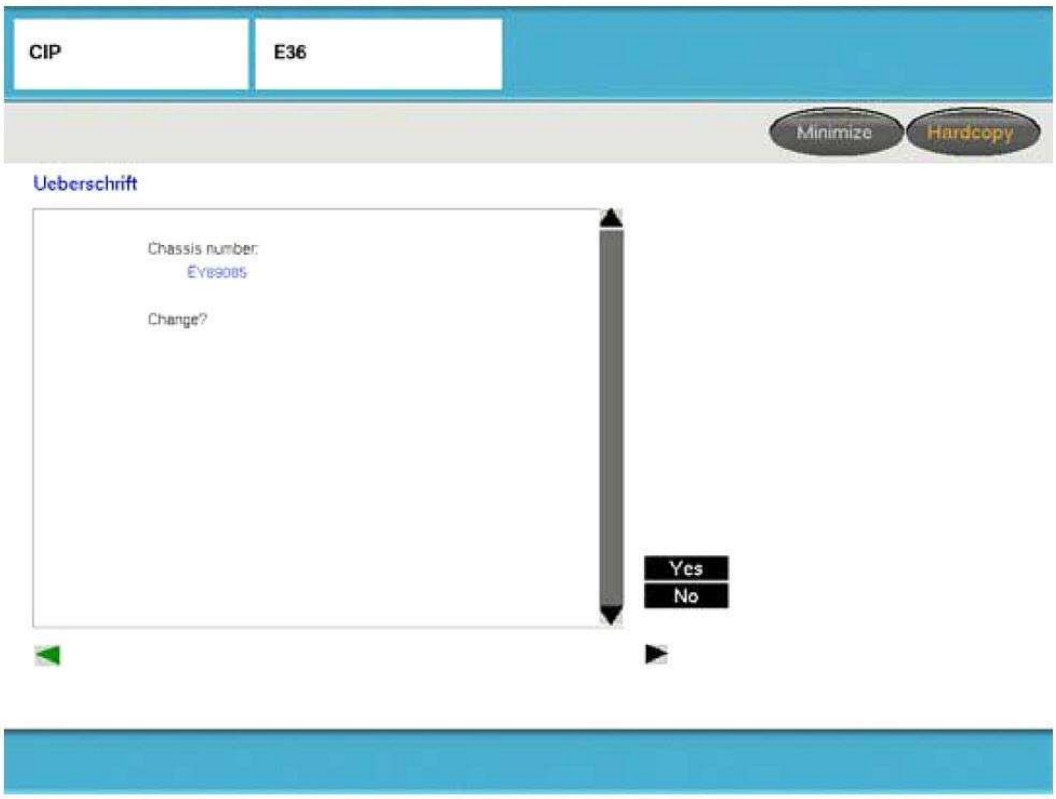
Chassis number of vehicle is displayed.

Select **"Yes"** to accept VIN.

Select **"No"** if VIN needs to be changed.

When installing a new module the last 7 digits of the VIN will need to be entered.

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Fig. 214: Selecting YES Button
Courtesy of BMW OF NORTH AMERICA, INC.

Follow the instructions given on screen.

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Fig. 215: Display Instructions
Courtesy of BMW OF NORTH AMERICA, INC.

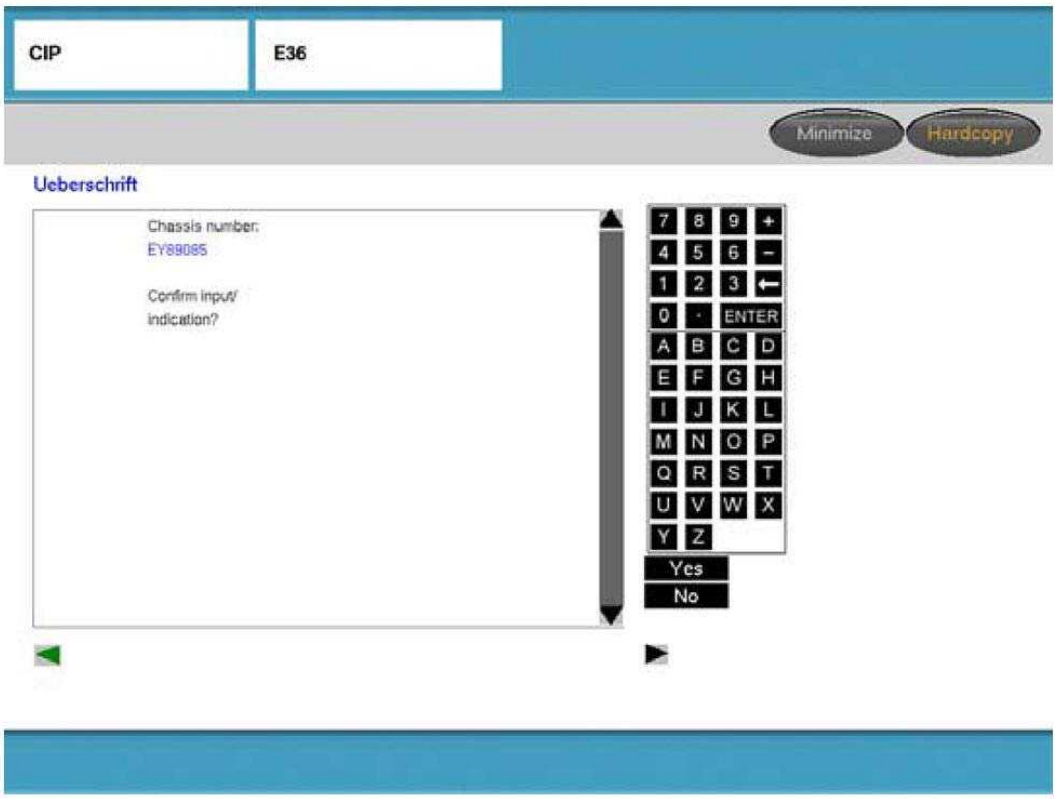
Chassis number of vehicle is displayed, enter VIN using touch screen pad or the keyboard on an SSS.

Select **"Yes"** to accept VIN.

Select **"No"** if VIN needs to be changed/corrected.

When installing a new module the last 7 digits of the VIN will need to be entered.

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Fig. 216: Display Chassis Number Of Vehicle
Courtesy of BMW OF NORTH AMERICA, INC.

Current ZCS code is displayed

Select **"YES"** to accept current code

Select **"No"** to change the ZCS data

When installing a new module the ZCS code of the vehicle will need to be entered. The information can be obtained from:

- ZCS print out of old module before removal
- ZCS label located in vehicle

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Fig. 217: Selecting Yes Button
Courtesy of BMW OF NORTH AMERICA, INC.

If the ZCS code must be changed follow the instruction given on screen and enter the required information exactly as indicated on the ZCS label or printout of ZCS code before removal of module.

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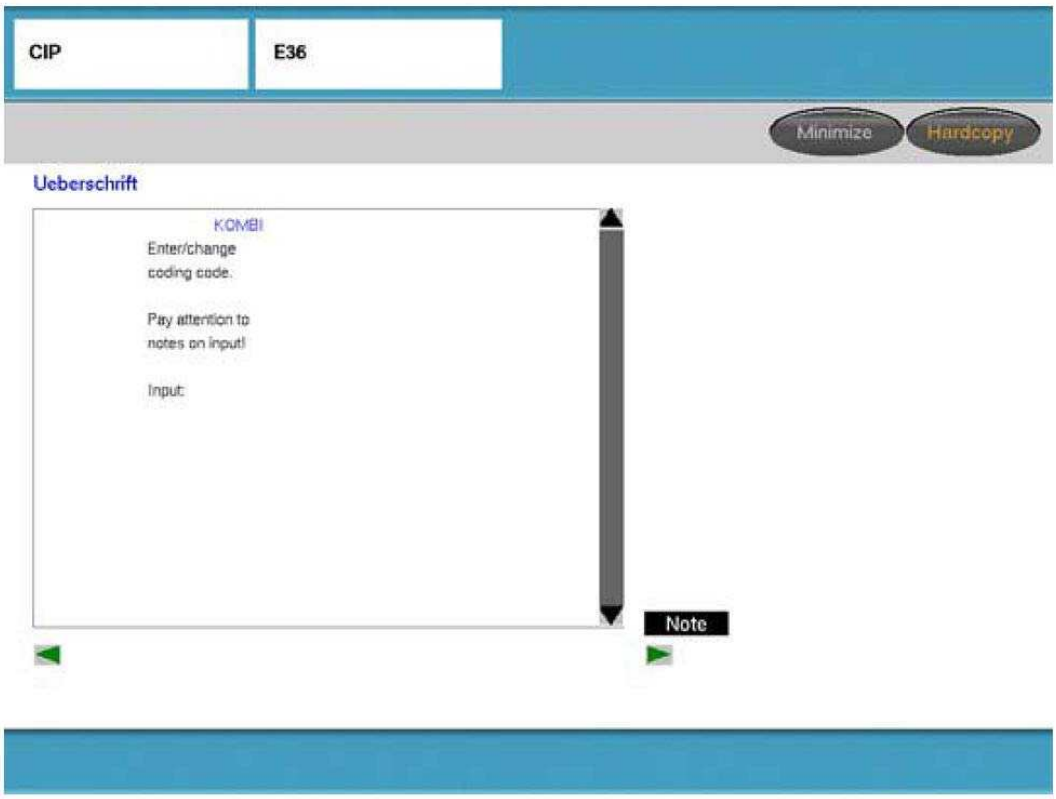
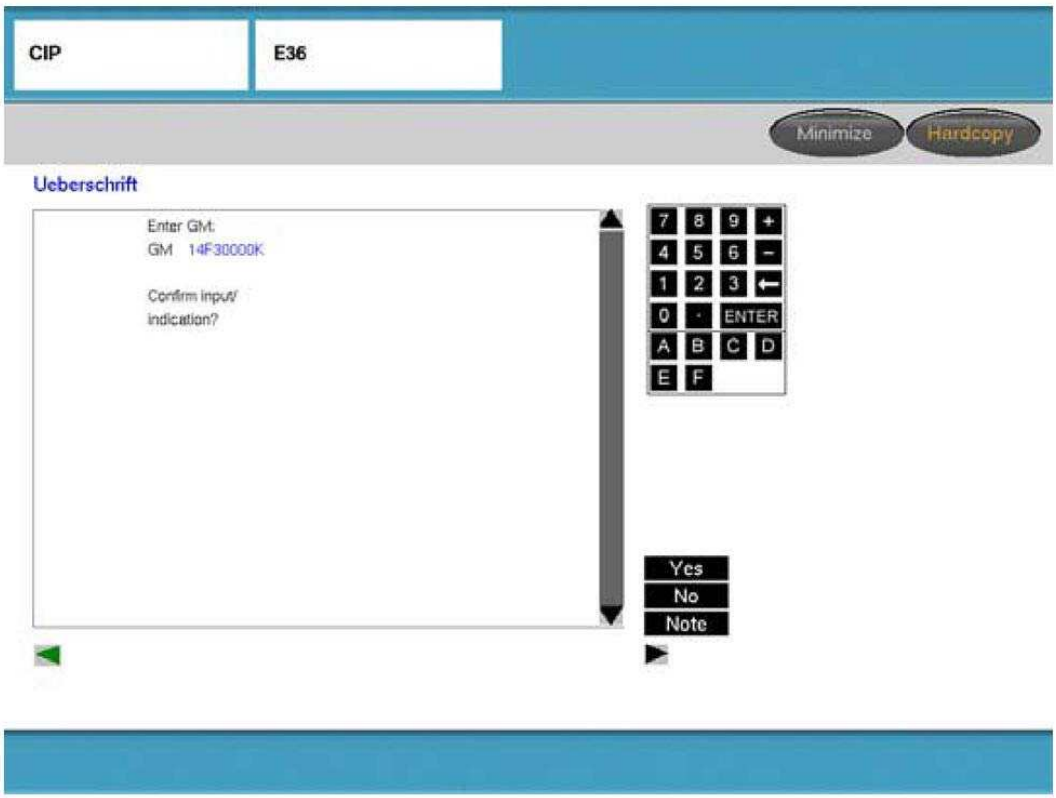


Fig. 218: Display Instruction
Courtesy of BMW OF NORTH AMERICA, INC.

Confirm or enter new GM information.

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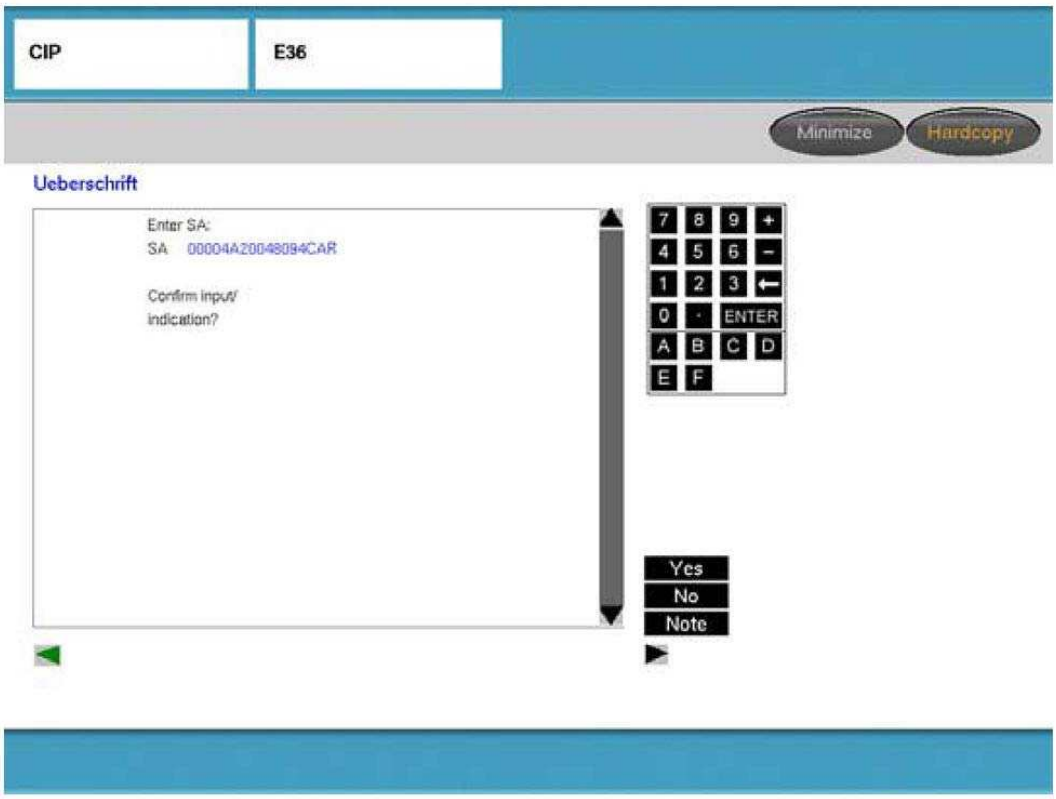


G03398073

Fig. 219: Entering New GM Information
Courtesy of BMW OF NORTH AMERICA, INC.

Confirm or enter new SA information.

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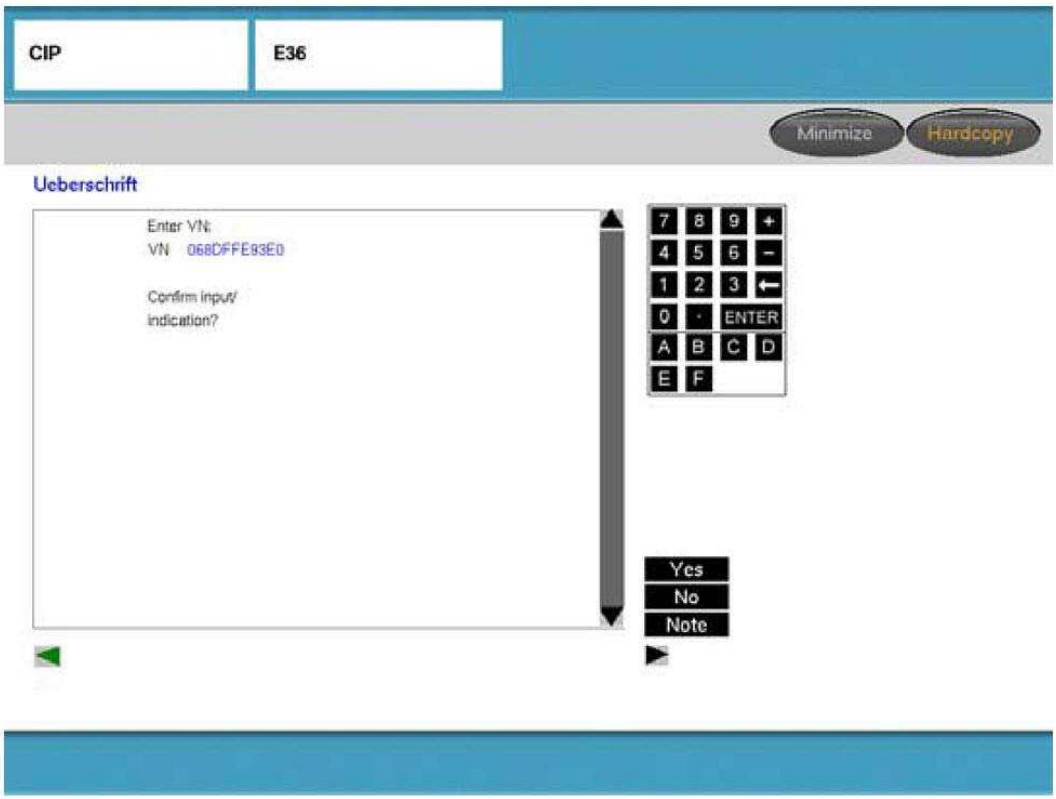


G03398074

Fig. 220: Entering New SA Information
Courtesy of BMW OF NORTH AMERICA, INC.

Confirm or enter new VN information.

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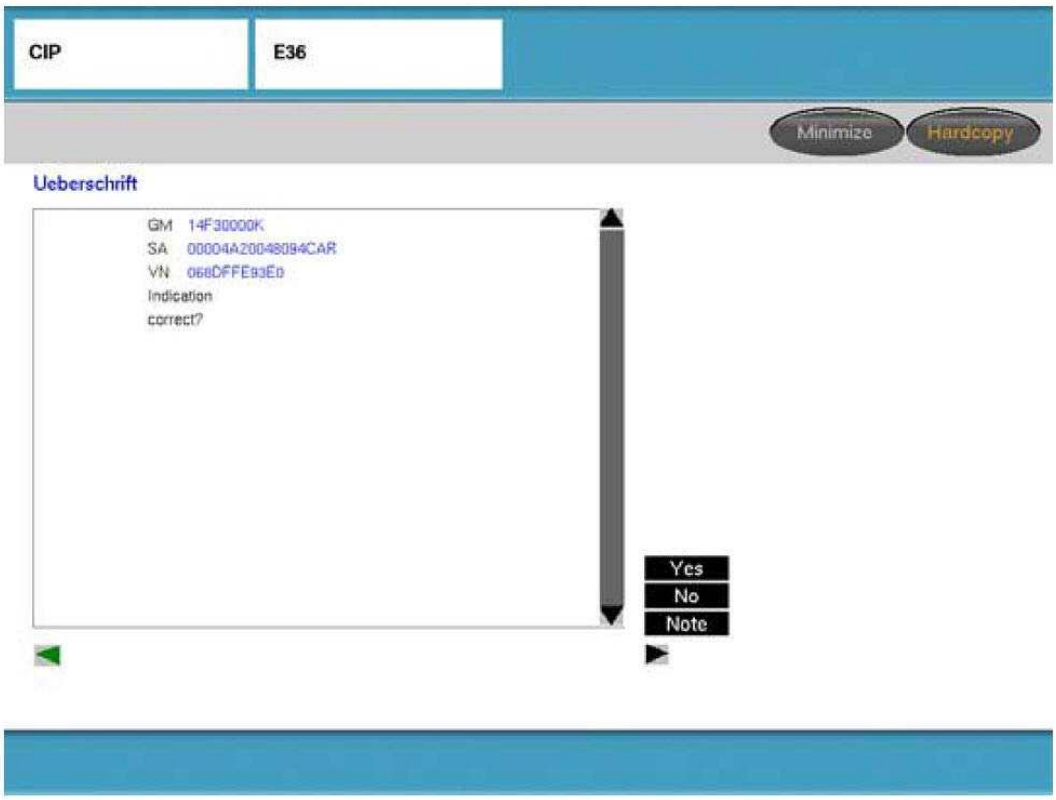


G03398075

Fig. 221: Entering New VN Information
Courtesy of BMW OF NORTH AMERICA, INC.

Confirm or correct ZCS information.

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Fig. 222: Confirming Correct ZCS Information
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Yes"** to begin the coding process for the installed/selected module.

Upon completion of the coding process print out a copy of the ZCS information displayed and attach it to the repair order to be maintained with vehicle file.

Switch ignition off for 10 seconds, then check for proper system operation.

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Fig. 223: Selecting Yes Button
Courtesy of BMW OF NORTH AMERICA, INC.

Automatic Coding Procedure

When a control module is replaced that does not store the ZCS code, the replacement module is coded automatically using the ZCS code stored in the Kombi, EWS or LSZ.

From Progman establish a connection to the interface connected to the vehicle and access CIP.

To perform the procedure from CIP the Model series must be selected **(3 series, 7 series ...).**

Then select the body **(E32, E36 ...).**

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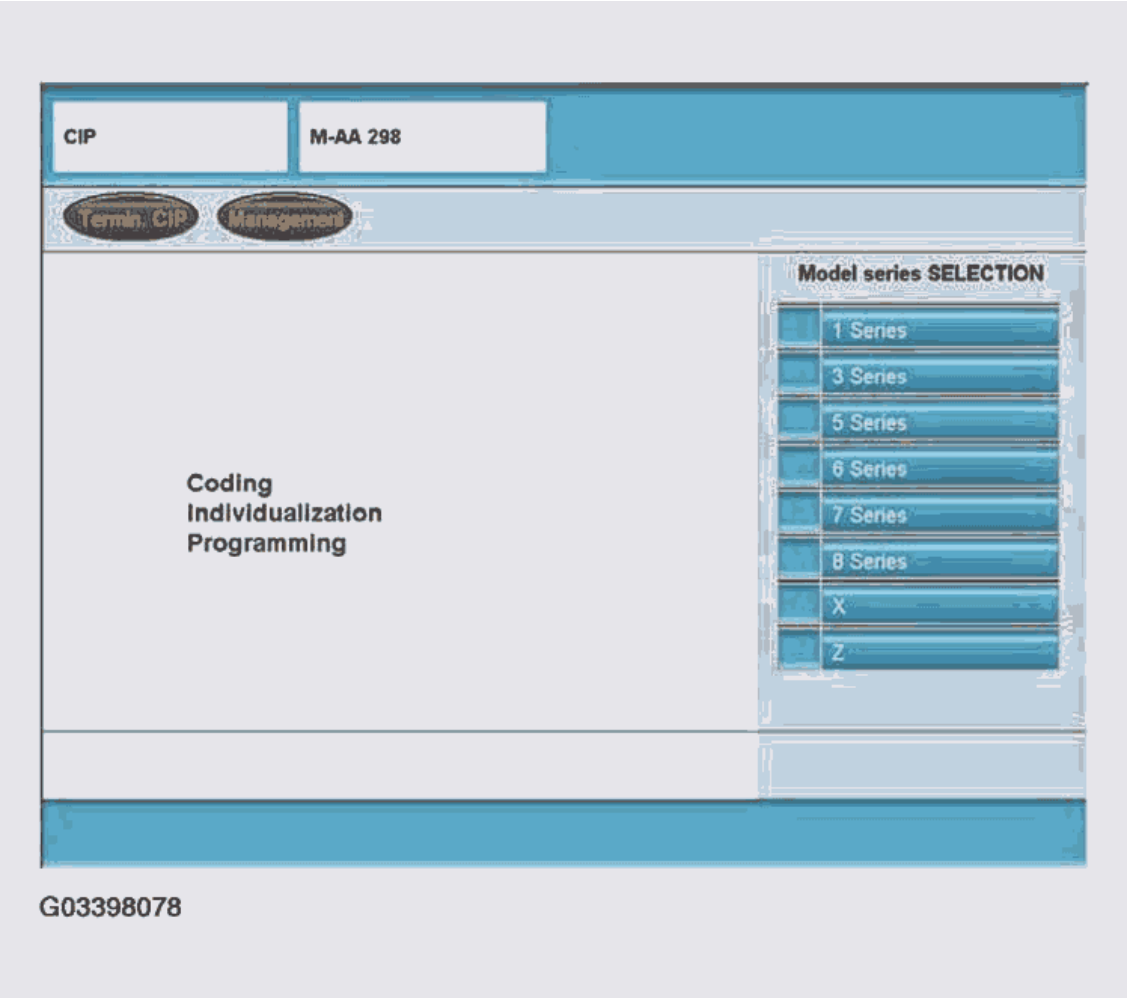


Fig. 224: Display Model Series Selection Screen
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Codierung ZCS/FA".**

Then advance screen to the right two times to enter the vehicle series selection screen.

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Fig. 225: Selecting Codierung ZCS/FA Button
Courtesy of BMW OF NORTH AMERICA, INC.

The version ID page is displayed.

Make sure it is the most up-to-date version of the software for the encoding procedure.

Press the right arrow.

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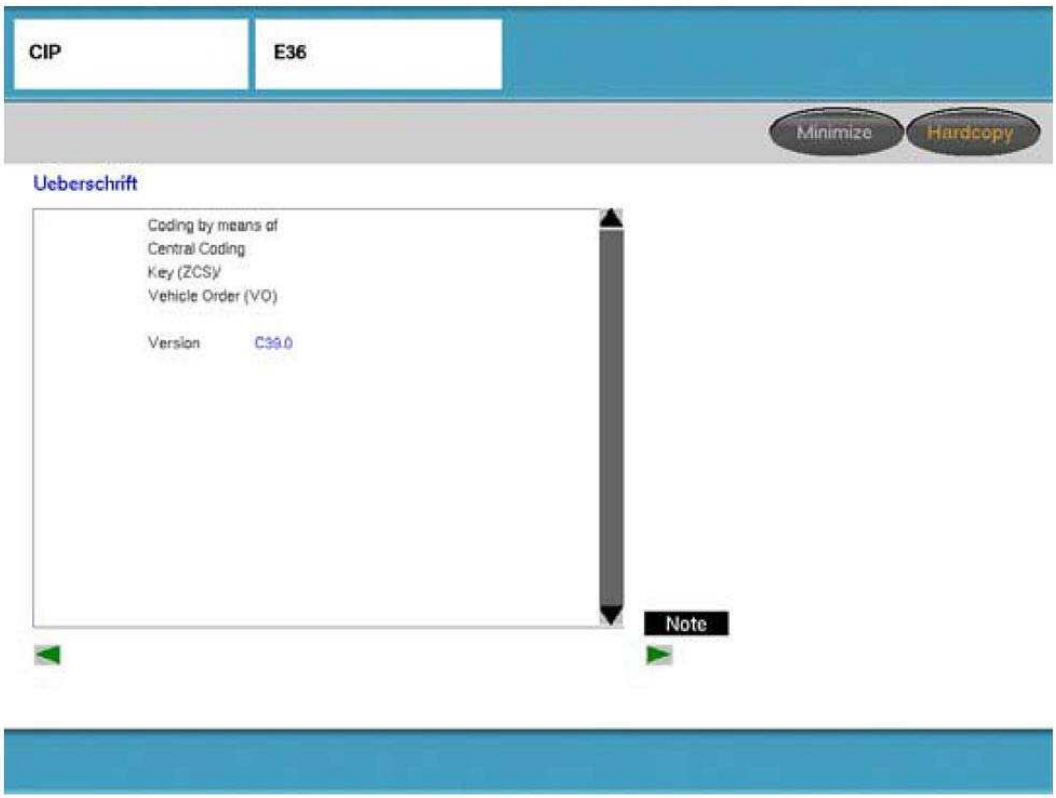


Fig. 226: Pressing Right Arrow
Courtesy of BMW OF NORTH AMERICA, INC.

Select vehicle series (i.e **"E36 Series").**

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Fig. 227: Selecting Vehicle Series
Courtesy of BMW OF NORTH AMERICA, INC.

Select **"Recoding"**

Then advance screen to the right.

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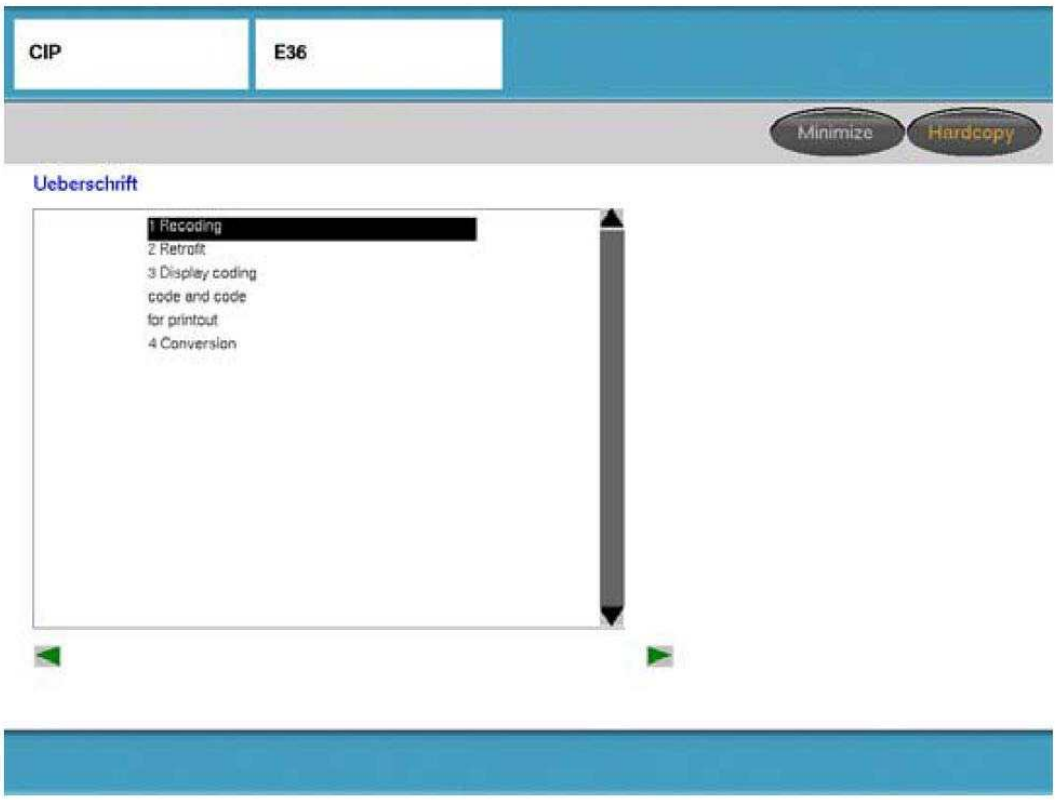


Fig. 228: Selecting Recoding Button
Courtesy of BMW OF NORTH AMERICA, INC.

Displays control modules that are ZCS codable.

Example:

Select **"ZVN II/GM (ZKE IV)".**

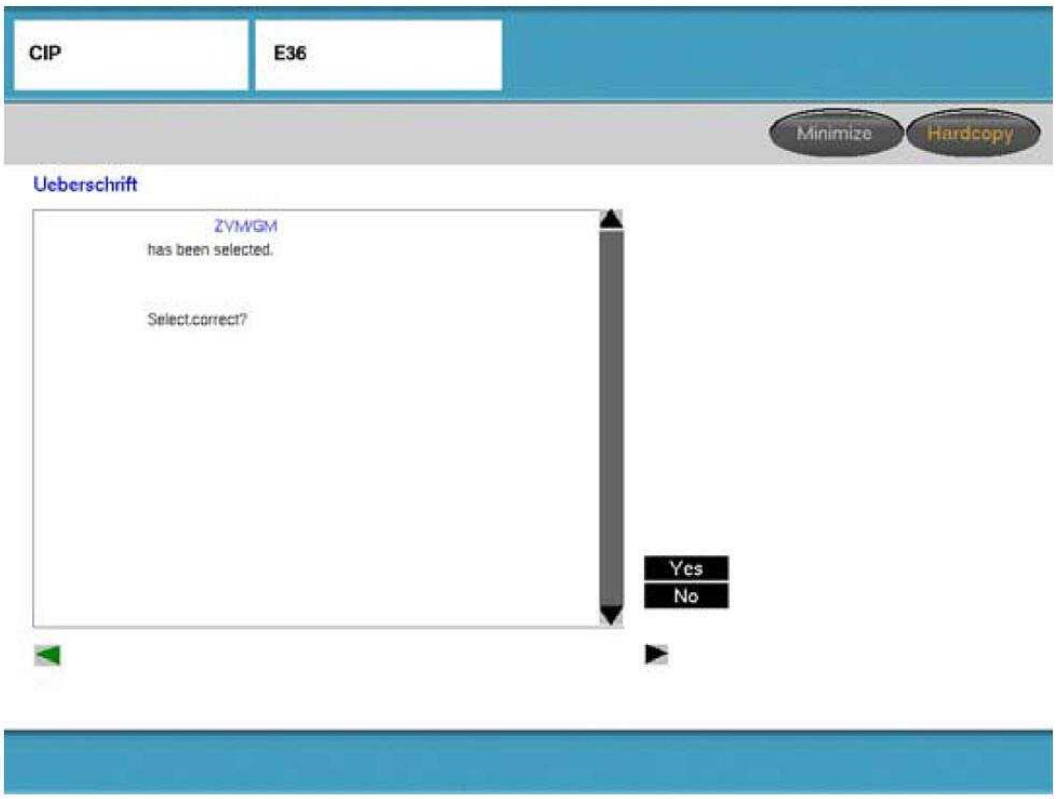
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Fig. 229: Selecting ZVN II/GM (ZKE IV) Button
Courtesy of BMW OF NORTH AMERICA, INC.

Confirm module selection.

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Fig. 230: Confirming Module Selection
Courtesy of BMW OF NORTH AMERICA, INC.

If a replacement module is to be installed install it now.

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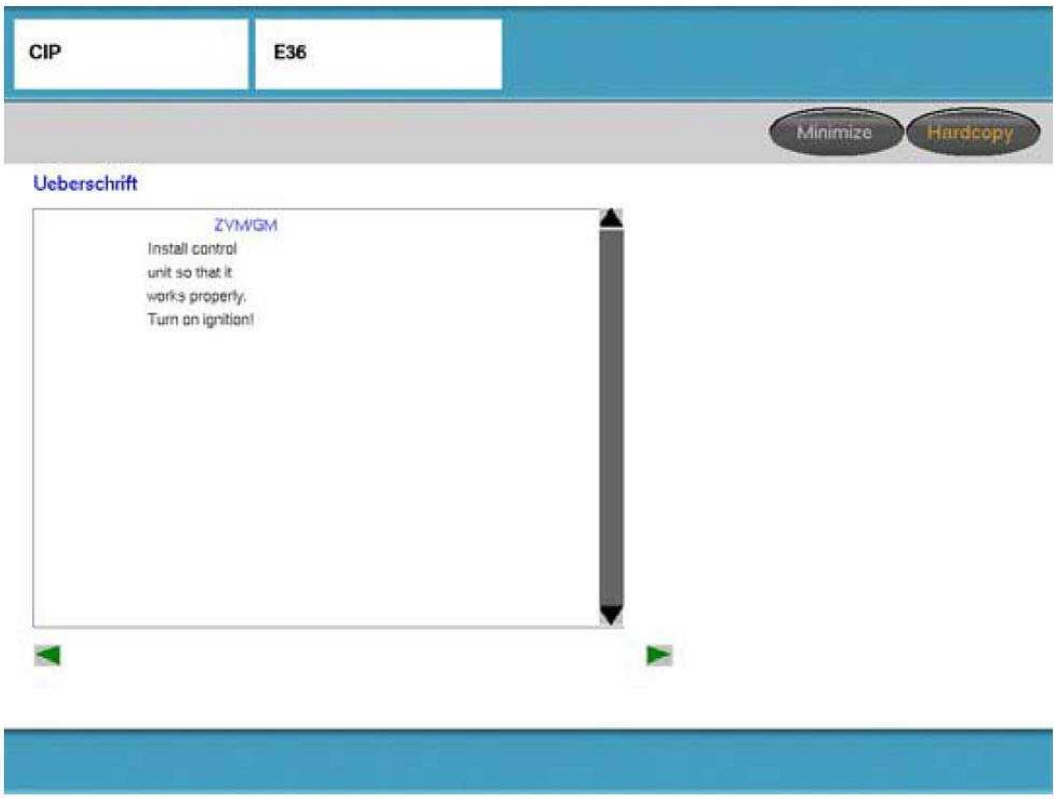


Fig. 231: Display ZVM/VM
Courtesy of BMW OF NORTH AMERICA, INC.

Select yes to begin coding or recoding the selected module.

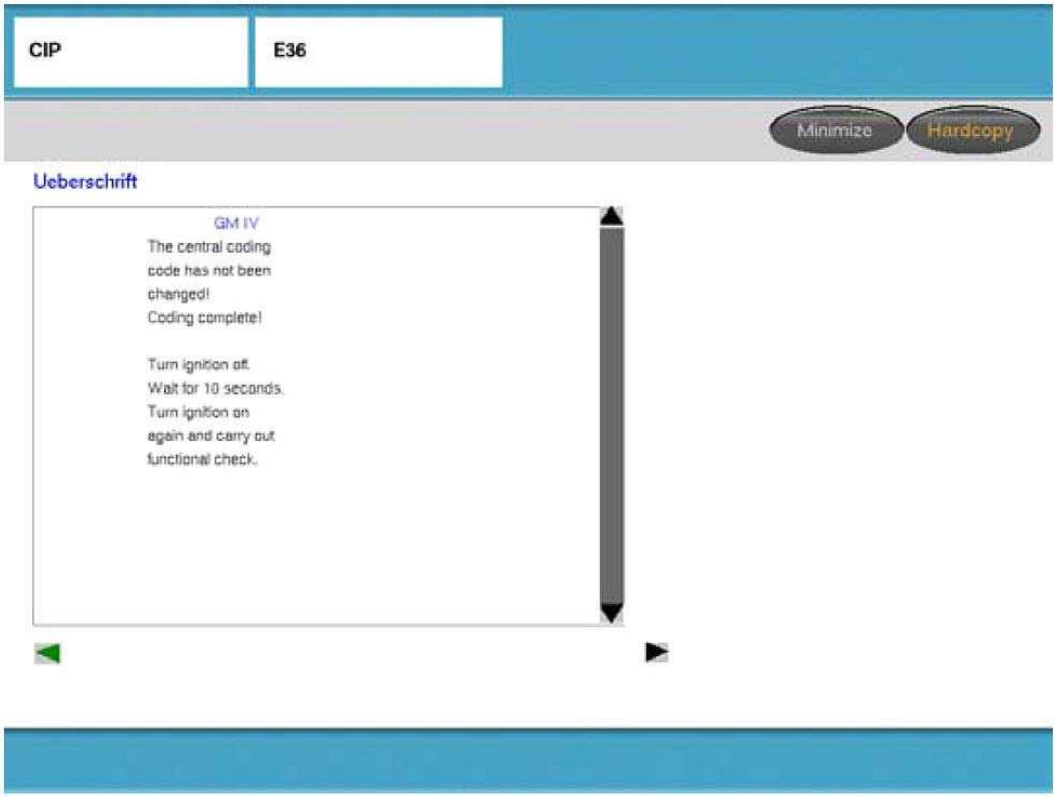
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Fig. 232: Selecting Yes Button
Courtesy of BMW OF NORTH AMERICA, INC.

Coding/recoding process of selected module is complete, follow the instructions given.

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Fig. 233: Display Instruction
Courtesy of BMW OF NORTH AMERICA, INC.

Additional ZCS Coding Functions

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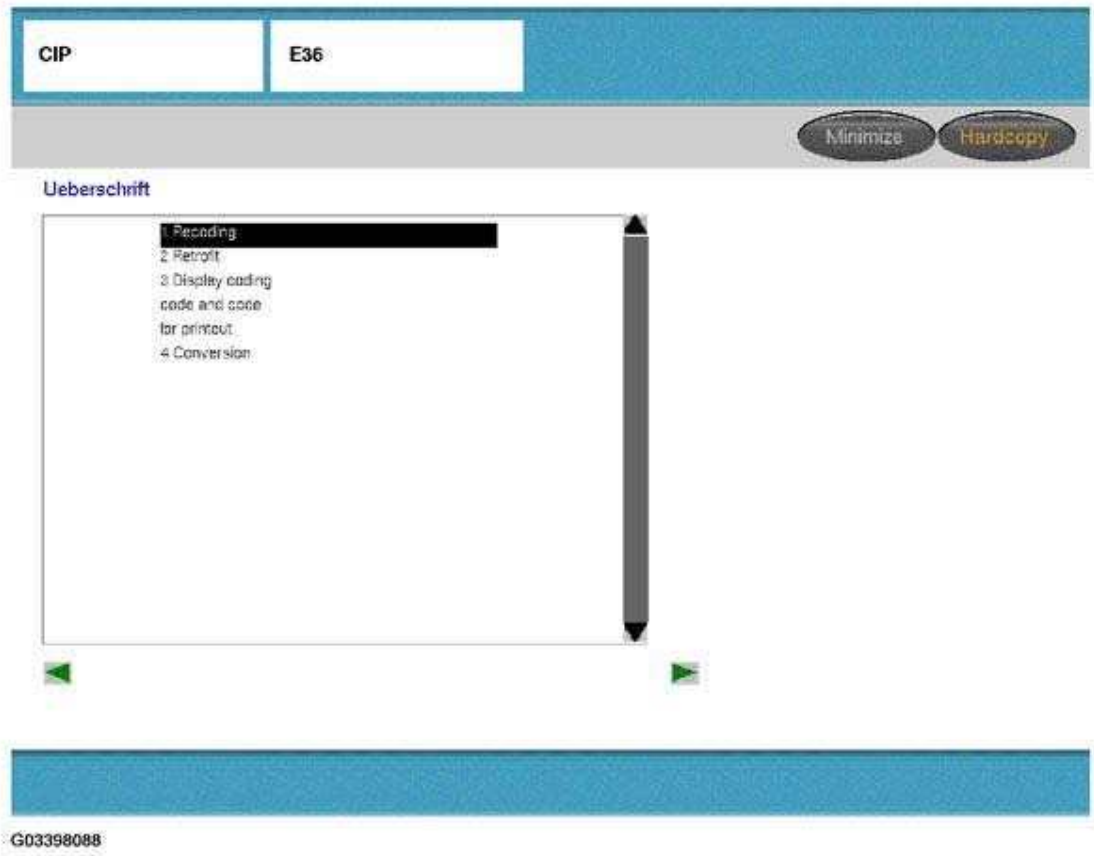


Fig. 234: Selecting Recoding Button
Courtesy of BMW OF NORTH AMERICA, INC.

Retrofit

The retrofit function allows options or accessory equipment to be added after the vehicle is manufactured.

By selecting to install a new option/accessory from the list of available retrofits for the specific vehicle, the ZCS information will be updated to reflect the addition of the new option or accessory that was installed. Updating of the ZCS information will ensure that the new component is recognized and able to communicate with the other modules in the vehicle.

Conversion

The conversion function allows specific features of certain control modules/systems to be modified, similar to the way Individualization (Vehicle & Key Memory) is used on newer models to "customize" a vehicle.

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GENERAL INFORMATION

Complete Vehicle - E83

COMPLETE VEHICLE E83



Fig. 1: Viewing Complete Vehicle
Courtesy of BMW OF NORTH AMERICA, INC.

HIGHLIGHTS IN BRIEF

The technical highlights of the BMW X3 are:

- xDrive, the new all-wheel drive system with variable drive torque distribution to the front and rear axles
- a multifunctional Panorama glass sunroof

The general electrical system of the E83 is largely based on the electrical system of the E46.

The E83 also employs state-of-the-art technology in its information and communication systems, based on the systems in the E85.

The following topics are briefly described below:

- **Body**

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- Design
- Interior
- Bulkhead

- **Electrics/electronics**
  - Vehicle circuit structure
  - Panorama glass sunroof
  - Adaptive headlights
  - Multiple restraint system
  - Information and communication systems
  - Starter actuation
  - Instrument cluster
  - Service interval indicator
  - Centre console switch cluster
  - General module
- **Suspension**
  - Runflat indicator
  - Wheels and tyres
  - Servotronic
  - Front axle
  - Rear axle
  - Trailer stabilisation control
- **Power plants**
  - xDrive
  - Engine
  - Transmission

Some of the topics are dealt with in detail in the BMW Technical bulletins stated.

Body

- **Design**

  The BMW X3 has unmistakable, typically BMW proportions.

  These include:

  - the long, striking bonnet
  - the roof contour the drops steeply to the rear
  - a sloping rear end
  - short overhangs

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- a long wheelbase

The striking design of the headlights, the broad grille frame and the contoured lines of the bonnet are the defining features of the front end of the BMW X3.

Protruding wheel housing give the vehicle a sporty appearance.



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Fig. 2: Viewing Front End Of Vehicle
Courtesy of BMW OF NORTH AMERICA, INC.

The lines of the rear side windows are especially conspicuous: The lower edge of the rear side window departs from the waist line and climbs dynamically to the D-pillar.

The large tailgate is made of a single element.

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Fig. 3: Viewing Rear Side Of Window
Courtesy of BMW OF NORTH AMERICA, INC.

- **Interior**

  The interior is functional and yet sporty. Modern layout, right down to the finest detail make the BMW X3 what it is (e.g. intricate areas on the door handle).

  Various materials are employed, from sporty aluminium to elegant full leather and wood.

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Fig. 4: Viewing Interior Of Vehicle
Courtesy of BMW OF NORTH AMERICA, INC.

- **Bulkhead**

  The bulkhead is bolted and for the first time on a BMW made of a steel/plastic composite.

IMPORTANT: If the bulkhead is damaged in an accident, do not attempt to straighten it but rather replace it.

The rigidity of the bulkhead is only provided in the original condition.

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G03306002

Fig. 5: Viewing Bulkhead Of Vehicle
Courtesy of BMW OF NORTH AMERICA, INC.

Electrics/Electronics

- **Vehicle circuit structure**

  The control units are networked in a similar manner to the E46. The following data buses are available on the E83:

  - **Body bus**

    The body bus (K bus) networks the following components:

    - Components of the general electrical system
    - Components of the information and communication systems
    - Components of the passive safety system.

    The major part of these systems and components have been taken from other models and

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adapted for the E83.

The control units for the Panorama glass sunroof and the multiple restraint system 4 (MRS) are connected to the K bus.

- **Powertrain CAN**

  The powertrain CAN (PT-CAN or powertrain controller area network) links the control units for the drive and running gear control systems.

  New features of the PT-CAN are: the control unit for the transfer box (VTG) and the control unit for the servotronic.

  The transfer box control unit controls the distribution of drive forces between the front axle and the rear axle.

  The servotronic control unit controls the speed-dependent power steering.

- **LIN bus**

  The LIN bus (Local Interconnect-Network bus) is serial, single-wire bus, standardised for the automotive industry. The LIN bus links the components for the electric exterior mirrors: switch block, base module and exterior mirrors.

  The LIN bus also connects the control unit for the adaptive headlights (AHL) with the stepper motor controllers. (The stepper motor controllers control the stepper motors for the headlight-range adjustment and for the AHL).

- **Diagnosis bus**

  The diagnosis bus (D-bus) is connected to the entire vehicle electrical system. The individual control units are either connected directly to the D-bus or via the control unit in the instrument cluster.

- **Panorama glass sunroof**

The fully automatic Panorama glass sunroof comprises 2 glass sunroofs: The front glass sunroof works like a sliding/tilt sunroof, the rear glass sunroof is a tilting glass sunroof.

The drive for the Panorama glass sunroof consists of 2 DC motors.

The wind deflector reduces wind noise inside the vehicle interior. The wind deflector is automatically extended, depending on the road speed.

For more information, refer to **PANORAMA GLASS SUNROOF - SI TECHNIQUES - E53, E61, E83, E91**

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- **Adaptive headlights**

  The adaptive headlights (AHL) directs the beam of the headlights towards the inside of the curve when cornering - the curve is illuminated better. Visibility is thus improved.

  When cornering, the driver is not looking into a "black hole" - instead, the adaptive headlights allow the driver to see the curve of the road. Adaptive headlights is an item of special equipment.

- **Multiple restraint system**

  The new multiple restraint system 4 (MRS) is an advanced development of the current MRS.

  MRS consists of a control unit, several external sensors for recording an impact, a seat-occupancy detector and gas generators for triggering the airbags.

  The external sensors are:

  - 2 airbag front sensors
  - Airbag sensor, front left door
  - Airbag sensor, front right door
  - Airbag sensor, B-pillar left
  - Airbag sensor, B-pillar right

  US version: Seat-occupancy detector

  In the US version, the seat-occupancy detector is able to detect the weight class of the occupant:

  - The seat-occupancy detector mat contains pressure-sensitive sensors.
  - The pressure generated by the person sitting on the seat-occupancy detector mat is recorded by the sensors.
  - The electronic evaluation unit uses the sensor signals to determine the weight class of the person on the front-passenger seat.

  For more information, refer to **AUDIO, NAVIGATION AND ANTI-THEFT** .

Information And Communication Systems

The information and communication systems have the following new features/modifications:

- Different telephone systems are employed on the E83.

  The permanently installed units use the "Everest" platform, bluetooth mobile phones work with the "universal charging and hands-free facility" (ULF).

- The audio system available are taken from the E85.

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The loudspeaker systems are new developments and have been adapted to the acoustic conditions in the E83.

- The CD changer is installed in a user-friendly manner in the front armrest between the driver's and front-passenger seat.
- The hi-fi amplifier in the luggage compartment of the E83 is a modified version of the hi-fi amplifier from the E85 and E46. The 10-channel hi-fi amplifier has been made into a 6-channel hi-fi amplifier through a series of modifications to the internal circuitry.
- Option 209 "Navigation system Professional" includes a folding central information display (CID). The CID is located in the middle of the instrument panel.
- **US version: Satellite Digital Audio Radio Service (SDARS)**

In the USA, BMW uses the SDARS of "Sirius Satellite Radio Inc.".

SDARS allows digital signal (audio and information signals) to be transmitted.

Audio signals are, e.g.:

- Music
- Speech

Information signals are, e.g.:

- Radio station
- Artist
- Music track

Signals are transmitted via 3 satellites (by the national radio station "Sirius Satellite Radio Inc." in New York).

The satellites transmit the signals to the mobile SDARS tuner in the vehicle and to stationary aerials on the ground (to enlarge the reception area).

- **Starter actuation**

  The E83 employs the EWS3 plus (EWS = electronic immobilizer). With the EWS3 plus system, the information "terminal 50 ON" is not forwarded to the DME / DDE (digital engine electronics / digital diesel electronics) by the starter, but rather directly by the EWS control unit.

- **Instrument cluster**

  The E83 instrument cluster differs from the E85 instrument cluster as follows:

  The instrument cluster on the E83 has the same software as that on the E85. All other function are identical.

  - The reading on the speedometer is restricted to a scale reading of 250 km/h

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- Additional warning light for washer fluid level in windscreen washer fluid reservoir
- Additional indicator and warning light for the digital diesel electronics (DDE)

  This indicator and warning light fulfils the same functions as the indicator and warning light for the electronic engine output control (EML). The EML warning lamp lights up if a fault develops in the engine electronics.

- **Service interval indicator**

  The service interval indicator (SIA 4) us installed on the E83.

  Condition Based Service (CBS) is not employed on the E83.

- **Centre console switch cluster**

  The Centre console switch cluster (SZM) has been taken from the E53.

  The SZM button for opening the upper tailgate is not longer fitted as the E83 does not have a 2-section tailgate.

- **General module**

  General module 5 (GM) is introduced with the E85 and on the E83 also controls the exterior mirrors (via the LIN bus).

Suspension

- **Servotronic**

  On the E83, the servotronic (SVT) is integrated in a separate control unit.

  The SVT control unit is connected to the powertrain CAN (PT-CAN) and to the body bus (K bus).

  For more information, refer to **STEERING AND WHEEL ALIGNMENT - SI TECHNIQUES - E83** .

- **Front axle**

  The front axle is a double pivot spring-strut axle with tension strut, transverse link and rack-and-pinion power-steering.

  The E83 front axle differs from the E53 front axle as follows:

  - Modified level sensor (identical component as on rear axle) with elongated hole and tab (locking device)
  - New bellows on steering track rod, transverse link and tension strut
  - Front axle carrier made of high-strength steel tubing and clipped plastic cover as protection against

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stone impact

- Screw connection for hinged bracket with different nuts at top and bottom
- Double screw connection for front axle carrier left and right

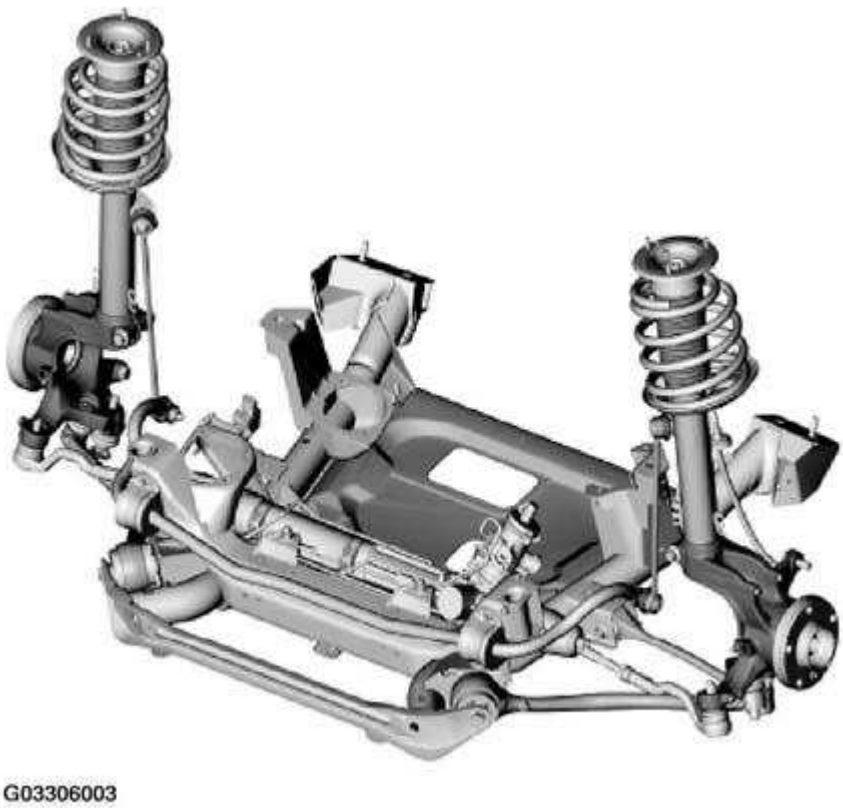


Fig. 6: Viewing Double Pivot Spring Strut Axle E38 Front Suspension
Courtesy of BMW OF NORTH AMERICA, INC.

- **Rear axle**

The rear axle is a central-link rear axle with subframe and double-elastic differential mounting.

The E83 rear axle differs from the rear axle of the E46 all-wheel drive as follows:

- Stabilizer mounting on rear-axle member uses clamps
- Front mounting of rear axle with bolts with additional guide washer
- Torque arm with holder for tension strut
- Transverse link made of galvanizes sheet steel plate
- Hinged bracket with ball joint secured directly on the transverse link (without additional bracket)
- Damper bolted to body with 3 bolts (mounting on body)

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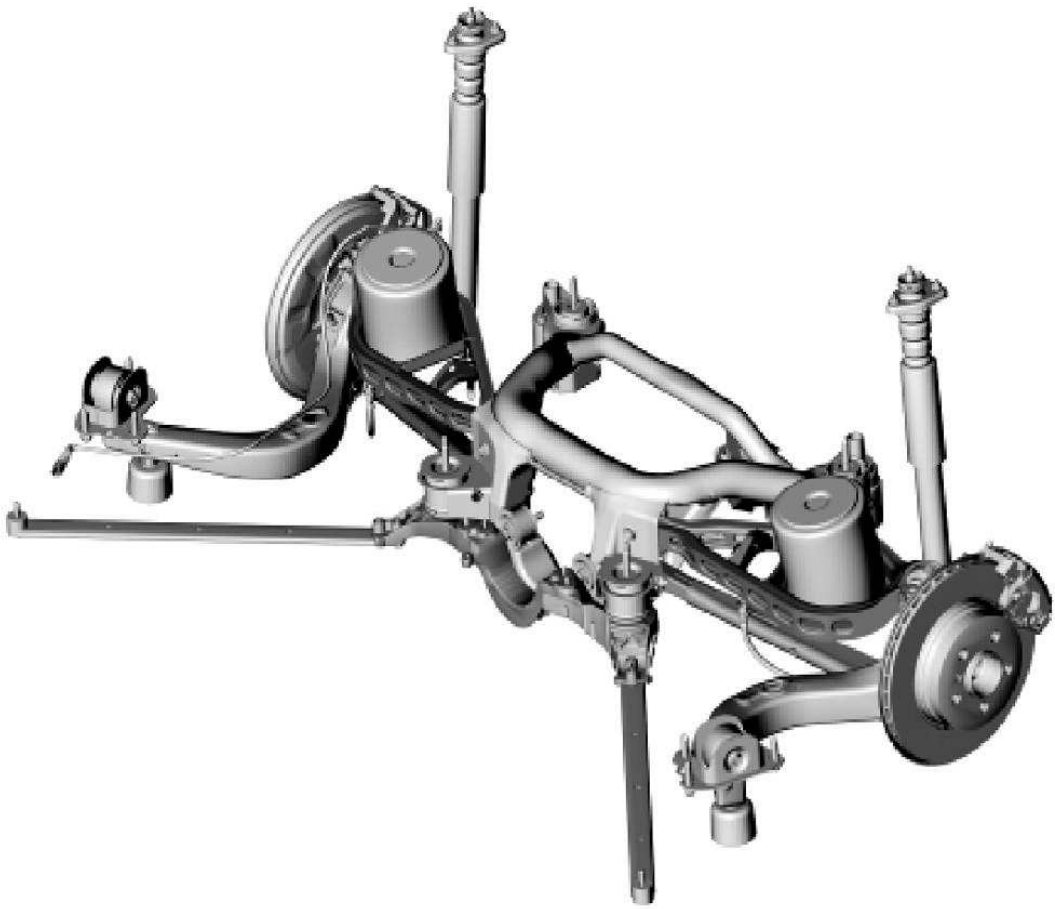


Fig. 7: Viewing Central Link Rear Axle
Courtesy of BMW OF NORTH AMERICA, INC.

- **Wheels and tyres**
  - All-season tyres

    The E83 runs as standard on 17 inch aluminium wheels with size 235 all-season tyres. In addition, 18 inch wheels are available in different designs and with several tire sizes.

  - Emergency wheel

    In series production, all versions are equipped with an emergency wheel (4B x 17 IS18 steel rim with T135/90 R17 104 M tire).

    The E83 has an emergency wheel tray for the emergency wheel on the floor of the vehicle, under the luggage compartment. The emergency wheel tray is released and lowered from the luggage

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compartment.

The emergency wheel tray has a special service opening. This allows the tire pressure to be checked from the outside, without having to lower the emergency wheel tray.

- **Runflat indicator**

The E83 is equipped as standard with a runflat indicator (RPA). The RPA monitors the tire pressure throughout the journey. The RPA indicates that a tire has lost a significant amount of pressure relative to the other tyres via an indicator and warning light any an acoustic signal.

The runflat indicator is integrated in the DSC control unit. By comparing the speed signals for all four wheels, the system detects differences in rolling circumference at the individual wheels.

- **Trailer stabilisation control**

Option 235 "Trailer coupling with detachable ball head" also includes trailer stabilisation control (familiar from the E53).

Trailer stabilisation control is integrated in the Dynamic Stability Control (DSC).

The system provides detects at an early stage when the trailer starts to fishtail and automatically brakes the vehicle as follows:

- Automatic brake application (by DSC)
- Reduced engine torque (by DSC)

Drive Train

- **xDrive**

xDrive is an innovative all-wheel drive system that comprises the Dynamic Stability Control (DSC) system and an electronically controlled multi-plate clutch in the transfer box.

Drive torque is smoothly distributed between the front and rear axles by an electronically controlled multi-plate clutch according to requirements (controlled by DSC).

xDrive distributes the drive torque to both axles as required, providing the following benefits:

- Superb operating stability up to the limits imposed by the laws of physics
- Optimal forward momentum
- Excellent traction in all road situations

For more information, refer to **XDRIVE (TRANSFER BOX) - SI TECHNIQUES - E53 & E83** .

- **Engine**

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The following familiar engines will be available on market launch:

- 6-cylinder spark-ignition engine M54B25
- 6-cylinder spark-ignition engine M54B30
- 6-cylinder diesel engine M57D30

- **Transmission**

The following familiar transmission will be available on market launch:

- 6-speed manual transmission, standard
- 5-speed automatic transmission, special equipment (option 205)

Subject to change.

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2004-05 GENERAL INFORMATION

Drive - Overview - X3

E83 DRIVE

PURPOSE OF THE SYSTEM

Drive

The E83 is available with the following engine and transmission variants in the US market:

E83 ENGINE AND TRANSMISSION VARIANTS SPECIFICATIONS

Engine	Manual Transmission	Automatic Transmission	Transfercase	Final Drive
M54B25 M54B30	GS6X37BZ	GA5R390R	ATC400	188K i = 3.64 (man. and auto.)

The vehicles are all fitted with the VAG 174 front axle drive.

Drive Modifications

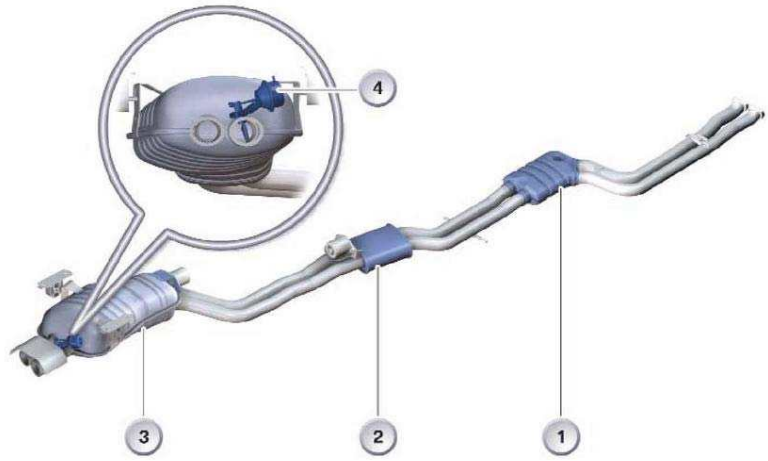
The following modifications have been made to the engine for use in the E83:

- Modified Belt Drive - the position of the deflection pulley on the alternator (150 A Bosch/Valeo) has been modified slightly.
- M54B25 manual and automatic transmission and M54B30 manual transmission equipped vehicles use Siemens MS45.0 engine management system. This system is LEV emission compliant.
- M54B30 automatic transmission equipped vehicles use Siemens MS45.1 engine management system. This system is ULEV II emission compliant.

Exhaust System

The following exhaust system is used at the start of E83 series production:

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1. Front silencer
2. Center silencer
3. Rear silencer
4. Diaphragm chamber to operate the exhaust flap

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Fig. 1: Identifying Exhaust System
Courtesy of BMW OF NORTH AMERICA, INC.

The E83 exhaust system is made of stainless steel. The exhaust system connected to the M54 engine is one piece from the exhaust manifolds to the rear silencer (muffler). However, the system is available in sections for service replacement.

As on current BMW M54 engines, each exhaust manifold is equipped with metal base catalytic converters, 2 pre-catalyst and 2 post catalyst oxygen sensors.

The rear silencer is equipped with an exhaust flap (similar to the E46). It reduces noise in the lower engine RPM range. The exhaust flap is operated by a Diaphragm (4). It is controlled by a solenoid valve, which is controlled in turn by the ECM (DME). The rear silencer has an 18.5 liter volume.

Cooling System

This section describes the cooling module installed in the E83 in conjunction with the M54B25 and M54B30. The following components of the cooling module were adopted from the E46 and E85:

- Module carrier
- Fan
- Transmission oil cooler (oil-water heat exchanger)
- Expansion tank

The following components were physically modified for use in the E83:

- Radiator - performance increased
- Fan shroud
- A/C condenser - performance increased
- PS cooler - performance increased

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Cooling Module Components

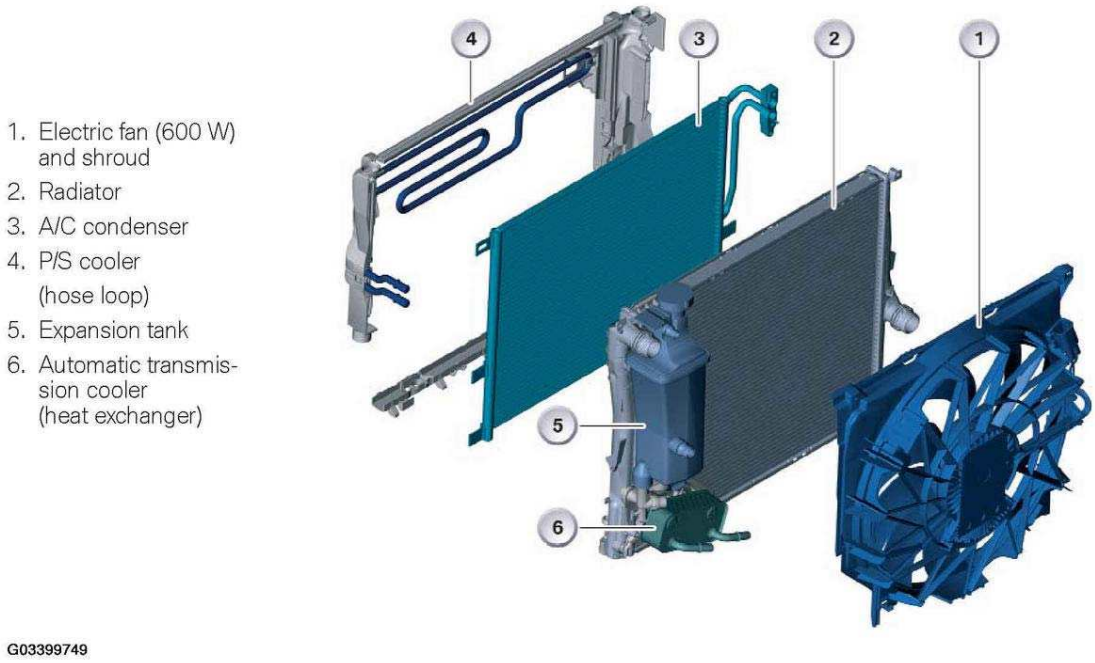


Fig. 2: Identifying Cooling Module Components
Courtesy of BMW OF NORTH AMERICA, INC.

E83 Fuel System Modifications

To comply with ever increasing emissions laws, the E83 fuel system has a further decrease in the number of openings and ports over previous series production. On the E83, the filler valves and service breather valves are completely encapsulated by the fuel tank.

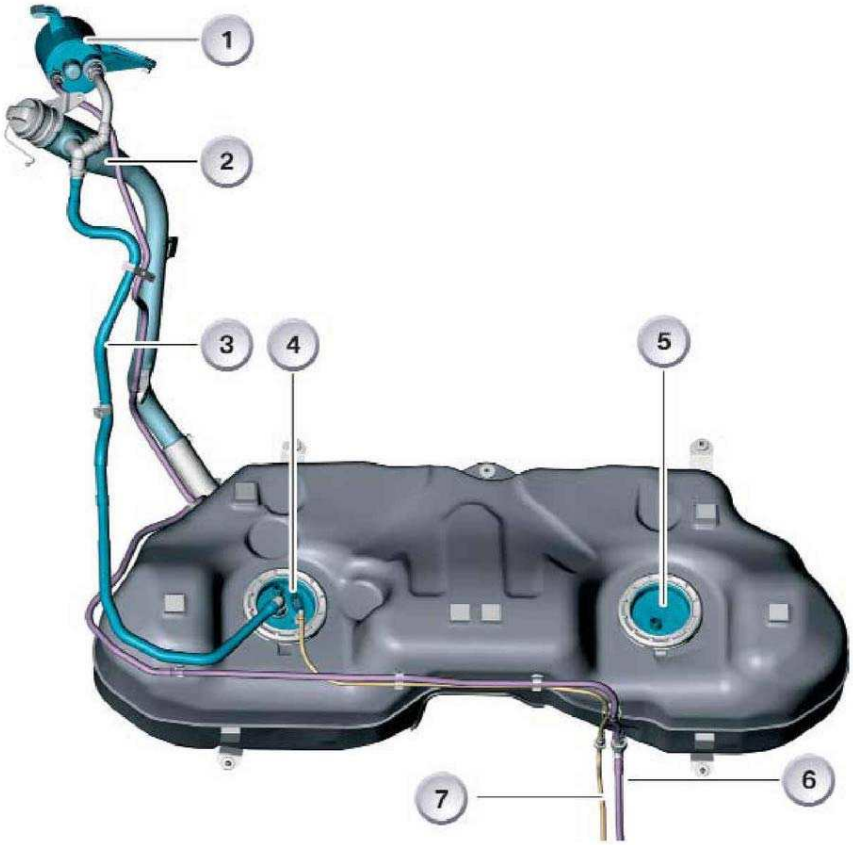
The only ports/openings except the fuel filler neck are located in the two service access cover plates.

Components

The fuel tank is located above the drive shaft in front of the rear axle (similar to E46) and is secured by two tensioning straps. The fuel tank capacity is 67 liters, including 8 liters of reserve fuel. It is made of plastic (multi-layer HDPE) with an intermediate layer (barrier layer).

Access to the fuel filter, pressure regulator, the two fuel level sensors and the electric fuel pump are through the two service access covers. The fuel filler neck is secured to the right hand side of the fuel tank with hose clamps.

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1. Activated charcoal filter with DM TL
2. Filler pipe
3. Vent line
4. Right service access cover
5. Left service access cover
6. Evaporative purge line
7. Fuel delivery line

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Fig. 3: Identifying Fuel System Components
Courtesy of BMW OF NORTH AMERICA, INC.

The fuel delivery unit comprises the following components in the right hand side of the fuel tank:

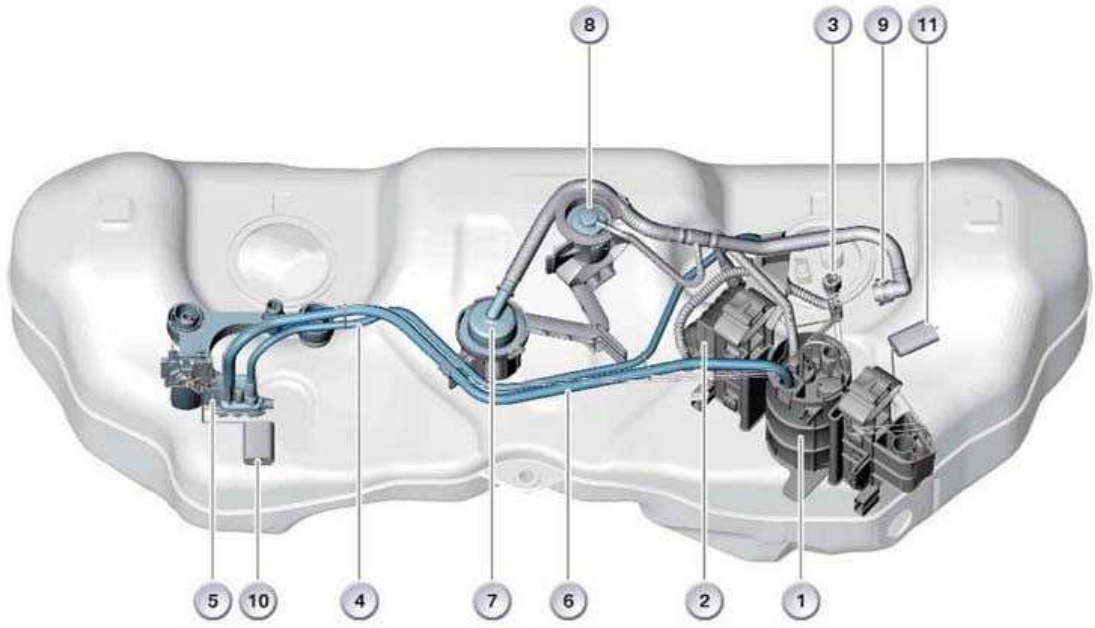
- Fuel baffle with electric fuel pump and right hand suction-jet pump
- Right hand fuel level sensor
- Fuel filter with pressure regulator.

In the left hand side of the fuel tank:

- Left hand fuel level sensor
- Left hand suction-jet pump

The components are accessible through the two service access covers.

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1. Fuel baffle chamber with electric fuel pump (EKP)
2. Fuel filter with pressure regulator (3.5 bar)
3. Fuel feed (port in the service access cover)
4. Return flow from the pressure regulator for the left hand suction-jet pump
5. Left hand suction-jet pump
6. Return flow from the left hand suction-jet pump into the fuel baffle chamber
7. Filler breather valve
8. Service breather valve
9. Vent line (port in the service access cover)
10. Left hand fuel level sensor
11. Right hand fuel level sensor

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Fig. 4: Identifying Fuel Delivery Unit And Fuel Tank
Courtesy of BMW OF NORTH AMERICA, INC.

The fuel filter and the pressure regulator form one component, the pressure regulator for the M54 engines are 3.5 bar.

The fuel filter is replaced together with the pressure regulator for service repairs.

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1. Pressure regulator
2. Port for return line
3. Supply from the electric fuel pump (EKP)
4. Fuel filter
5. Supply to fuel rail



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Fig. 5: Identifying Pressure Regulator
Courtesy of BMW OF NORTH AMERICA, INC.

Fuel System Overview

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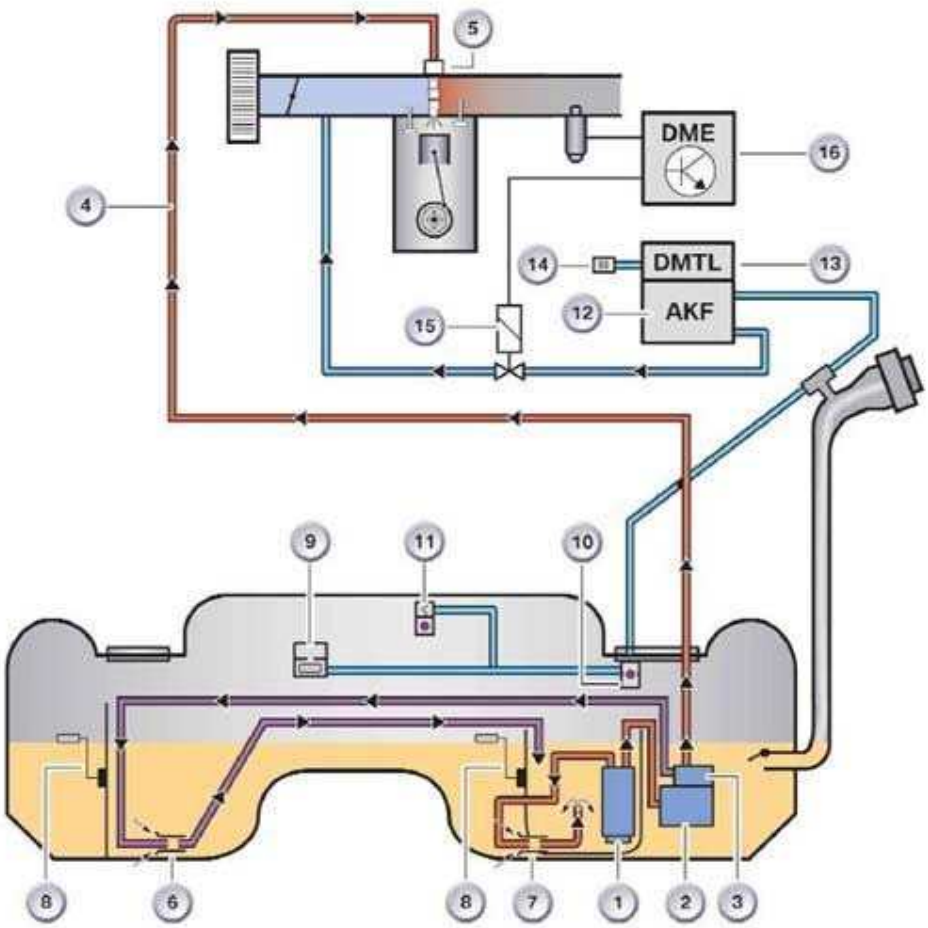


Fig. 6: Identifying Fuel System Overview
Courtesy of BMW OF NORTH AMERICA, INC.

Fuel Delivery

The fuel is supplied to the engine from the fuel tank as follows:

- From the right hand half of the fuel tank
- Through the non-return valve inside the fuel baffle chamber (only for initial filling of the fuel baffle)
- Into the fuel baffle chamber
- Pumped out by the electric fuel pump (EKP)

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- Into the fuel filter
- Through the line in the right hand service access cover to the engine
- Pumped out by the electric fuel pump in parallel through a separate fuel line to the right hand suction-jet pump, then from the right hand half into the fuel baffle (level increase)

Fuel Pressure Regulation

With pressure regulation, fuel is fed through the fuel tank as follows:

- Fuel pressure controlled by the pressure regulator (3.5 bar)
- To the suction-jet pump in the left hand half of the fuel tank
- Into the fuel baffle chamber

At the same time, the suction-jet pumps draw the fuel from the right and left hand sides of the fuel tank. This ensures that the fuel baffle and the electric fuel pump are supplied with fuel at all times.

Filler Venting

To provide filler venting, there is a breather unit in the fuel tank consisting of a service breather valve (11) and filler breather valve (9). There is also a roll over valve (10) on the right hand service access cover. The filler breather valve allows air and fuel vapors to escape from the fuel tank when the vehicle is refuelled (venting).

When the vehicle is refuelled, the air and fuel vapors vent via:

- The filler breather valve
- Through the vent line
- To the roll over valve
- Through the T-fitting on the fuel filler neck
- Into the activated charcoal filter

When the maximum capacity is reached, the filler breather valve is closed by the fuel lifting the internal float valve. The fuel level rises in the fuel filler neck and trips the fuel pump nozzle. A vapor barrier (approximately 15 liters) remains in the tank above the filler breather valve after the tank has been filled. This provides internal liquid/vapor separation.

Service Breather Valve

The fuel vapors produced are vented:

- Through the filler breather valve
- Through the service breather valve if the filler breather valve is closed
- To the roll over valve
- Through the vent line
- Through the T-fitting on the fuel filler neck

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- Into the activated charcoal filter (AKF)
- Through the evaporative purge line
- Through the evaporative purge valve (TEV)
- To the engine intake manifold

The service breather valve only opens if the filler breather valve is closed (fuel tank full to capacity). The service breather valve location is higher in the tank than the filler breather valve and opens at a pressure of 50 mbar. When the fuel tank is not full, vapors are vented through the filler breather valve.

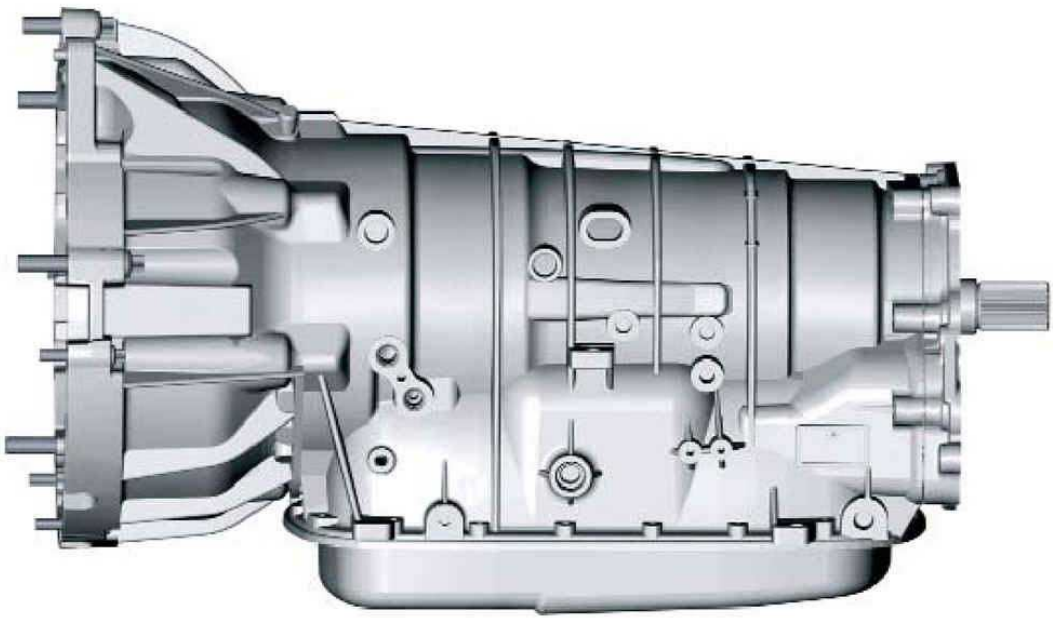
Notes:

Automatic Transmission

The previously used 5-speed GM5 automatic transmission is used in the E83 and E53 MU.

The transmission designation is GA5R390R.

Modifications have been made to the output shaft and tail housing to accommodate the ATC 400/500 transfer case.



G03399754

Fig. 7: Identifying Automatic Transmission
Courtesy of BMW OF NORTH AMERICA, INC.

Technical Data

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AUTOMATIC TRANSMISSION TECHNICAL DATA

Index	Explanation
Type	Automatic gearbox with five forward gears. 5th gear is designed as an overdrive gear.
Power transmission	The maximum torque is 390N.m in 1st/2nd/3rd and 5th gear and 410N.m in 4th gear with the converter clutch closed.
Torque converter	With M54B30 = W245 with controlled converter clutch
Gear ratios	1st gear 3.24 2nd gear 2.22 3rd gear 1.60 4th gear 1.00 5th gear 0.75 Reverse gear 3.03
Selector positions	P-R-N-D and Steptronic
Control	Electrohydraulic with adaptive shift characteristic control
Weight with oil (1)	77 to 78 kg depending on the version
(1) **Lifetime oil fill**	

Transmission Control

The transmission control has been adopted from the E46. The transmission control unit (GS20 as on E46) is located in the electronics box in the engine compartment and is on the PT-CAN.

Manual Transmission

The 6 speed manual transmission in the E83 and E53 MU was previously used in series production.

The transmission designation is GS6X37BZ (H-gearbox) with the M54 engine.

Modifications have been made to the external gearshift mechanism as well as the output shaft and tail housing to accommodate the ATC 400/500 transfer case.

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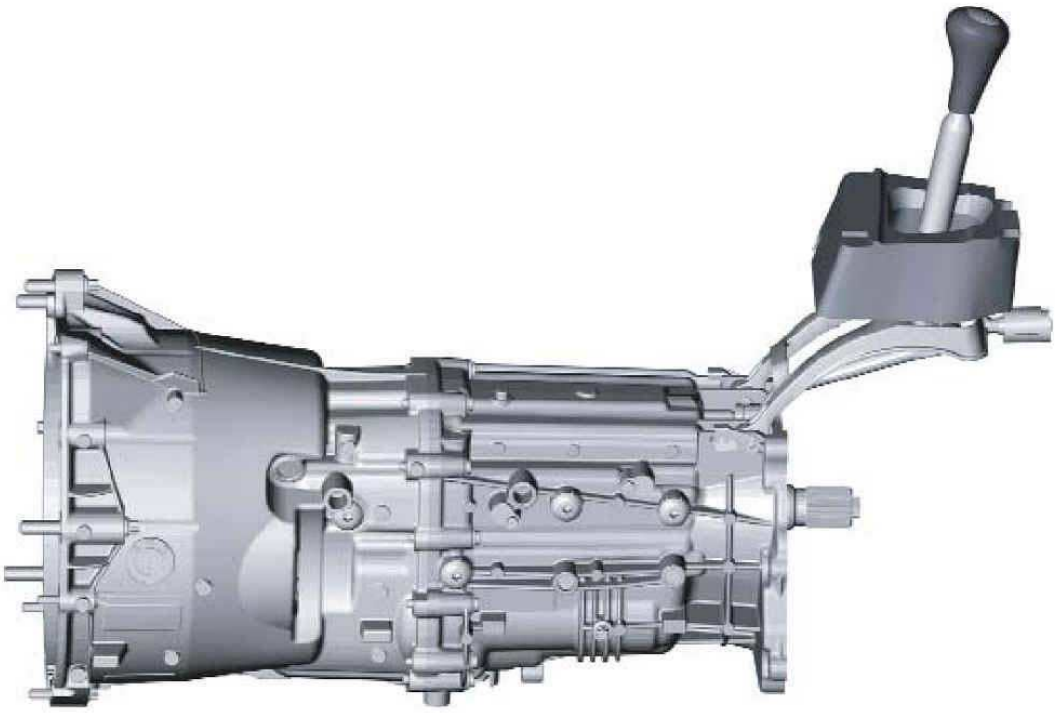


Fig. 8: Identifying Manual Transmission
Courtesy of BMW OF NORTH AMERICA, INC.

Technical Data

MANUAL TRANSMISSION TECHNICAL DATA

Gear	Gear ratio GS6-37BZ (H-gearbox)
1	4.35
2	2.50
3	1.67
4	1.23
5	1.00 (direct drive)
6	0.85 (overdrive)
R	3.93
Lifetime oil fill.	

Drive Train

The E83 drive train has been largely adopted from the E46/3-16 (3 Series, Touring, all wheel drive).

Components

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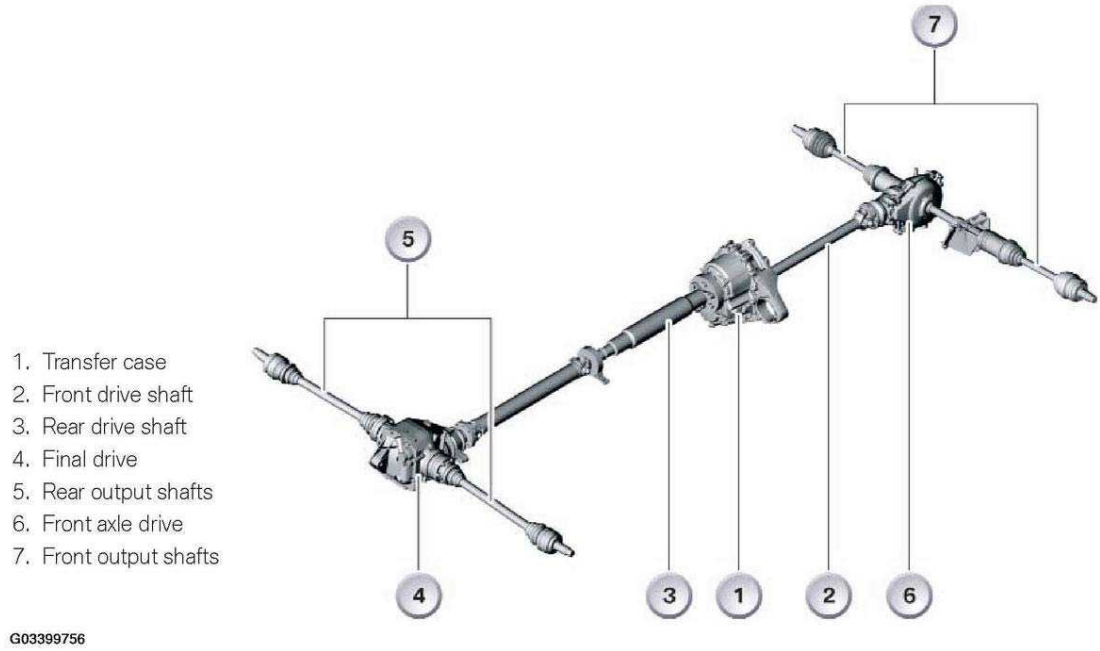


Fig. 9: Identifying Drive Train Components
Courtesy of BMW OF NORTH AMERICA, INC.

Rear Driveshaft

The rear drive shaft in the E83 with the M54 engine is a steel universal joint shaft (arrow on the right).

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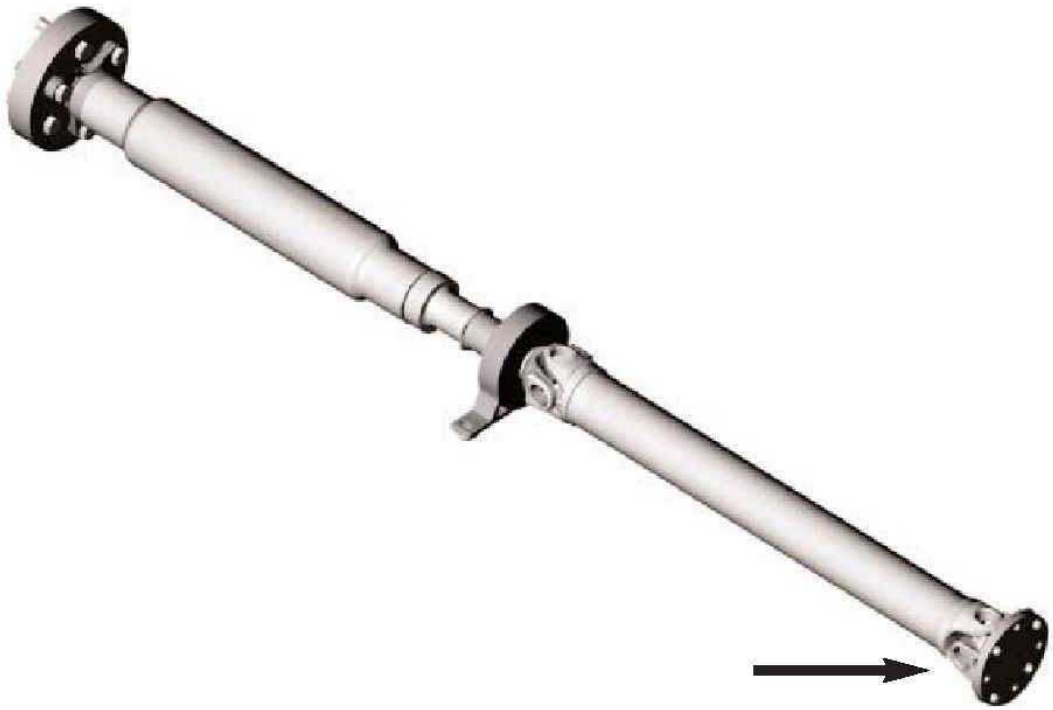


Fig. 10: Identifying Rear Driveshaft
Courtesy of BMW OF NORTH AMERICA, INC.

To minimize noise, a constant velocity joint shaft is used in the E53 MU.

1. Flexible coupling
2. Front section of drive shaft (collapsing tube)
3. Center bearing
4. Universal joint
5. Rear section of drive shaft
6. Constant velocity joint

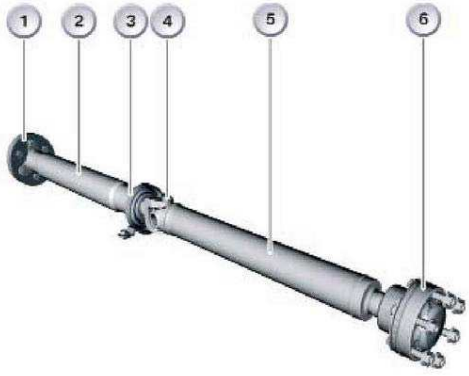


Fig. 11: Identifying Constant Velocity Joint Shaft
Courtesy of BMW OF NORTH AMERICA, INC.

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Both style rear drive shafts are equipped with a deforming element.

The front section of the drive shaft is designed as a collapsing tube (1).

When the drive shaft is compressed (collapsed) it absorbs a defined force.

After collision or accident repairs, the drive shafts must always be checked for compression of the collapsing tube.

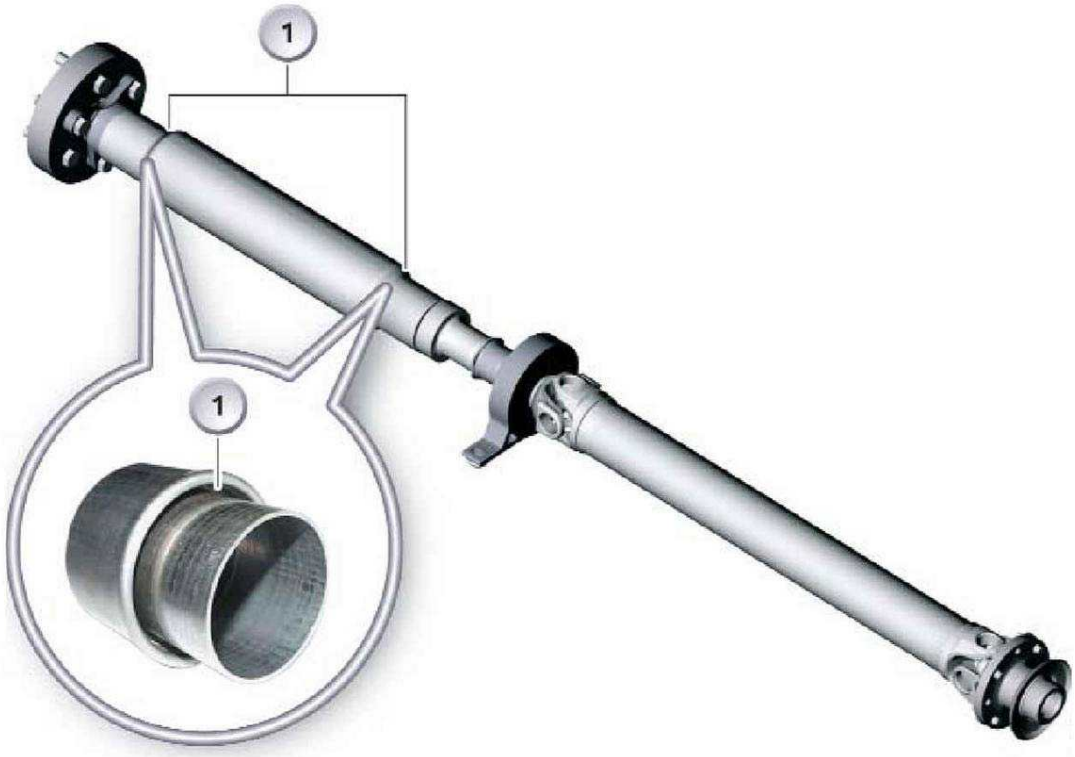


Fig. 12: Identifying Front Section Of Drive Shaft (Collapsing Tube)
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: When the collapsing tube is deformed, the drive shaft must be replaced.

Front Drive Shaft

The front drive shaft connects the transfer case to the front axle drive. It is designed as a one piece section without a center bearing and has two universal joints.

Rear Axle Final Drive

The 188 K (ring gear size) final drive is known from the previous model series productions. The final drive ratio

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varies depending on the engine/gearbox combination. For the US with M54 engines, the ratio is 3.64:1 for both automatic and standard transmissions.

Front Axle Drive

The vehicles are equipped with the familiar VAG 174 front axle drive, regardless of the engine and transmission variant. The front axle ratio is always identical to the final drive ratio (3.64:1 for US with M54 engines).

NOTE: Lifetime oil fill on both axles.

Rear Output Shafts

The rear output shafts have sliding joints for length compensation on both wheel side (1) and axle side (2).

NOTE: There is a difference in shaft tube length of approximately 54 mm between the right and left output shaft.

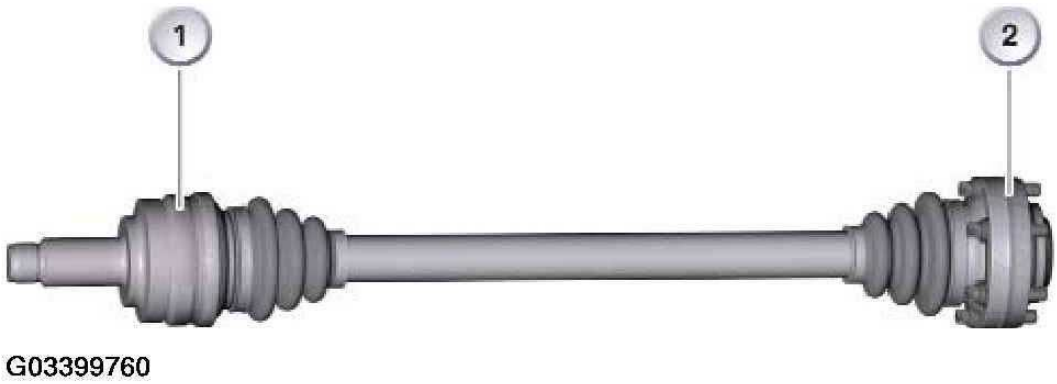
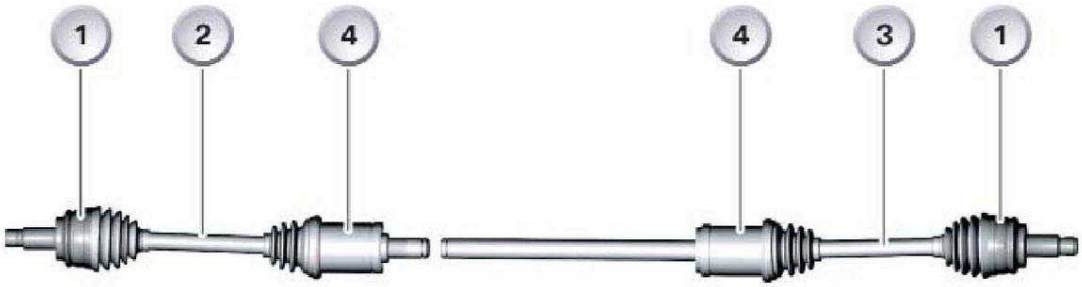


Fig. 13: Identifying Rear Output Shafts
Courtesy of BMW OF NORTH AMERICA, INC.

Front Output Shafts

The locking angle of wheel side fixed joint (1) is 50°. The axle side joint (4) slides to compensate for differences in length caused by suspension/axle movements.

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1. Constant velocity joint (fixed joint), wheel side
2. Front left output shaft
3. Front right output shaft
4. Triple roller joint (sliding joint), axle side

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Fig. 14: Identifying Front Output Shafts
Courtesy of BMW OF NORTH AMERICA, INC.

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GENERAL INFORMATION

DVOM - Overview

THE DVOM

Model: All

Production Date: All

INTRODUCING THE DVOM

The ability to measure voltage, current flow, and resistance is important in the diagnosing of electrical problems. Without the results of these measurements troubleshooting in an electrical system is a futile process.

The instrument most commonly used to make electrical measurements is called the Digital Voltage-Ohm Meter (DVOM).

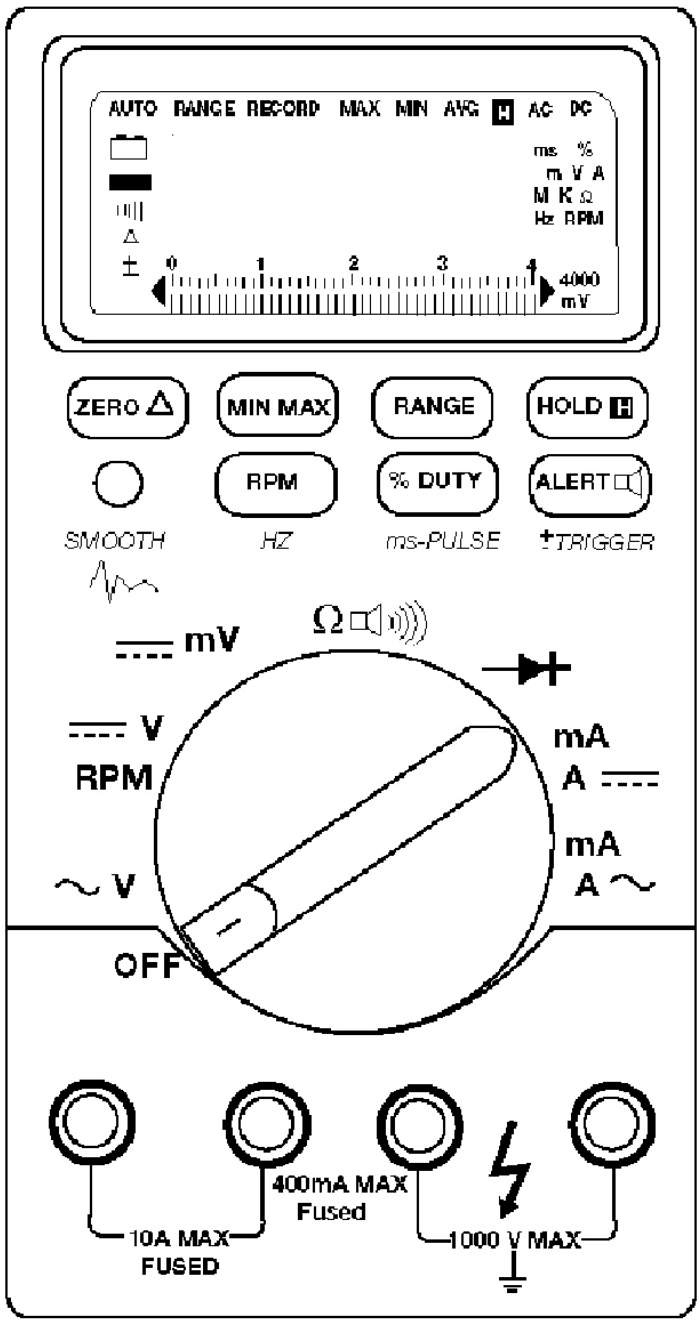
Basic DVOM's are capable of measuring:

- AC Voltage.
- DC Voltage.
- Millivolts.
- Resistance.
- Conductance.
- Capacitance.
- Continuity.
- Diode Test.
- Amps/Milliamps.
- Microamps.

Advanced DVOM's add:

- Frequency.
- RPM.
- Duty Cycle.
- Pulse Width.

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Fig. 1: Identifying DVOM
Courtesy of BMW OF NORTH AMERICA, INC.

The DVOM provides for a method of accurate measurements.

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Even though accurate measurements are the key to electrical diagnosis, the following four factors determine the effectiveness of the measurements:

- Accuracy of the measuring instrument.
- Correct installation in the circuit of the measuring instrument.
- Ability of the Technician to read the instrument.
- Skill of the Technician in interpreting the results.

As it is clearly seen, only one of the factors depends on the DVOM (e.g. accuracy), the rest will always depend the ability of the technician to read and interpret the results.

CHOOSING A DVOM

A good choice of a DVOM is the DISplus or the MoDic, as the measuring system of each contains a highly accurate DVOM.

Choosing a handheld DVOM from a reputable manufacturer, however, leaves the DISplus and MoDic free to perform other tasks that a DVOM can not do (e.g. Retrieval of fault codes).

In choosing a DVOM several factors need to be considered, one of which is **Impedance.**

Impedance is the combined resistance to current created by the resistance, capacitance and inductance of the meter. Impedance is measured in **'Ohms per Volt'.**

Meters with the highest **'Ohms per Volt'** impedance are the most accurate. More importantly using a meter with high impedance will not cause damage to sensitive electronic circuitry.

When a Meter is connected across a circuit to measure voltage, it must be connected in parallel. This adds parallel resistance. The total resistance in a parallel circuit is less than the lowest resistance in that circuit (Ohms Law). Using a Meter with low impedance will reduce the total resistance of the circuit and allow more current to flow.

A meter with low impedance can draw enough current to cause inaccurate measurement, voltage drops or damage sensitive electronic circuit boards. A high impedance meter will draw little current and insure accurate readings.

Using older type meters with low impedance values (20,000 to 30,000 ohms-per-volt) can damage modern electronic circuits and components or give inaccurate readings.

Test lights should be avoided for the same reason. They lower the total resistance of the circuit and cause increased current flow.

Other factors in choosing the proper DVOM are:

- Cost.
- Features.

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Basic DVOM's are available reasonably priced. These basic models may be more than sufficient for use in BMW Centers, given the availability of the DISplus and MoDic for advanced measurement and scope functions.

Advanced features and price go hand in hand. The more features added the higher the cost. Some of those features may be worth the increase in cost (e.g. frequency, duty cycle and pulse width). Other features may not (e.g. oscilloscope, graphing).

Choose a DVOM wisely based on personal preference and cost. Like many other tools it is valuable in the diagnosis and repair of BMW's. Experience has shown if the technician is not comfortable with the DVOM or confident in the results of the measurements, the DVOM will not be used. Considering the technology in BMW automobiles, diagnosing with a quality DVOM certainly makes repairing the problem correctly and expediently a more manageable task.

THE FUNCTIONS

Function Selector Rotary Switch

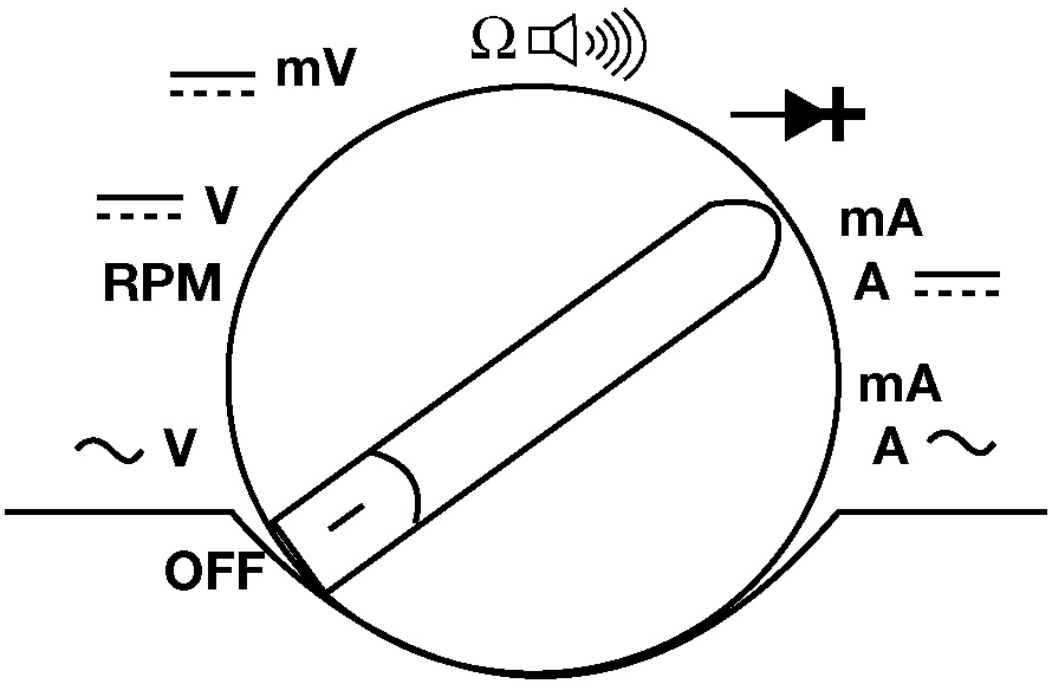


Fig. 2: Identifying Function Selector Rotary Switch (Off)
Courtesy of BMW OF NORTH AMERICA, INC.

Power to the meter is turned off.

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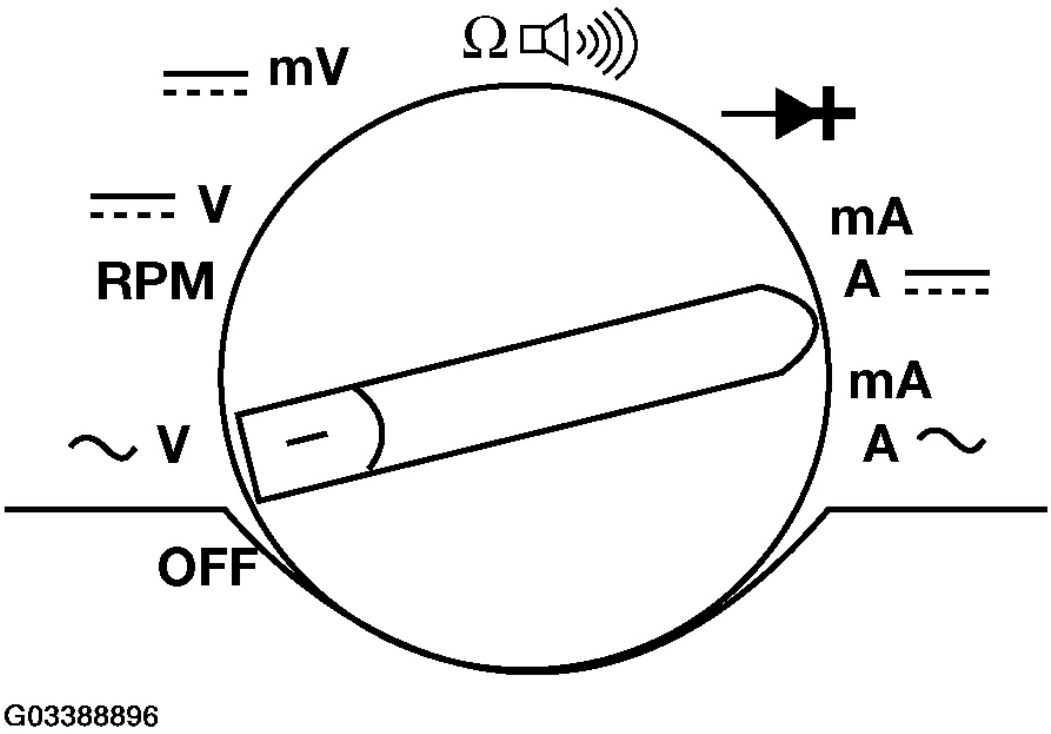


Fig. 3: Identifying Function Selector Rotary Switch (Volts AC)
Courtesy of BMW OF NORTH AMERICA, INC.

Volts AC.

Measures AC voltage.

Ranges 400mV, 4V, 400V, 1000V.

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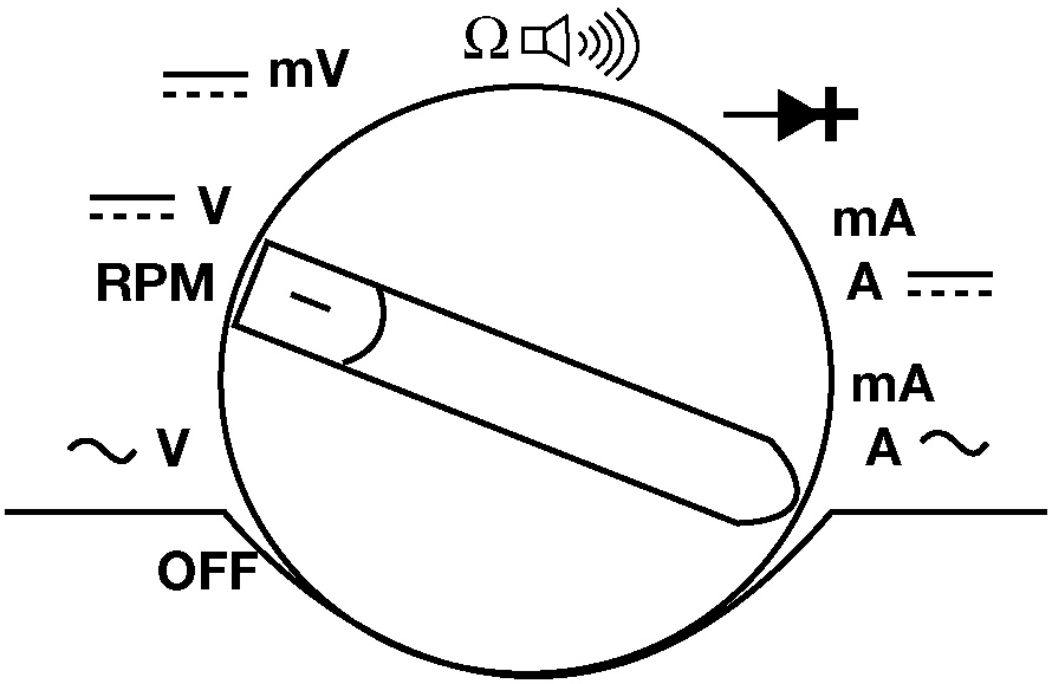


Fig. 4: Identifying Function Selector Rotary Switch (Volts DC, RPM)
Courtesy of BMW OF NORTH AMERICA, INC.

Volts DC, RPM.

Measures DC Voltage.

Ranges 4V, 40V, 400V, 1000V.

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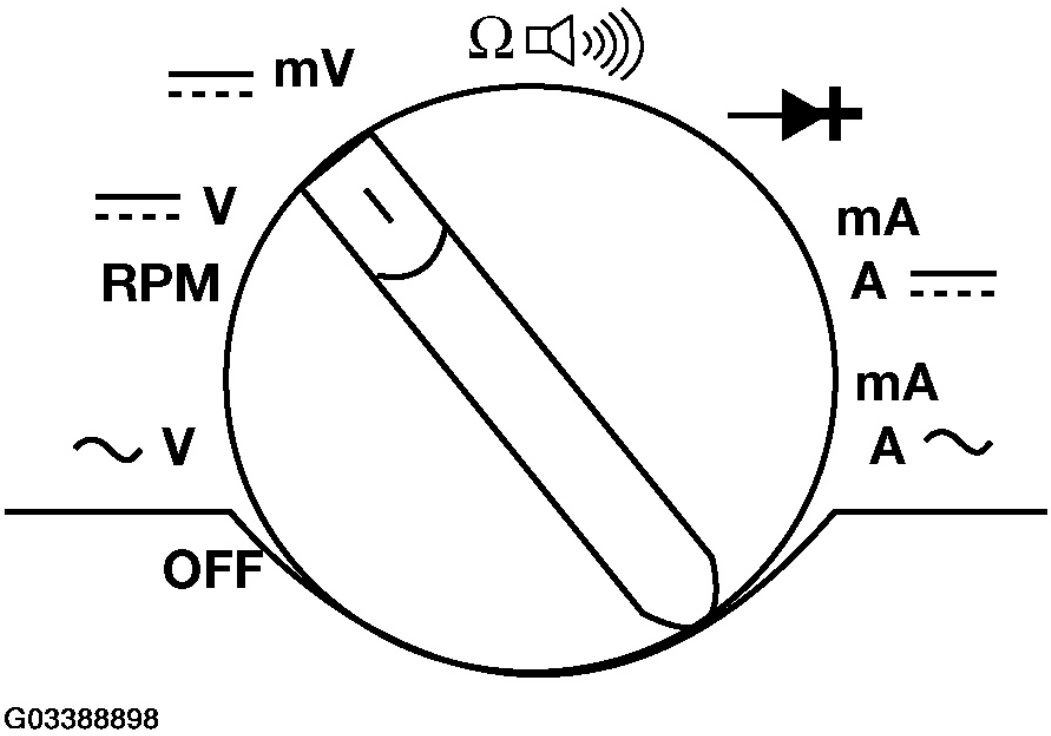


Fig. 5: Identifying Function Selector Rotary Switch (mV)
Courtesy of BMW OF NORTH AMERICA, INC.

mV.

Measures DC Millivolts.

Range: 400mV.

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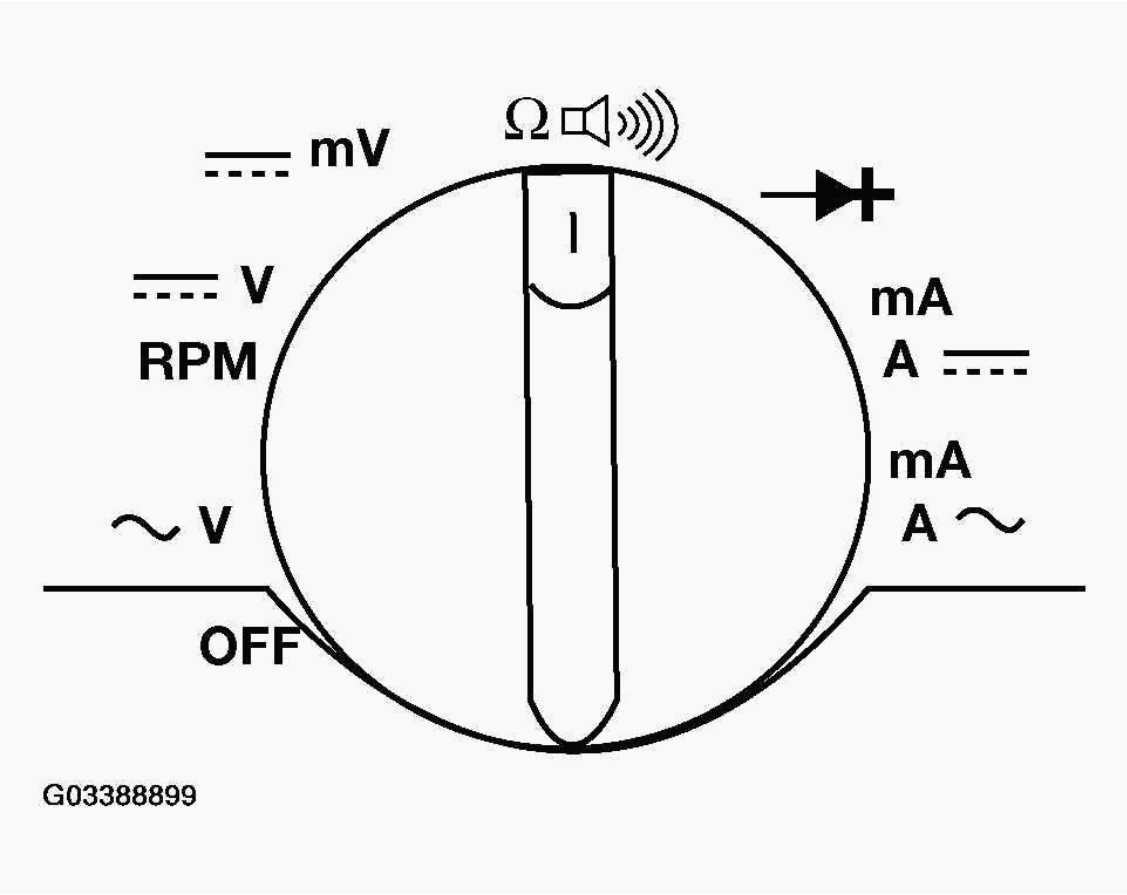


Fig. 6: Identifying Function Selector Rotary Switch (Continuity/Ohms)
Courtesy of BMW OF NORTH AMERICA, INC.

Continuity/Ohms.

Measures Continuity and Ohm.

Ranges: 400ohms,4kohms, 400kohms, 4Mohms, 40Mohms.

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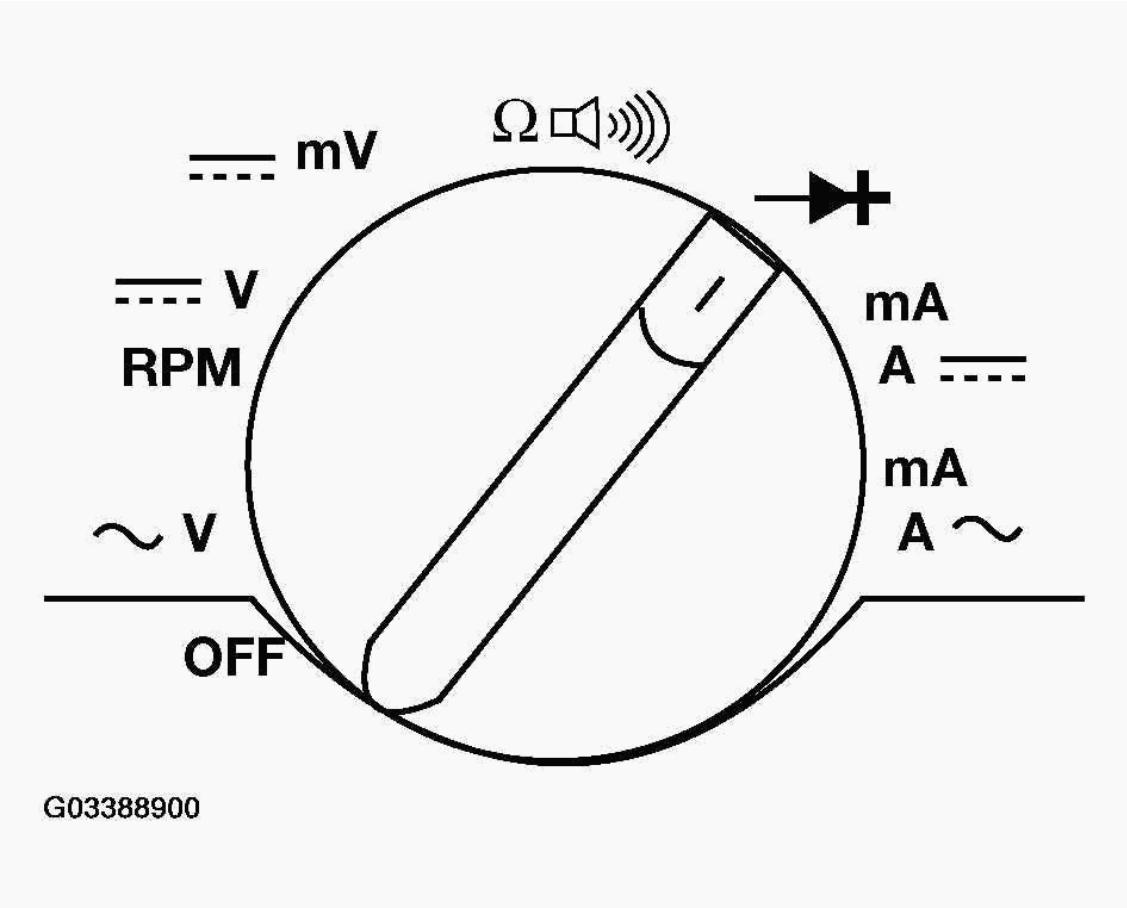


Fig. 7: Identifying Function Selector Rotary Switch (Diode Test)
Courtesy of BMW OF NORTH AMERICA, INC.

Diode Test.

Test diode operation.

Range: 3.000V.

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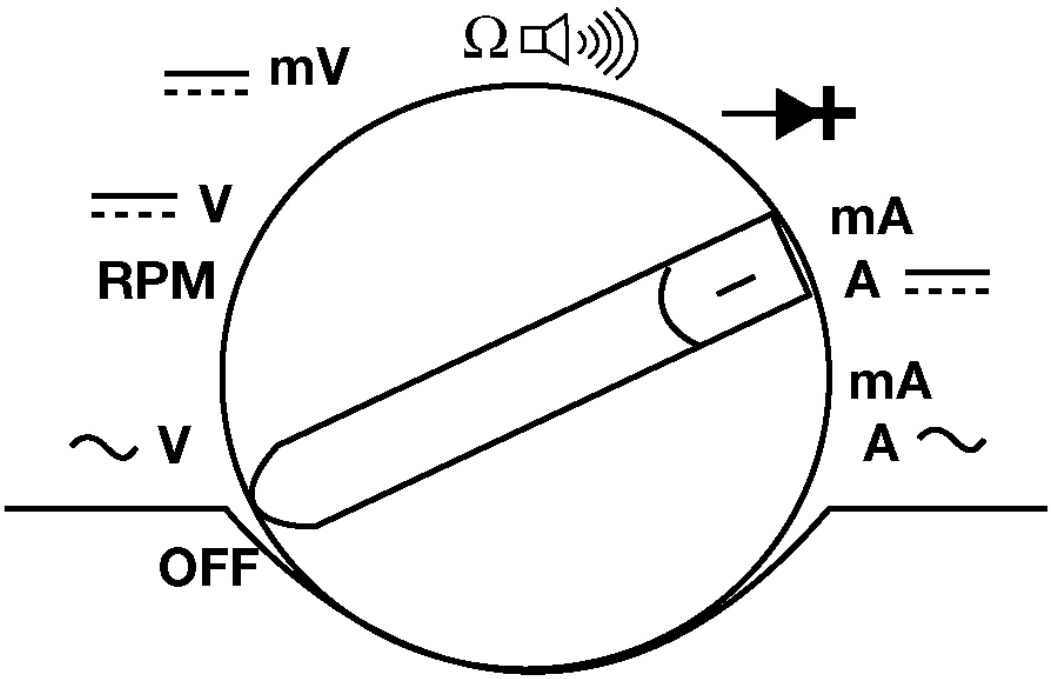


Fig. 8: Identifying Function Selector Rotary Switch (Amps DC)
Courtesy of BMW OF NORTH AMERICA, INC.

Milliamp or Amps DC.

Measures DC Milliamps or amps.

Ranges: 40mA or 400mA for mA input 4000mA or 10 A for A input.

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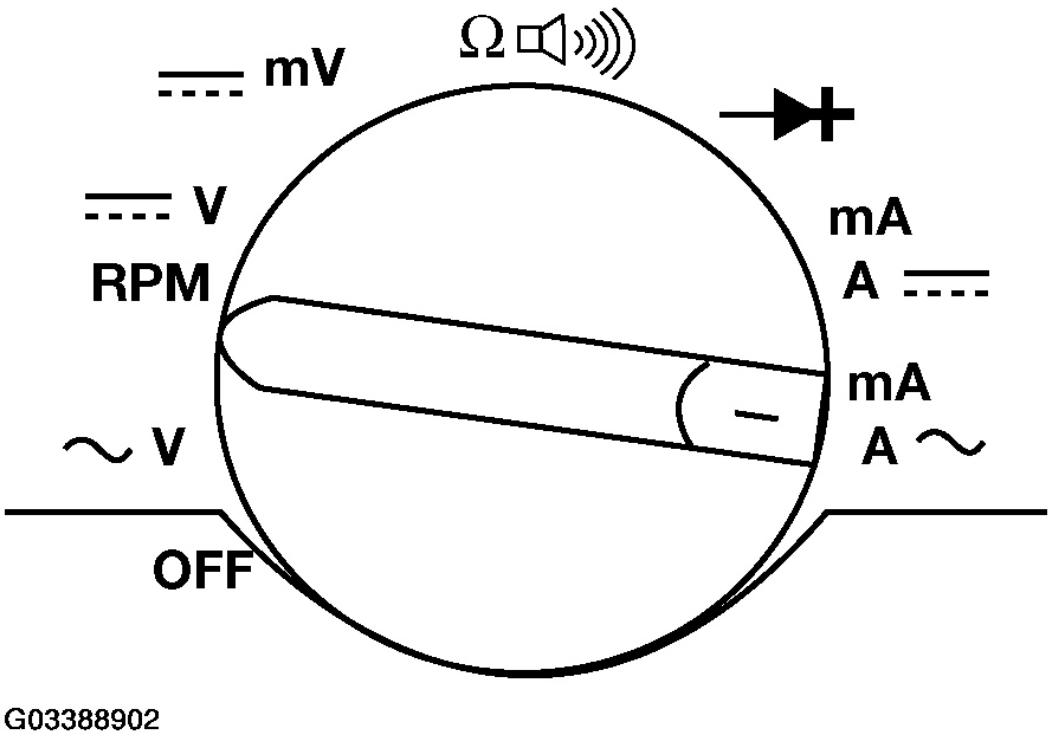


Fig. 9: Identifying Function Selector Rotary Switch (Amps AC)
Courtesy of BMW OF NORTH AMERICA, INC.

Milliamps or Amps AC.

Measures AC Milliamps or amps.

Ranges: 40mA or 400mA for mA input 4000mA or 10 A for A input.

PUSH BUTTON FUNCTIONS

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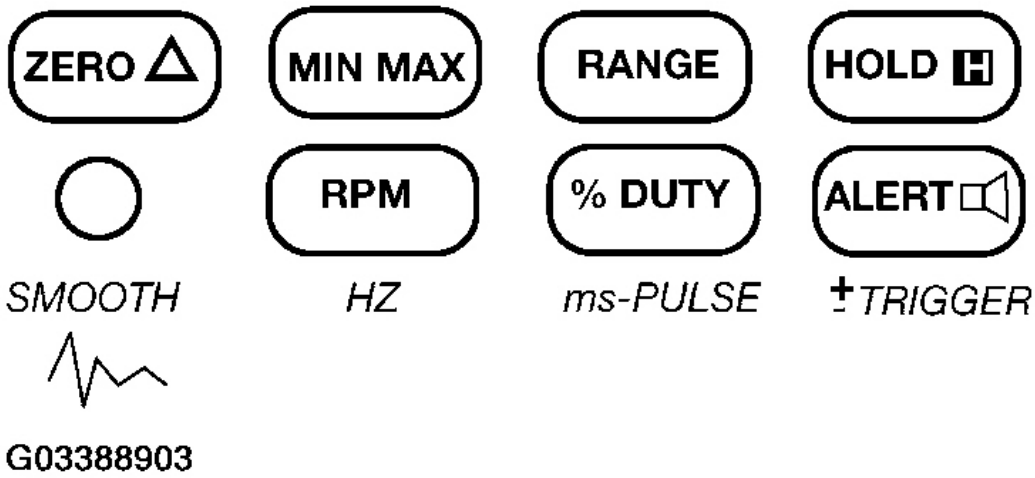


Fig. 10: Identifying Push Button Functions
Courtesy of BMW OF NORTH AMERICA, INC.

Zero (Relative Reading) Function:

Displays difference between the measured value and the stored value.

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Fig. 11: Identifying Zero (Relative Reading) Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

Minimum (Min), Maximum (Max), Average (AVG) Recording:

Records minimum, maximum and calculates the true average.

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Fig. 12: Identifying Min/Max, AVG Recording Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

Manual Range or Autorange:

In Manual Range user selects fixed range. Meter stays in that range until user changes it, selects Autorange or turns meter off. In Autorange meter selects range automatically.

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Fig. 13: Identifying Manual Range or Autorange Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

Touch Hold:

Touch Hold holds last stable reading on display. A new stable reading causes beeper to sound and display to update.

If meter is in MIN MAX Recording, RPM, Duty Cycle, Pulse Width or Hz, Touch Hold interrupts the function. The display is frozen, but recorded readings are not erased.

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Fig. 14: Identifying Touch Hold Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

RPM / HZ.

RPM 2, RPM 1, or frequency.

RPM 2, 4-cycle engines.

RPM 1, 2-cycle engines.

Hz. counts frequency between 0.5 Hz and 200 kHz.

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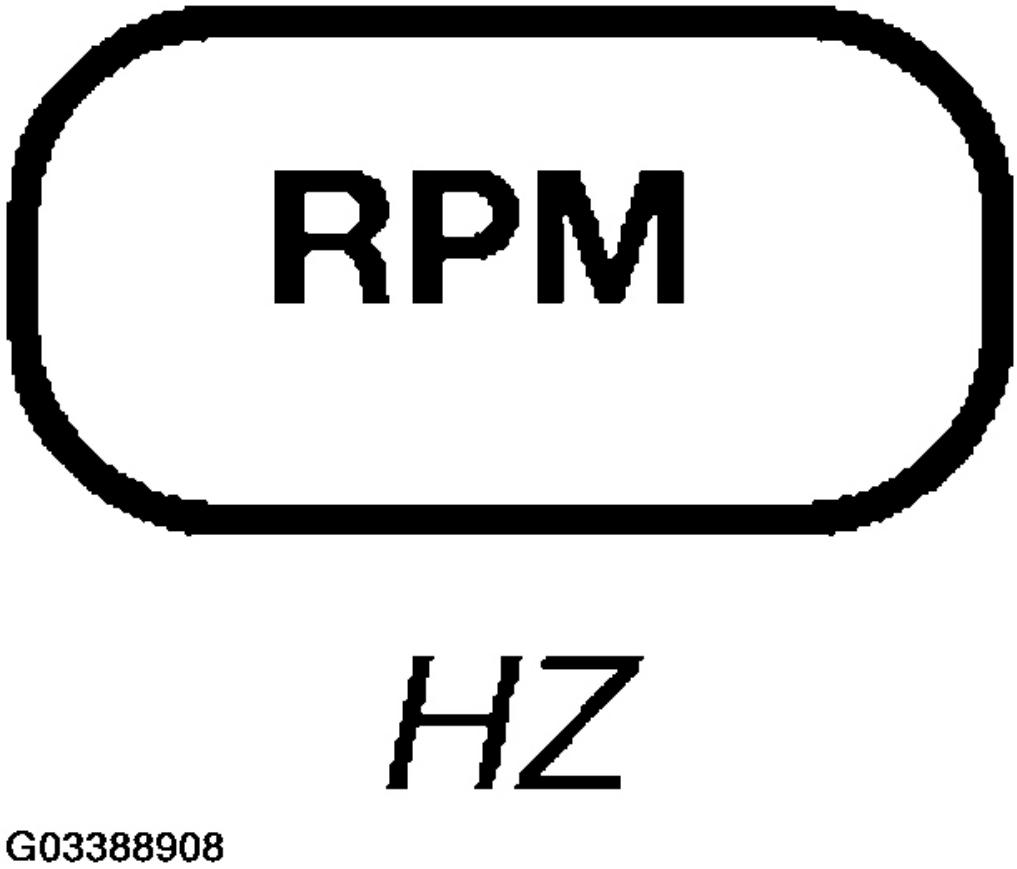


Fig. 15: Identifying RPM / HZ Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

Duty Cycle or Pulse Width.

Duty Cycle between 0.0 and 99.9% displayed.

Pulse Width between 0.002 and 1999.9 ms displayed.

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Fig. 16: Identifying Duty Cycle Or Pulse Width Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

Change Alert, Continuity Beeper or +/- Trigger.

In voltage or current functions selects Change Alert.

In ohms function selects Continuity Tests.

In Duty Cycle or Pulse Width selects trigger slope.

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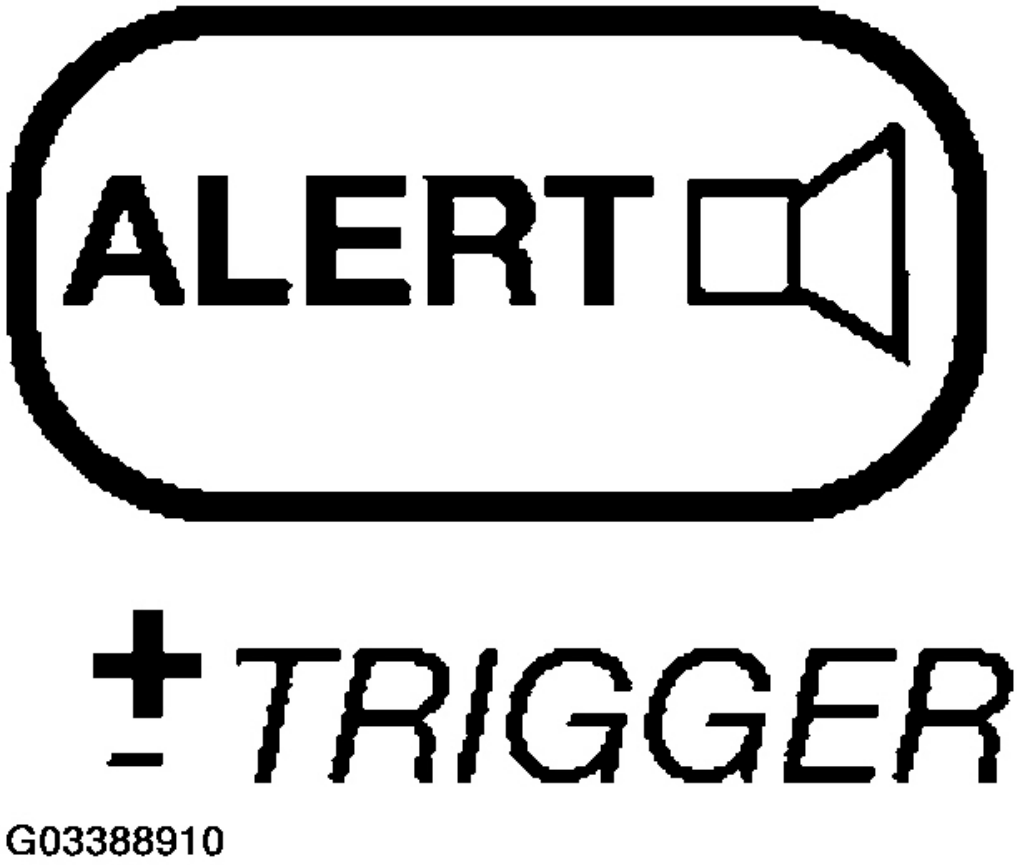


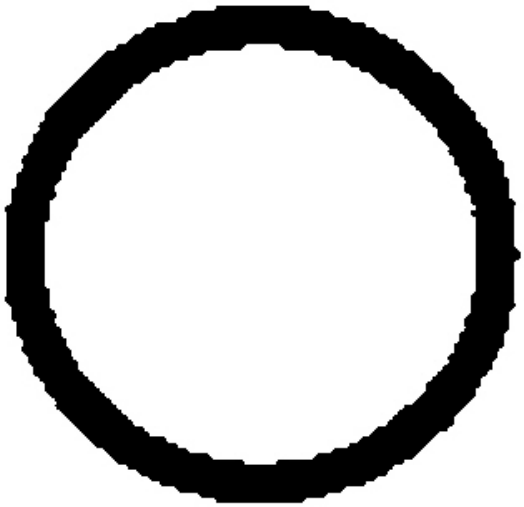
Fig. 17: Identifying Change Alert Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

Smoothing Function and Back-light display (advance model only).

Smooth displays average of last eight readings.

Press Yellow button to turn on or off back-light.

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SMOOTH



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Fig. 18: Identifying Smoothing Function Push Button
Courtesy of BMW OF NORTH AMERICA, INC.

INPUT TERMINALS

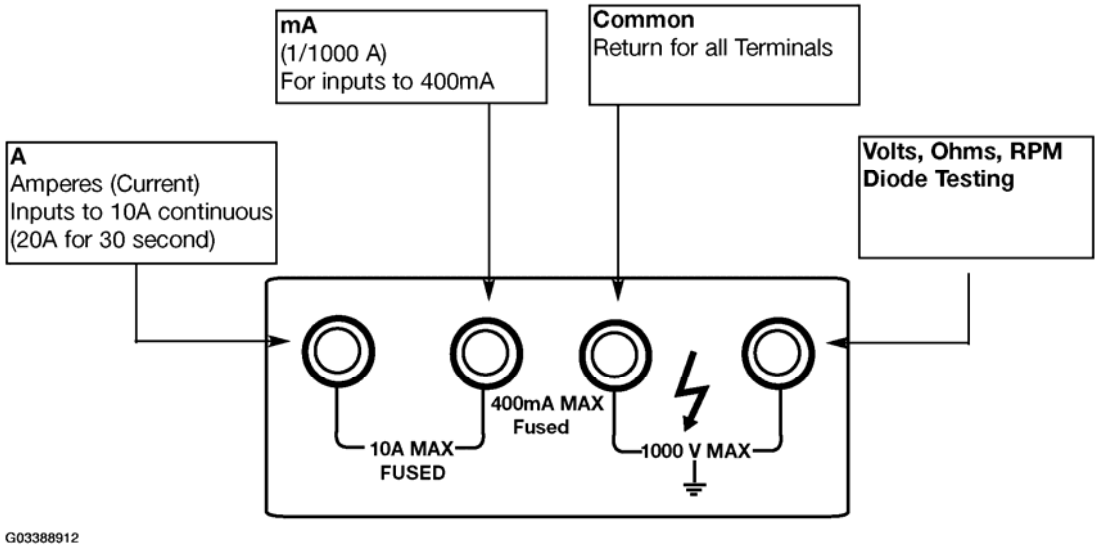


Fig. 19: Identifying Input Terminals
Courtesy of BMW OF NORTH AMERICA, INC.

DISPLAY

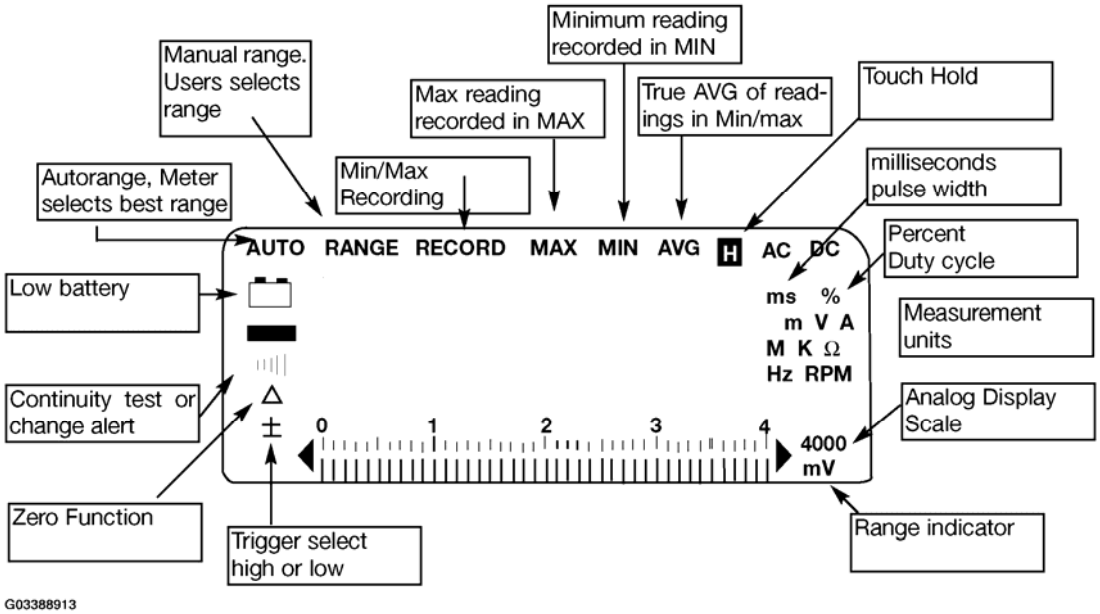


Fig. 20: View Of Functions Display

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Courtesy of BMW OF NORTH AMERICA, INC.

INFINITY DISPLAY

While most displays of DVOMs are standard (i.e. mV means millivolt, mA means milliamp) the display or symbol for infinity or open circuit can be confusing. A display of 0ohms indicates no or little resistance. It means the circuit or portion of the circuit being measured has continuity or is complete. A reading of OL means the circuit is open or not complete, the resistance is said to be "INFINITY". Some meters may use the symbol "INFINITY" for Infinity. Be aware of which reading the meter being used will give for infinity or open circuit.

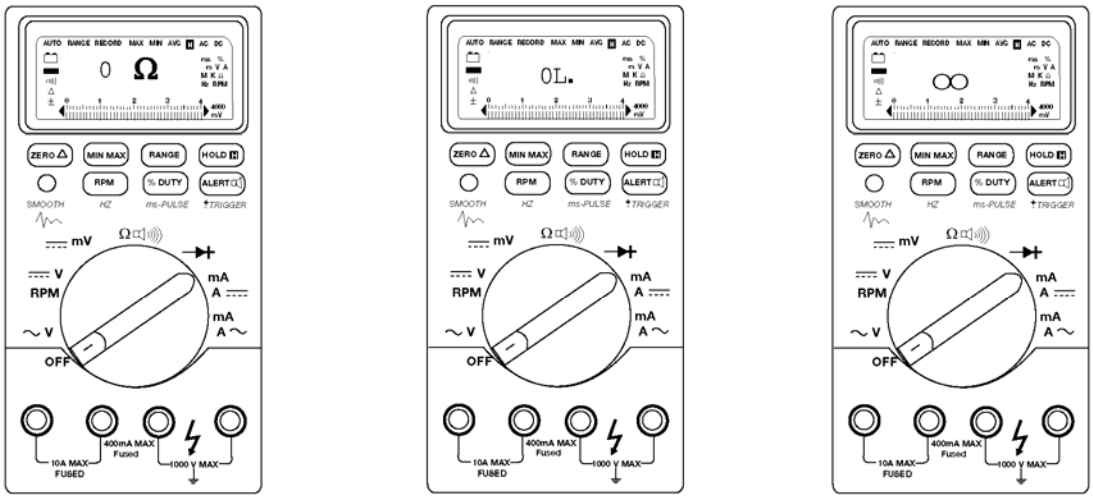


Fig. 21: Infinity Display
Courtesy of BMW OF NORTH AMERICA, INC.

VOLTAGE TESTING

The voltmeter (DVOM) must be connected in parallel with the load or circuit.

The DVOM has a high resistance and taps off a small amount of current.

A voltmeter must be used with the current on and with the correct polarity.

The red lead should be connected to the B^+ side of the circuit and the black lead to the B^- side of the circuit.

If the leads are reversed the reading will be a negative number.

Typical Application of Voltage Testing

- Checking Power Supply.

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- Charging System.
- Complete Basic Circuits.
- Control Module Functions (Input/Output).

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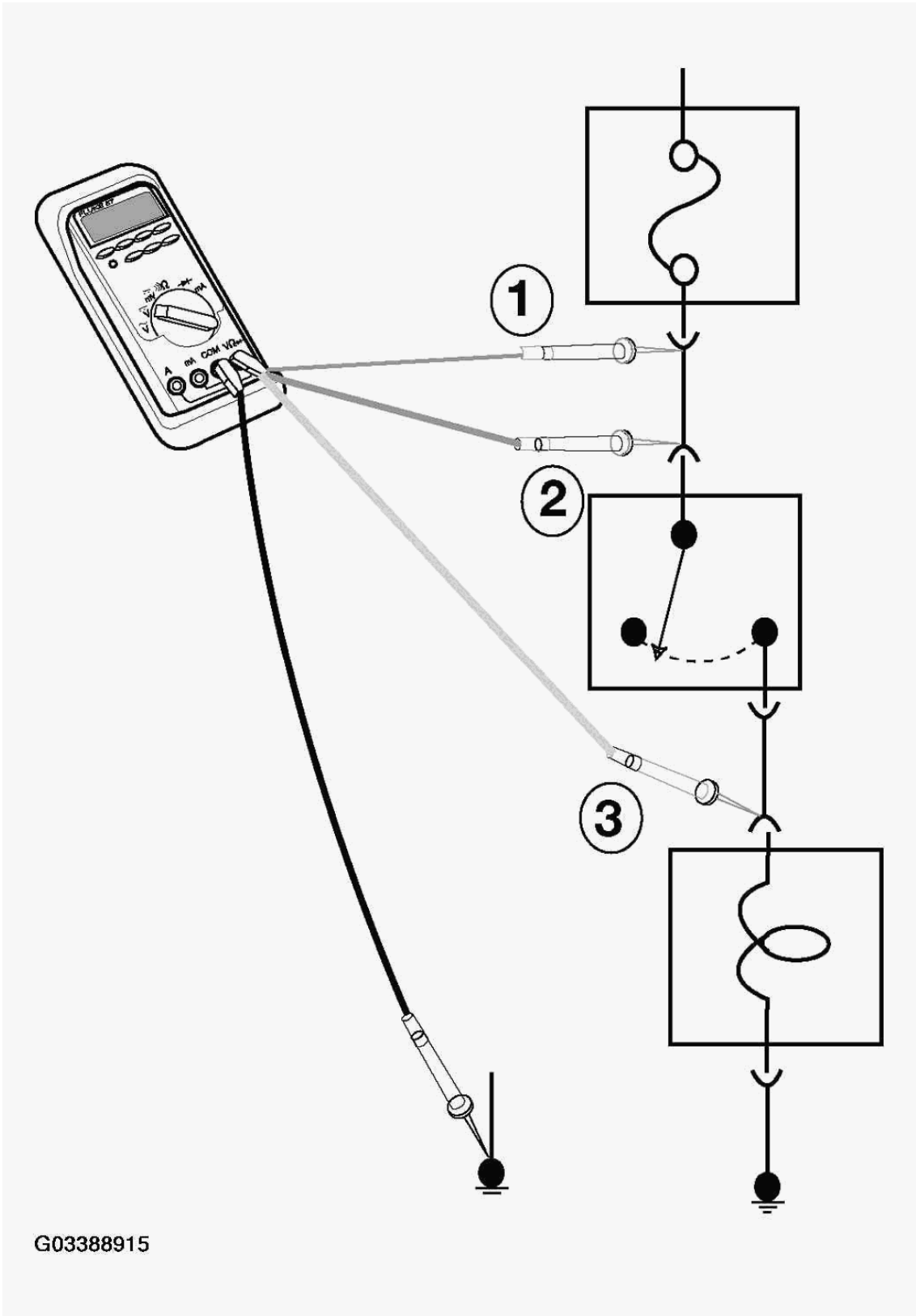


Fig. 22: Identifying Voltage Testing
Courtesy of BMW OF NORTH AMERICA, INC.

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Measure at different points checking for change or interruption in the voltage supply.

- Select proper function and range of DVOM.
- Connect (-) lead of meter to battery B- or known good ground.
- Connect (+) lead of meter to test circuit.

DVOM will indicate supply or available voltage at that point.

AMPERAGE TESTING

To measure amperage the meter must be installed in series in the circuit. The current flow of the circuit must flow through the meter itself.

Current must be flowing in the circuit.

Installing the meter in parallel with the circuit may cause damage to the meter, because of the increased current flow in the circuit, due to the low resistance in the meter.

CAUTION: Most ampere meters or DVOMs are rated for no more than 10 amps. Current flow above 10 amps will damage the internal fuse of the DVOM and render it unable to measure amperage.

Typical Application of Amperage Testing

- Proper Component Operation (Correct Current Draw).
- Parasitic Draw Testing.

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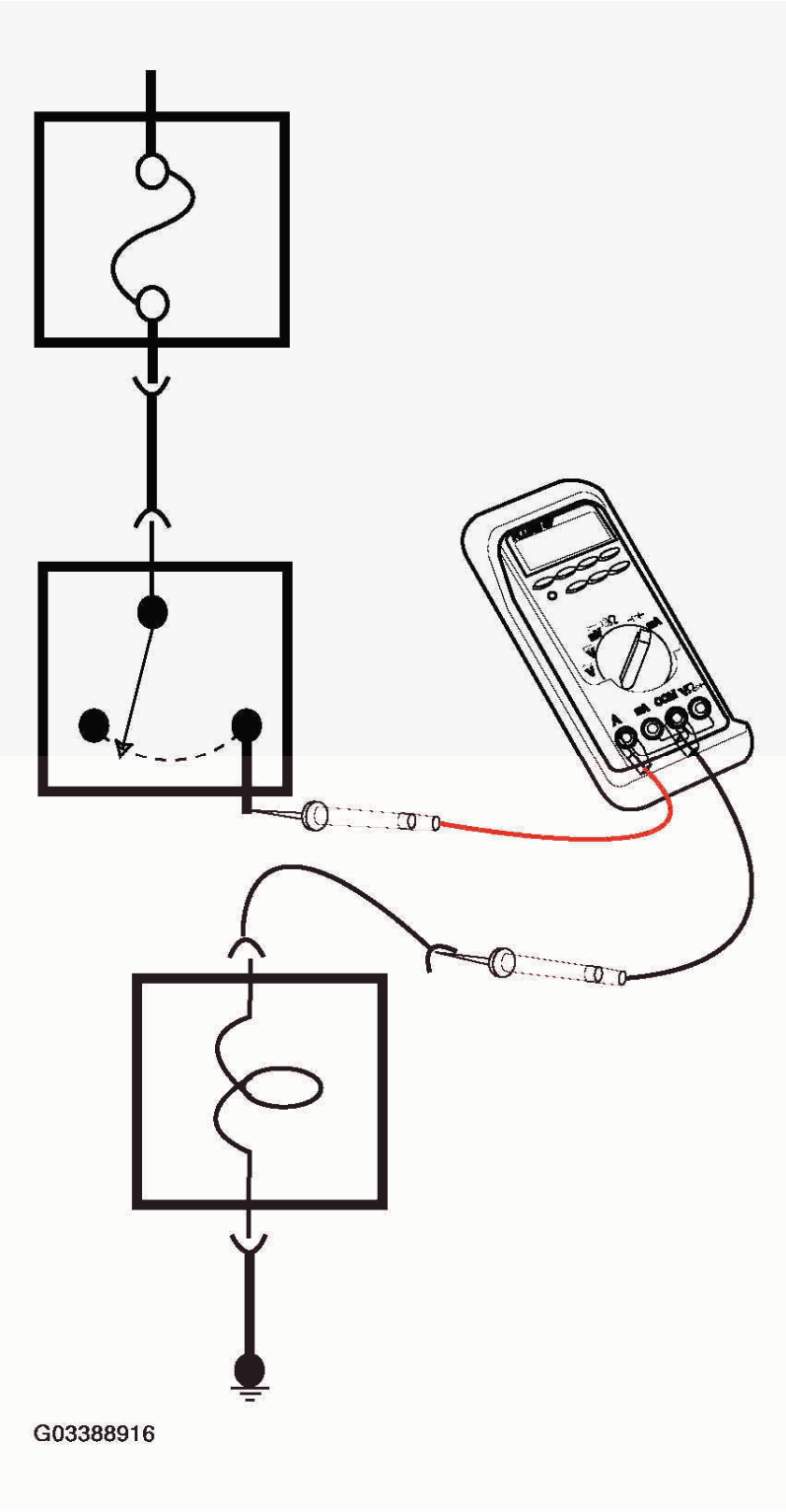


Fig. 23: Identifying Amperage Testing
Courtesy of BMW OF NORTH AMERICA, INC.

Ensure meter is capable of handling current flow.

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Use caution when activating additional consumers.

- Select proper function of DVOM and move leads to proper position.
- Connect meter in series with (+) lead on the B^+ side of the circuit.
- Connect (-) lead of meter to complete circuit.

NOTE: If the expected load may exceed the range of the meter, use a meter with a higher range (DISplus inductive pick-up) for initial testing.A convenient location to apply meter (e.g. across fuse terminals). DVOM will indicate current flow (Amps) through circuit.

RESISTANCE TESTING

When set for resistance testing (Ohms) the DVOM must never be connected in a live circuit.

The component or portion of a circuit being measured, must be isolated from the power source.

Most modern day DVOM's are self ranging when set to measure resistance, so the meter can not be damaged by out of range measurements.

The test leads may be used without regard for polarity, unless the circuit contains a diode.

The DVOM functions by placing a very small amount of current on the circuit being tested, the red lead must be placed on the anode side of the diode.

Typical Application of Resistance Testing

- Locating a Short to Ground (As Shown).
- Determining Resistance of Components (e.g. Temp Sensors and Injectors).

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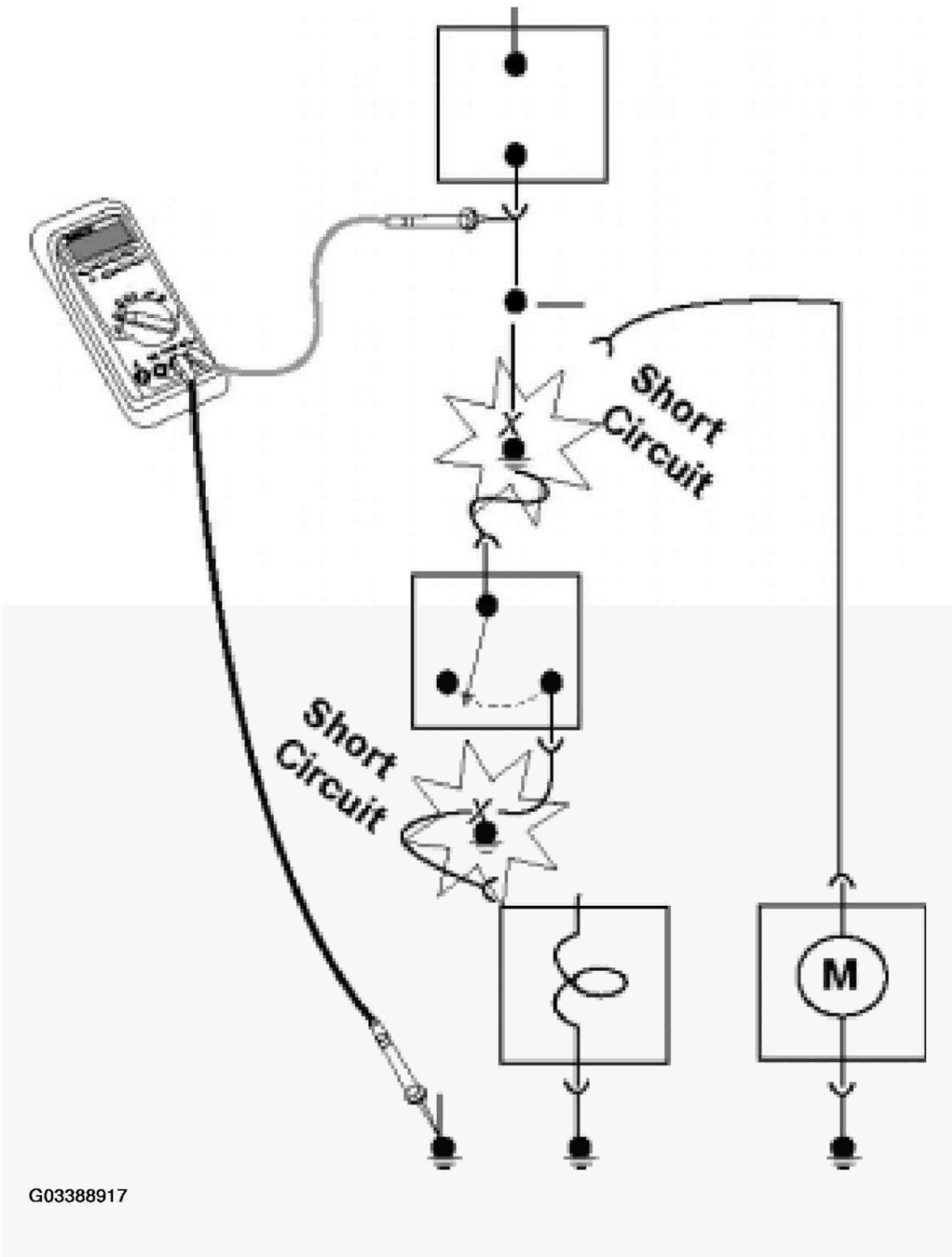


Fig. 24: Identifying Resistance Testing
Courtesy of BMW OF NORTH AMERICA, INC.

An Ohmmeter uses its internal power to test a circuit or component.

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- Select correct function and range (Most meters are self ranging in this function).
- Disconnect power to circuit.
- Disconnect any circuit wired in parallel with circuit being tested.
- Connect test leads.

NOTE: There must be NO current available to the circuit during the resistance (Ohmic) test. DVOM will indicate resistance (Ohms) of component or circuit being tested.

CONTINUITY TESTING

The DVOM may have a separate setting for continuity testing.

When set for continuity testing the DVOM must never be connected in a live circuit.

The power source must be disconnected from the circuit being tested. Any circuits wired in parallel with the circuit being tested must also be disconnected.

The DVOM uses its own internal power supply to test the continuity of the circuit.

Continuity testing verifies that circuit connections are intact. The continuity mode is extremely fast and is used to detect either shorts or opens that last as little as 1ms.

When a change is detected the beeper tone is stretched to last at least 1/4 second so both shorts and opens can be audibly detected.

This is a valuable troubleshooting aid when diagnosing intermittent faults associated with wiring, connections, switches and other components of the circuit.

Typical Application of Continuity Testing:

- Circuit Continuity.
- Intermittent Wiring Harness Faults.

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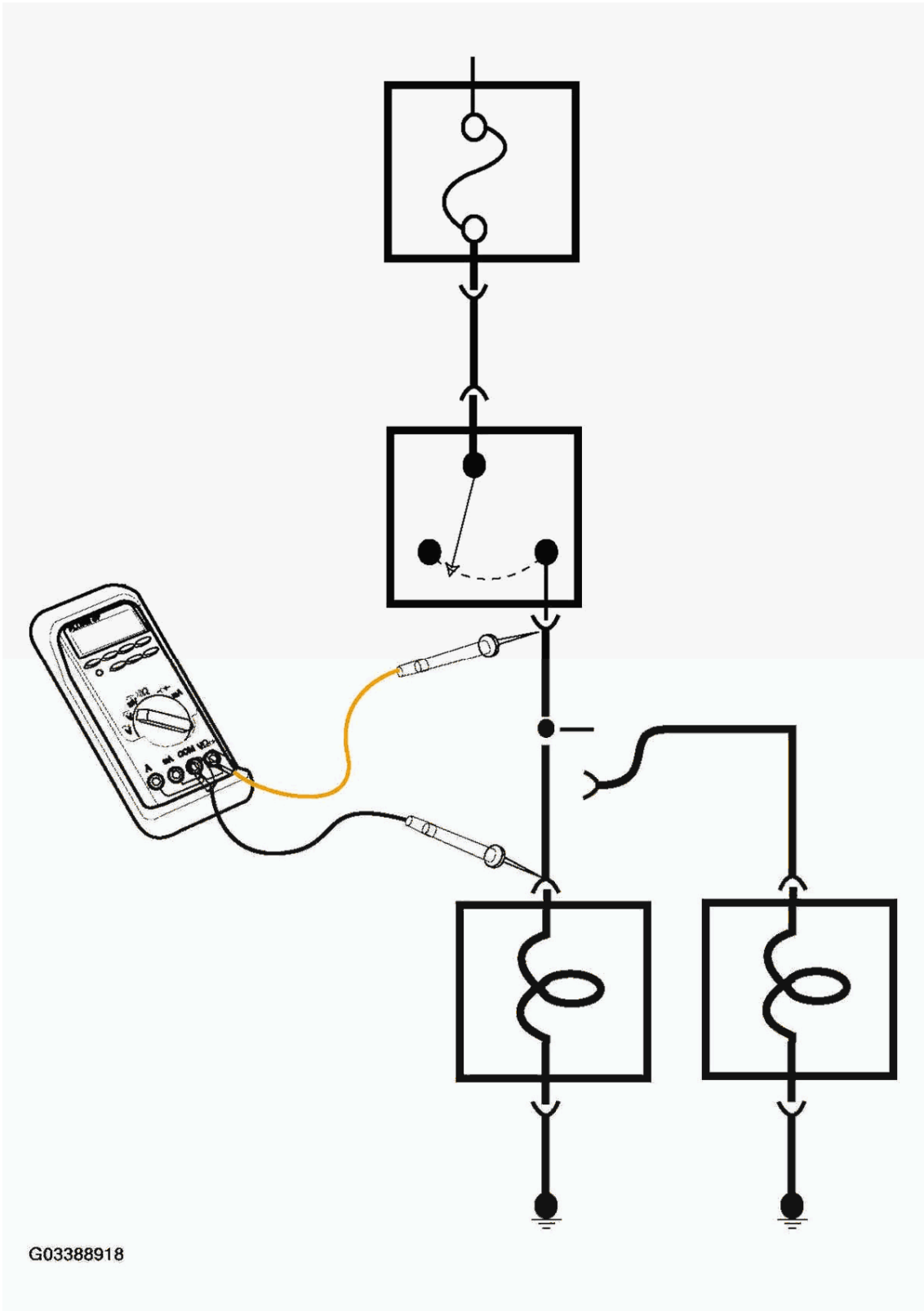


Fig. 25: Identifying Continuity Testing
Courtesy of BMW OF NORTH AMERICA, INC.

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- Select correct function and range of DVOM.
- Disconnect power to the circuit.
- Disconnect any circuits wired in parallel.
- Connect DVOM leads to the circuit to be tested.

NOTE: There must be NO current available to the circuit during the continuity test. DVOM display will indicate continuity of circuit.

VOLTAGE DROP TESTING

Voltage Drop Tests determine the resistance of an active circuit, a circuit with current flowing.

Voltage drop tests are preferred over simple resistance measurements because the power source is not removed from the circuit.

By measuring the voltage on both sides of a load, the amount of voltage consumed by the load is measured.

The voltage drops of each part of a series circuit added together must equal the power supply for that circuit while it is active.

Typical Application of Voltage Drop Testing:

- Determine proper component operation.
- Active circuit continuity.
- Active circuit resistance.

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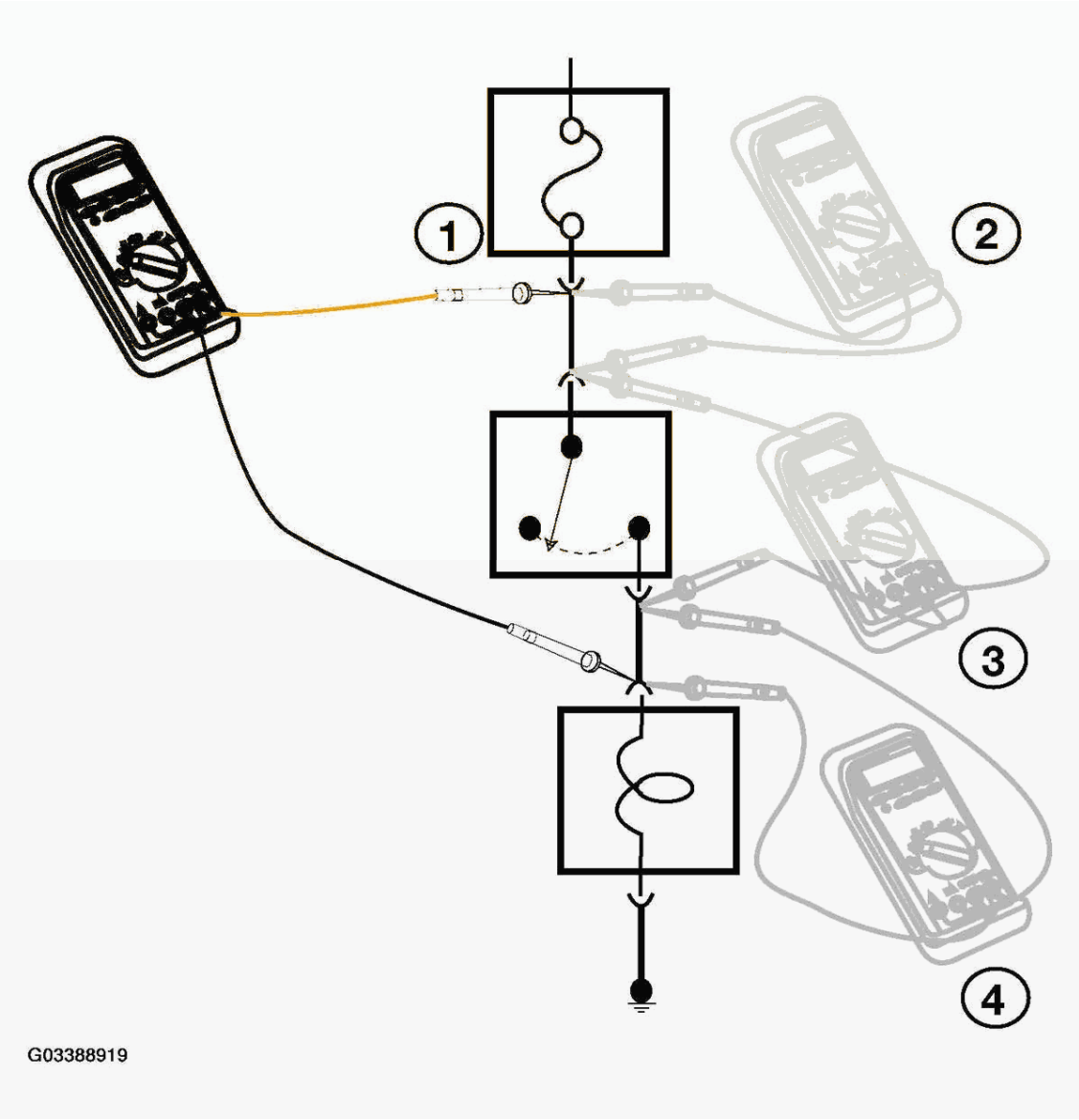


Fig. 26: Identifying Voltage Drop Testing
Courtesy of BMW OF NORTH AMERICA, INC.

As a "Dynamic" test with the circuit operational, a voltage drop in any non-resistive part of the circuit indicates a fault in the circuit,

- Select proper function and range of DVOM.
- Connect (+) lead to the B+ side of the circuit or component being tested.
- Connect (-) lead to the B- side of the circuit or component.

NOTE: All consumers of the test circuit should be active during the test. Always include ground circuit as part of voltage drop test. DVOM display will indicate the voltage drop in the circuit tested between the DVOM leads.

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GENERAL INFORMATION

E83 Product Overview - X3

E83 LIFE CYCLE IMPULSE

Model: E83 X3 3.0si

Production: from August 2006

INTRODUCTION

The BMW X3 has been available on the market as of the 2004 model year and represents a premium product in the segment of compact luxury SUVs.

As of August 2006 production, the E83 will undergo a redesign in order to maintain its leading position in the market and to fend off the ever increasing number of competitors.

This model redesign, known as LCI (Life Cycle Impulse), includes a pronounced visual upgrade, the introduction of new engines as well as a whole series of improvements in details as well as in the range of interior trim and fittings.

As of September 2006, the E83 X3 3.0i with M54B30 (170 kW/231 bhp) will be replaced with the X3 3.0si with N52B30O1 (191 kW/260 bhp).



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Fig. 1: BMW X3 Model
Courtesy of BMW OF NORTH AMERICA, INC.

BODY

Bodyshell

The only technical change is to the openings for the reversing lights in the inner panel of the rear hatch. Due to the higher positioning of these lights, it was also necessary to displace the clearance for their bulbs further upward.

The carrier, sheet metal components and assembly concept remain unchanged. Only the underbody paneling has been adapted to the new engines as part of the model redesign. Modifications to the bodyshell components are solely restricted to details such as the repositioning of threaded connections, pins or securing elements for the adapted wiring harnesses.

All parts of the bodyshell (hood/tailgate, side panels, doors, sills and weatherstrips) remain unchanged. The same also applies to the body connection points.

Front

The redesigned E83 can be immediately distinguished from its predecessor by the partly painted bumpers and the double kidney grill that extends further downward.

The newly designed front bumper which was previously two-piece is now three pieces. A top section painted in the car color and a bottom cover that is also painted are now clipped onto the black-structured, bolted carrier. These painted parts can be individually replaced as required by removing the complete bumper.



Front view - Left: E83 up to 8/06, Right: E83 LCI

Fig. 2: Front View Of BMW - Left E83 Up To 8/06, E83 LCI
Courtesy of BMW OF NORTH AMERICA, INC.

The kidney grills now extend further downward is available only with light titanium bars.

The grill between the double kidney and bumper as well as the lower grill are black on all vehicles.

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Rear

The rear bumper on the E83 LCI is also a new design. It is now made up of four main parts (previously one-piece). Two black side panels and one exhaust finisher also in black are fitted on a carrier painted in the car color.

In the same way as the front bumper, the rear bumper can also be dismantled for repairs and paint work (after disassembly).

Two separate reflectors are clipped on to the left and right of the exhaust finisher. The PCD sensors of the rear bumper are located in the painted area and are therefore painted in the car color (unchanged black at the front).

The panel at the lower edge of the rear hatch is now also painted in the car color, thus making a decisive contribution to the overall higher grade impression of the X3's rear end.

Vehicle Exterior Lighting

Headlights

The front headlights retain their outer contour and connection points. However, vehicles with halogen headlights are now equipped with new open-design segments for high beam and low beam reflector. The tube body, cover frame and housing are new. In addition, vehicles with bi-xenon lights now have lights with four light coronas (previously two).

The previous headlight washer system with free-standing water jets has now been replaced by a system with retractable washer jets.

Fog Lights

The new fog lights for the X3 have been modified.

A new cornering light function has been added. This function is controlled by means of signals from the direction indicator and steering angle sensor. When turning, the respective fog light is switched on thus optimally illuminating the turn-off area.

Turn Indicators

The design of the front direction indicator lights has been slightly modified in the same way as the side repeater lights which are white. The vehicle is additionally equipped with side markers.

Taillights

The tail lights have also undergone a facelift. A new chamber arrangement (reversing lights now further up) as well as the use of active light guides for the tail light function (instead of the previous bulbs) give the rear end of the X3 a modern appearance.

The lights on the side panels retain their outer contour and connection points while the contour of the lights on the rear hatch have been modified.

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Rear view - Left: E83 up to 8/06, Right: E83 LCI

Fig. 3: Rear View Of BMW - Left E83 Up To 8/06, E83 LCI
Courtesy of BMW OF NORTH AMERICA, INC.

INTERIOR DESIGN

Cockpit

The dashboard has been upgraded by numerous details. The instrument cluster shroud (previously attached) provides for a wider color separation groove and a more harmonious general impression. The dashboard, shroud, and airbag cover also have a new structure finish.

The cover of the glove compartment is positioned slightly lower.

The trim covers for the fresh air grills, the light switch cluster and the cup holder are now coated with soft paint (three different colors - depending on interior color).

Both the basic steering wheel as well as the sports steering wheel now feature a new steering wheel rim and a new cover.

In addition, the sports steering wheel features new spokes and a new backing. Both steering wheels have 3 spokes, the previous 4-spoke basic steering wheel is no longer available.

As in other model series, the interior rear-view mirror in the E83 is available with a digital compass.

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Fig. 4: Identifying Cockpit - Left E83 Up To 8/06, Right E83 LCI
Courtesy of BMW OF NORTH AMERICA, INC.

Door Panels

The door mirrors have also been distinctly upgraded by new surface structuring and geometry. The connection to the dashboard has been improved while the trim covers for the speakers are now larger due to the installation of new speakers.

Storage compartment shelves integrated in the door trim panel replace the previous netshell combination. The finishers for the power window switches are now smaller.



Fig. 5: Door Trim Panels Left E83 Up To 8/06, Right E83 LCI
Courtesy of BMW OF NORTH AMERICA, INC.

Rear Seat

Modifications to the foam material in the seat and the seat cover of the rear bench seat have raised the front edge by 30 mm thus improving the seating comfort in the rear. A seat heating system will be additionally offered for the rear seat.

DRIVETRAIN

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N52 Engine

The N52 engine first offered in the E90 will be reengineered for the September 2006 launch and will then be known as the N52K. The exact engine designation will N52B30O1.

Compared to the M54 6-cylinder engine previously fitted in the E83, the N52K is characterized by lower fuel consumption (12% reduction), reduced weight (10 kg less), 35 hp (30 kW) increase in power output and an increase of 11 lb ft torque.



Fig. 6: N52 Engine Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

The exhaust manifold has been slightly adapted to match the geometry of the E83.

The same also applies to the oil pan with modified underbody area and threaded connection to the front axle.

The shape of the engine support has been modified to accept the N52. The power steering oil reservoir is now mounted on the screw connection for the alternator instead of on the frame side member as previously.

Intake Air Duct

For the first time at BMW, the intake silencer is a fixed part in the engine. The unfiltered air duct is crash-optimized. An unfiltered air resonator and a time chamber filtered air resonator are used in order to satisfy acoustics requirements.

Digital Engine Electronics (DME)

The engine management MSV80 is used in connection with the N52K. This system is a further development of the MSV70 and has been adapted in terms of several details.

Exhaust System

For acoustics reasons, the exhaust system is now mounted at the level of the transfer case instead of at the engine support as previously.

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NOTE: For detailed information on this engine please refer to the ST613 " " technical training manual.

Gearbox

6-speed Manual Transmission

The synchromesh of the gearshift mechanism has been newly developed to provide outstanding gearshift comfort both at low as well as elevated shift forces.

1st/2nd gearshift now takes place in double cone synchromesh and single-cone synchromesh for 3rd/4th and 5th/6th gear.

A central selector valve connects the gearshift with a shift gate on the inside for the first time. Another new feature is the passive shift lock that guarantees distinctly greater locking reliability in addition to further optimized smoothness of operation.

The pressure diecast aluminum transmission casing is of 2-piece design similar to that of the 5-speed manual transmission.

6-speed Automatic Transmission GM6 (6L45)

The new automatic transmission GM6 replaces the previous transmission GM5 in the E83. As indicated by its designation, the transmission has 6 forward drive ranges (GM5: 5).

The spread and gear ratio are virtually identical to the GM5.

The power transmission capacity of the transmission weighing 170lbs (76.9 kg), including oil, is 258 lb ft (350 Nm). Its main advantages include a 6 % reduction in fuel consumption and improved gearshift dynamics.

The lower fuel consumption results from the use of the so-called neutral idle control (NIC), low converter slip thanks to the use of a turbine-torsion damper as well as reduced drag losses in the clutches.

The structure of the transmission generally corresponds to that of the 6HP19. The main difference in the GM6 is a one-way clutch to ensure stable shift quality when shifting from 1st to 2nd. Thanks to their high drive percentage with the clutch engaged, converters with turbine-torsion dampers provide a direct connection to the engine.

The transmission control unit is accommodated together with the hydraulic control unit in the transmission (mechatronics concept). This arrangement provides advantages in terms of package space and, due to the smaller number of interfaces, it also ensures increased system reliability.

RUNNING GEAR

Rear Axle Differential (final drive)

A new final drive unit (L-axle drive) has been developed to improve the efficiency of the final drive for the X3. The final drive has adopted the new bearing concept from the BMW 3 Series together with the new double

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angular contact ball bearings. This results in a considerable reduction in the operating temperature of the final drive, having a positive effect on operation and service life.

At the same time, oil flow losses have been substantially reduced while adapting and optimizing the efficiency of the gearing in terms of the displacement characteristics.

The torque capacities of the final drive units HAG168L and HAG188L have been increased by 10 % making these final drive units heavier. For acoustics reasons, their casings are still made from spheroidal cast iron.

The table below identifies the differential usage and ratio by vehicle equipment options:

DIFFERENTIAL SPECIFICATION

Model/equipment	Differential (ratio)
X3 3.0si manual	HAG188L (3.73 :1)
X3 3.0si automatic	HAG168L (4.44:1)

Two-stage Disc-type Vibration Absorber

For effective acoustic decoupling of the drive train, a two-stage disc-type vibration absorber is fitted between the propeller shaft and transfer case that becomes harder as the applied torque increases.

CHASSIS

Various modifications to the chassis of the E83 have been necessary to accommodate the higher performance N52K engine. Most of these modifications, however, are restricted to geometric adaptations (steering system and heat shields).

Mounts

The engine and transmission mounts are new.

DXC+

The driving dynamics system DXC+ in the E83 features additional functions.

In addition to the known features such as ABS, ASC, CBC, DSC and HDC, the following will be added:

- Dynamic Traction Control (DTC) for ensuring maximum traction irrespective of the driving surface
- Hill starting assistance (Hill-holder)
- Dry brakes in rain
- Brake standby/brake travel reduction
- Brake fading assistance

RDC

All E83 vehicles will be equipped with the tire pressure monitoring system RDC which was introduced in

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March 2006.

Power Steering Cooling

The DSC control unit has an additional program module for the power steering cooling. This function increases the fan speed to secure the required cooling capacity under high load conditions (e.g. uphill/downhill driving) at low speed. The signals relating to the driving speed, power output (via HFM) and steering angle lock are used as the control data for this purpose.

ELECTRICAL SYSTEMS

EWS 4.4

The E83 will be equipped with the EWS 4.4 already known from other model series. Thanks to improved logic of the vehicle immobilizer, this electronic control provides increased anti-theft protection, resulting in a more favorable insurance classification of the E83.

Lights Module 2

The lights module 2 replaces the previous light switch cluster in the E83 LCI; it combines its functionality with that of the AHL control unit.

Rear Seat Heating

Rear seat heating will be offered in all X3 models.

Oil Level Indicator

The oil level indicator is now integrated in the instrument cluster.

Radio, CD

The new radio platform of all E83 features a double tuner and station list expansion.

An AUX-In jack is provided on the center console for the connection of external audio sources.

The Random function in the CD changer now only refers to the selected CD and no longer to all (up to six) CDs in the magazine of the changer. This reduced number of selection options substantially shortens the pauses between the music tracks.

Navigation

The computer hardware is now lead-free and therefore recyclable.

SPECIFICATIONS

SPECIFICATIONS

	X3 3.0si

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Engine	N52B30O1
Type/cylinders/valves	In-line 6/4
Displacement (ccm)	2996
Stroke/bore (mm)	85
Power output (kW/bhp)	260
At engine speed (rpm)	6600
Torque (Nm)	305
At engine speed (rpm)	2500
Governed engine speed (rpm)	6800
Compression ratio	10.7 : 1
Engine electronics	MSV80
Engine weight (kg)	165
Emission stage	ULEV II
Rims	(1)
Tires	(1)
Battery (Ah)	70
Alternator (A/W)	150/2100
Payload (kg)	520
Performance: 0 - 60 mph	Auto 7.1 sec Man 6.9 sec

(1) Value not available when going to print

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2005 GENERAL INFORMATION

Electronic Signals - Overview - All Models

ELECTRONIC SIGNALS

Model: All

Production Date: All

PURPOSE OF SIGNALS

Electronic signals move information much like cars move passengers down the highway. It would be difficult to get to work without transportation, and there would be no transportation with out signals.

Signals allow devices (e.g. sensors or switches) to communicate with control modules (either complicated processors or simple relays) which in turn perform or request (through more signaling) other functions to be carried out.

Signals inform the Climate Control of the outside air temp or tell the brake lights the right time to illuminate.

The use of electronic signals goes far beyond the basic application of electron flow to control components, enabling complex information to be passed from one component to another.

The data (input or output) is conveyed through various forms of changing voltages, resistances, current or frequency modulation.

1. AC Voltage Signals:
    A. Inductive Signals.
    B. Phase Shifted Signals.

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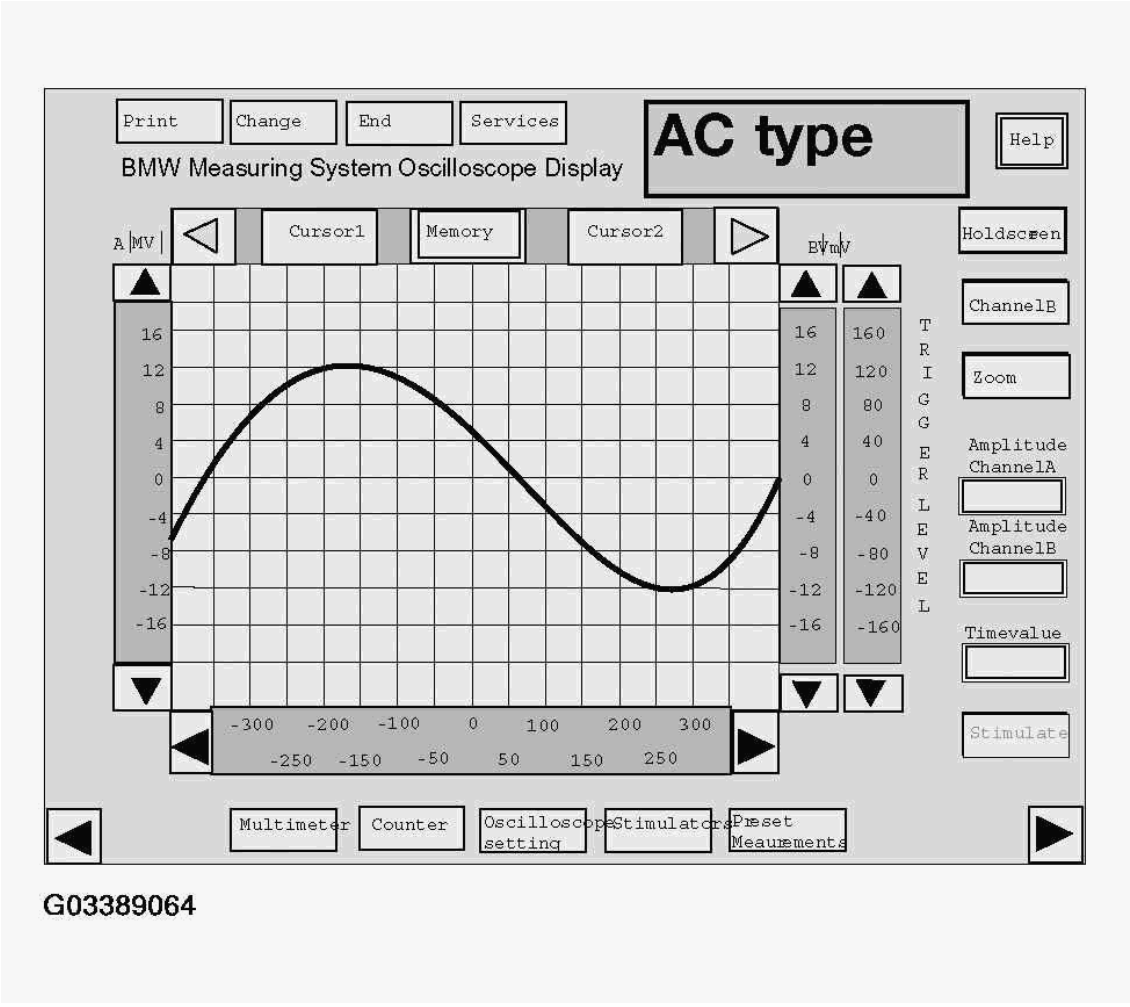


Fig. 1: Identifying AC Voltage Signals
Courtesy of BMW OF NORTH AMERICA, INC.

2. DC Voltage Signals:
   A. Analog Signals.
   B. Digital Signals:
      1. Switched (High/Low) Signals.
      2. Modulated Square Wave Signals:
         a. Frequency Controlled Signals.
         b. Pulse Width Controlled Signals.
         c. Duty Cycle Controlled Signals.
   C. Designated Value Signals.
   D. Coded Ground Signals.
   E. Transistor Signals:
      1. Modulated B+/B- Signals.
      2. Momentary B+/B- Signals.

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3. Constant B+/B- Signals.

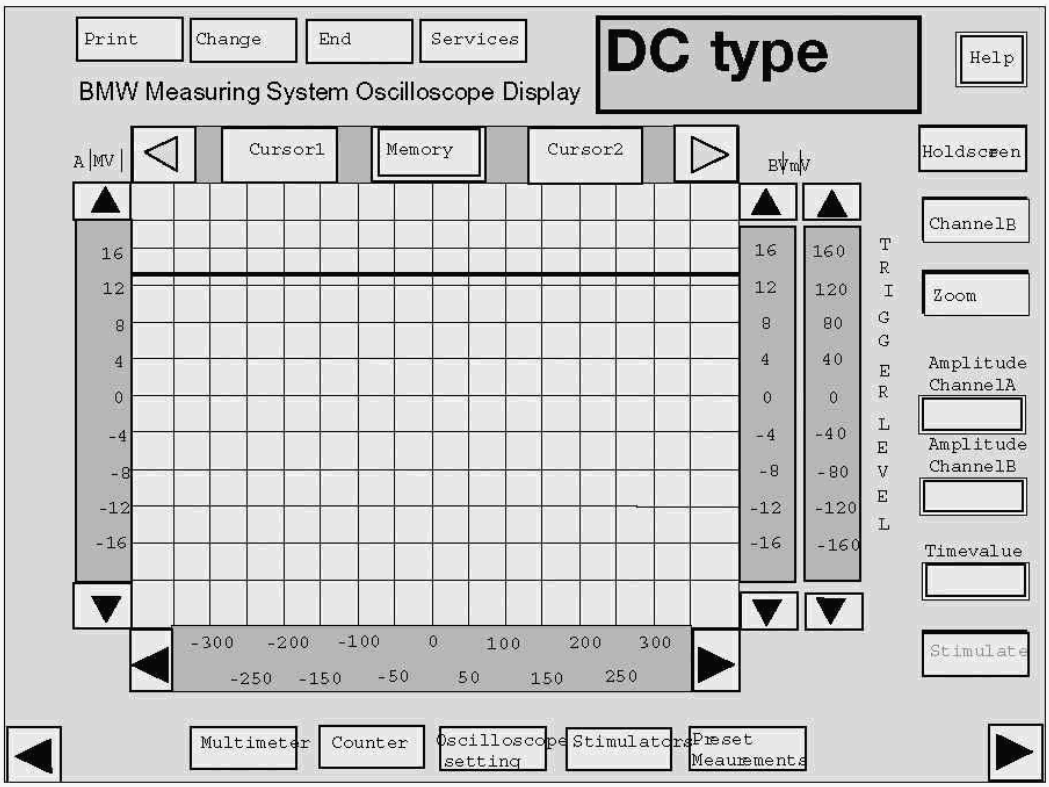


Fig. 2: Identifying DC Voltage Signals
Courtesy of BMW OF NORTH AMERICA, INC.

AC VOLTAGE SIGNALS

Two types of AC Voltage signals are used:

- Inductive Signals (Induced Voltage).
- Phase Shifted Signals (Angle Pulse Generator).

INDUCTIVE SENSORS

Inductive sensors produce an AC Sine Wave signal. The AC voltage is induced by the shifting of a magnetic field. The sensor consists of an impulse wheel (the moving part) and a coil wound magnetic core (the stationary part).

As each tooth of the impulse wheel approaches the sensor tip, the magnetic field of the sensor shifts toward the

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impulse wheel and induces a voltage pulse in the windings.

As the teeth move away from the sensor, the magnetic field shifts back inducing a voltage pulse in the opposite direction.

This shifting of the magnetic field produces an alternating current (positive to negative).

Control modules which receive this alternating current, count the impulses (shifts from positive to negative) and interpret the speed of rotation of the impulse wheel.

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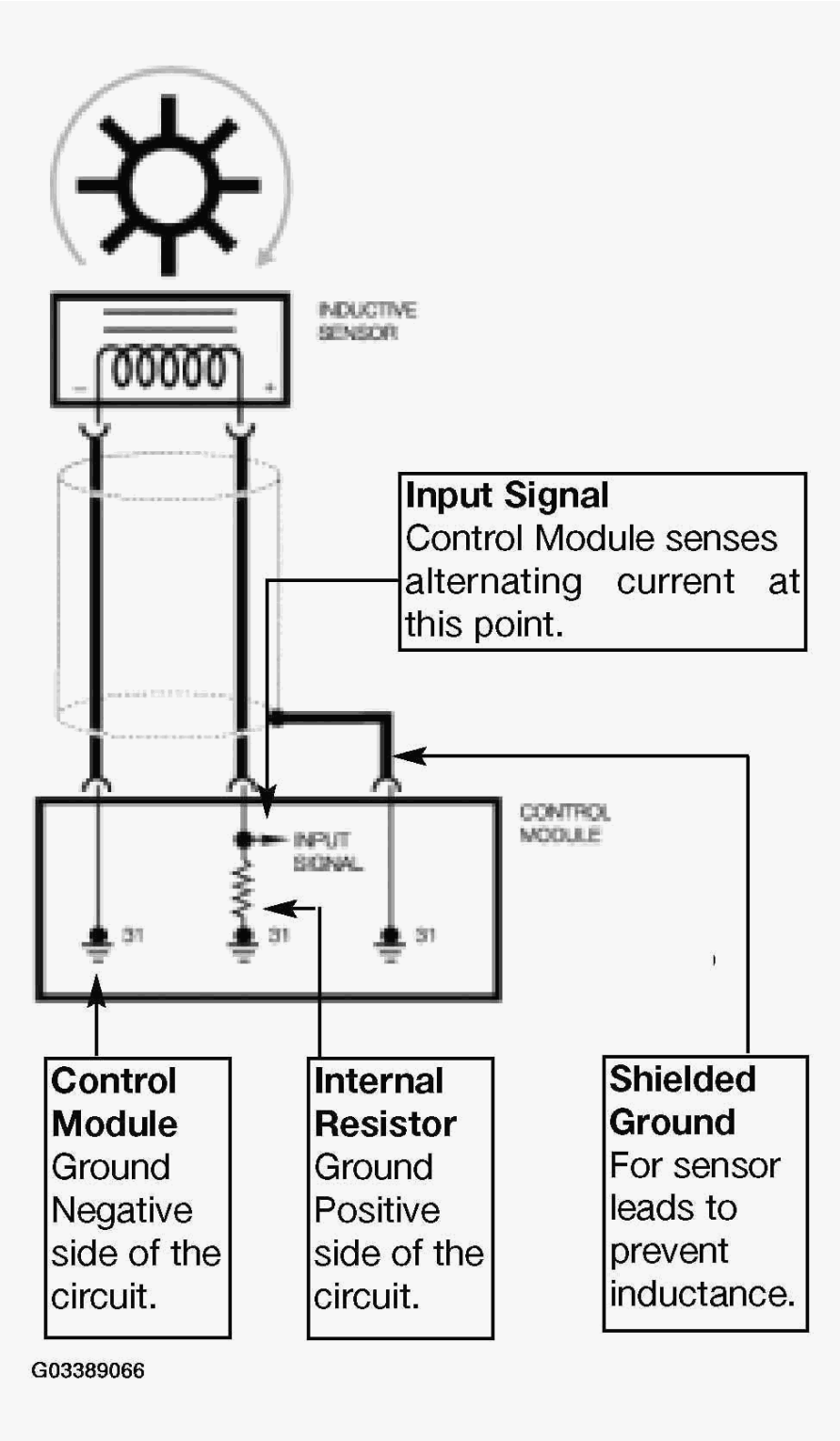
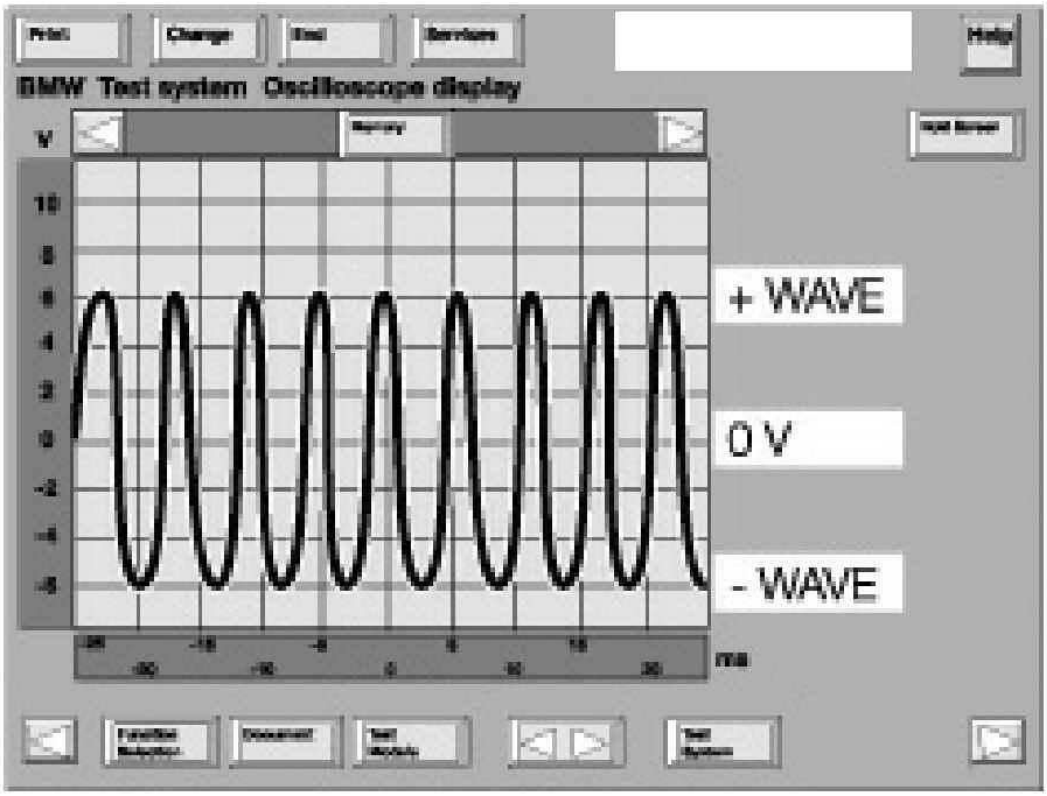


Fig. 3: Inductive Sensor Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of Inductive Sensors:

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- Crankshaft Speed Sensor.
- Camshaft Speed Sensor.
- Transmission Input/Output Speed Sensor.
- Wheel Speed Sensor.



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Fig. 4: Identifying AC Sine Wave Signal
Courtesy of BMW OF NORTH AMERICA, INC.

Voltage levels are dependent on sensor design.

Not all inductive sensors produce 12 volts.

ANGLE PULSE GENERATOR

An Angle Pulse Generator Sensor acts on an existing AC voltage signal rather than produce a new one.

The sensor consists of two windings (primary and secondary) that are connected together at one end and a magnetic iron core (stationary) along with a trigger wheel (movable).

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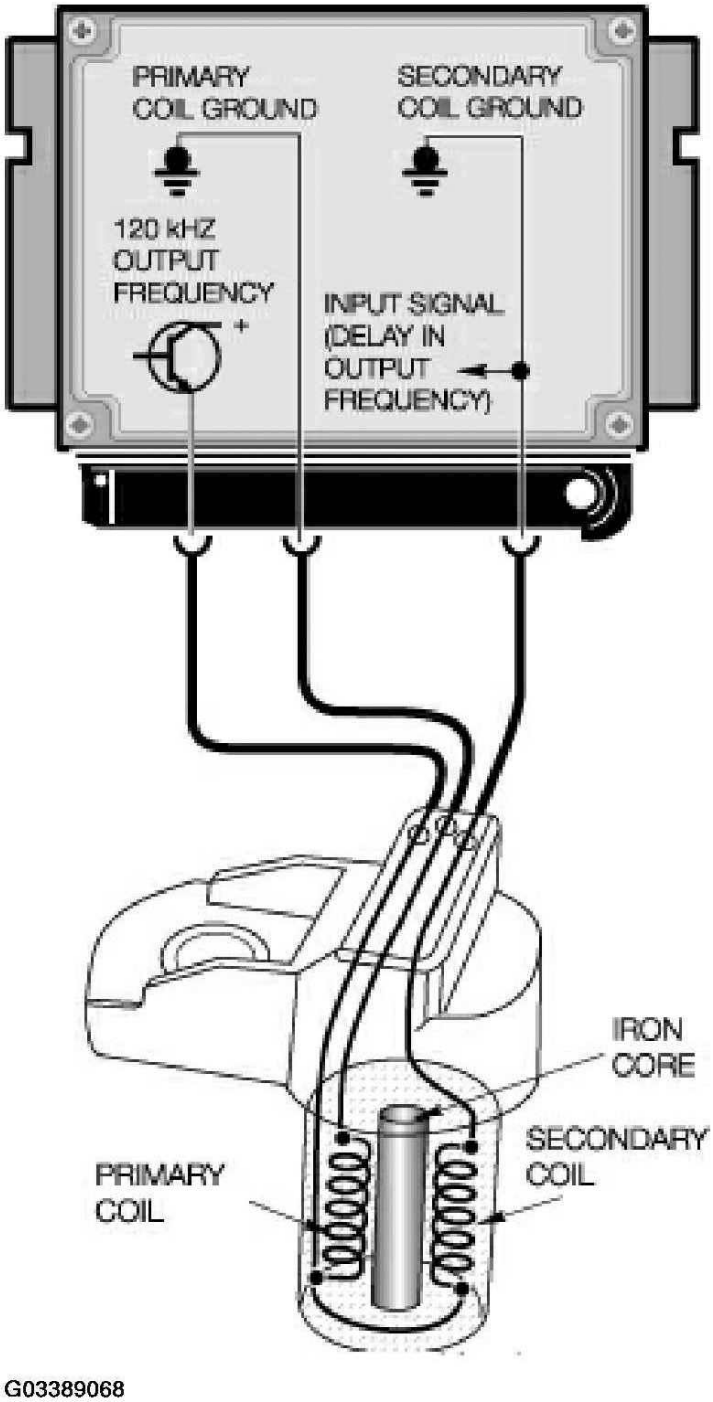


Fig. 5: Checking Angle Pulse Generator
Courtesy of BMW OF NORTH AMERICA, INC.

The primary winding (coil) is supplied with a 120kHz AC signal by the control module. The magnetic coupling (core) causes a voltage at the same frequency to be induced in the secondary winding. The induced frequency

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has a slight phase shift due the induction time delay.

The trigger wheel influences the magnetic field of the sensor and causes the phase shift to increase as the disc of the wheel moves closer to the sensor.

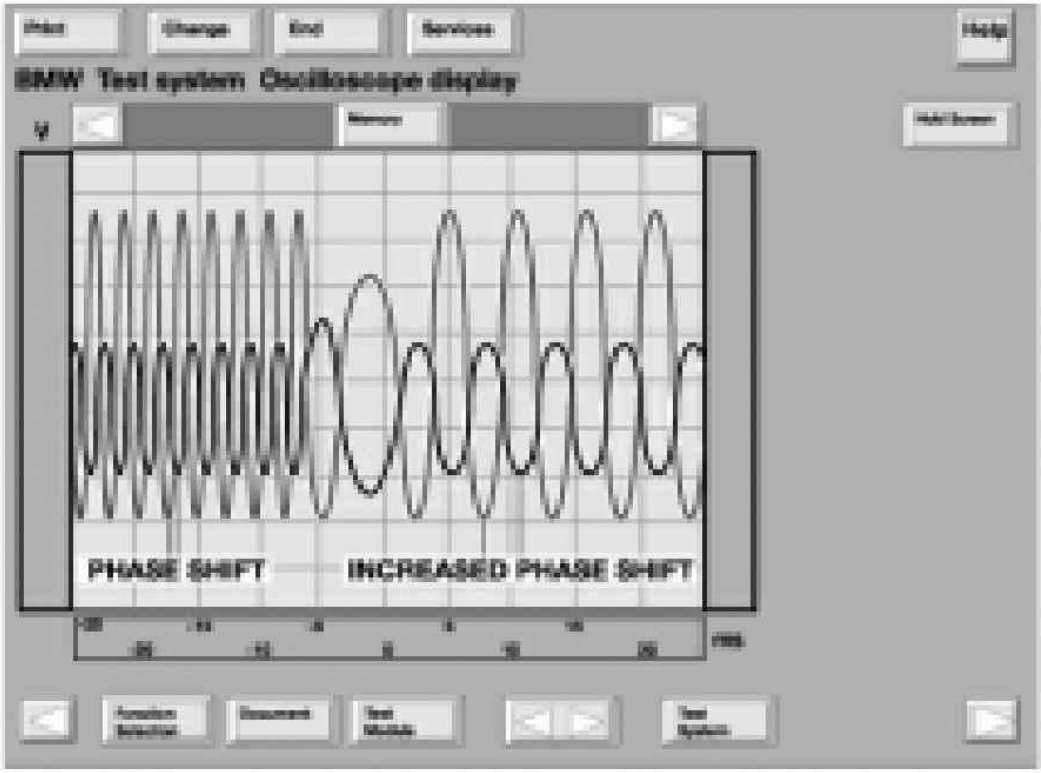
This changing of the phase shift (time delay) from a smaller time period to a larger time period and back again provides the control module with trigger wheel position.

The angle pulse generator provides position information regardless of movement. Trigger wheel position is established with the application of an output frequency from the control module and the return of the phase shifted signal.

Typical Application of Angle Pulse Generator

- Camshaft Sensor MS41.1.
- Pedal Request Sensor EML.

(a bank of three)



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Fig. 6: Angle Pulse Generator Wave Signal
Courtesy of BMW OF NORTH AMERICA, INC.

DC VOLTAGE SIGNALS

Five Types of DC Voltage Signals Are Used:

- Analog Signals.
- Digital Signals.
- Designated Value Signals.
- Coded Ground Signals.
- Transistor Signals.

DC voltage signals are based on either 5 volts or 12 volts.

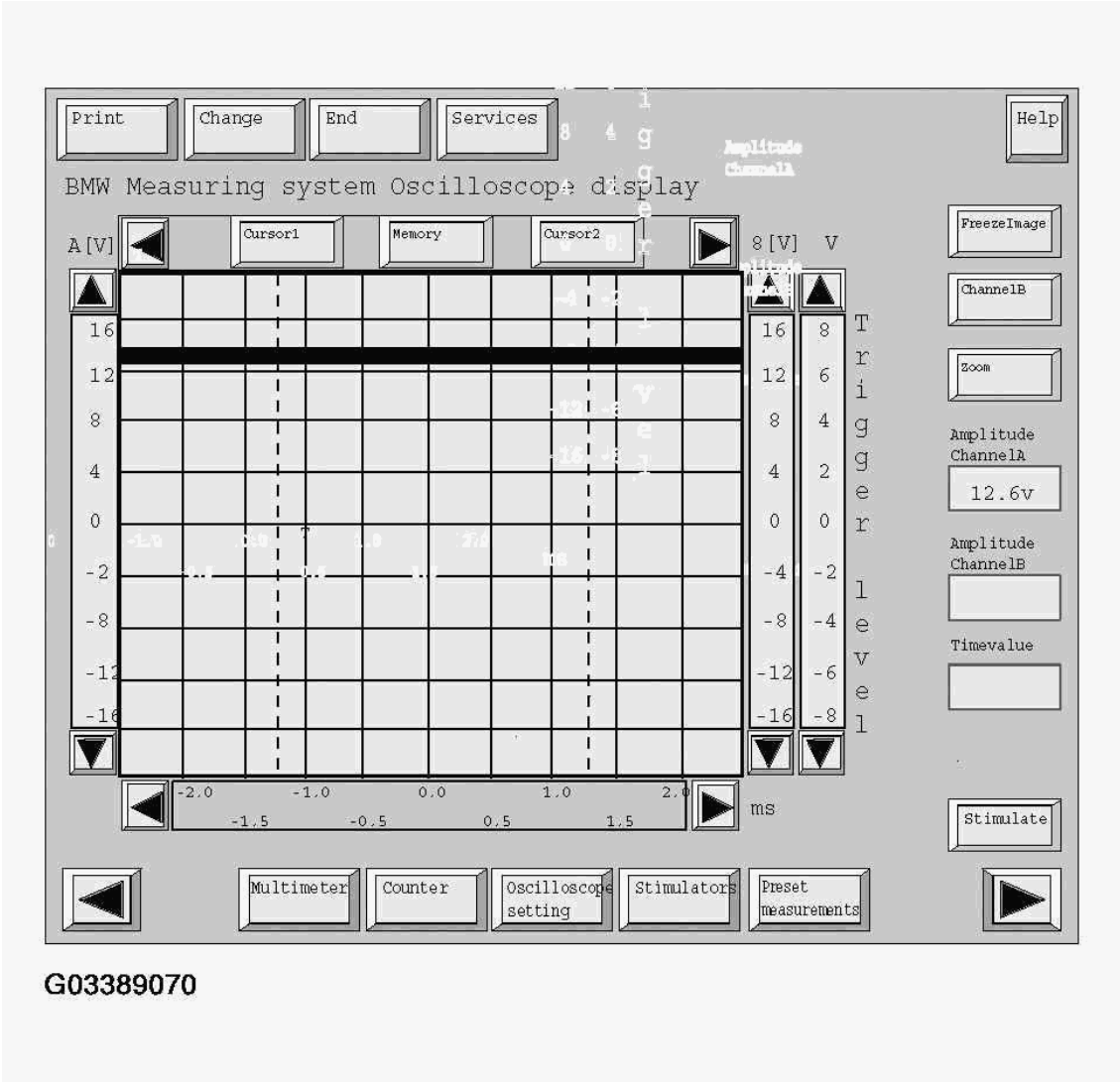


Fig. 7: Identifying DC Voltage Signals

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Courtesy of BMW OF NORTH AMERICA, INC.

ANALOG SIGNALS

Analog signals transmit information through an electrical circuit by regulating or changing the current or voltage.

The voltage of the signal has no fixed value. The value may be anywhere in the operating range of the signal.

Three sources of analog signals are:

- NTC Sensors.
- PTC Sensors.
- Potentiometers.

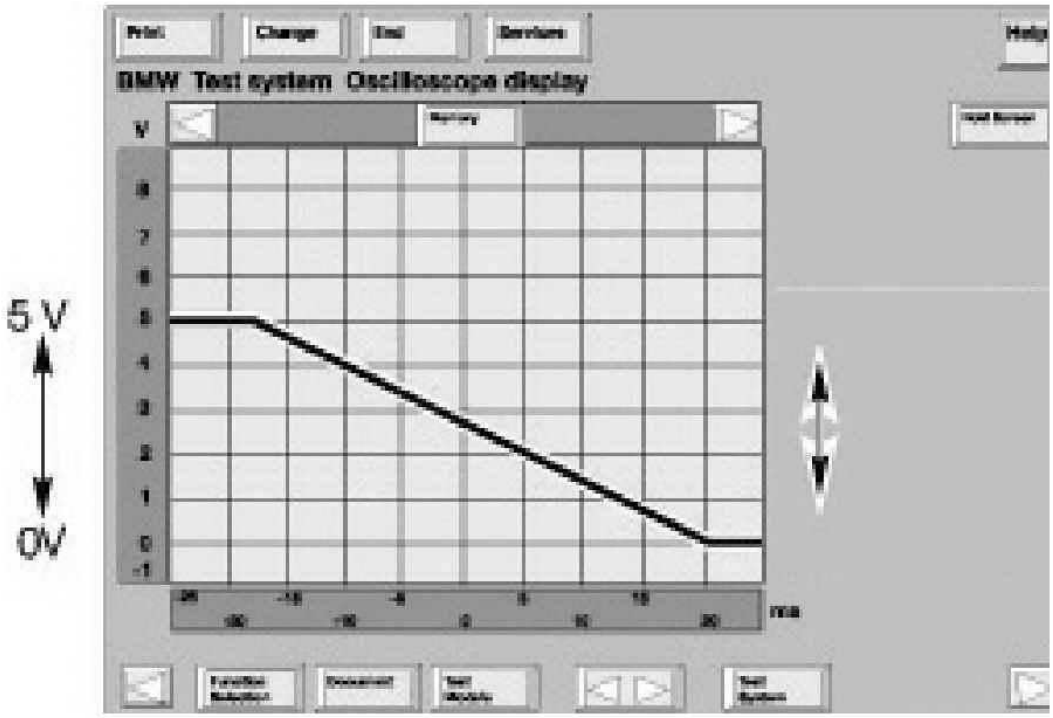


Fig. 8: Identifying Analog Signals
Courtesy of BMW OF NORTH AMERICA, INC.

NTC SENSORS

NTC (Negative Temperature Coefficient) sensors change resistance based on temperature. As the temperature

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goes up the resistance goes down. This decrease in resistance causes the voltage drop across the sensor to decrease and the input signal voltage at the control module decreases.

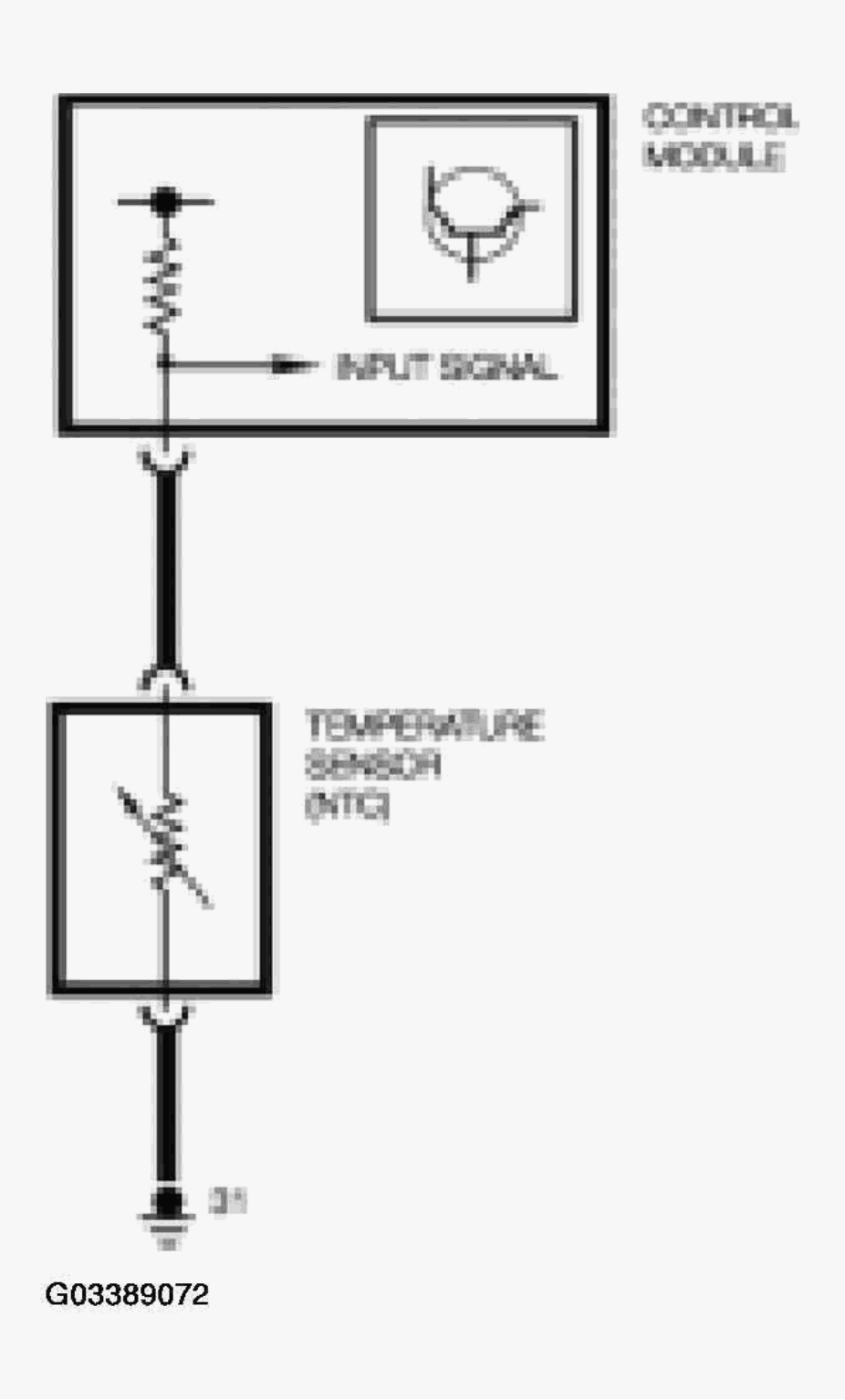


Fig. 9: NTC Sensor Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

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Examples Of NTC Sensors

Intake Air Temperature Sensor

The intake air temp sensor provides a 0--5 volt analog signal to the DME indicating temperature of the incoming air.

The intake air temp sensor is located either in the intake manifold or integrated in the mass air flow meter.

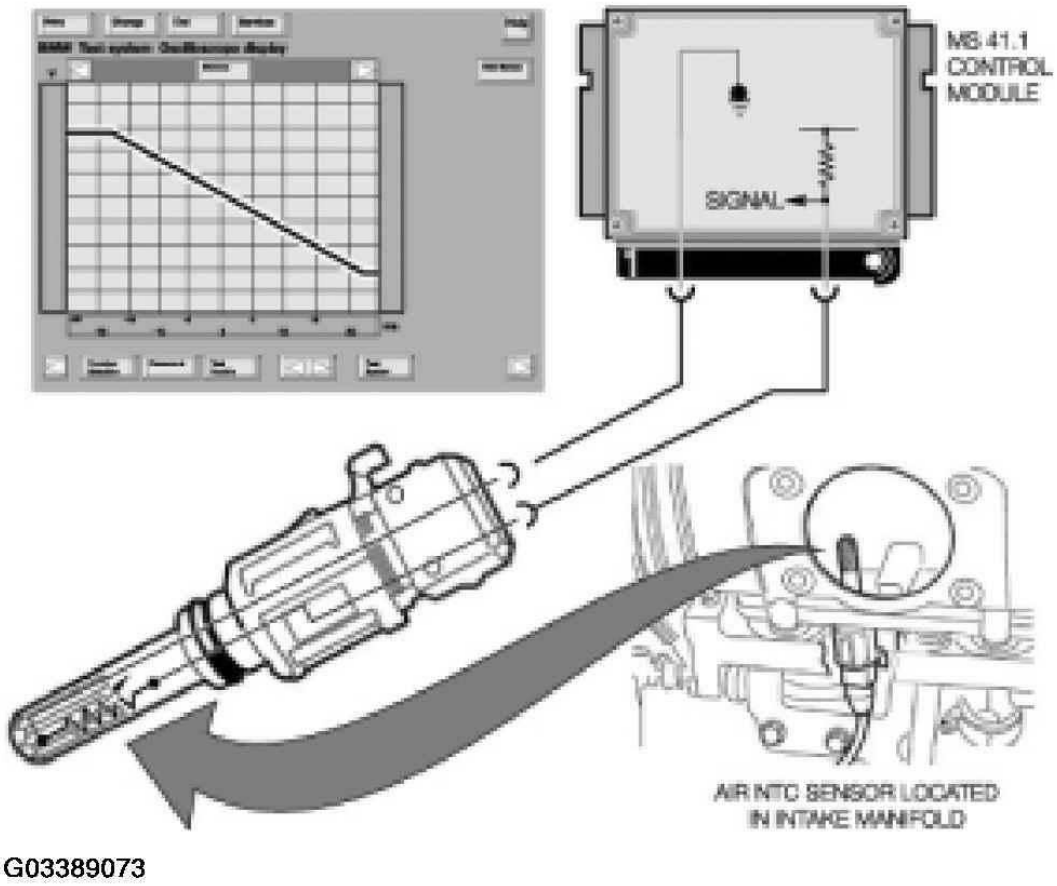


Fig. 10: Checking Intake Air Temperature Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

Engine Coolant Temperature Sensor

A dual sensor is used for engine temp. Operation is the same as other NTC sensors, 0-5 volt operating range, except that two independent sensors are housed in one assembly.

One is for the engine temperature input to the DME.

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The other sensor is used to input engine temp to the instrument cluster.

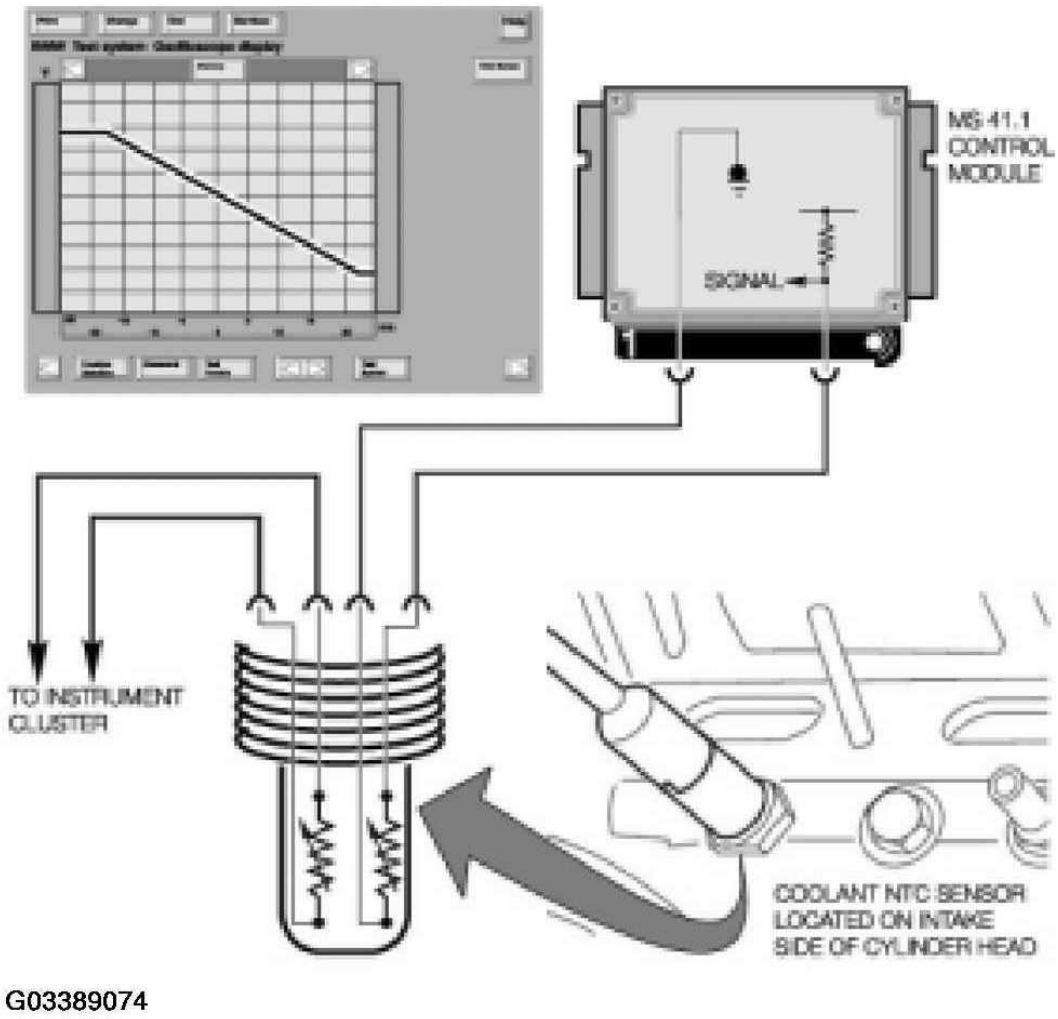


Fig. 11: Checking Engine Coolant Temperature Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of NTC Type sensor:

- Engine Coolant Temp Sensor.
- Intake Air Temp Sensor.
- Transmission Temp Sensor.

PTC SENSOR

PTC (Positive Temperature Coefficient) sensors also change resistance based on temperature. In a PTC sensor

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as the temperature goes up the resistance also goes up. The increase in resistance causes the voltage drop across the sensor to increase and the input voltage signal at the control module increases.

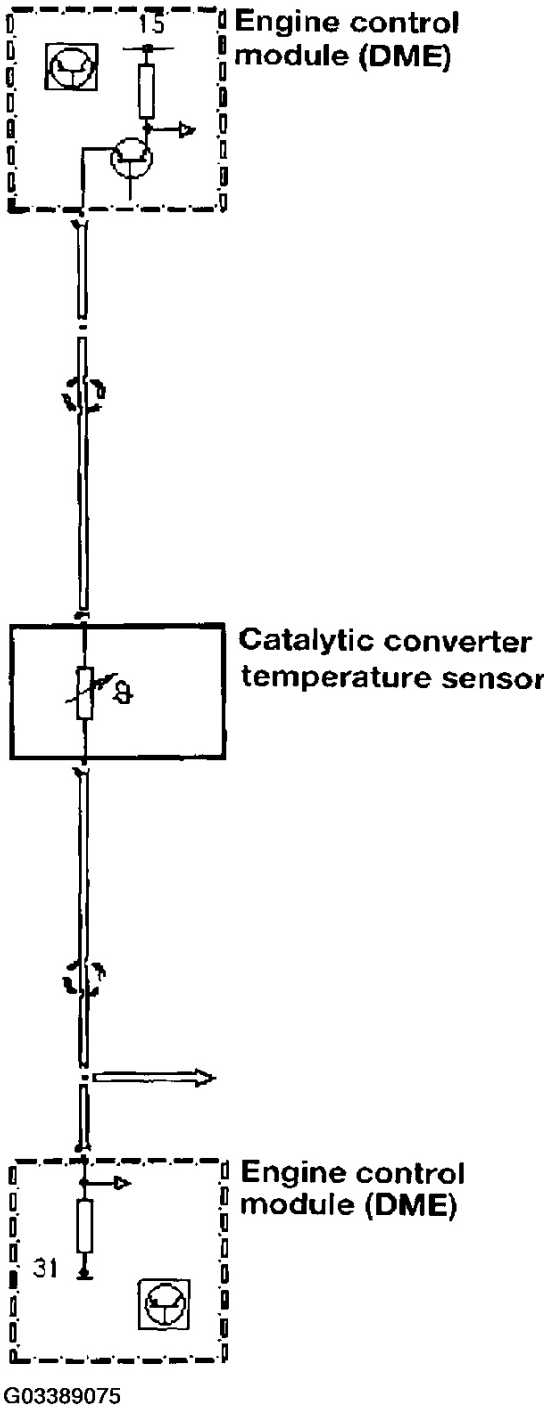


Fig. 12: PTC Sensor Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

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Typical Application of A PTC Type Sensor:

- Exhaust Temp Sensor.
- Transmission Temp Sensor.

Example of PTC Sensor

A M5 Catalytic Convertor uses a PTC type sensor to monitor exhaust temperature.

A 0-12v signal is supplied to the DME indicating catalyst temperature.

Workshop Hints NTC/PTC Sensors:

When troubleshooting a faulty input display, the input signal must be verified as "good" BEFORE the control module is replaced.

When checking a NTC Sensor look for these voltages and problems:

0 volts = no supply voltage or shorted to ground.

2v = sensor is indicating a warm condition for system being measured.

4v = sensor is indicating a cold condition for system being measured.

5v = sensor or wiring harness is open.

Remember a PTC type sensor will indicate opposite results on intermediate readings (i.e. 4 volts = warm).

POTENTIOMETERS

A Potentiometer produces a gradually changing voltage signal to a control module. The signal is infinitely variable within the operating range of the sensor.

This varying voltage reflects a mechanical movement or position of the potentiometer wiper arm and its related components.

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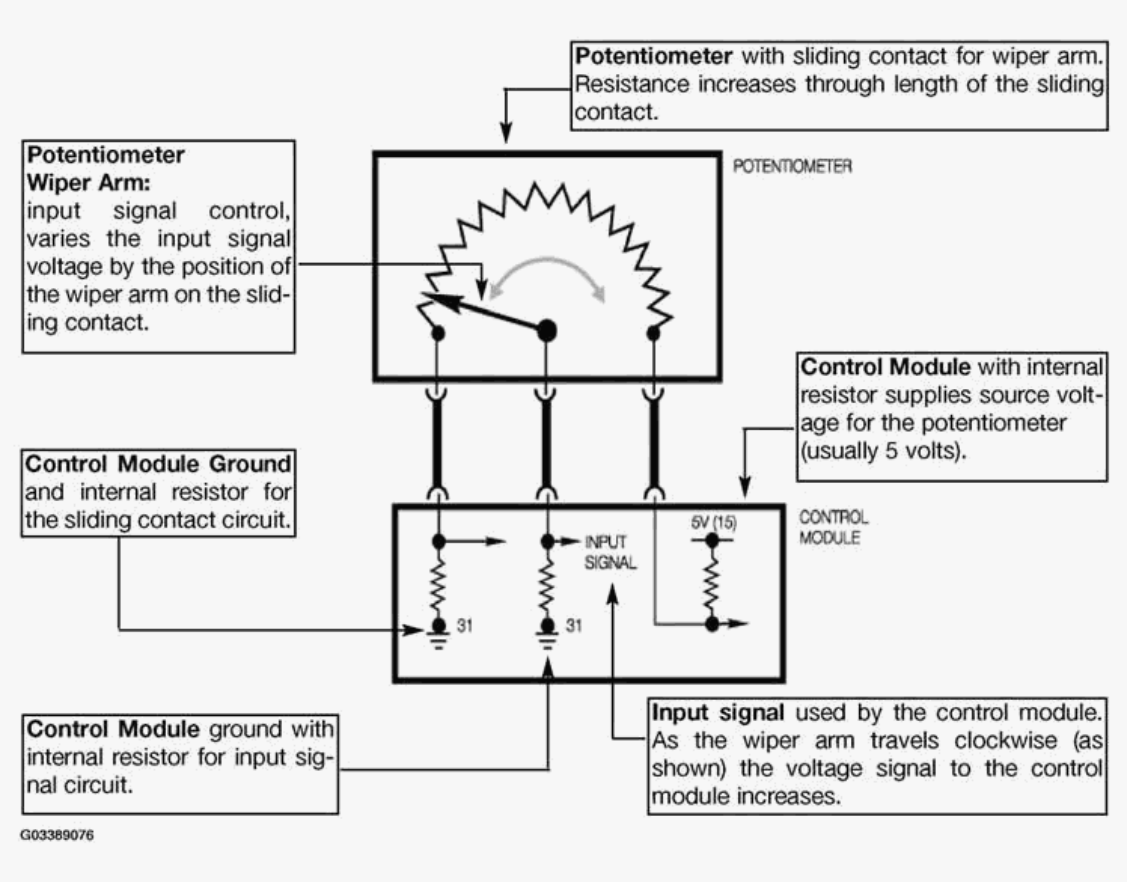


Fig. 13: Identifying Potentiometer
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of Potentiometers:

- Air Flow Meter.
- Pedal Position Sensors.
- Seat and Mirror Memory Position.
- Throttle Position Sensors (Also Feedback Potentiometers).

DIGITAL SIGNALS

Digital Signals transfer information through an electrical circuit by switching the current on or off. Unlike analog signals which vary voltage, a digital signal has only two possible states, control voltage or 0 voltage.

Two types of Digital Signals:

- Switched (High/Low) Signals.
- Modulated Square Wave signals.

SWITCHED B+ SIGNAL

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This DC voltage signal produces a YES/NO type input to the control module. The voltage level will indicate a specific operating condition.

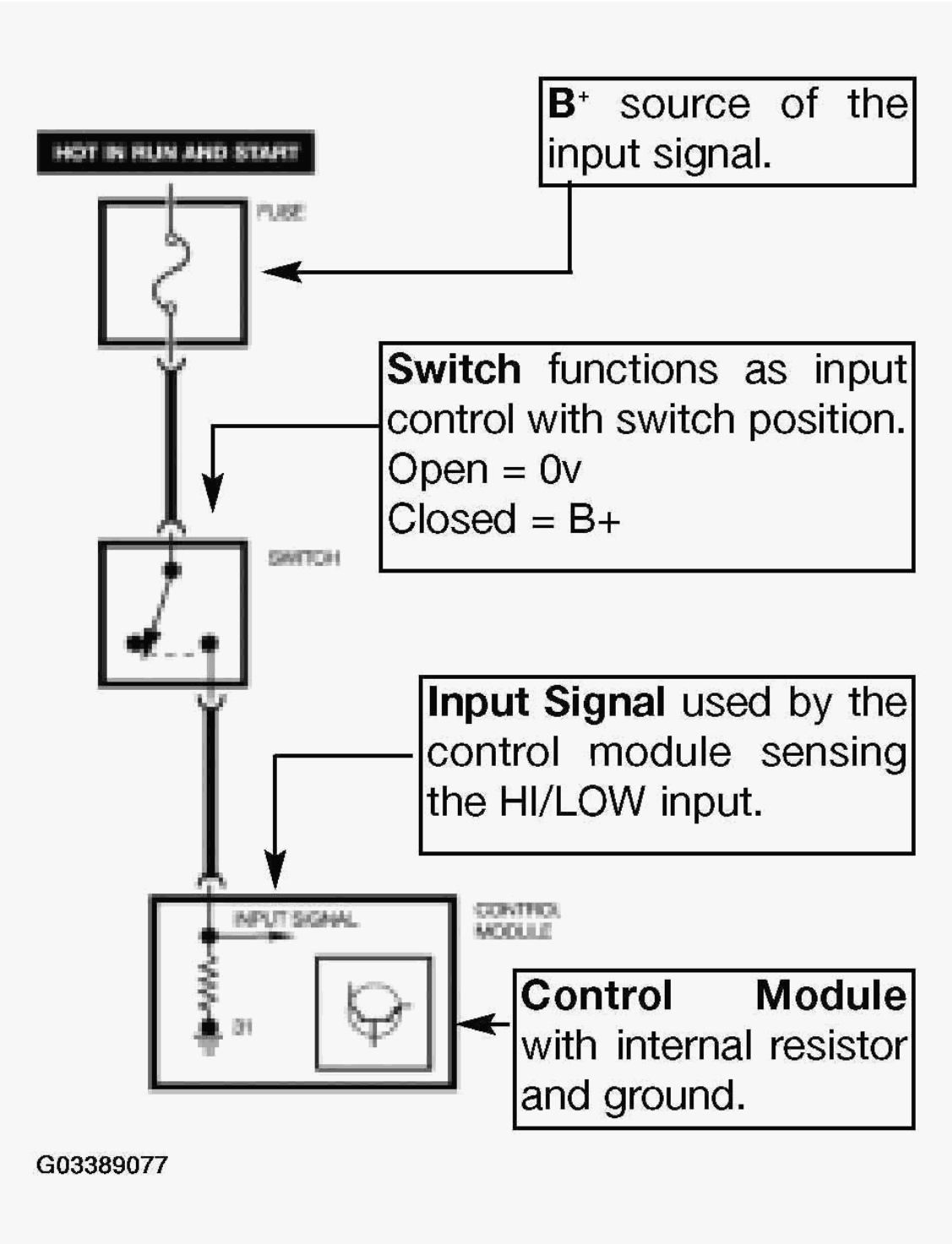
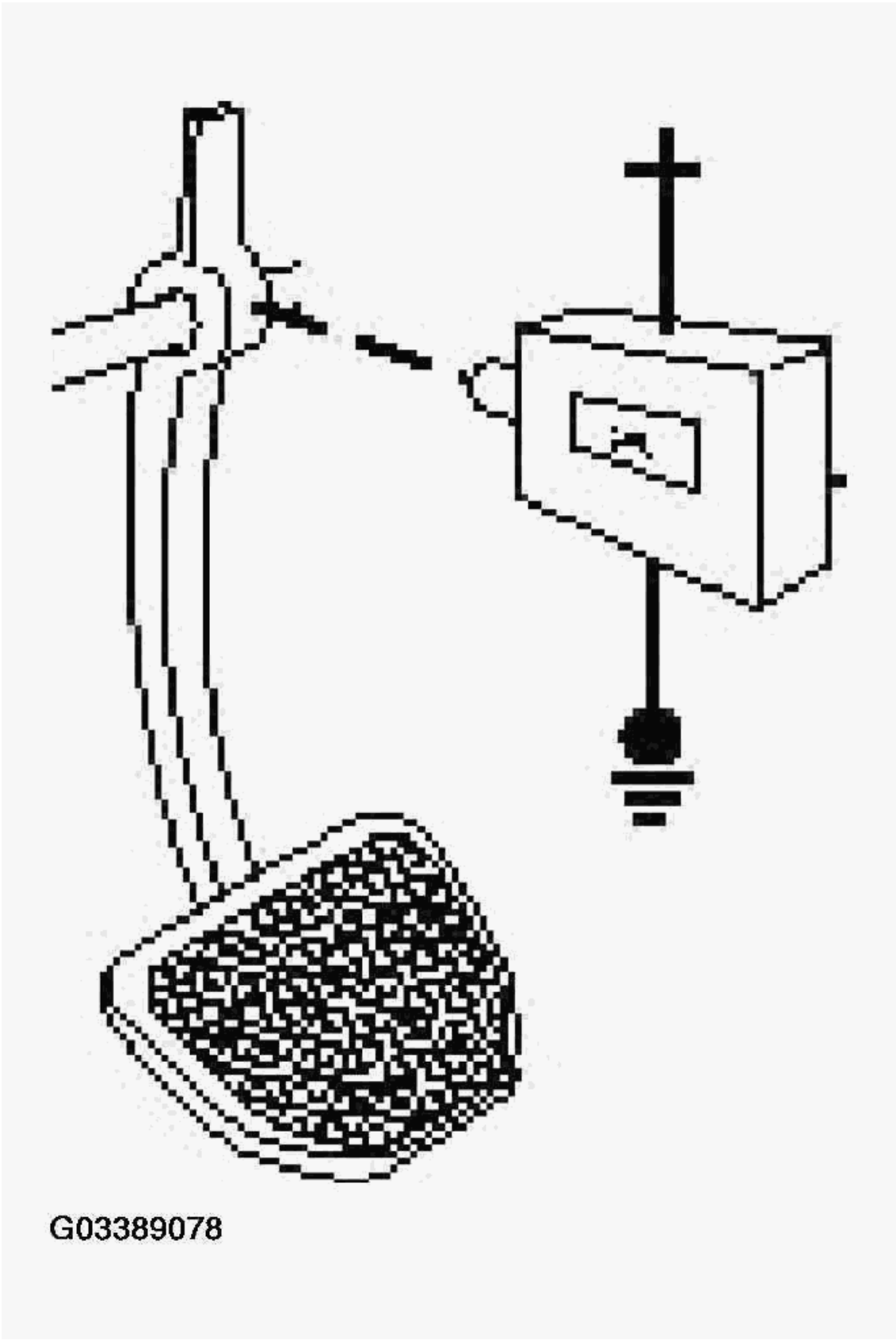


Fig. 14: Digital Signals Transfer Information Chart
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 15: Identifying Brake Light Switch
Courtesy of BMW OF NORTH AMERICA, INC.

Hall effect Brake Light Switch

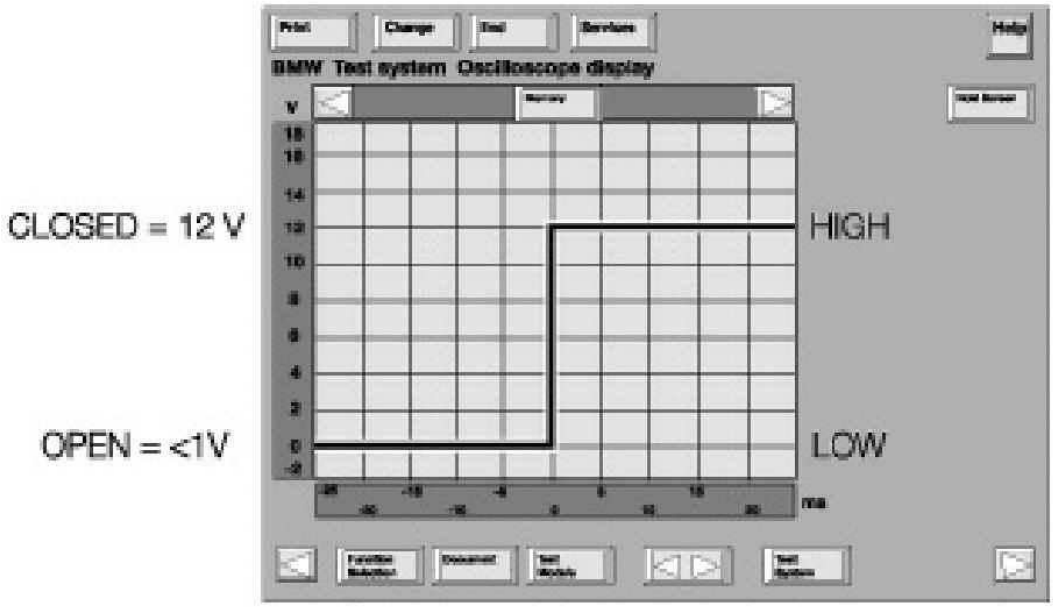


Fig. 16: Identifying DC Voltage Signal
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of Switched B+:

- Ignition Switch.
- Seat Belt Switch.
- Light Switch.
- Hall Effect Switch (e.g. Brake Light Switch).
- Reed Switch.

SWITCHED B- SIGNAL

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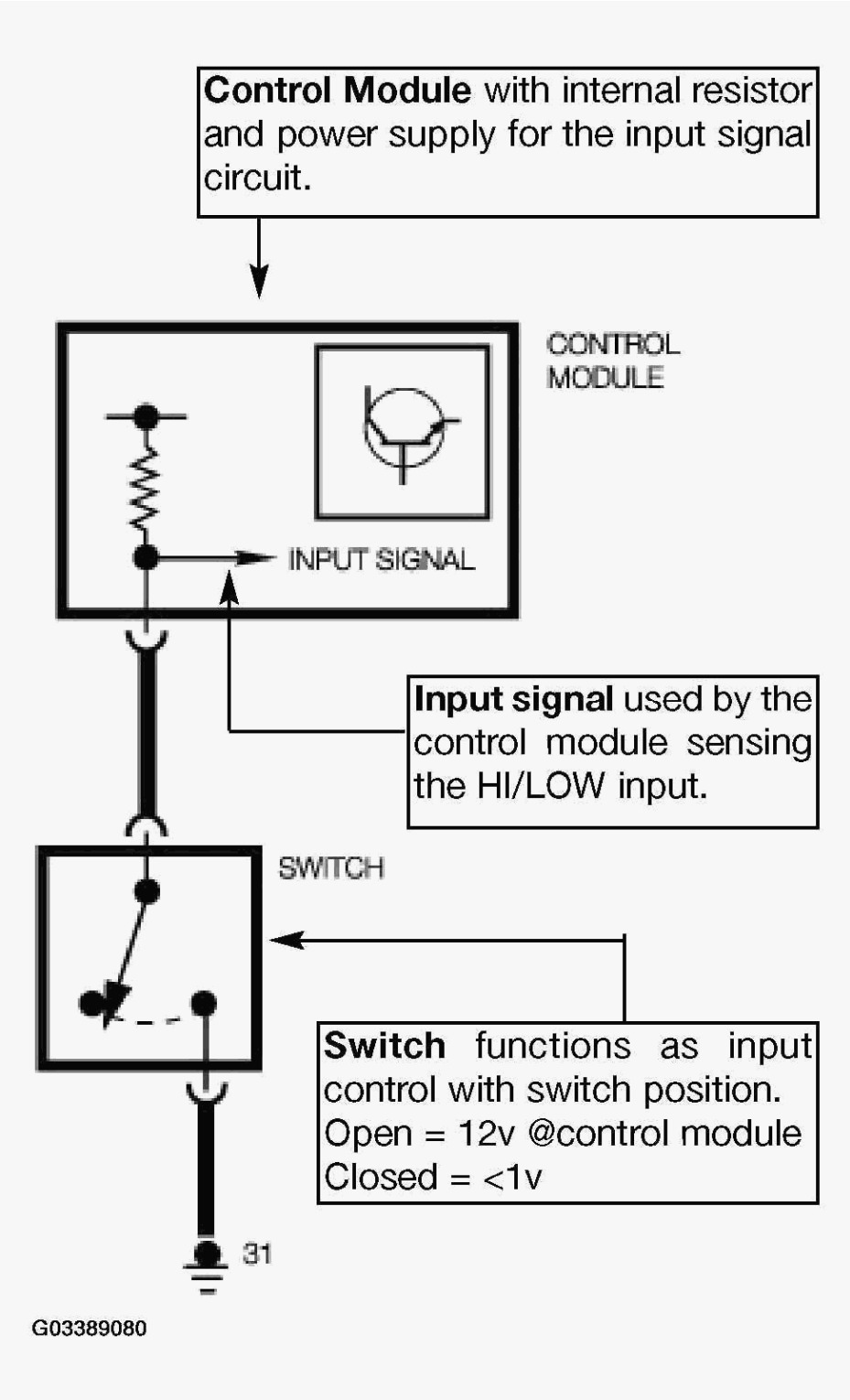


Fig. 17: Identifying (High/Low) Signal
Courtesy of BMW OF NORTH AMERICA, INC.

This Ground Signal produces a YES/NO type input to the control module. The voltage level will indicate a specific operating condition.

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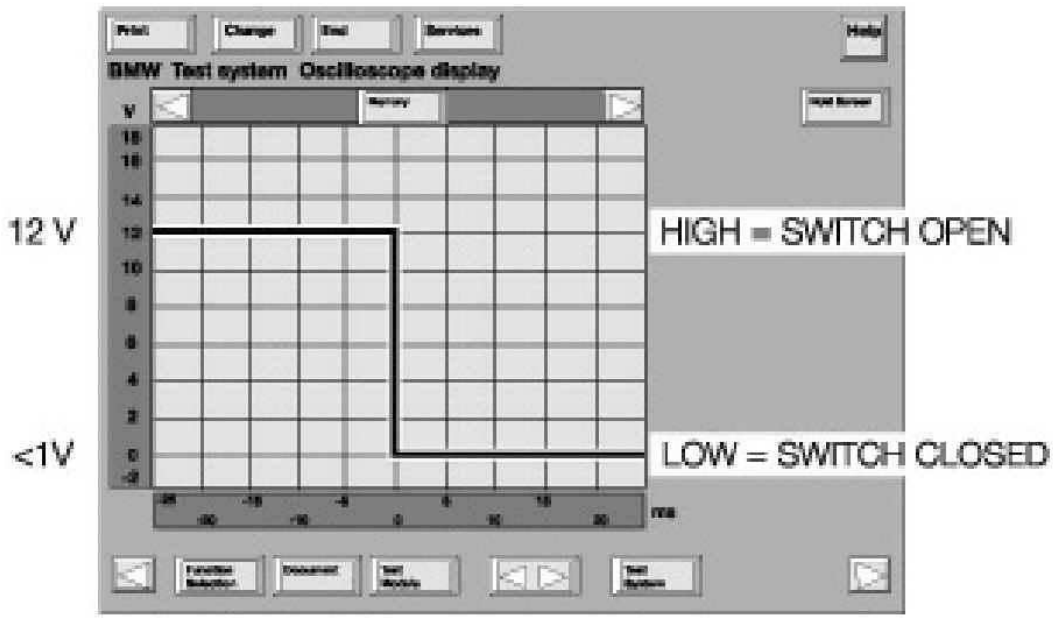


Fig. 18: Identifying Ground Signal
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of Switched B-

- Door Position Switch.
- Kickdown Position Switch.
- A/C Pressure Switch.

MODULATED SQUARE WAVE

A Modulated Square Wave is a series of High/Low signals repeated rapidly.

Like the switched signals (B+, B-) the square wave has only two voltage levels.

A high level and a low level.

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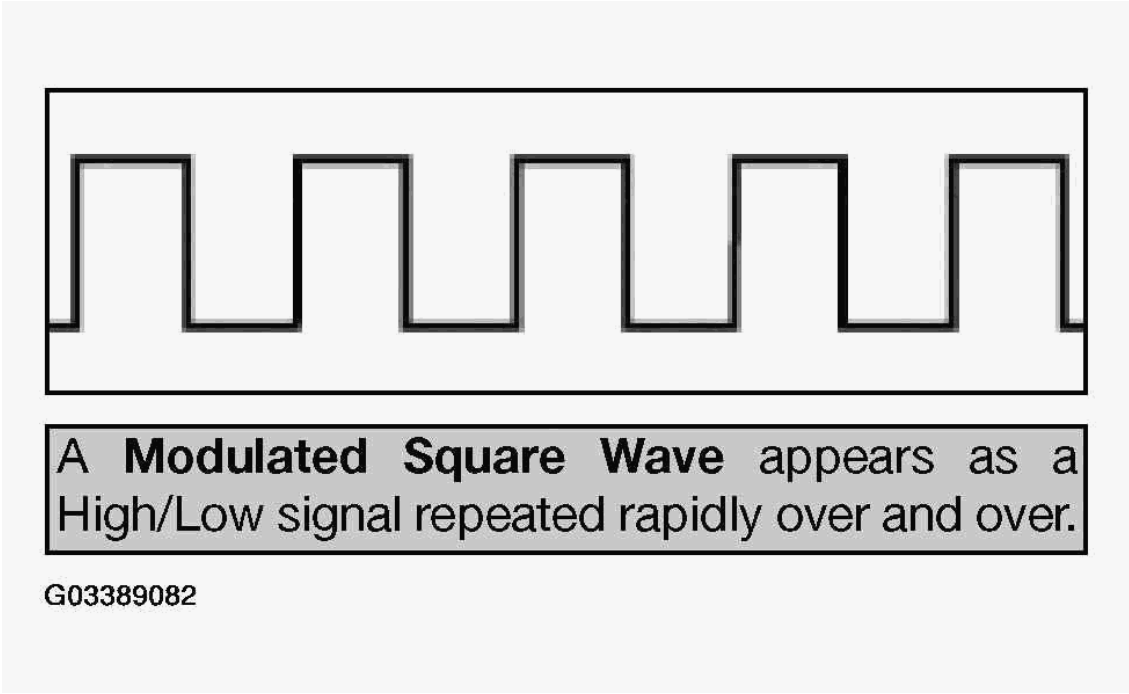


Fig. 19: Identifying Modulated Square Wave
Courtesy of BMW OF NORTH AMERICA, INC.

A modulated square wave has 3 characteristics that can be modified to vary the signal:

- Frequency.
- Pulse Width.
- Duty Cycle.

Frequency

The frequency of a modulated square wave signal is the number of complete cycles or pulses that occur in one second. This number of cycles or frequency is expressed in **Hertz (Hz)** . 1Hz = 1 complete cycle per second.

An output function may use a fixed or varied frequency.

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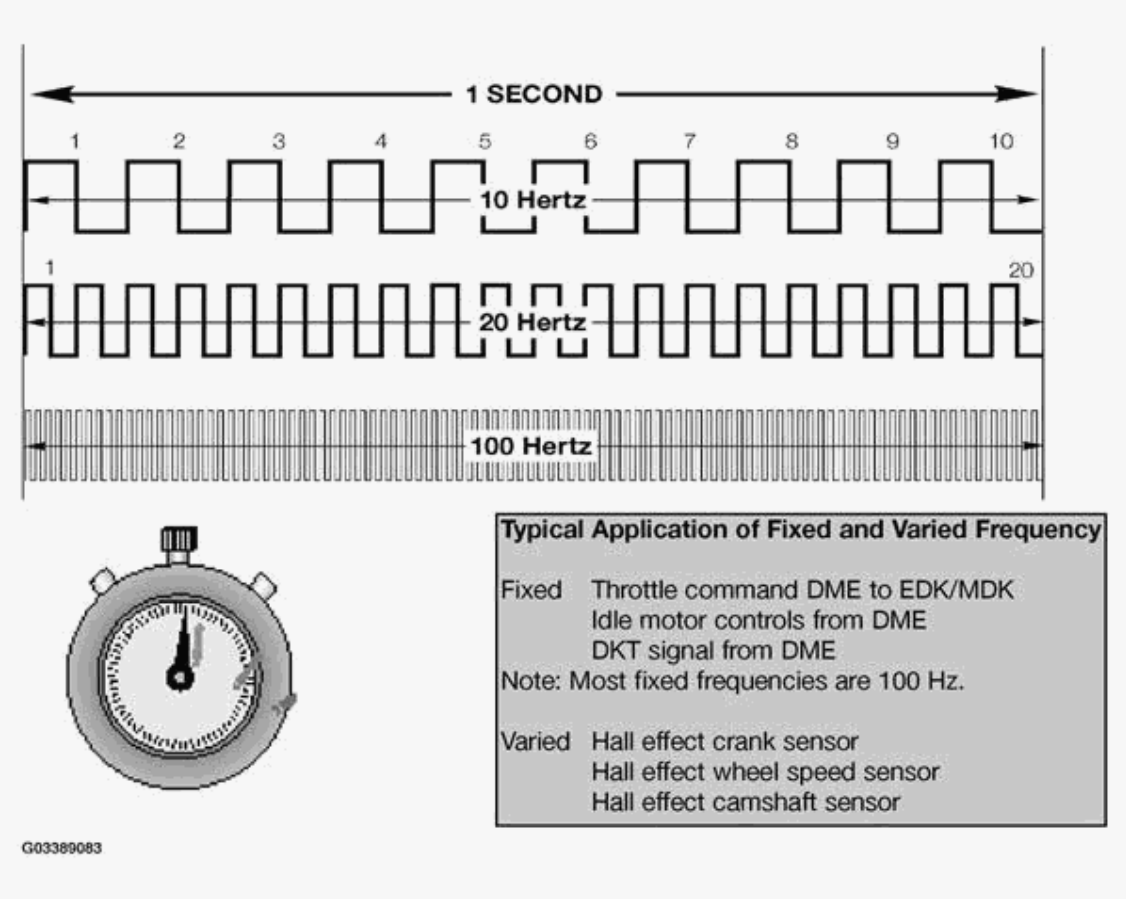


Fig. 20: Identifying Modulated Square Wave Signal
Courtesy of BMW OF NORTH AMERICA, INC.

Pulse Width

The Pulse Width of a square wave is the length of time one pulse is ON. Vehicle systems may use fixed or varied ON times or pulse width. Pulse width is expressed in **milliseconds** (ms).

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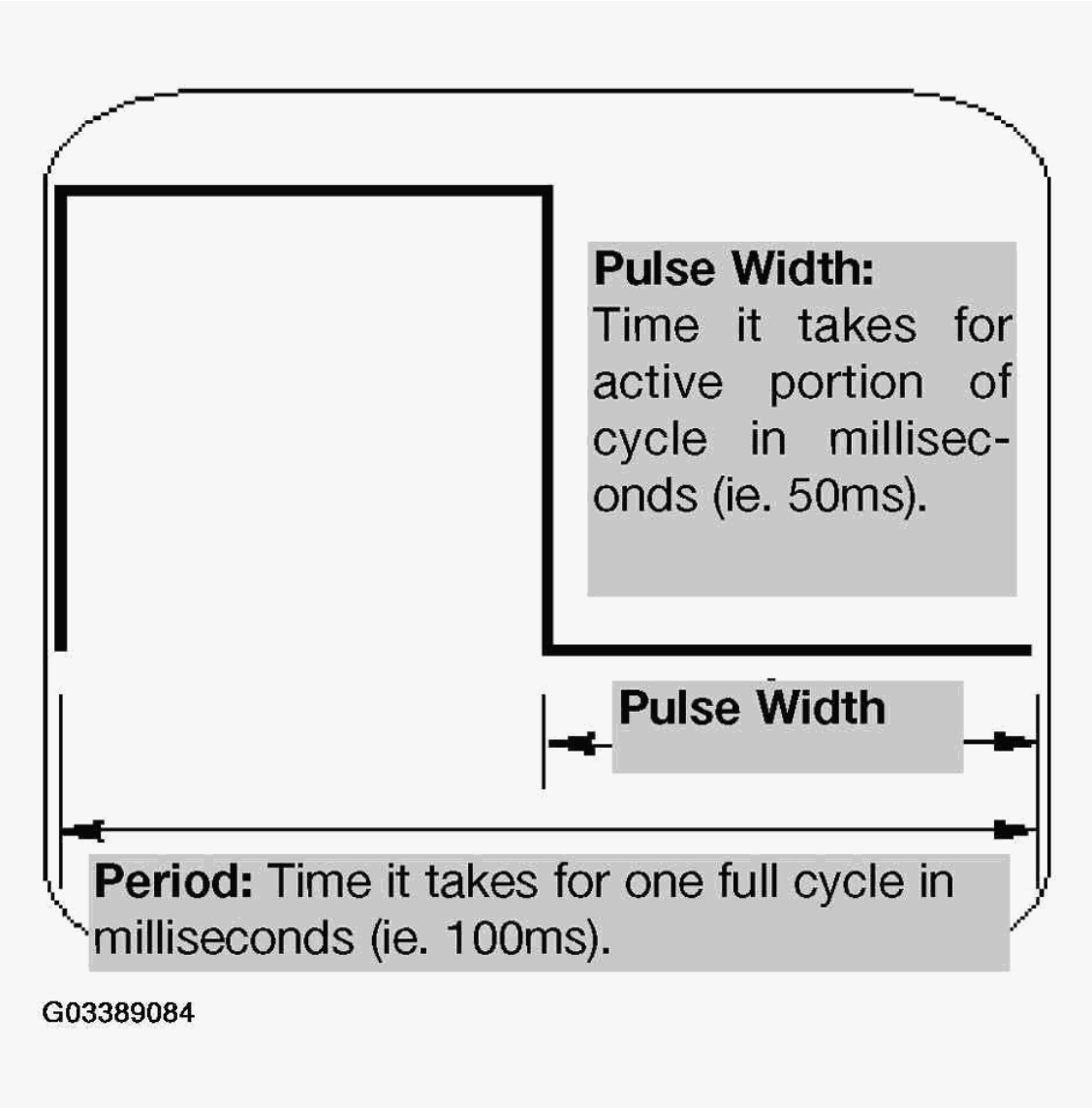


Fig. 21: Identifying Pulse Width Display
Courtesy of BMW OF NORTH AMERICA, INC.

Duty Cycle

The Duty Cycle of a square wave is the ratio of ON time to OFF time for one cycle.

Duty cycle is expressed in %.

Vehicle systems use both fixed duty cycle signals and variable duty cycle signals.

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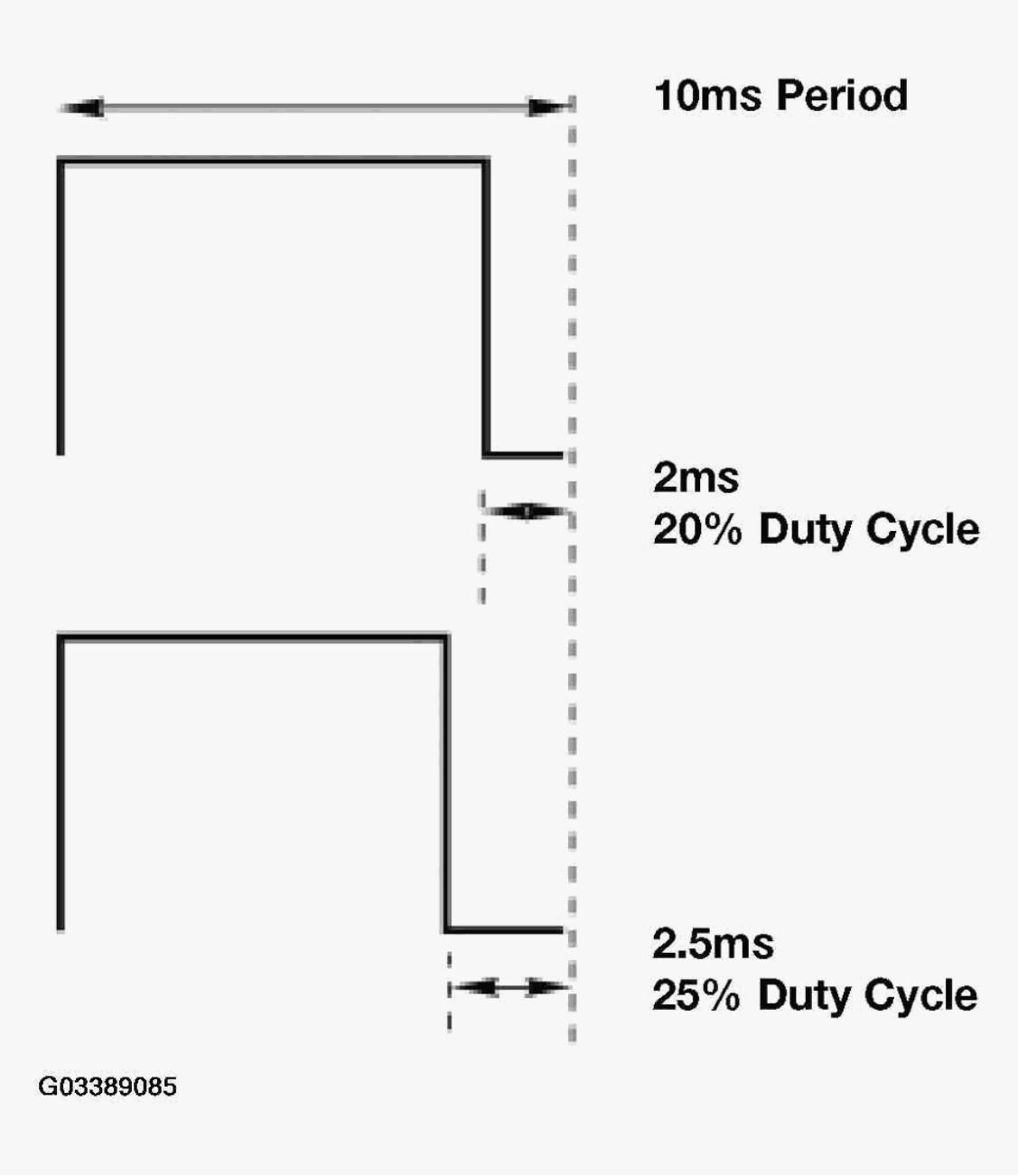


Fig. 22: Identifying Duty Cycle (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

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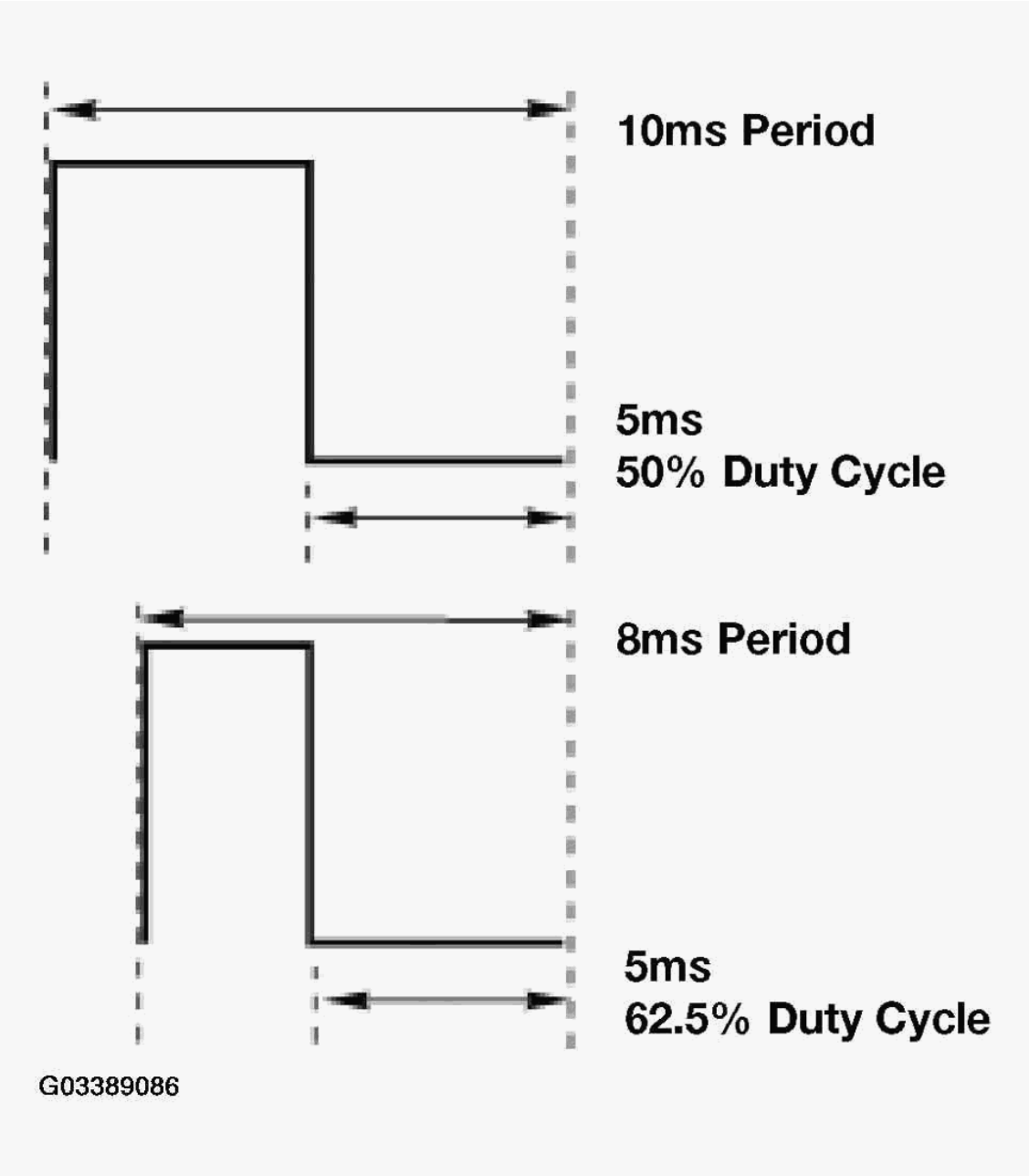


Fig. 23: Identifying Duty Cycle (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Time

1 second = 1000 milliseconds (ms).

1/2 second = 500 milliseconds.

1/4 second = 250 milliseconds.

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1/10 second = 100 milliseconds.

1/100 second = 10 milliseconds.

1/1000 second = 1 milliseconds.

HALL-EFFECT SENSORS

Hall Effect Sensors produce a modulated square wave.

Hall Effect Sensors are electronic switches that react to magnetic fields to rapidly control the flow of current or voltage ON and OFF.

The Hall Sensor consists of an epoxy filled non-magnetic housing containing a hall element and a magnet, and a trigger wheel.

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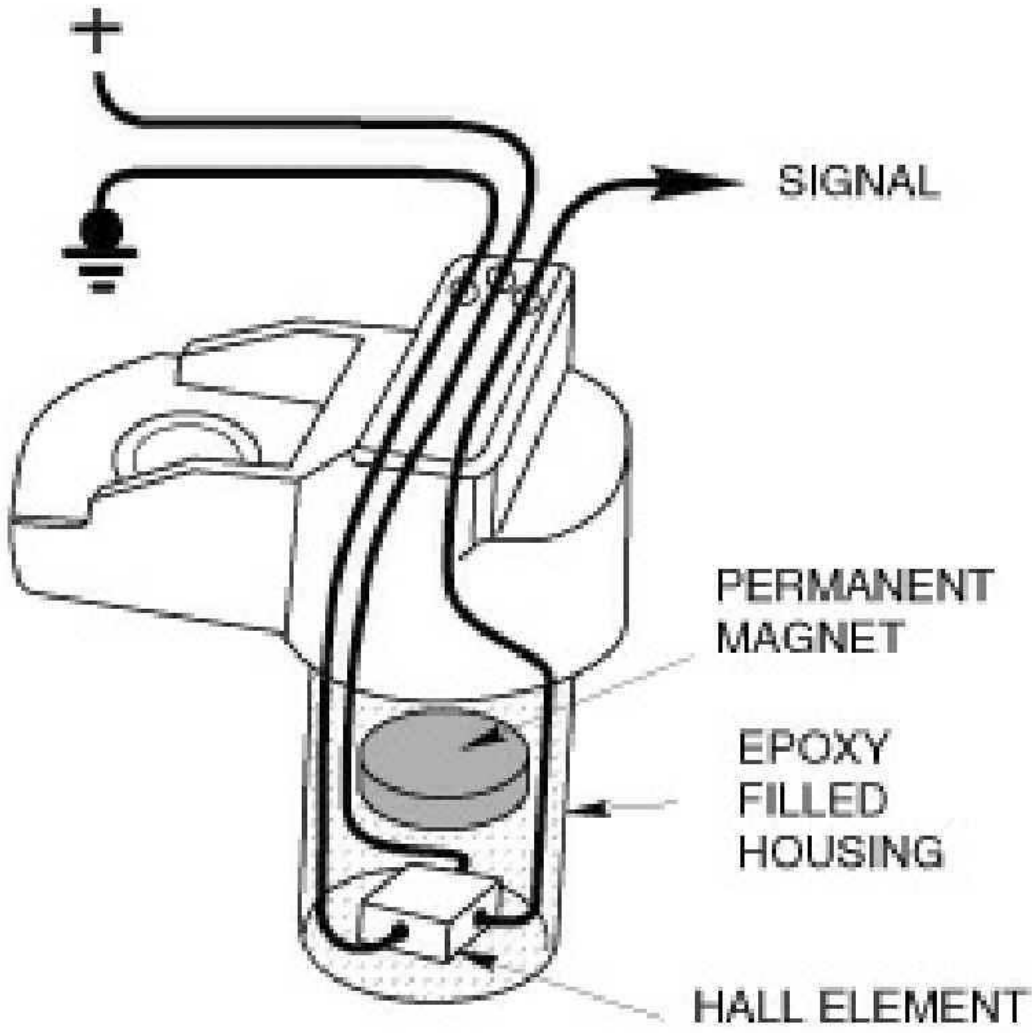


Fig. 24: View Of Hall Effect Sensors
Courtesy of BMW OF NORTH AMERICA, INC.

The Hall element is a thin non-magnetic plate which is electrically conductive. (Voltage will flow through the plate.) Electron flow is equal on both sides of the plate.

Since everything between the magnet and the hall element is non-magnetic the magnet (magnetic field) has no effect on the current flow.

As a metal disk or solid area of a toothed wheel, flywheel or other trigger device approaches the sensor, a magnetic field is created between the magnet and the disk.

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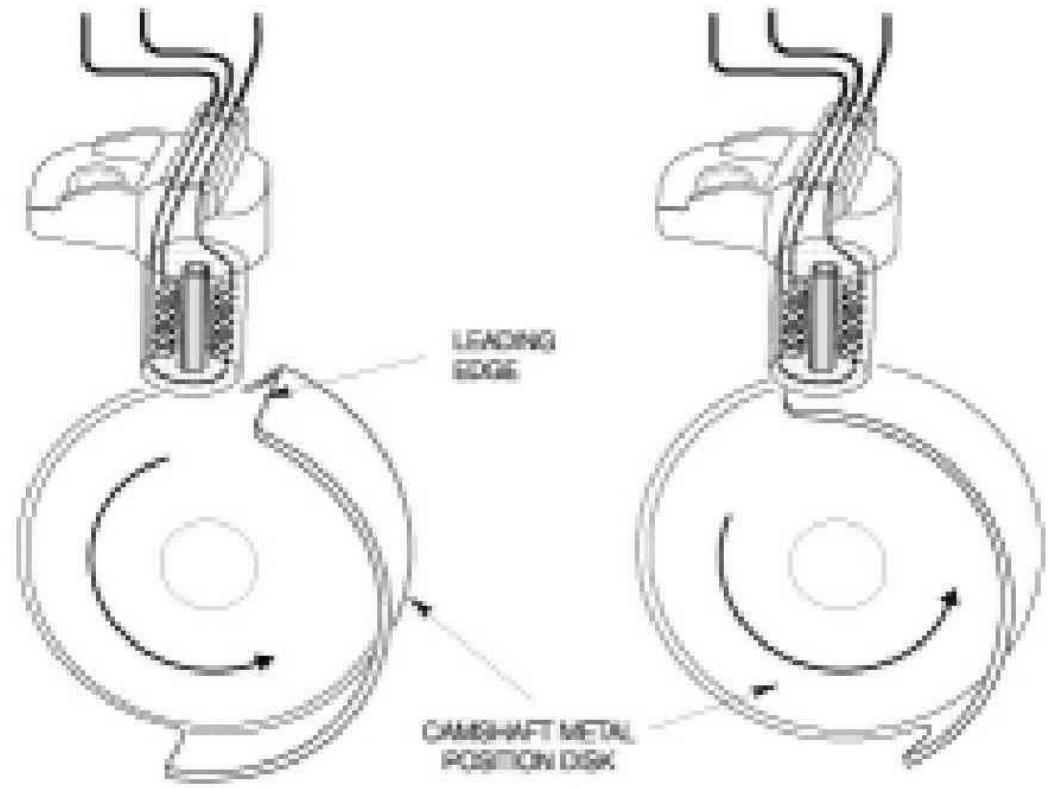


Fig. 25: Identifying Magnetic Field
Courtesy of BMW OF NORTH AMERICA, INC.

The magnetic field cause the electron flow to stop on one side of the plate. Electrons continue to flow on the other side of the plate.

The Hall Sensor Signal is a measurement of the voltage drop between the two sides of the plate or element.

When the magnetic field increases (disc or solid toothed area in front of sensor) the voltage drop across the two sides of the element increases. High voltage on one side, little on the other. The signal output from the sensor is High.

As the disc moves away from the sensor the magnetic fields weakens and is lost. The loss of the magnetic field (blank toothed or open area of the wheel in front of the sensor) produces very little voltage drop across the two sides of the element. The output signal is Low.

This rapid switching of the voltage ON/OFF produces a HIGH/LOW signal that the control module uses to recognize speed and position.

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Examples of Hall Effect Sensors

Motor Position Hall Sensors

Hall sensors are used on many electric motors to monitor speed and position. (i.e. electric window motors and sunroof motors.)

The Hall Effect principal is the same except the magnet is placed on the shaft of the motor.

The magnet is aligned to rotate in a precise position in front of the element. The polarization of the magnetic ring causes a polarity switch in the Hall element to occur as it rotates The square wave produced provides speed and position information to the control module.

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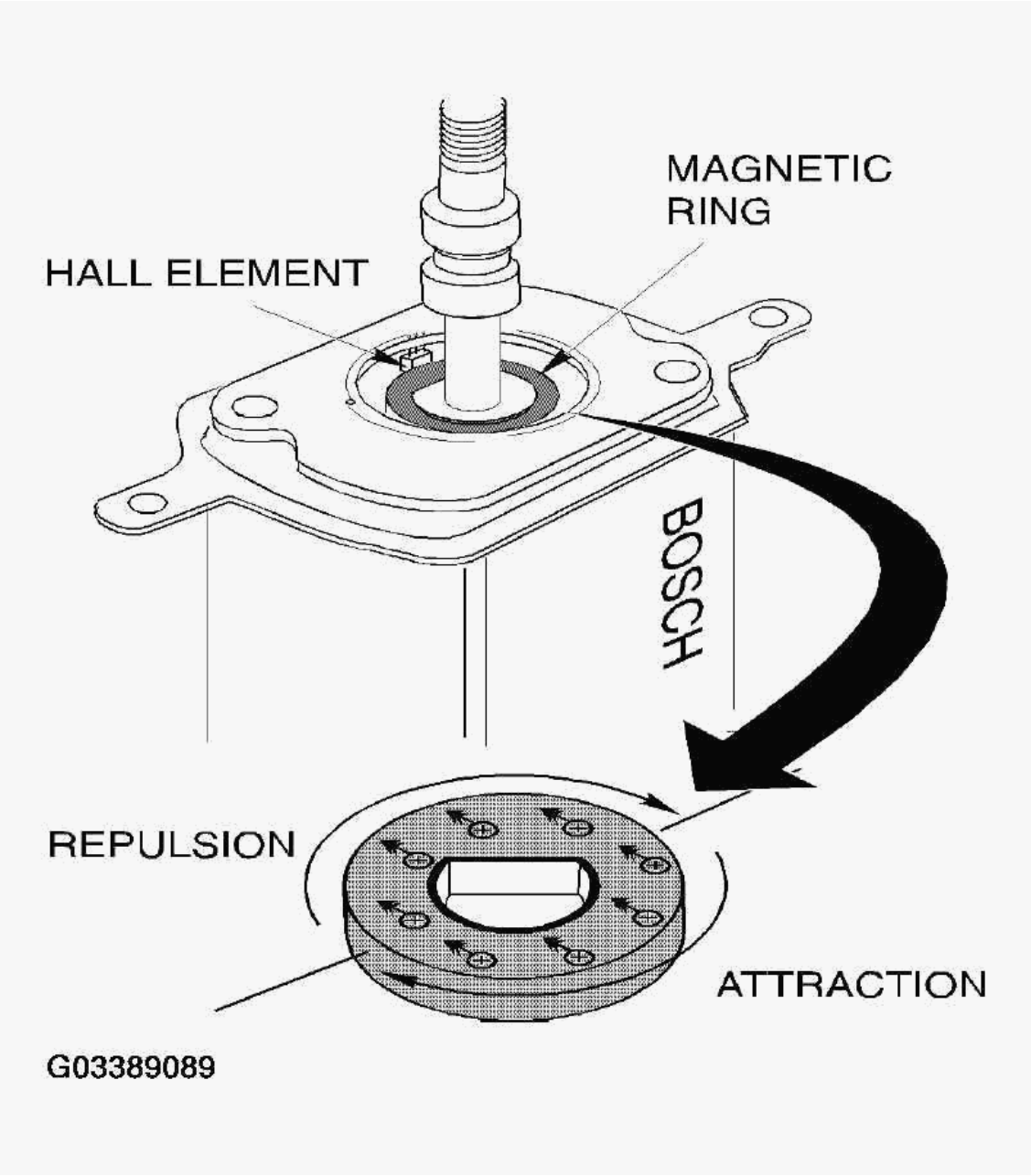


Fig. 26: Identifying Motor Position Hall Sensors
Courtesy of BMW OF NORTH AMERICA, INC.

Wheel Speed Hall Effect Sensors

Hall Effect sensors are used to indicate wheel speed.

Conventional Hall Effect Sensors use three wires, power supply (usually 5v or 12v) a ground wire and a signal wire back to the control module.

The Hall Effect sensors used as wheel speed sensors are unique in that they are two wire Hall Effect Sensors.

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The two wire sensors eliminate the separate ground wire and the signal wire functions as the ground also.

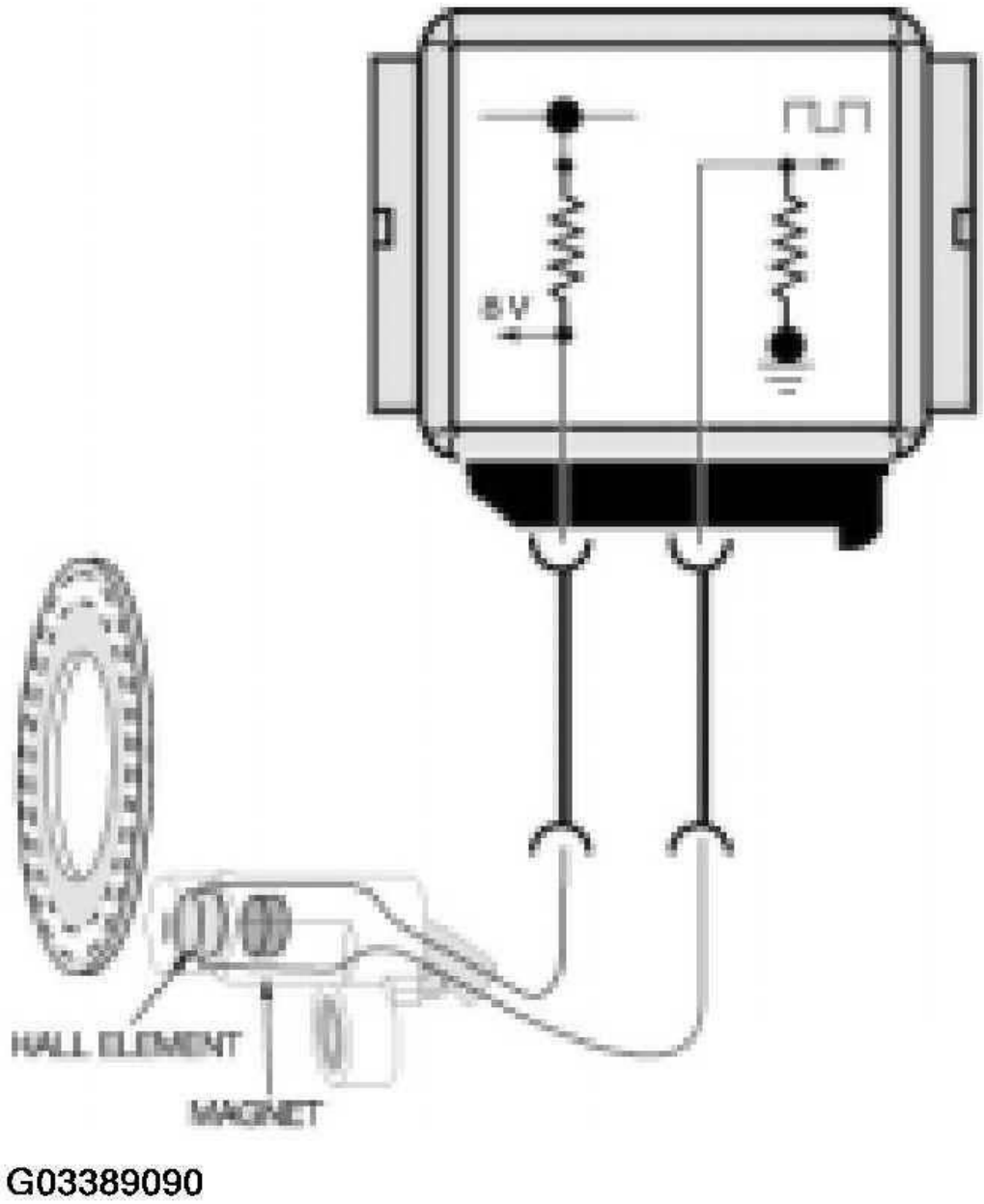


Fig. 27: Identifying Wheel Speed Hall Effect Sensors
Courtesy of BMW OF NORTH AMERICA, INC.

The unique two wire arrangement provides the control module with a HIGH/LOW signal having a low voltage of .75 volts and a high voltage of 2.5 volts.

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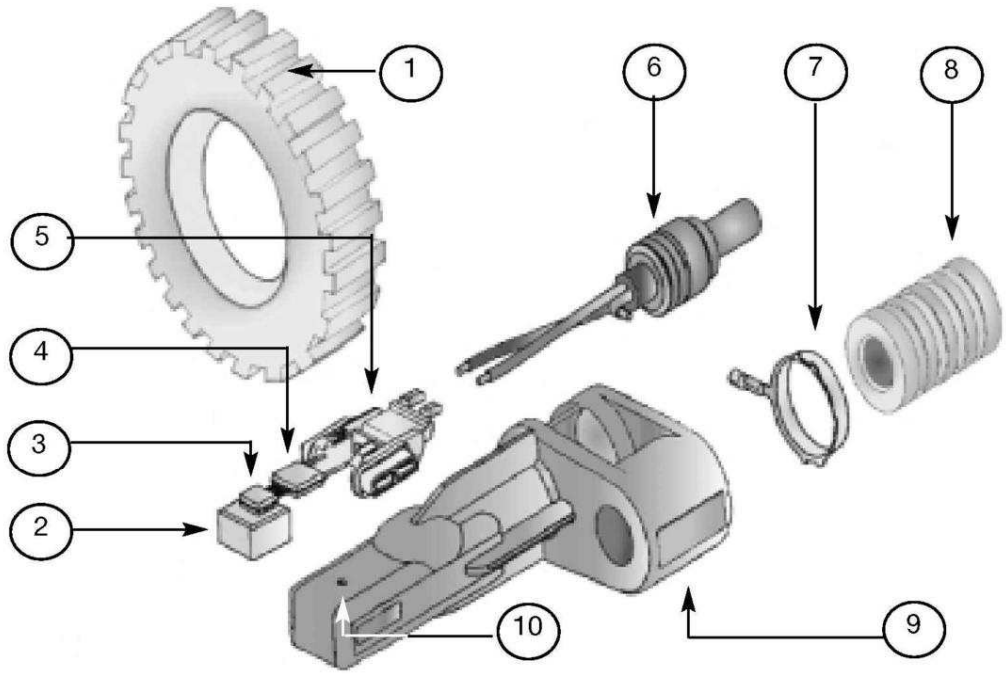
Typical Application of Hall Effect sensors

- Crankshaft Sensors.
- Motor Position and Speed Sensors (e.g. Window Motor, Sunroof Motor).
- Camshaft Sensors.
- Wheel Speed Sensors.

MAGNETORESISTIVE SENSORS

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.



1. Metal Pulse Wheel
2. Magnet
3. Sensor Element
4. Evaluation Module
5. Support for Sensor Element
6. Sensor Wiring With Weather Boot
7. Ground Contact Ring
8. Fastening Element
9. Sensor Housing
10. Pick-Up Surface

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Fig. 28: Exploded View Of Magnetoresistive Sensors
Courtesy of BMW OF NORTH AMERICA, INC.

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The sensor element is a ferromagnetic alloy that changes its resistance based on the influence of magnetic fields.

As the high portion of the pulse wheel approaches the sensing element a deflection of the magnetic field stream is created. This creates a resistance change in the thin film ferromagnetic layer of the sensor element.

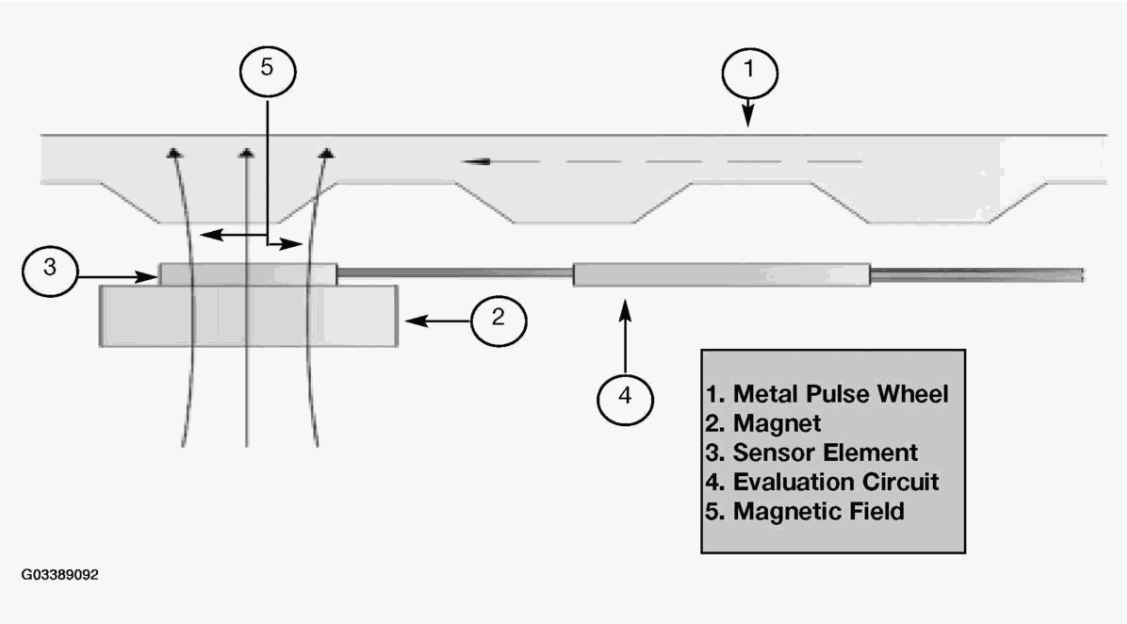


Fig. 29: View Of Sensor Element
Courtesy of BMW OF NORTH AMERICA, INC.

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.

The resistance change in the sensor element affects the voltage that is supplied by the evaluation circuit. The small amount of voltage provided to the sensor element is monitored and the voltage changes (1 to 100mv) are converted into current pulses by the evaluation module.

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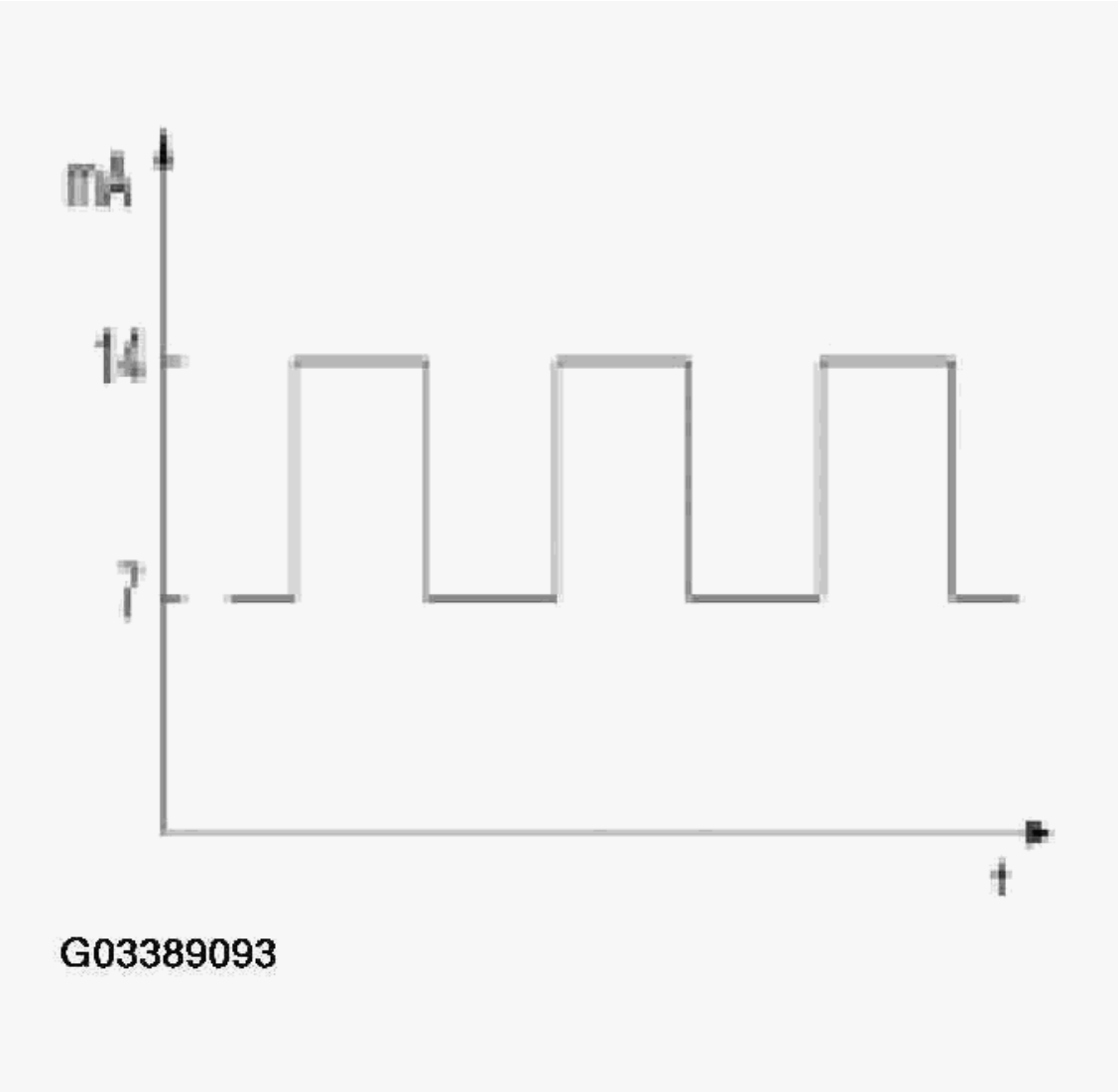


Fig. 30: Identifying High And Low Current Pulses
Courtesy of BMW OF NORTH AMERICA, INC.

- Signal Low-**7mA** .
- Signal High-**14mA** .

The sensor is supplied 12V by the control unit. Output voltage from the sensor is approximately 10V. The control unit counts the high and low current pulses to determine the wheel speed.

Typical Application of Magnetoresistive Sensor:

- Found Currently on E46 with Teves DSCIII MK-60.

DESIGNATED VALUE SIGNALS

Designated values are produced through fixed resistance positions of a multi-position switch. As the switch is

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operated the voltage drop across the resistor(s) of each switch position causes the voltage level of the input signal to change to a predetermined voltage value.

These predetermined (designated) voltages signal the control module to perform specific functions.

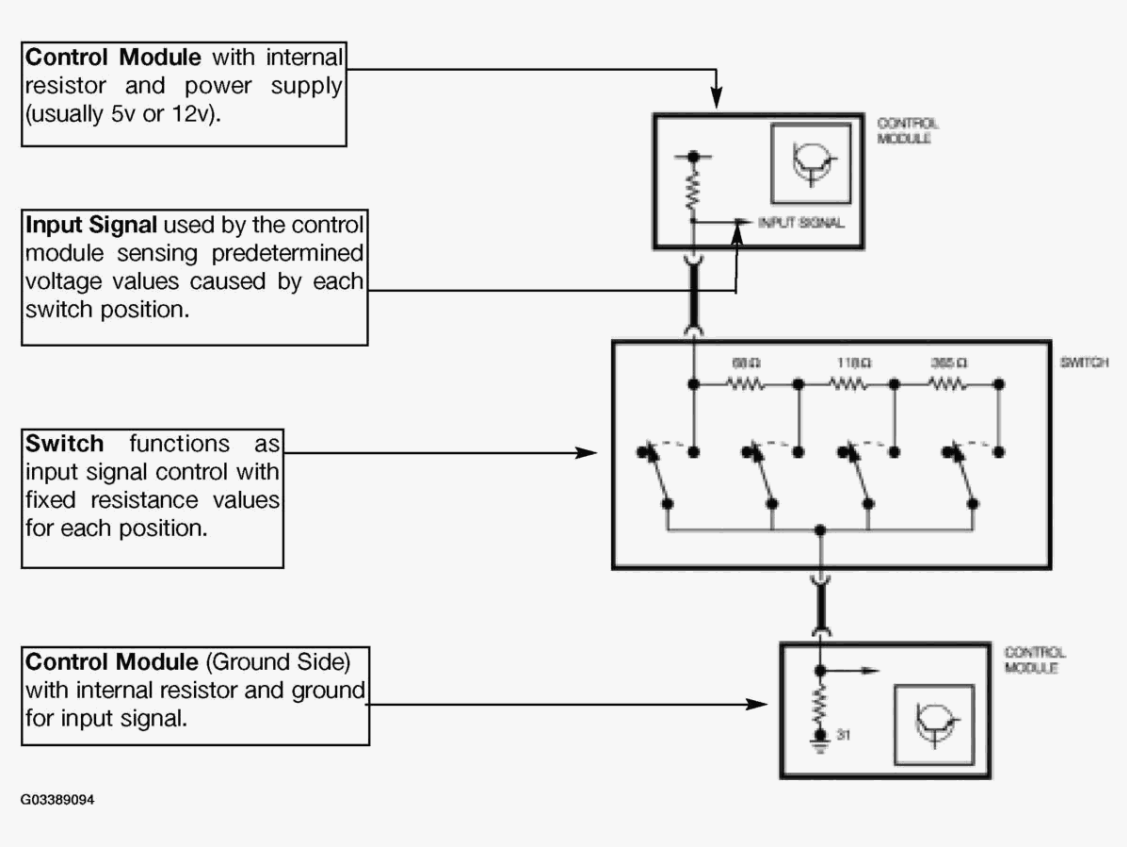


Fig. 31: Identifying Designated Value Signals
Courtesy of BMW OF NORTH AMERICA, INC.

Voltage Values seen as input by control module.

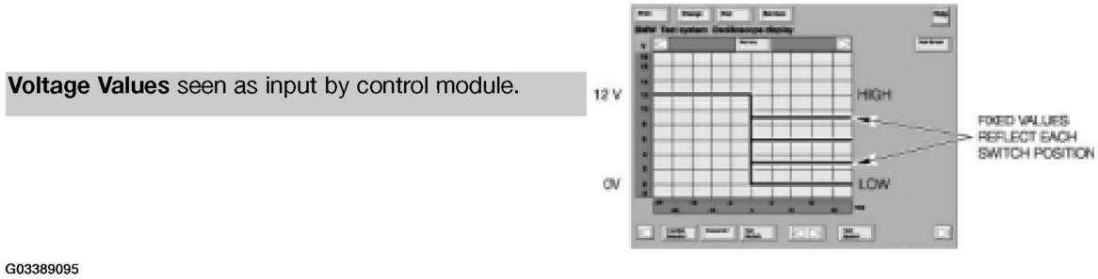


Fig. 32: Voltage Values Display
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of Designated Values:

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- Cruise Control Switch On E 32.
- Seat and Mirror Memory Position Buttons.

Coded Ground Signals

Coded ground signals produce a set of High/Low requests, the combination (pattern) of which is interpreted by the control module to perform a specific function. Coded ground signals are generated through a switch or series of switches signaling the control module requests for operation.

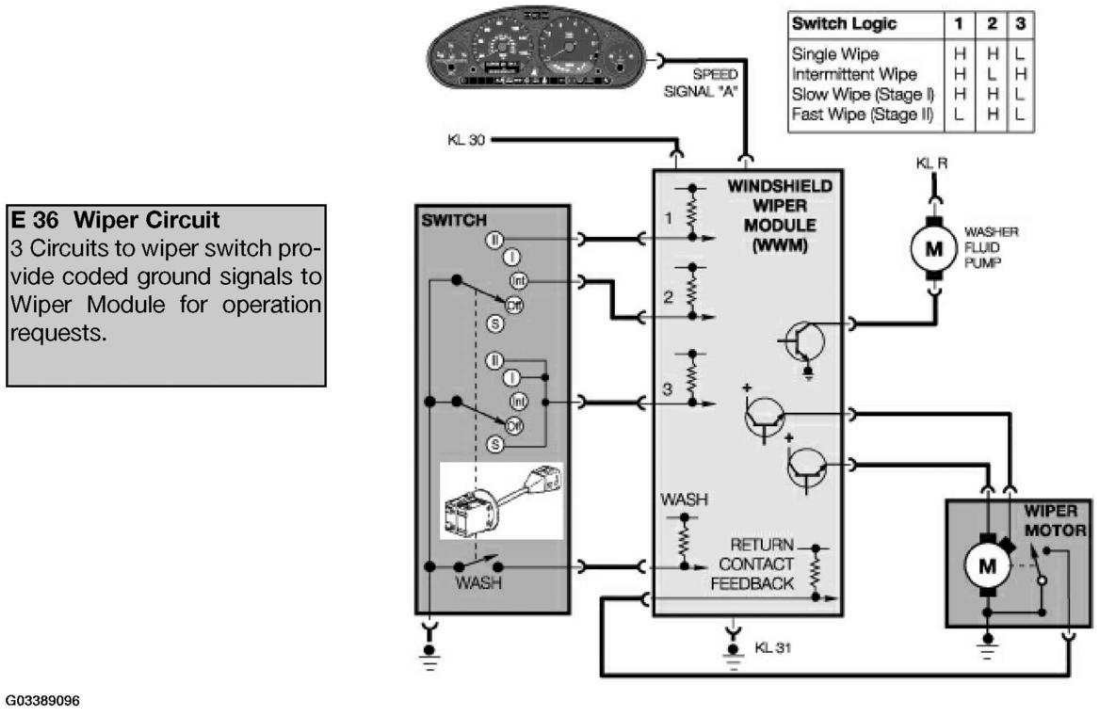


Fig. 33: Identifying E 36 Wiper Circuit
Courtesy of BMW OF NORTH AMERICA, INC.

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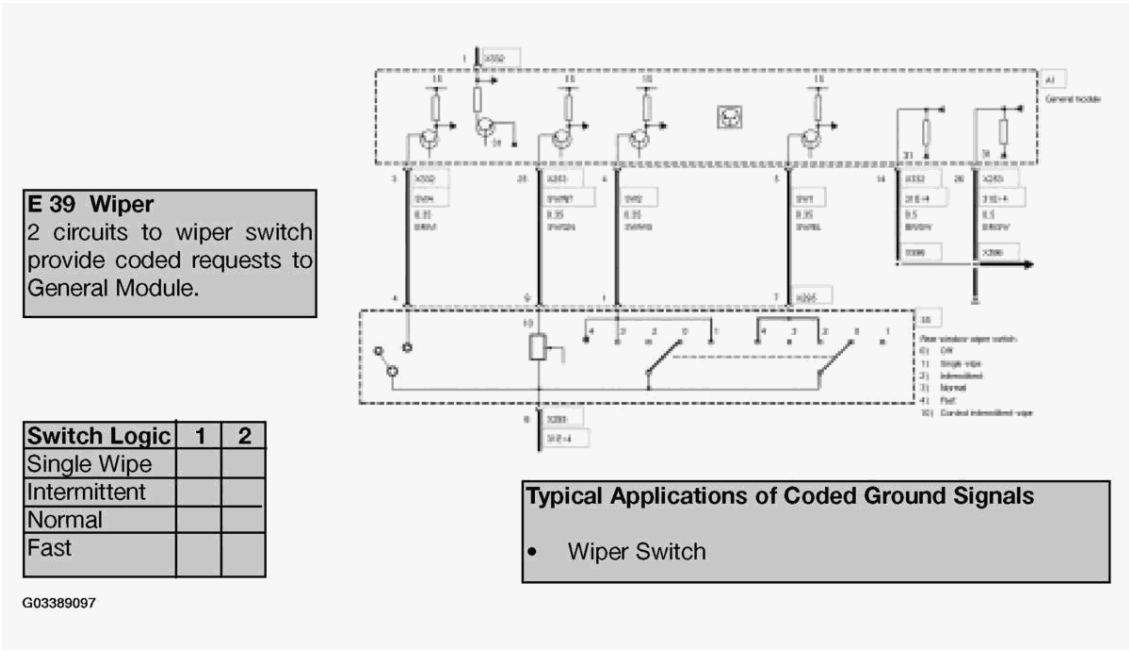


Fig. 34: Identifying E 39 Wiper Circuit
Courtesy of BMW OF NORTH AMERICA, INC.

TRANSISTOR FUNCTION

The transistor takes on a number of applications that must be understood to effectively analyze a circuit.

The transistor in operation functions as two parts much like a relay. Both the relay and the transistor control high currents with a low current signal.

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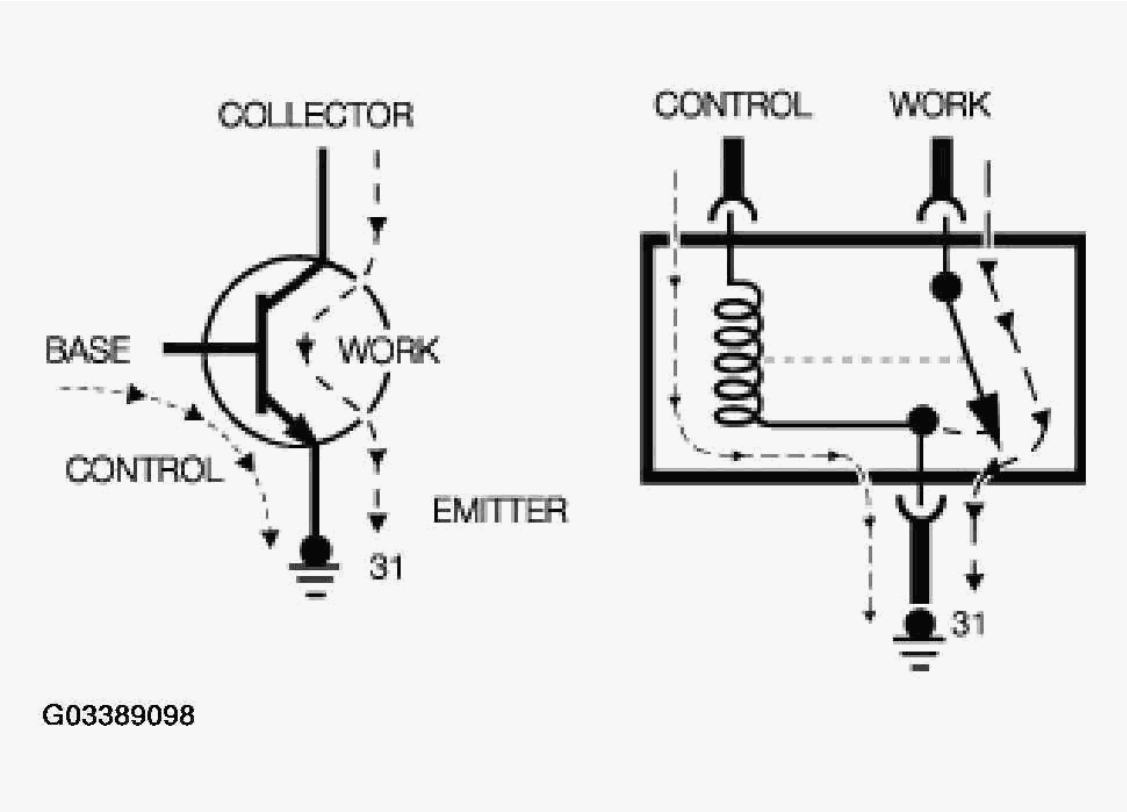


Fig. 35: Identifying Transistor Final Stage Function (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

The base/emitter path functions as the control circuit activated by the control module to oversee or control the work.

The collector/emitter path functions as the work side of the circuit, supplying power or switching on the work.

In operation the transistor can be switched ON momentarily, or supply a constant power or ground.

The transistor can also be modulated or pulsed to supply a modulated square wave signal.

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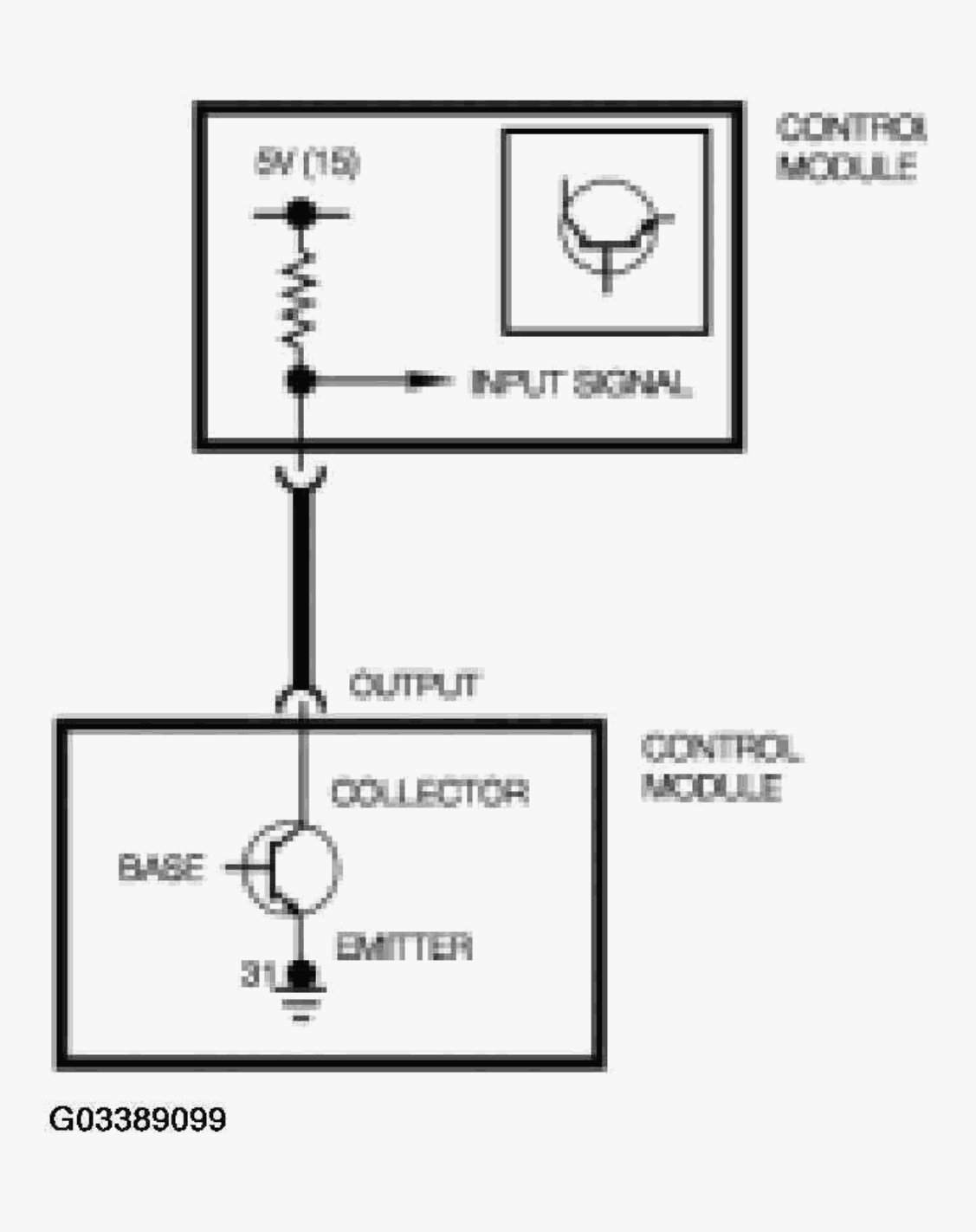


Fig. 36: Identifying Transistor Final Stage Function (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Modulated, Momentary, Constant B- as Input/Output

The input signal of control module 1 is an output signal of control module 2.

Control module 2 through activation of its internal transistor provides a ground input for control module 1.

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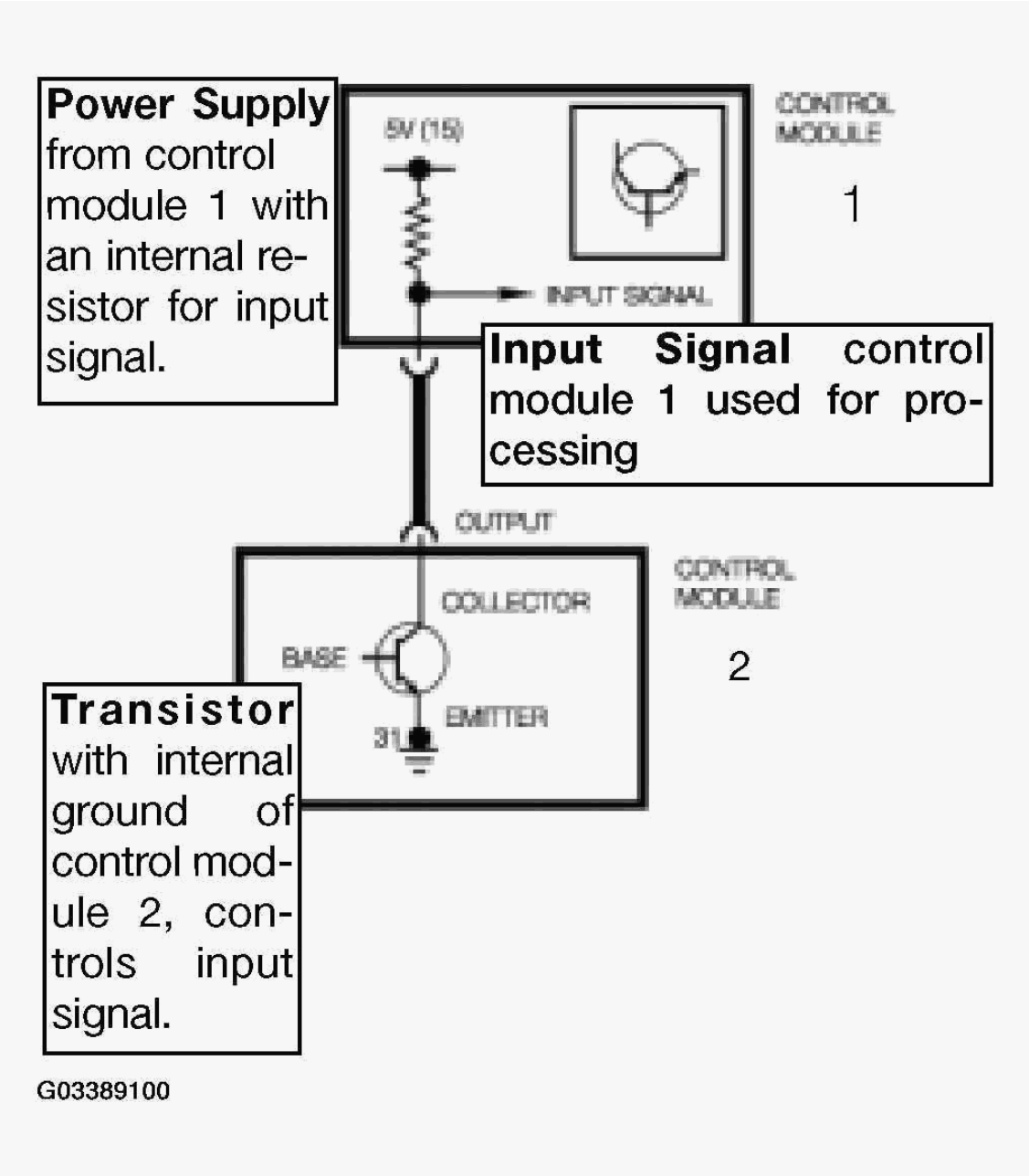


Fig. 37: Identifying Modulated, Momentary, Constant B- As Input/Output Function
Courtesy of BMW OF NORTH AMERICA, INC.

The input signal at control module 1 is either a momentary/constant signal (i.e torque convertor signal from TCM to DME) or a modulated signal (i.e. vehicle speed signal ASC to DME).

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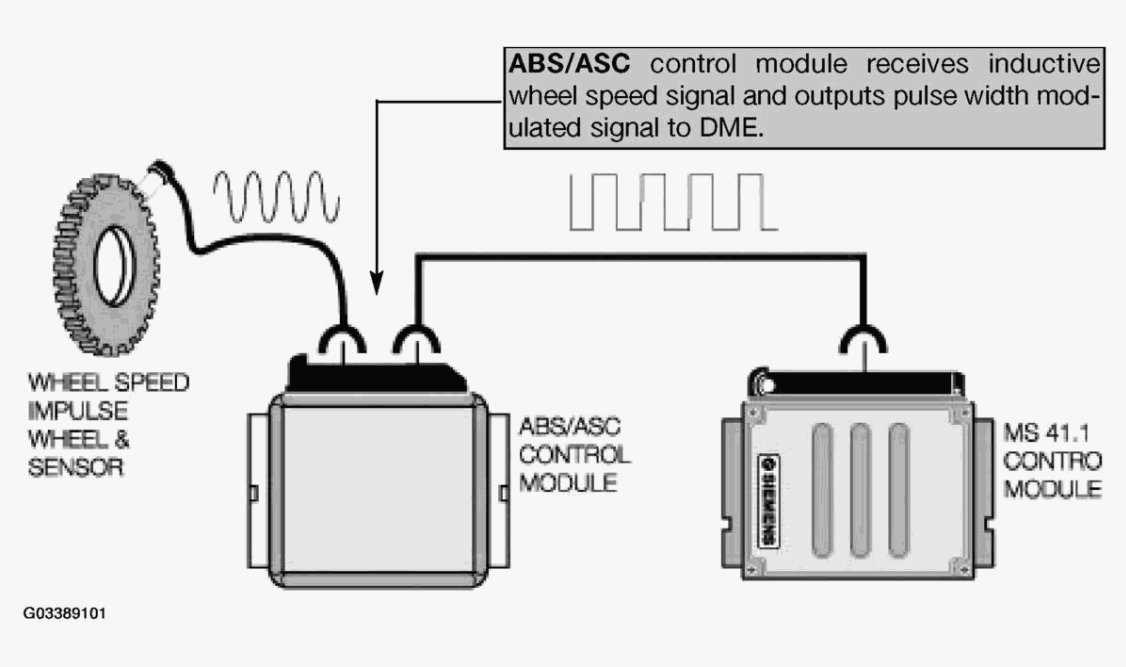


Fig. 38: Identifying Wheel Speed Signal And Output Pulse
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of Modulated, Momentary, Constant B- as Input/Output Signal:

- A/C KO Signal.
- Speed Signal From ABS/ASC.
- TI/TD Output Signal From DME.

Momentary/Constant B^+ as an Input/Output Signal

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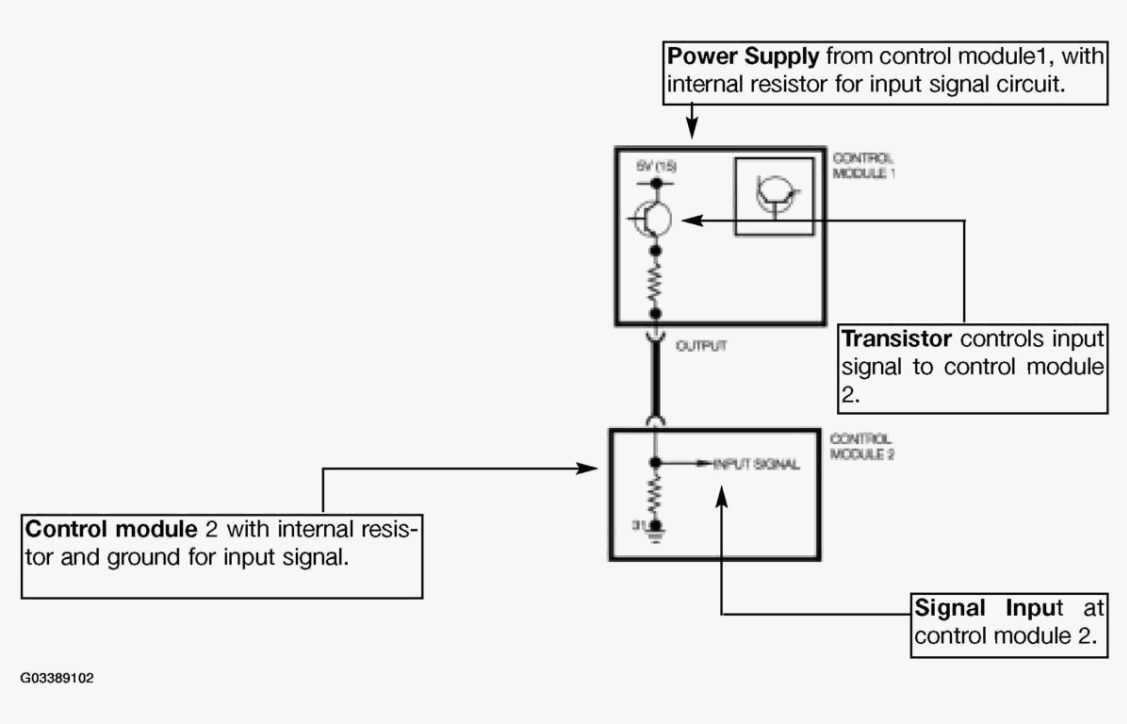


Fig. 39: Identifying Momentary/Constant B As An Input/Output Signal Function
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of Momentary/Constant B^+ as an Input/Output Signal:

- OBC Code Signal to DME.
- A/C Signal to DME.

Constant B-/B+ To Energize a Component

Constant B-

Output function to energize a component.

Relay is energized by control module.

Internal activation of the transistor provides a ground for the relay coil.

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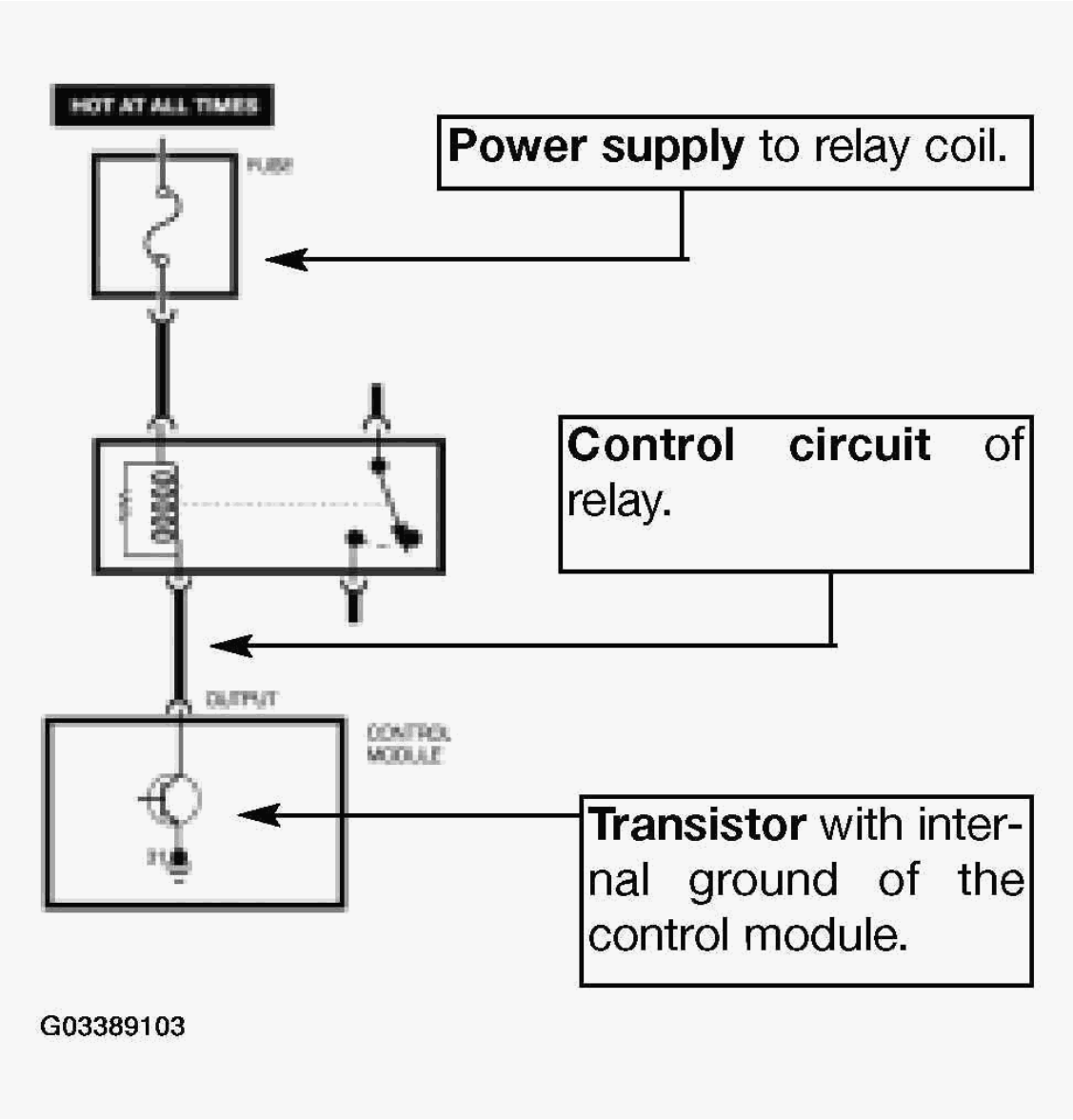


Fig. 40: Identifying Output Function To Energize Component (Constant B-)
Courtesy of BMW OF NORTH AMERICA, INC.

Constant B+

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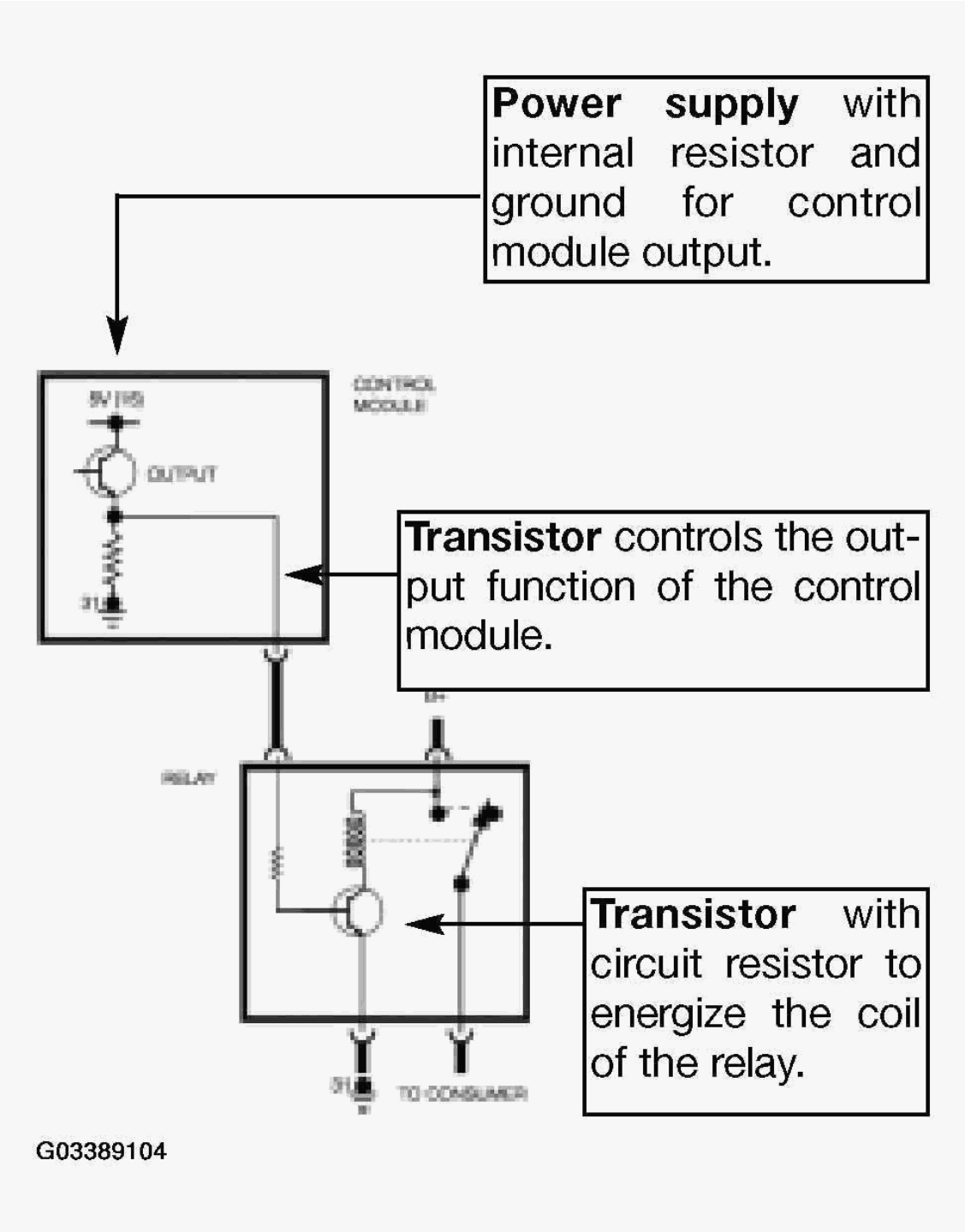


Fig. 41: Identifying Output Function To Energize Component (Constant B+)
Courtesy of BMW OF NORTH AMERICA, INC.

Control module output function to energize a component.

Transistor controls output function of the control module.

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Control module supplies power to the relay. The relay is activated by the control module through internal activation of the transistor which provides a ground for the relay coil.

Modulated B-/B+ To Operate A Component

Modulated B-

Output function to operate a component.

The idle valve motor is operated by the control module through internal activation of the transistor which provides a ground for the open winding of the valve.

The idle control valve is operated by regulation of the duty cycle at a specific frequency.

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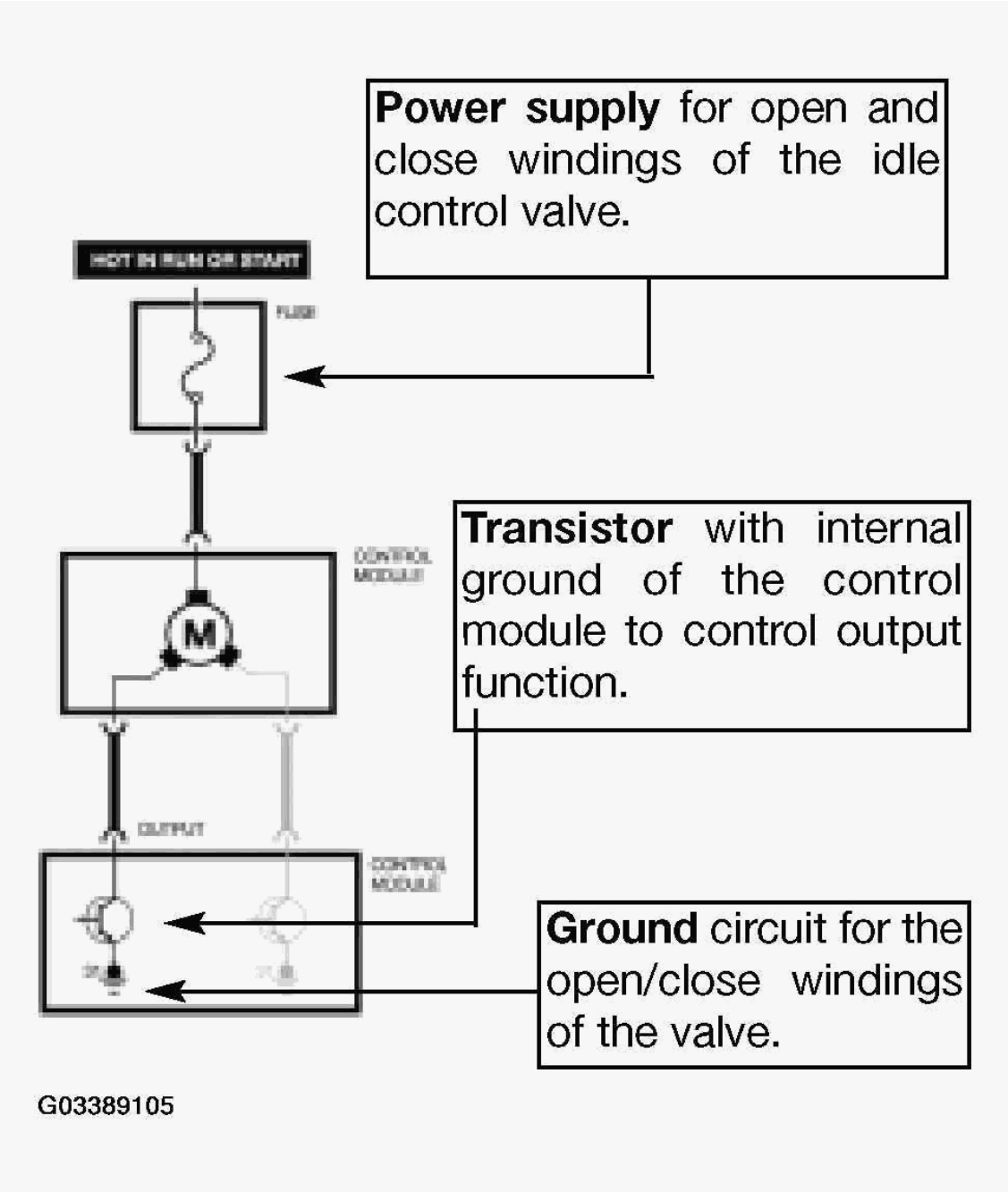


Fig. 42: Identifying Output Function To Operate Component (Modulated B-)
Courtesy of BMW OF NORTH AMERICA, INC.

Typical Application of modulated B-

- Idle Control Motor.
- Purge Valve.
- Injector.
- Ignition Coil.

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Modulated B+

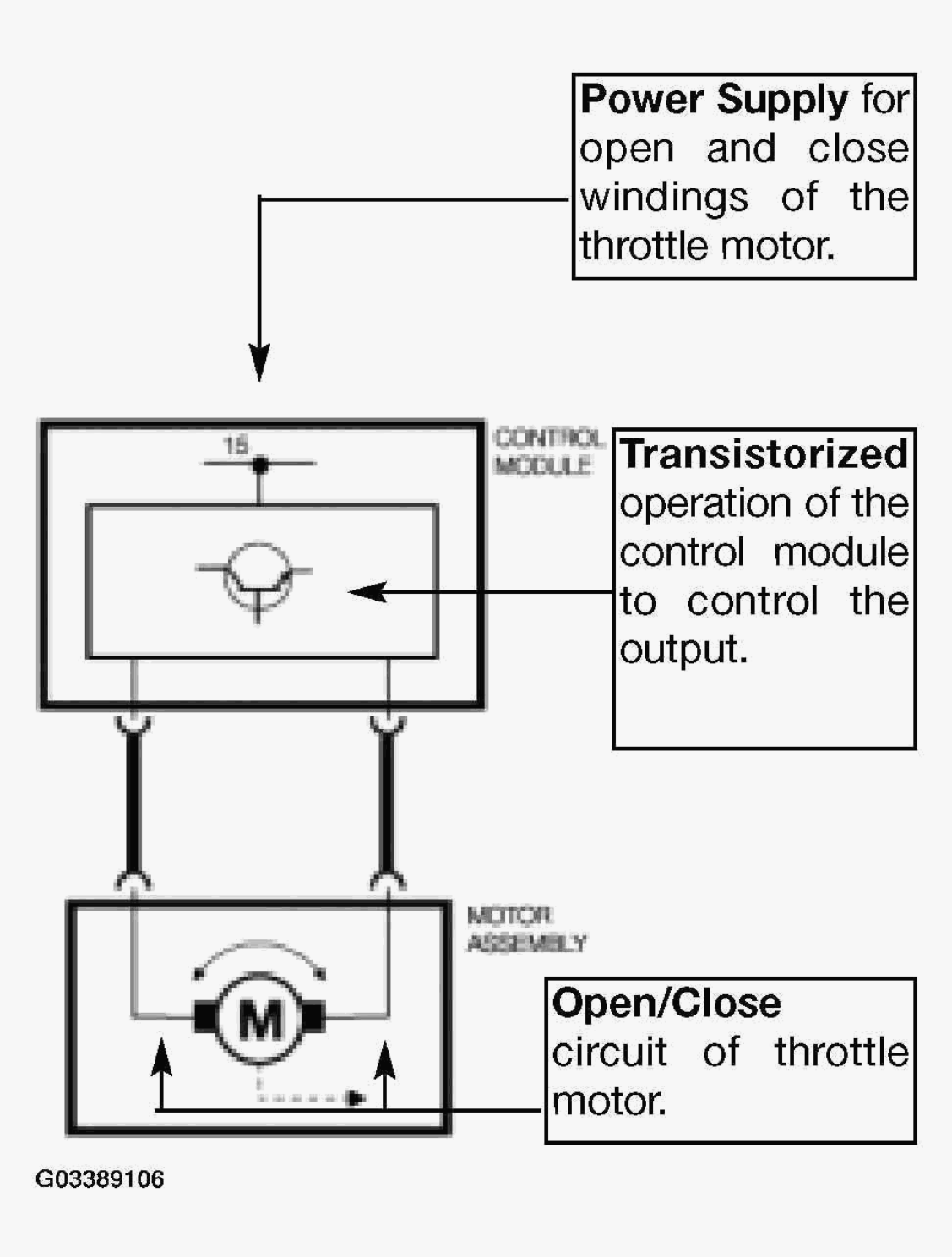


Fig. 43: Identifying Output Function To Operate Component (Modulated B+)
Courtesy of BMW OF NORTH AMERICA, INC.

Output function to operate a component.

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The motor is controlled by a transistorized function of the control module, which provides a modulated voltage at a specific frequency to the motor. The throttle position is changed by altering the Duty Cycle of the pulses.

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GENERAL INFORMATION

Emissions - Overview

EMISSION OVERVIEW

Models: All Equipped with OBD II

Production Date: 1995 to Present

Manufacturer: Bosch and Siemens Engine Control Modules

Pin Connector: 88 and 134 Pins

EMISSIONS OVERVIEW

What Is OBD?

Today many of the engine's control systems such as throttle opening, fuel injection, ignition, emissions and performance are controlled by an electronic control module and the related sensors and actuators. The first on-board diagnostic (OBD) systems were developed by the manufacturer as a way to detect problems with the electronic systems.

Beginning with 1994 model year, requirements for OBD systems have been established by the EPA and CARB. The purpose of the OBD system is to assure proper emission control system operation for the vehicle's lifetime by monitoring emission-related components and systems for deterioration and malfunction. This includes also a check of the tank ventilation system for vapor leaks.

The OBD system consists of the engine and transmission control modules, their sensors and actuators along with the diagnostic software. The control modules can detect system problems even before the driver notices a driveability problem because many problems that affect emissions can be electrical or even chemical in nature.

What Happens If A Problem Is Detected?

When the OBD system determines that a problem exists, a corresponding "Diagnostic Trouble Code" is stored in the control module's memory.

The control module also illuminates a yellow dashboard Malfunction Indicator Light indicating "Check Engine" or "Service Engine Soon" or displays an engine symbol.

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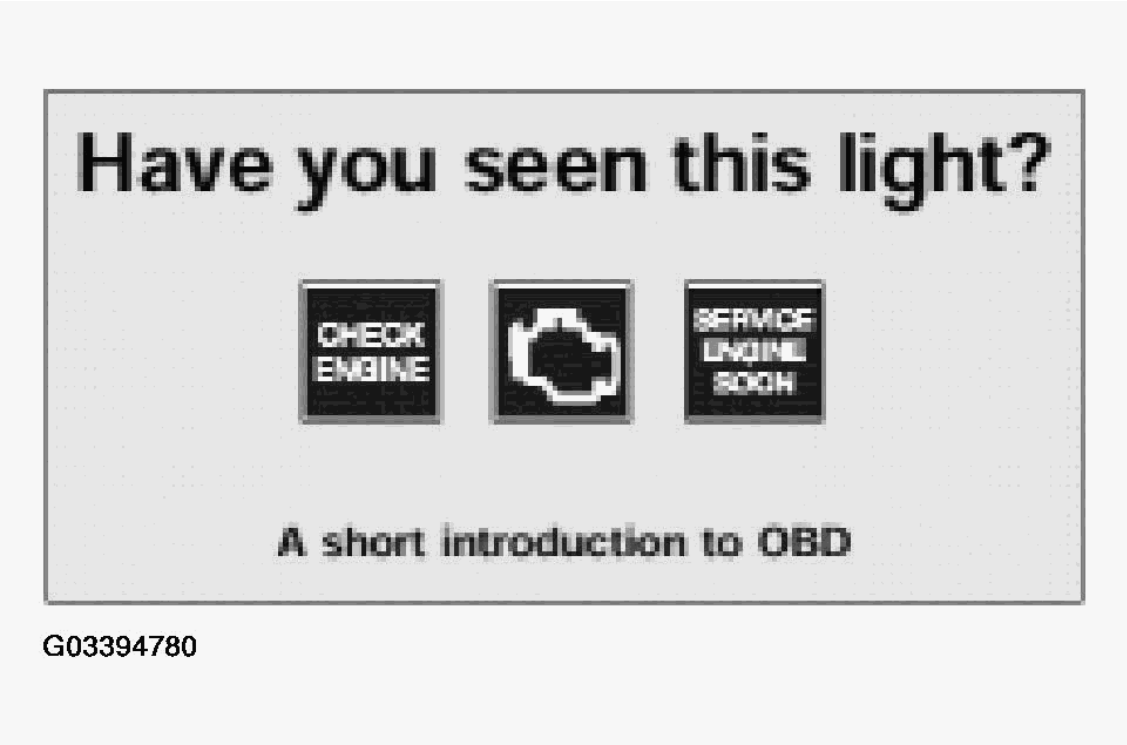


Fig. 1: Identifying OBD System
Courtesy of BMW OF NORTH AMERICA, INC.

This light informs the driver of the need for service, NOT of the need to stop the vehicle. A blinking or flashing dashboard light indicates a rather severe level of engine misfire.

After fixing the problem the Fault code is deleted to turn off the light. If the conditions that caused a problem are no longer present the vehicle's OBD system can turn off the dashboard light automatically. If the OBD system evaluates the component or system three consecutive times and no longer detects the initial problem, the dashboard light will turn off automatically.

What Is The Most Common Problem Detected By OBD?

Fuel Filler Cap

If the fuel filler cap is not properly closed after refueling, the OBD system will detect the vapor leak that exists from the cap not being completely tightened.

If you tighten the cap subsequently, the dashboard light should be extinguished within a few days or after deleting the Fault code. This is not an indication of a faulty OBD system. The OBD system has properly diagnosed the problem and accordingly alerted the driver by illuminating the dashboard light.

Please check the fuel filler cap first when the dashboard light comes on to avoid unnecessary diagnostic time. To check the fuel filler cap turn the cap to the right until you hear a click or the cap reaches the full stop. Make sure that the retaining strap is not caught between the filler pipe and the fuel filler cap. If the light should stay on further in depth evaporative leak diagnosis is required.

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Misfire Detection

As part of the CARB/OBD II regulations the Engine Control Module must determine if misfire is occurring and also identify the specific cylinder(s). The ECM will determine severity of the misfire event, and whether it is emissions relevant or catalyst damaging. In order to accomplish these tasks the ECM monitors the crankshaft for acceleration losses during firing segments of cylinder specific firing order. If the signal is implausible an erroneous reference mark can be obtained by the ECM which will result in a misfire fault being set.

Possible causes of cylinder misfire faults (actual field findings):

- Vehicle ran low or out of fuel
- Poor fuel quality (ex. water in fuel, customer uses an additive, etc.)
- Low/high fuel pressure
- Ignition coil
- Fouled spark plug(s)
- Restricted/contaminated fuel injector(s)
- Crankshaft position sensor
- Poor combustion due to low compression or high leakage
- Blocked/restricted catalyst

ENGINE MISFIRE DIAGNOSIS

Engine Misfire is the result of inefficient combustion in one or more cylinders. The causes of Engine Misfire are extensive but can be grouped into the following sub-systems. Consider the charts below as an additional diagnostic aid once the DISplus/MoDIC is connected, the correct fault symptom has been chosen and the fault memory has been interrogated. Follow the Test Module as displayed by the DISplus/MoDIC.

- COMPONENT
- POSSIBLE CONDITION
- TEST
- CORRECTION
- **Spark Plug:**
  - Incorrect spark plug installed
  - Electrode gap closed or too small
  - Electrode(s) missing
  - Oil or fuel fouled spark plug
  - Ceramic insulation cracked
- Secondary Ignition DISplus Preset Measurement
  - Verify correct spark plug
  - Replace if necessary
  - Swap with another cylinder
- **Secondary circuit: (wiring, M73-cap, rotor)**

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  - Wet or moist due to water infiltration.
  - High resistance due to corrosion.
  - Check water ingress, repair, replace
  - Check resistance value, replace
- **Ignition Coil(s):**
  - Secondary/Primary Circuits open or shorted.
  - Housing cracked, damaged.
- Secondary and Primary
  - Inspect and replace if necessary
  - Swap with another cylinder
- **Ignition Coil & Engine Harness Connectors**
  - Power supply, Primary control and ground (shunt signal) circuits impaired.
- Primary Ignition & Term 4A feedback Preset Measurements
  - Look for open, loose connector, corrosion, crossed or backed out pins (also consider ignition unloader or ECM relay on MY97 and newer cars).
  - Determine defective condition, repair or replace.
  - A secondary ignition oscilloscope display provides vital information about the ignition system's condition.
  - Follow the precautions in group 12 of the Repair Instructions.
  - Use the following scope patterns as a guideline for ignition system diagnosis. Use the preset measurement function of DISplus.

    Evaluation of secondary signal amplitude at idle speed.

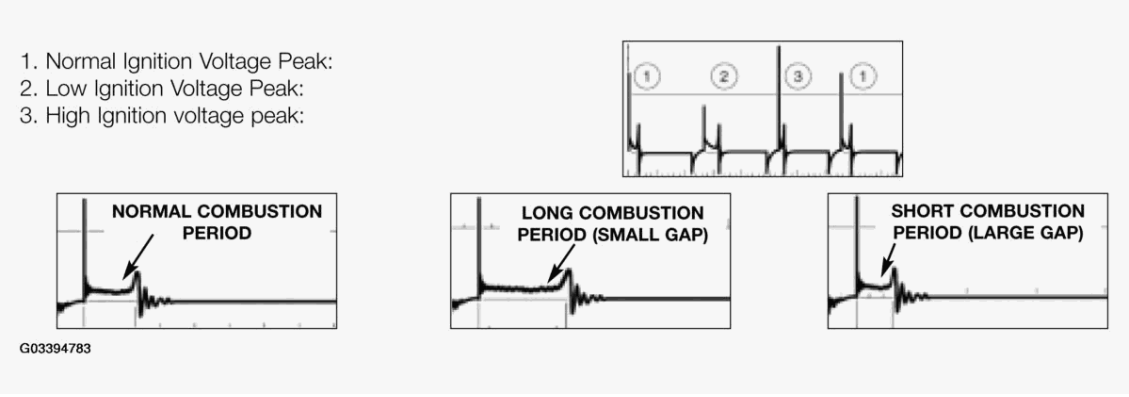


Fig. 2: Identifying Evaluation Of Secondary Signal Amplitude At Idle Speed
Courtesy of BMW OF NORTH AMERICA, INC.

  - COMPONENT
  - POSSIBLE CONDITION
  - TEST
  - CORRECTION

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- **Pistons, Rings, Valves, Camshaft:**
  - Hole in piston crown, ring(s) broken, valve(s) not seating, valve(s) bent, valve spring(s) broken, camshaft lobe cracked, etc.
  - Idle Quality - Rough Running Preset.
  - Cylinder compression & leakdown tests.
  - Correct condition as required.
- **Hydraulic Valve Actuator (HVA):**
  - HVA oil bore restricted or blocked.
  - Engine oil pressure builds up too slow.
  - **Intermittent Misfire Fault** - Not Currently Present.
  - HVA binding/sticking in bore.
  - Idle Quality - Rough Running Preset.
  - Listen to HVA
  - Check Oil Pressure
  - Cylinder leakdown
  - Always consider mechanical components when diagnosing misfire.
  - Inspect for scoring.
- **Vacuum Leaks:**
  - Unmetered vacuum leaks causing a "**lean** " operating condition. Possible "**Excessive Mixture Deviation** " fault codes.
  - Idle Quality - Rough Running Preset. Test for vacuum leaks.
  - Interpret Add. & Multipl. adaptation values
  - Correct condition as required
  - COMPONENT
  - POSSIBLE CONDITION
  - TEST
  - CORRECTION
- **Fuel (quality):**
  - Contaminated fuel, (water, other non combustible).
  - Clean fuel system, replace fuel.
- **Fuel Delivery:**
  - Fuel pump delivery pressure low, restriction in fuel line to fuel rail or running loss valve.
  - Fuel filter restricted (clogged).
  - Low fuel in tank.
  - Check fuel pressure & volume.
  - Check fuel pump power and ground
  - Determine restriction/flow reduction, replace component as necessary.
  - Interpret Additive and Multiplicative adaptation values.

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- **Running Loss Valve:**
  - Valve stuck in "small circuit" position.
  - Check valve
  - Display "diagnosis requests" in DISplus and test valve for proper function, replace valve as necessary.
- **Fuel Injectors:**
  - Leaking fuel injector pintle seats cause rich engine starts with hot ambient temperatures.
  - Blocked (dirty) injector(s).
  - Ti Preset & status page.
  - Sec Ign scope pattern.
  - Check injectors for leakage.
  - Swap suspect injector with another cylinder.
  - Inspect injector, replace if necessary.
- **Fuel Pressure Regulator:**
  - Regulator defective, causes fluctuation in the injected quantity of fuel causing mixture adaptation faults.
  - Fuel pressure
  - Check nominal fuel pressure value with engine operating under varied speeds.
- **Evaporative System:**
  - Defective evaporative system vent causing fuel tank collapse and fuel. starvation.
  - DISplus status, EVAP test with pressure tool, purge valve func. test.
  - Check the fuel tank condition and vent line.
  - Check Fresh Air Valve on TLEV E36 vehicles or LDP/DM TL and filter on ORVR vehicles for proper system "breathing".
  - COMPONENT
  - POSSIBLE CONDITION
  - TEST
  - CORRECTION
- **Crankshaft Position Sensor or Increment Wheel:**
  - Implausible signal for misfire detection.
  - Increment wheel loose or damaged (internal on M44, M52 and M54, external on M62 & M73).
  - Air gap between sensor and wheel.
  - Noticeable at higher RPM.
  - DISplus preset measurement.
  - Determine defective sensor or increment wheel and replace.
- **Catalyst Damaged:**
  - Excessive exhaust back pressure (bank specific fault present, more noticeable under heavy load and high RPM).

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- DISplus preset measurement of oxygen sensor.
- Back pressure test per SIB with Special Tool.
- Determine catalyst condition, replace or repair as necessary.

- **Oxygen Sensor:**
  - Excessive mixture deviation, **possible vacuum leaks.**
  - Monitor oxygen sensor signal via DIS preset.
  - Swap sensor from other bank (if applicable) and see if fault transfers to other bank.
- **Engine Control Module**
  - Internal control module fault.
  - Misfire Reprogramming.
  - Check fault memory.
  - Highly unlikely but must be considered.
  - Check Model/Prod range - reprogram

When diagnosing a Misfire fault code, Remember:

"Misfire" is caused by a defect in the internal combustion engine or a defect in the control of the engine operation.

"Misfire" is the result of improper combustion **(variation between cylinders) as measured at the crankshaft due to:**

- Engine mechanical defects; breakage, wear, leakage or improper tolerances.
- Excessive mixture deviation; air (vacuum leaks), fuel and all the components that deliver air/fuel into the combustion chambers.
- Faulty ignition; primary, secondary including spark plugs.
- Faulty exhaust flow; affecting back pressure.
- Tolerance parameters; ECM programming.

A Misfire fault code(s) is the "symptom" of a faulty input for proper combustion. When diagnosing a misfire, review the charts to assist you in finding the faulty input.

OBD HISTORY

As a result of low fuel costs, together with a high standard of living and a dense population, the state of California was affected particularly heavily by air pollution. This spurred the state to pass the most comprehensive and stringent emissions and consumption laws in the world. The automobile manufacturers were reminded of their obligations and this drove them on to comply with the new regulations at enormous expense.

- In continuing efforts to improve air quality, the Environmental Protection Agency (EPA) amended the Clean Air Act in 1990. The Clean Air Act was originally mandated in 1970. The Clean Air Act has a direct impact on automobile manufactures whereby they are responsible to comply with the regulations set forth by the EPA. The 1990 amendment of the Clean Air Act set forth all of the changes currently

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being introduced on vehicles sold in the United States today.

- In 1967, the State of California formed the California Air Resources Board (CARB) to develop and carryout air quality improvement programs for California's unique air pollution conditions. Through the years, CARB programs have evolved into what we now know as ON Board Diagnostics and the National Low Emission Vehicle Program.
- The EPA has adopted many of the CARB programs as National programs and laws. One of these earlier programs was OBD I and the introduction of the "CHECK ENGINE" Light.
- BMW first introduced OBD I and the check engine light in the 1987 model year. This enhanced diagnosis through the display of "flash codes" using the check engine light as well as the BMW 2013 and MoDIC. OBD I was only the first step in an ongoing effort to monitor and reduce tailpipe emissions.
- By the 1989 model year all automotive manufactures had to assure that all individual components influencing the composition of exhaust emissions would be electrically monitored and that the driver be informed whenever such a component failed.
- Since the 1996 model year all vehicles must comply with OBD II requirements. OBD II requires the monitoring of virtually every component that can affect the emission performance of a vehicle plus store the associated fault code and condition in memory.

  If a problem is detected and then re-detected during a later drive cycle more than one time, the OBD II system must also illuminate the "CHECK ENGINE" Light in the instrument cluster to alert the driver that a malfunction has occurred. **However, the flash code function of the Check Engine Light in OBD I vehicles is not a function in OBD II vehicles.**

- This requirement is carried out by the Engine Control Module (ECM/DME) as well as the Automatic Transmission Control Module (EGS/AGS) and the Electronic Throttle Control Module (EML) to monitor and store faults associated with all components/systems that can influence exhaust and evaporative emissions.

OBD I

The essential elements here are that electrical components which affect exhaust emissions are monitored by the motor-electronics system and an optical warning signal (CHECK ENGINE Light) is issued in the event of an OBD I-relevant malfunction. The corresponding fault can be read out via a flashing code without the aid of a testing device.

OBD II

Since January 1996, OBD II has been compulsory on all vehicles in the US market. The main difference from OBD I is that not only are the purely electrical components monitored but also all the systems and processes that affect exhaust emissions and fuel system evaporative emissions.

The operational reliability of the exhaust-treatment system must be guaranteed for 5 years and/or 100,000 miles; this is maintained by emission certification. In this case, the data relevant to exhaust/evaporative emissions are read out via a standardized interface with a universal "diagnosis device". If a violation is identified, the vehicle manufacturer in question is legally bound to eliminate the fault throughout the entire vehicle series.

Objectives Of OBD II

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- Permanent monitoring of components relevant to exhaust emissions in all vehicles.
- Immediate detection and indication of significant emission increases over the entire service life of each vehicle.
- Permanently low exhaust emissions in the field.

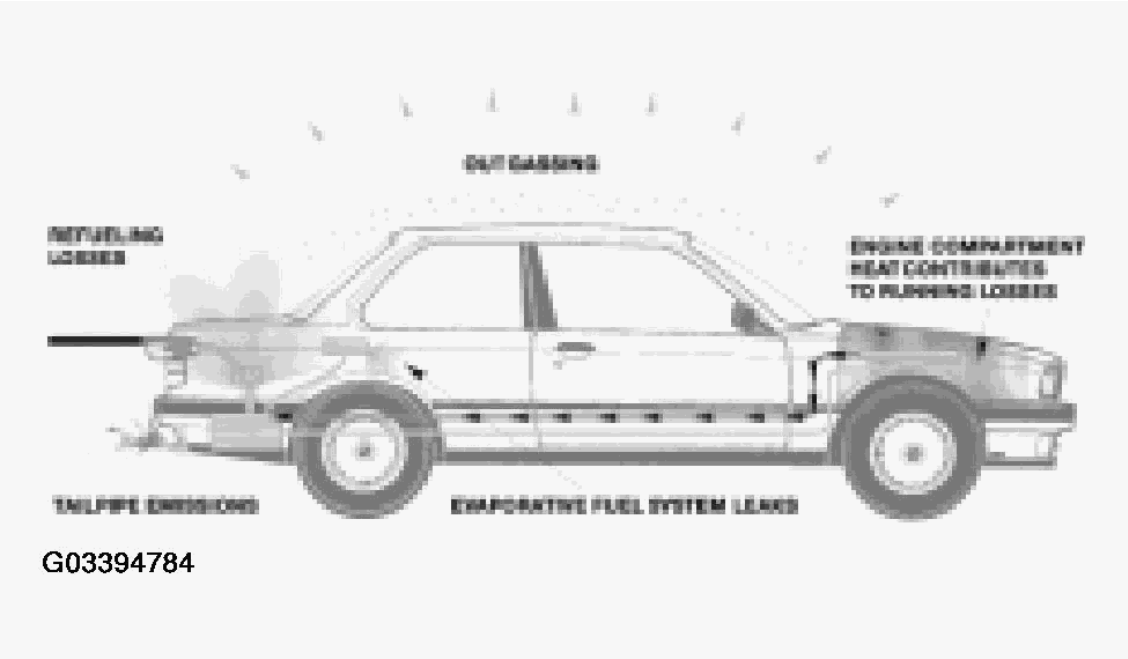


Fig. 3: Identifying Objectives Of OBD II
Courtesy of BMW OF NORTH AMERICA, INC.

OVERVIEW OF THE NATIONAL LOW EMISSION VEHICLE PROGRAM

Emission Reduction Stages:

While OBD II has the function of monitoring for emission related faults and alerting the operator of the vehicle, the National Low Emission Vehicle Program requires a certain number of vehicles produced (specific to manufacturing totals) ***currently*** comply with the following emission stages;

TLEV : Transitional Low Emission Vehicle

LEV: Low Emission Vehicle

ULEV: Ultra Low Emission Vehicle.

Prior to the National Low Emission Vehicle Program, the most stringent exhaust reduction compliancy is what is known internally within BMW as **HC II** . The benefit of exhaust emission reductions that the National Low Emission Vehicle Program provides compared with the HC II standard is as follows:

TLEV- 50% cleaner.

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LEV- 70% cleaner.

ULEV -84% cleaner.

- Compliance Level
- NMHC Non Methane Hydrocarbon
- CO Carbon Monoxide
- NOx Oxide(s) of Nitrogen
- TLEV
- 0.250
- 3.4
- 0.4
- LEV
- 0.131
- 3.4
- 0.2
- ULEV
- 0.040
- 1.7
- 0.2
- Compliance Level
- NMHC Non Methane Hydrocarbon
- CO Carbon Monoxide
- NOx Oxide(s) of Nitrogen
- TLEV
- 0.125
- 3.4
- 0.4
- LEV
- 0.075
- 3.4
- 0.2
- ULEV
- 0.040
- 1.7
- 0.2
- Compliance Level
- NMHC Non Methane Hydrocarbon
- CO Carbon Monoxide

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- NOx Oxide(s) of Nitrogen
- TLEV
- 0.156
- 4.2
- 0.6
- LEV
- 0.090
- 4.2
- 0.3
- ULEV
- 0.055
- 2.1
- 0.3

OBD II Emission Compliance Chart

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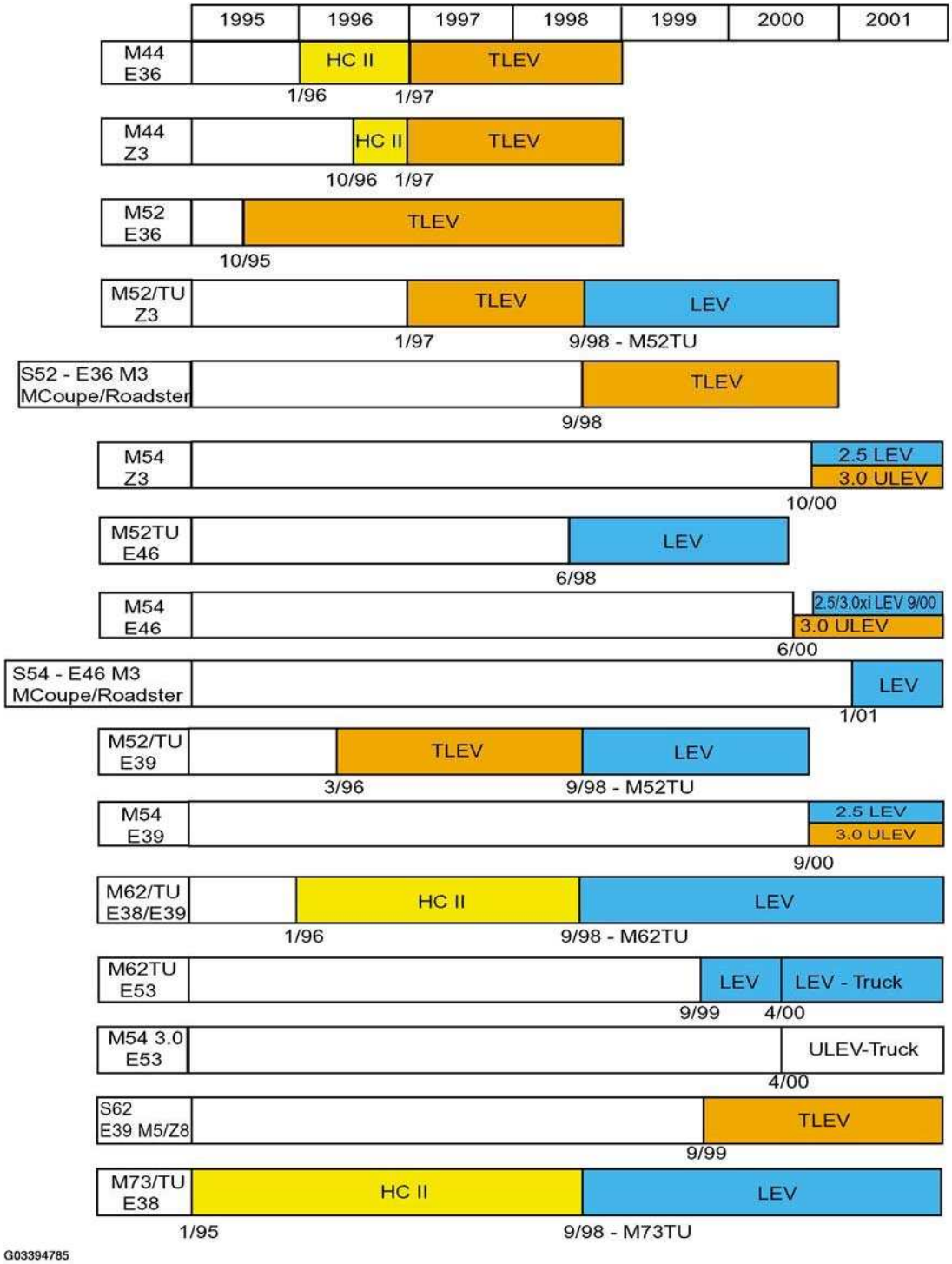


Fig. 4: Identifying OBD II Emission Compliance
Courtesy of BMW OF NORTH AMERICA, INC.

SYSTEM MONITORING

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Within the framework of OBD II, certain components/systems must be monitored once per driving cycle while other control systems (e.g. misfire detection) must be monitored permanently. ***A "driving cycle" consists of engine startup, vehicle operation (exceeding of starting speed), coasting and engine stopping.***

Permanent Monitoring

Permanently monitored systems are monitored according to temperature immediately after startup. In the event of malfunctions (e.g. oxygen sensor), the Malfunction Indicator Light will illuminate immediately.

The following are monitored permanently:

- Misfire Detection
- Fuel System (duration of injection)
- All emission related electrical circuits, components and systems of the ECM, TCM and EML (if equipped).

Cyclic Monitoring

Systems monitored once per driving cycle will only result in a fault being registered after the corresponding operating conditions have been completed. Therefore, there is no possibility for checking when the engine is started up briefly and then shut down.

The following are monitored once per driving cycle:

- Oxygen Sensor Function
- Secondary Air Injection System
- Catalytic Converter Function (efficiency)
- Evaporative Vapor Recovery System

Due to the complexity involved in meeting the test criteria within the defined driving cycle, all tests may not be completed within one "customer driving cycle". The test can be successfully completed within the defined criteria, however customer driving styles may differ and therefore may not always monitor all involved components/systems in one "trip".

Drive Cycle

The following diagram shows how a drive cycle is set (test drive) in order for all the systems to be monitored once. The test conditions can be created in any desired order after startup.

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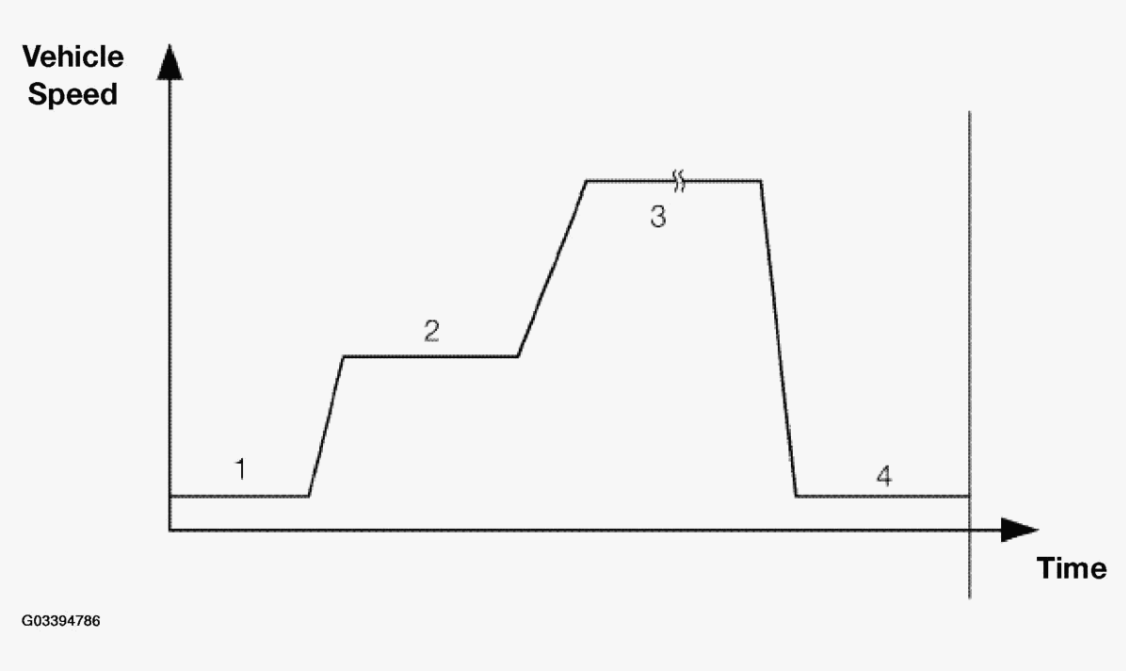


Fig. 5: Identifying Drive Cycle Graph
Courtesy of BMW OF NORTH AMERICA, INC.

1. Engine cold start, idling, approximately 3 minutes. Evaluated:
   - **Secondary Air System**
   - **Evaporative Leak Detection (LDP Equipped Vehicles)**
2. Constant driving at 20 to 30 MPH, approximately 4 minutes. Evaluated:
   - **Oxygen Sensors - Achieved "Closed Loop" Operation**
   - **Oxygen Sensors - Response Time and Switching Time (Control Frequency)**
3. Constant driving at 40 to 60 MPH, approximately 15 minutes (sufficient vehicle coasting phases included). Evaluated:
   - **Catalytic Converter Efficiency**
   - **Oxygen Sensors - Response Time and Switching Time (Control Frequency)**
4. Engine idling, approximately 5 minutes. Evaluated:
   - **Tank-Leak Diagnosis (DM TL Equipped Vehicles after KL 15 is switched OFF)**

NOTE: The diagnostic sequence illustrated above will be interrupted if:

- **The engine speed exceeds 3000 RPM.**
- **The driving speed exceeds 60 MPH.**
- **Large fluctuations in the accelerator pedal position.**

THE "MALFUNCTION INDICATOR LIGHT" (MIL) WILL BE ILLUMINATED UNDER THE FOLLOWING CONDITIONS

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- Upon the completion of the next consecutive driving cycle where the previously faulted system is monitored again and the emissions relevant fault is again present.
- Immediately if a "Catalyst Damaging" fault occurs (Misfire Detection).

The illumination of the light is performed in accordance with the Federal Test Procedure (FTP) which requires the lamp to be illuminated when:

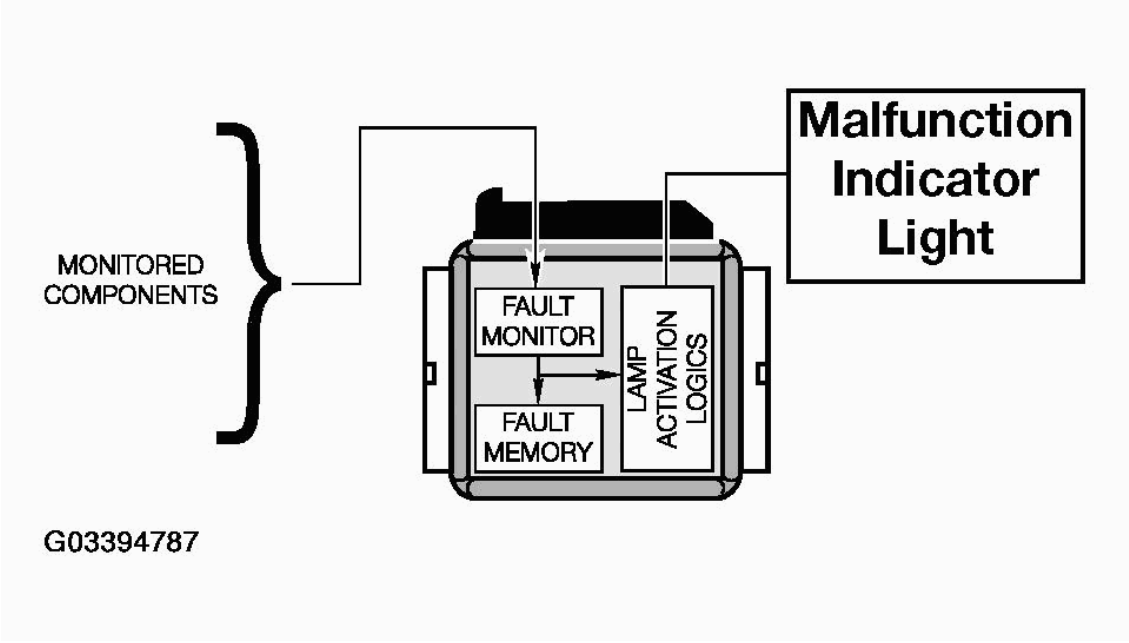


Fig. 6: Identifying Malfunction Indicator Light
Courtesy of BMW OF NORTH AMERICA, INC.

- A malfunction of a component that can affect the emission performance of the vehicle occurs and causes emissions to exceed 1.5 times the standards required by the (FTP).
- Manufacturer-defined specifications are exceeded.
- An implausible input signal is generated.
- Catalyst deterioration causes HC-emissions to exceed a limit equivalent to 1.5 times the standard (FTP).
- Misfire faults occur.
- A leak is detected in the evaporative system, or "purging" is defective.
- ECM fails to enter closed-loop oxygen sensor control operation within a specified time interval.
- Engine control or automatic transmission control enters a "limp home" operating mode.
- Ignition is on (KL15) position before cranking = **Bulb Check Function.**

Within the BMW system the illumination of the Malfunction Indicator Light is performed in accordance with the regulations set forth in CARB mail-out 1968.1 and as demonstrated via the Federal Test Procedure (FTP). The following page provides several examples of when and how the Malfunction Indicator Light is illuminated based on the "customer drive cycle".

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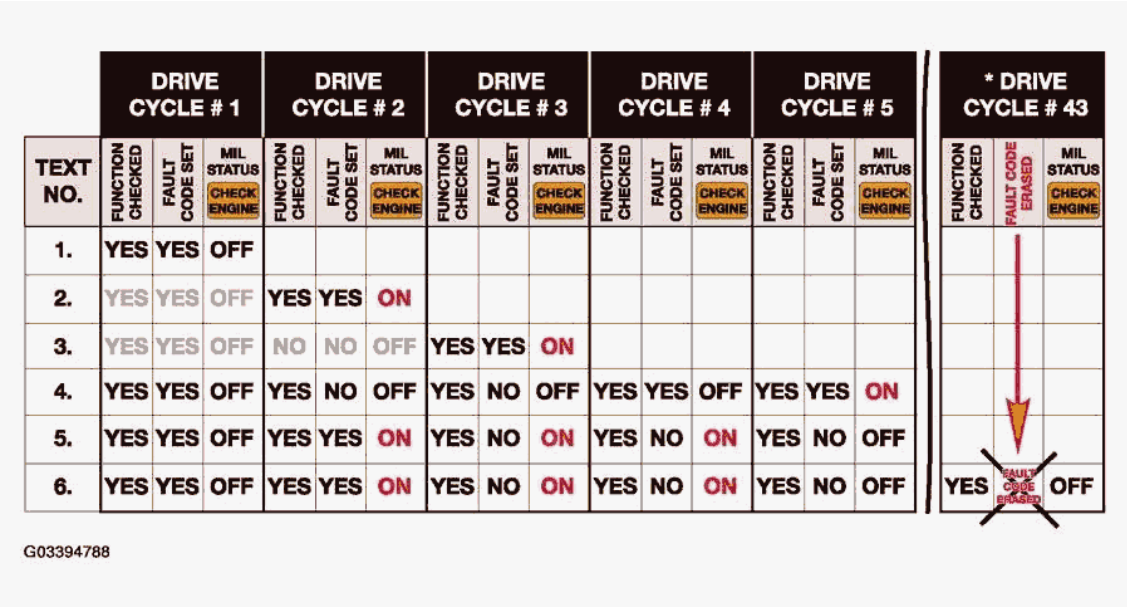


Fig. 7: Checking Bulb Function
Courtesy of BMW OF NORTH AMERICA, INC.

1. A fault code is stored within the ECM upon the first occurrence of a fault in the system being checked.
2. The "Malfunction Indicator Light" will not be illuminated until the completion of the second consecutive "customer driving cycle" where the previously faulted system is again monitored and a fault is still present or a catalyst damaging fault has occurred.
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 "Malfunction Indicator Light" is illuminated if the function is checked and the fault is still present.
4. If there is an intermittent fault present and does not cause a fault to be set through multiple drive cycles, two complete consecutive drive cycles with the fault present are required for the "Malfunction Indicator Light" to be illuminated.
5. Once the "Malfunction Indicator Light" is illuminated it will remain illuminated unless the specific function has been checked without fault through three complete consecutive drive cycles.
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 or with the use of either the DIS, MODIC or Scan tool.

NOTE: In order to clear a catalyst damaging fault (see MISFIRE DETECTION) from memory, the condition must be evaluated for 80 consecutive cycles without the fault reoccurring.

With the use of a universal scan tool, connected to the "OBD" DLC an SAE standardized DTC can be obtained, along with the condition associated with the illumination of the "Malfunction Indicator Light". Using the DISplus or MODIC, a fault code and the conditions associated with its setting can be obtained prior to the illumination of the "Malfunction Indicator Light".

READINESS CODE

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The readiness code provides status (Yes/No) of the system having completed all the required monitoring functions or not. The readiness code is displayed **with an aftermarket Scan Tool or the DISplus/MoDIC** . The code is a binary (1/0) indicating;

- 0 = Test Not Completed or Not Applicable - six cylinder vehicles (not ready - V8 and V12)
- 1 = Test Completed - six cylinder vehicles (ready - V8 and V12)

A "readiness code" must be stored after any clearing of fault memory or disconnection of the ECM. A readiness code of "0" will be stored (see below) after a complete diagnostic check of all components/systems, that can turn on the "Malfunction Indicator Light" is performed.

The readiness code was established to prevent anyone with an emissions related fault and a "Malfunction Indicator Light" on from disconnecting the battery or clearing the fault memory to manipulate the results of the emissions test procedure (IM 240).

Interpretation of the Readiness Code by the ECM(s) (SAE J1979)

The complete readiness code is equal to "one" byte (eight bits). Every bit represents one complete test and is displayed by the scan tool, as required by CARB/EPA. For example:

0 = EGR Monitoring (=0, N/A with BMW)

1 = Oxygen Sensor Heater Monitoring

1 = Oxygen Sensor Monitoring

0 = Air Condition (=0, N/A with BMW)

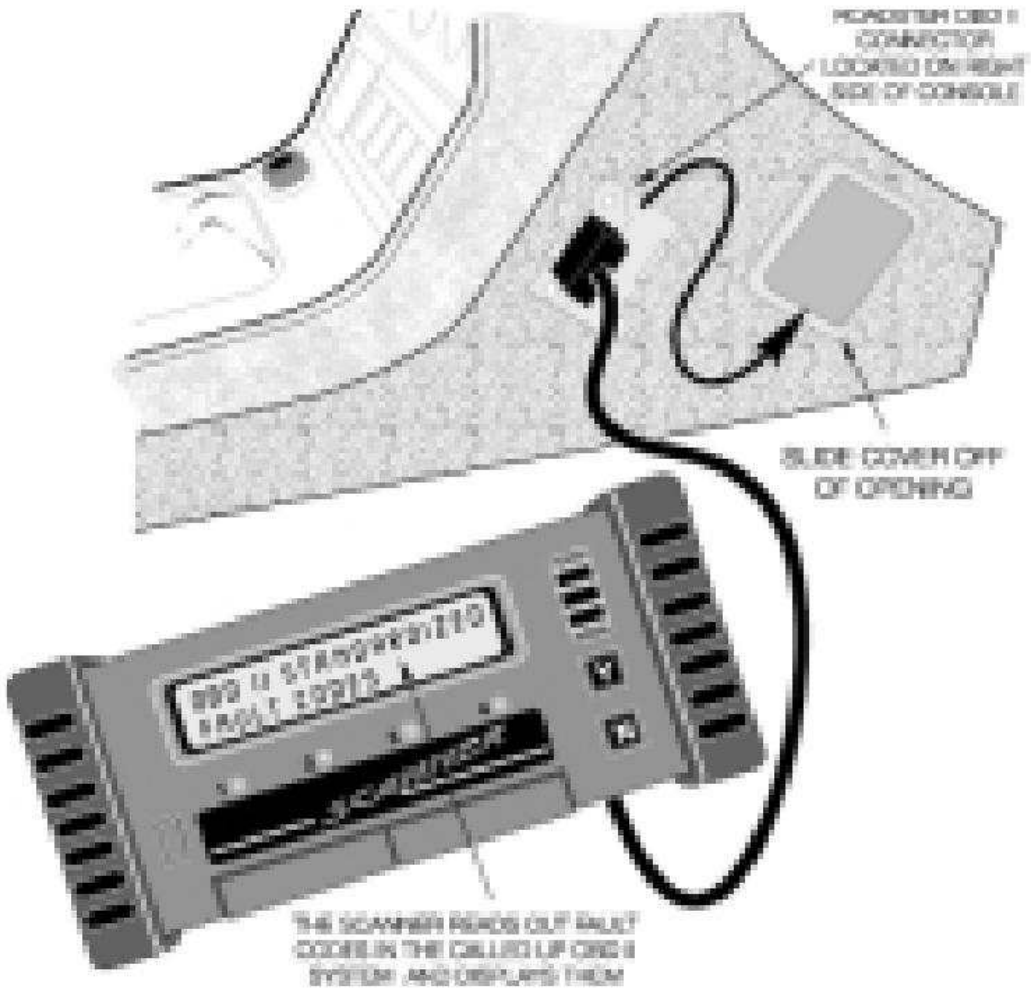
1 = Secondary Air Delivery Monitoring

1 = Evaporative System Monitoring

0 = Catalyst Heating

1 = Catalyst Efficiency Monitoring

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Fig. 8: Identifying Secondary Air Delivery Monitoring
Courtesy of BMW OF NORTH AMERICA, INC.

Drive the car in such a manner that all tests listed above can be completed (refer to the **DRIVE CYCLE**). When the complete "readiness code" equals "1" (ready) then all tests have been completed and the system has established its "readiness".

Readiness Code Using DISplus/MoDIC

The readiness code can be checked with the DISplus/MoDIC. This is particularly helpful in verifying that "drive cycle" criteria was achieved. **A repair can be confirmed before returning the vehicle to the customer by a successfully completed drive cycle.**

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Using an MS43 system for example, the readiness code is found under **"Service Functions"**

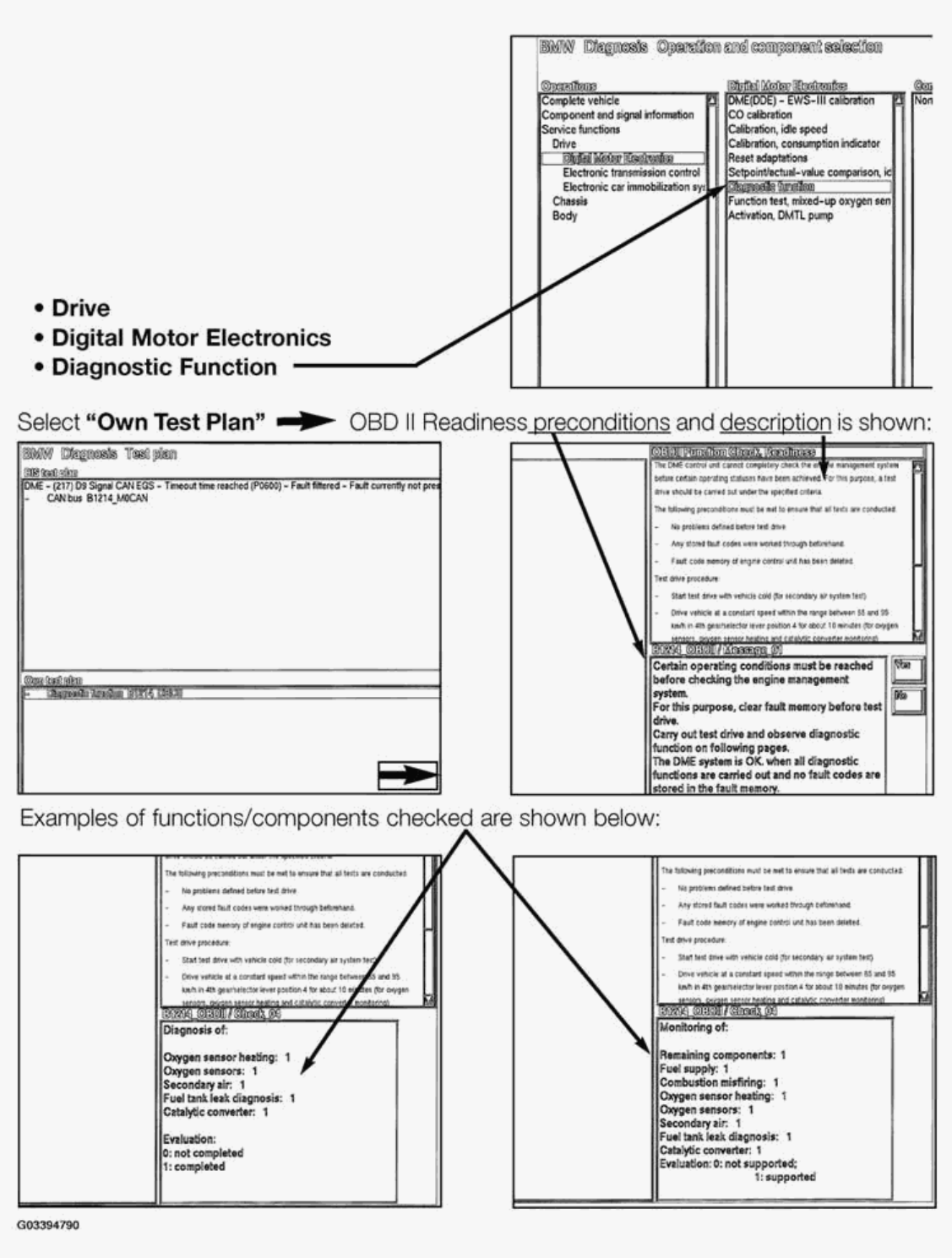


Fig. 9: Identifying Readiness Code Using Displus/MoDIC
Courtesy of BMW OF NORTH AMERICA, INC.

OBD II DIAGNOSTIC TROUBLE CODES (DTC)

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The Society of Automotive Engineers (SAE) established the Diagnostic Trouble Codes used for OBD II systems (SAE J2012). The DTC's are designed to be identified by their alpha/numeric structure. The SAE has designated the emission related DTC's to start with the letter "P" for Powertrain related systems, hence their *nickname* "P-code".

For example:

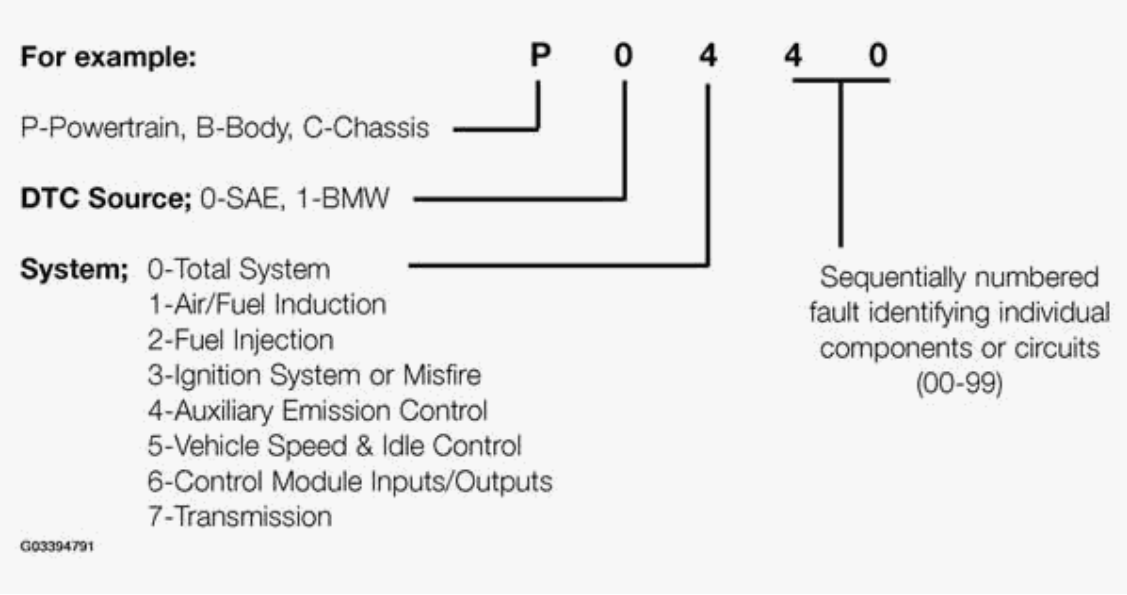


Fig. 10: Identifying Obd II Diagnostic Trouble Codes (DTC)
Courtesy of BMW OF NORTH AMERICA, INC.

- DTC's are stored whenever the "Malfunction Indicator Light" is illuminated.
- A requirement of CARB/EPA is providing universal diagnostic access to DTC's via a standardized Diagnostic Link Connector (DLC) using a standardized tester (scan tool).
- DTC's only provide one set of environmental operating conditions when a fault is stored. This single "Freeze Frame" or snapshot refers to a block of the vehicles environmental conditions for a specific time when the fault first occurred. The information which is stored is defined by SAE and is limited in scope. This information may not even be specific to the type of fault.

SCAN TOOL CONNECTION

Starting with the 1995 750iL, soon after on all 1996 model year and later BMW vehicles, a separate OBD II Diagnostic Link Connector (DLC) was added.

The DLC provides access for an aftermarket scan tool to all emission related control systems:

- ECM - Engine Management Monitored Emissions Functions/Components
- TCM (AGS/EGS) -Transmission Control
- EML - Electronic Throttle Control

This diagnostic communication link uses the existing TXD II circuit in the vehicle through a separate circuit on

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the DLC when the 20 pin cap is installed.

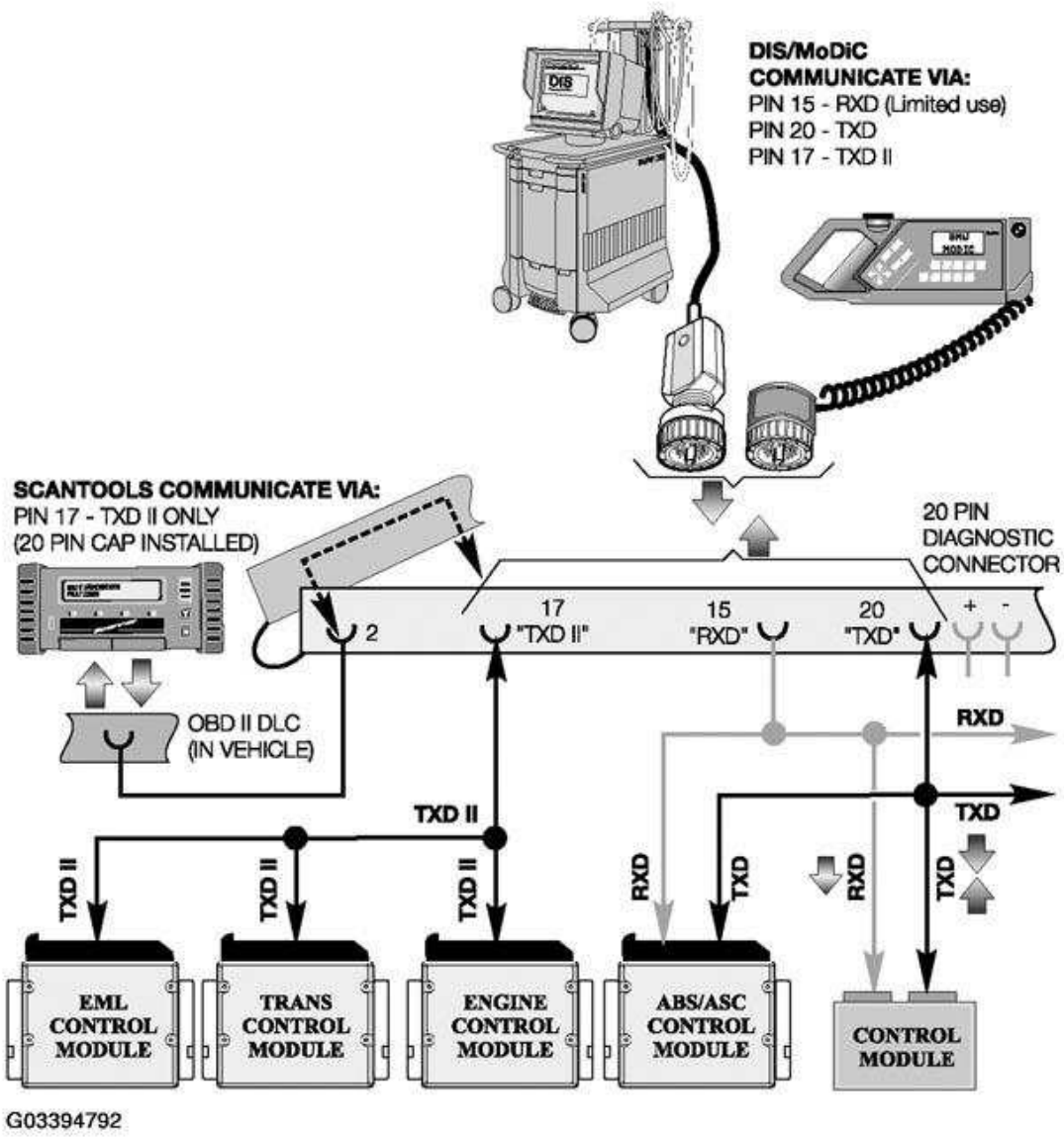


Fig. 11: Identifying Scan Tool Connection
Courtesy of BMW OF NORTH AMERICA, INC.

The DLC Connector bridging cap is marked "**OBD II** " and is found:

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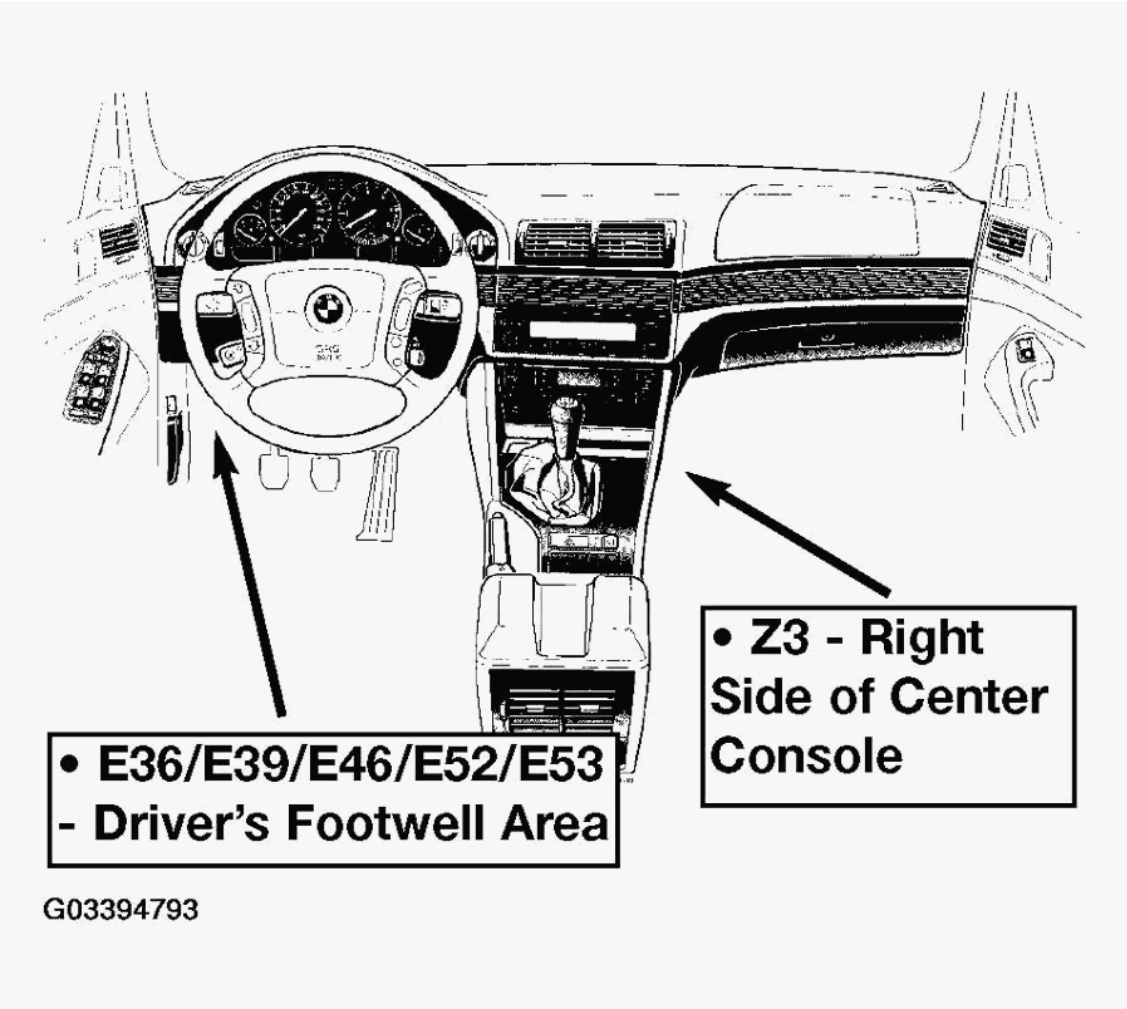


Fig. 12: Identifying DLC Connector Bridging Cap
Courtesy of BMW OF NORTH AMERICA, INC.

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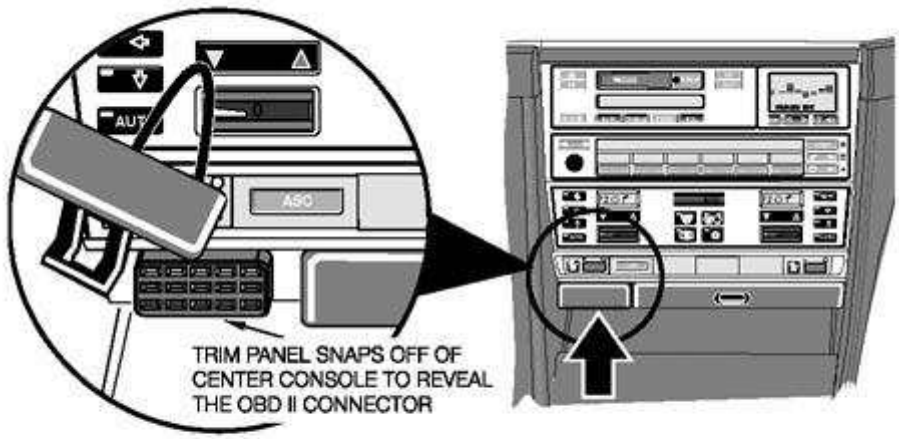


Fig. 13: Identifying E38 Center Console
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: E38 and older models have a cosmetic cover and a secured DLC cover.

20 Pin Diagnostic Socket Deletion

Model And Production Date: E46 From 6/00 E39, E52, E53 From 9/00

For model year 2001 the E39, E46 and E53 will eliminate the 20 pin diagnostic connector from the engine compartment. The 16 pin OBD II connector located inside the vehicle will be the only diagnosis port.

The E38 and Z3 will continue to use the 20 pin connector until the end of production.

The 16 pin OBD II connector has been in all BMWs since 1996 to comply with OBD regulations requiring a standardized diagnostic port.

Previously before 2001, only emissions relevant data could be extracted from the OBD II connector because it did not provide access to TXD (D-bus).

The TXD line is connected to pin 8 of the OBD II connector on vehicles without the 20 pin diagnostic connector.

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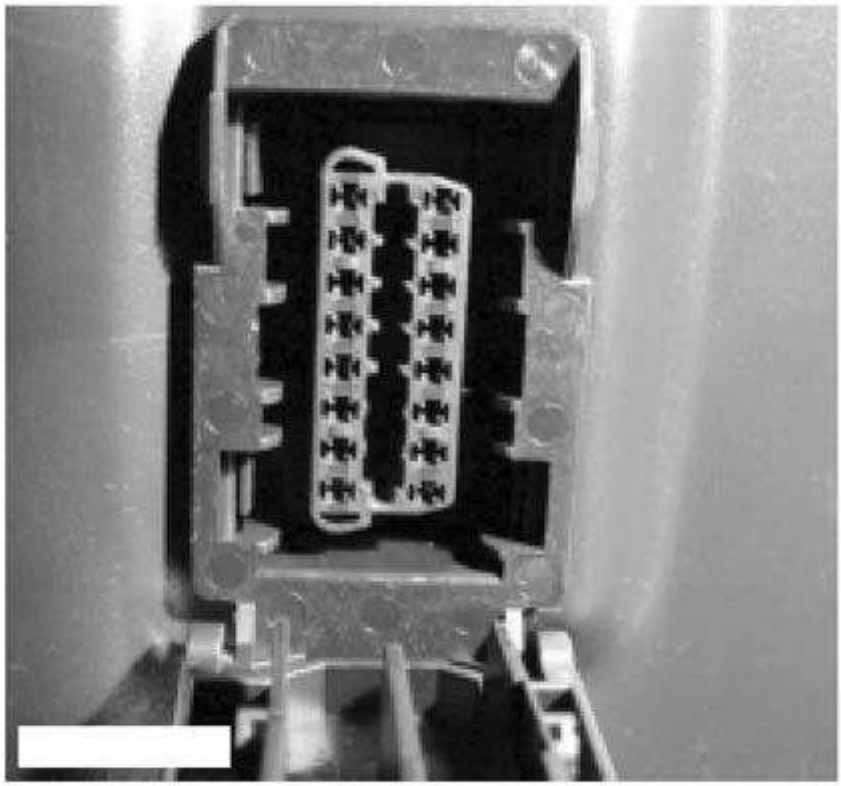


Fig. 14: Identifying 20 Pin Diagnostic Socket
Courtesy of BMW OF NORTH AMERICA, INC.

The cap to the OBD II connector contains a bridge that links KL 30 to TXD and TXD II. This is to protect the diagnostic circuit integrity and prevent erroneous faults from being logged.

The OBD II connector is located in the driver's footwell to the left of the steering column for E39, E46 and E53 vehicles.

Special tool 61 4 300 is used to connect to the 20 pin diagnostic lead of the DIS until the introduction of the DISplus.

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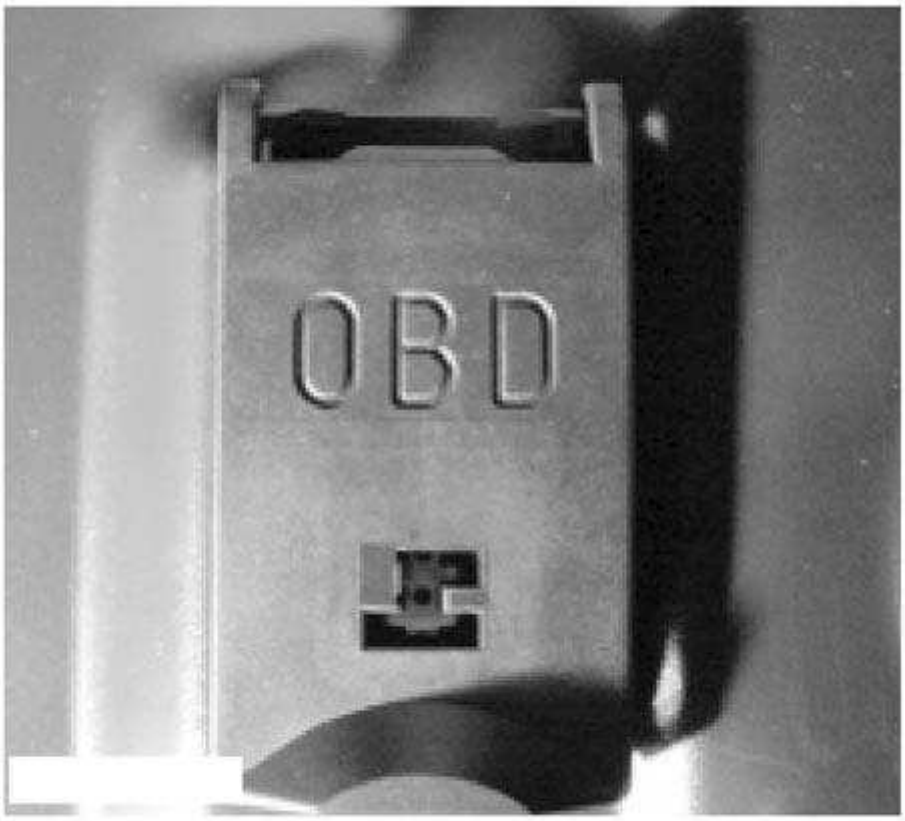


Fig. 15: Identifying ODB II
Courtesy of BMW OF NORTH AMERICA, INC.

Diagnostics Via OBD II Connector

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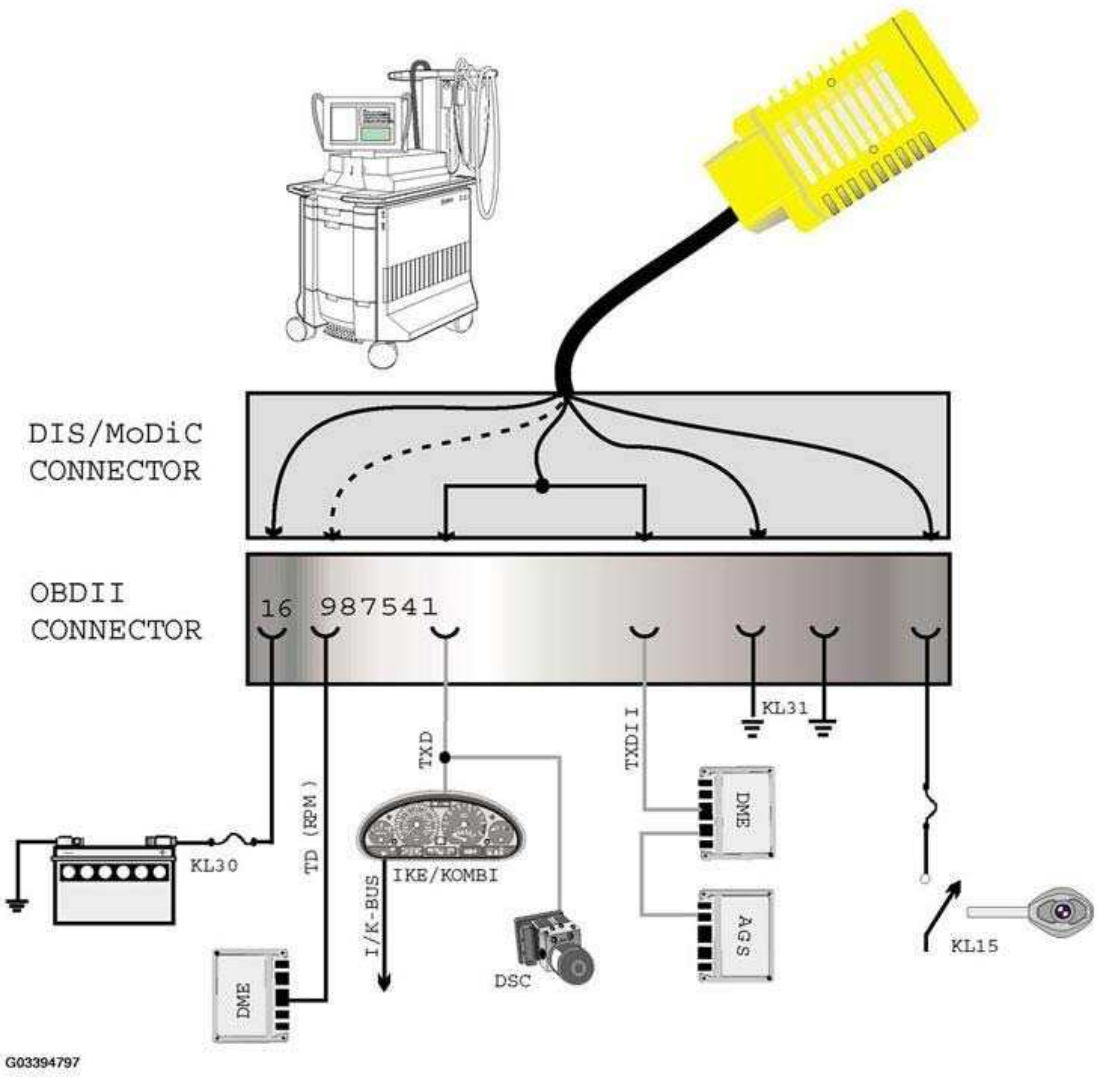


Fig. 16: Diagnostics Via OBD II Connector
Courtesy of BMW OF NORTH AMERICA, INC.

BMW FAULT CODE (DISPLUS/MODIC)

- BMW Codes are stored as soon they occur even before the "Malfunction Indicator Light" comes on.
- BMW Codes are defined by BMW, Bosch and Siemens Engineers to provide greater detail to fault specific information.
- **Siemens systems** - one set from four fault specific environmental conditions is stored with the first fault occurrence. This information can change and is specific to each fault code to aid in diagnosing. A maximum of ten different faults containing four environmental conditions can be stored.
- **Bosch systems** - a maximum of four sets from three fault specific environmental conditions is stored within each fault code. This information can change and is specific to each fault code to aid in diagnosing. A maximum of ten different faults containing three environmental conditions can be stored.
- BMW Codes also store and displays a "time stamp" when the fault last occurred.

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- A fault qualifier gives more specific detailed information about the type of fault (upper limit, lower limit, disconnection, plausibility, etc.).
- BMW Fault Codes will alert the Technician of the current fault status. He/she will be advised if the fault is actually still present, not currently present or intermittent.

  The fault specific information is stored and accessible through DISplus/MoDIC.

- BMW Fault Codes determine the diagnostic output for BMW DISplus/MoDIC.

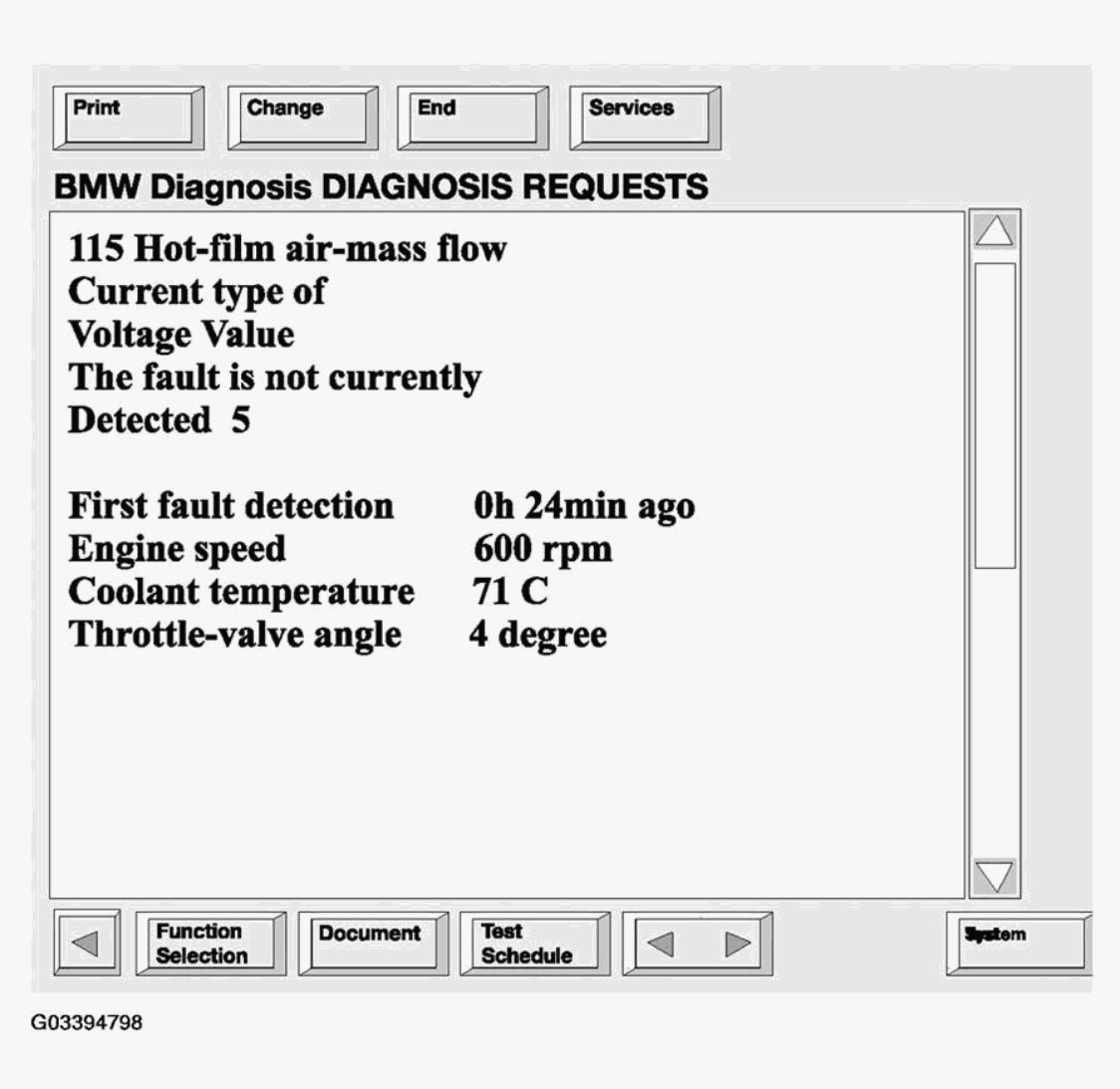


Fig. 17: Identifying BMW Diagnosis Requests
Courtesy of BMW OF NORTH AMERICA, INC.

OBD II Fault Memory and Fault Codes

Within the framework of OBD II, a diagnosis of all emission-related components/functions must take place during driving. Faults will be stored and displayed if necessary. For this purpose, the ECM includes OBD II

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memory. The standardized P codes for malfunctions are stored in this memory. The memory can be read out with the DISplus/MoDIC or a Scantool.

Emission Control Function Monitoring & Comprehensive Component Monitoring

OBD II regulations are based on section 1968.1 of Title 13, California Code of Regulations (CCR), The law set forth in section 1968.1 requires an increased scope of monitoring emission related control functions including:

- Catalyst Monitoring
- Heated Catalyst Monitoring (currently used on BMW 750iL vehicles)
- Misfire Monitoring
- Evaporative System Monitoring
- Secondary Air System Monitoring
- Air Conditioning System Refrigerant Monitoring (Not applicable for BMW vehicles)
- Fuel System Monitoring
- Oxygen Sensor Monitoring
- Exhaust Gas Recirculation (EGR) System Monitoring (Not applicable for BMW vehicles)
- Positive Crankcase Ventilation (PCV) System Monitoring (Not required at this time).
- Thermostat Monitoring (if equipped)

Monitoring these emission requirements is a function of the ECM which uses "data sets" while monitoring the conditions of the environment and the operation of the engine using existing input sensors and output actuators.

The data sets are programmed reference values the ECM refers to when a specific monitoring procedure is occurring. If the ECM cannot determine the environmental and/or engine operating conditions due to an impaired or missing signal, it will set a fault and illuminate the "Malfunction Indicator Light".

This input or control signal monitoring falls under another category called ***"Comprehensive Component Monitoring"*** . The ECM must recognize the loss or impairment of the signal or component. The ECM determines a faulted signal or sensor via three conditions:

1. Signal or component shorted to ground.
2. Signal or component shorted to B+.
3. Signal or component lost (open circuit).

Specific fault codes are used to alert the diagnostician of these conditions.

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GENERAL INFORMATION

Engine Diagnosis - Overview

ENGINE DIAGNOSIS

ENGINE DIAGNOSIS

When attempting to diagnose driveability complaints, always consider the basics. Regardless of the level of technology employed on an engine, it still needs a few basic things to occur in order to run properly. Whether the engine is very basic or uses so-called "New Generation" technology always refer to the basic principles first.

Any engine using four-cycle spark-ignition principles must meet the same fundamental conditions to run properly. Most engine related driveability problems fall into a few basic categories:

- No Start/No Crank
- Extending cranking before engine start
- Rough Running Cold Idle
- Rough Running Warm Idle
- Rough Running Under Load
- Lack of Power
- Check Engine Light (MIL)

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Fig. 1: Sectional View Of Engine
Courtesy of BMW OF NORTH AMERICA, INC.

When referring to engine basics, all engines need fuel, air and spark to run. However, in order for a spark-ignition engine to run properly, a few things must be taken into consideration. The fuel, air, spark principle can be broken down further into the following categories:

- Sufficient engine compression with a leak-free combustion chamber.
- Sufficient amount of ignition voltage (spark) at the correct time.
- Proper fuel pressure and volume.
- Properly functioning fuel injection system (Engine management).

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- Properly functioning air management system (Electronic throttle systems).
- Correct valve timing (VVT and VANOS).

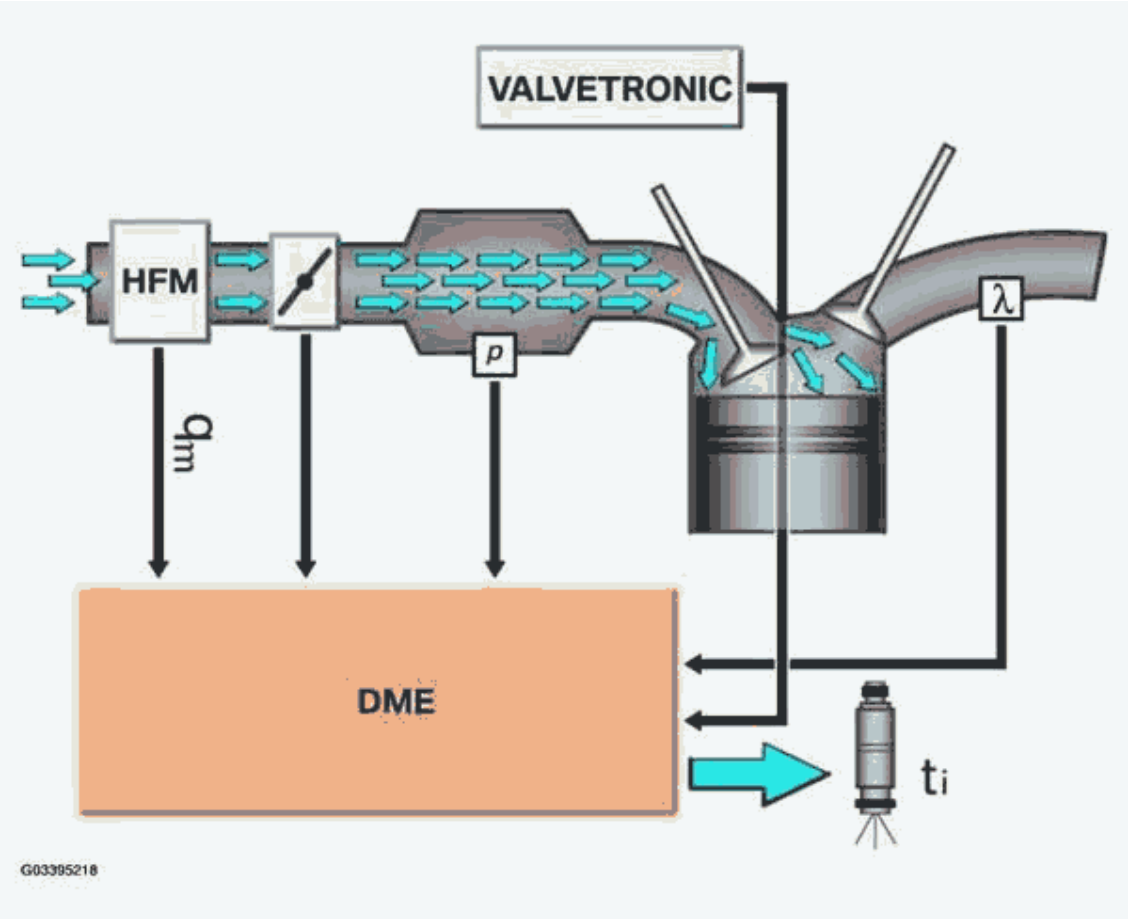


Fig. 2: Operation Of Valvetronic
Courtesy of BMW OF NORTH AMERICA, INC.

Compression Testing

In order for an engine to run smoothly and efficiently, the combustion chamber must be free of leakage. An engine with low compression in one or more cylinders is inefficient and will run rough or lack in performance. Low compression may or may not cause the MIL to illuminate.

Low compression can be caused by the following:

- Leaking valves caused by burned valves or seats. The valve guide can also be worn causing the valve not to seat properly. Valves can also be bent from piston contact (from over-rev).
- Piston Rings which can be worn from high mileage or poor maintenance. Also, the rings can be damaged from foreign material or improper installation.
- Cracks in cylinder head or engine block. Cracks can be caused by overheating resulting in misfires or rough running.
- Defective cylinder head gasket. The cylinder head gasket can fail due to overheating which can cause

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cylinder leakage resulting in misfire, low compression and rough running.

- Bent connecting rod. A connecting rod can be bent from a defective fuel injector or water ingress into the combustion chamber causing hydrostatic lock.

Compression testing can be performed using a conventional compression gauge. There are some preliminary tasks and safety precautions that must be carried out before starting the compression test:

- Remove the fuel pump fuse and or relay, start the vehicle and allow vehicle to stall out on residual fuel
- Disable ignition by unplugging all ignition coils and remove **ALL** sparkplugs.
- Connect battery charger to vehicle
- Ensure that the throttle is wide open during cranking
- Crank engine until compression gauge stops increasing. Be sure to crank engine equally between cylinders.
- Continue compression test on ALL cylinders so comparisons can be done. Record readings.
- If necessary, re-check cylinders with suspect readings.
- If some cylinder readings come up low, add a few drops of oil and re-check. This can differentiate between valves/rings.

Cylinder Leakage Testing

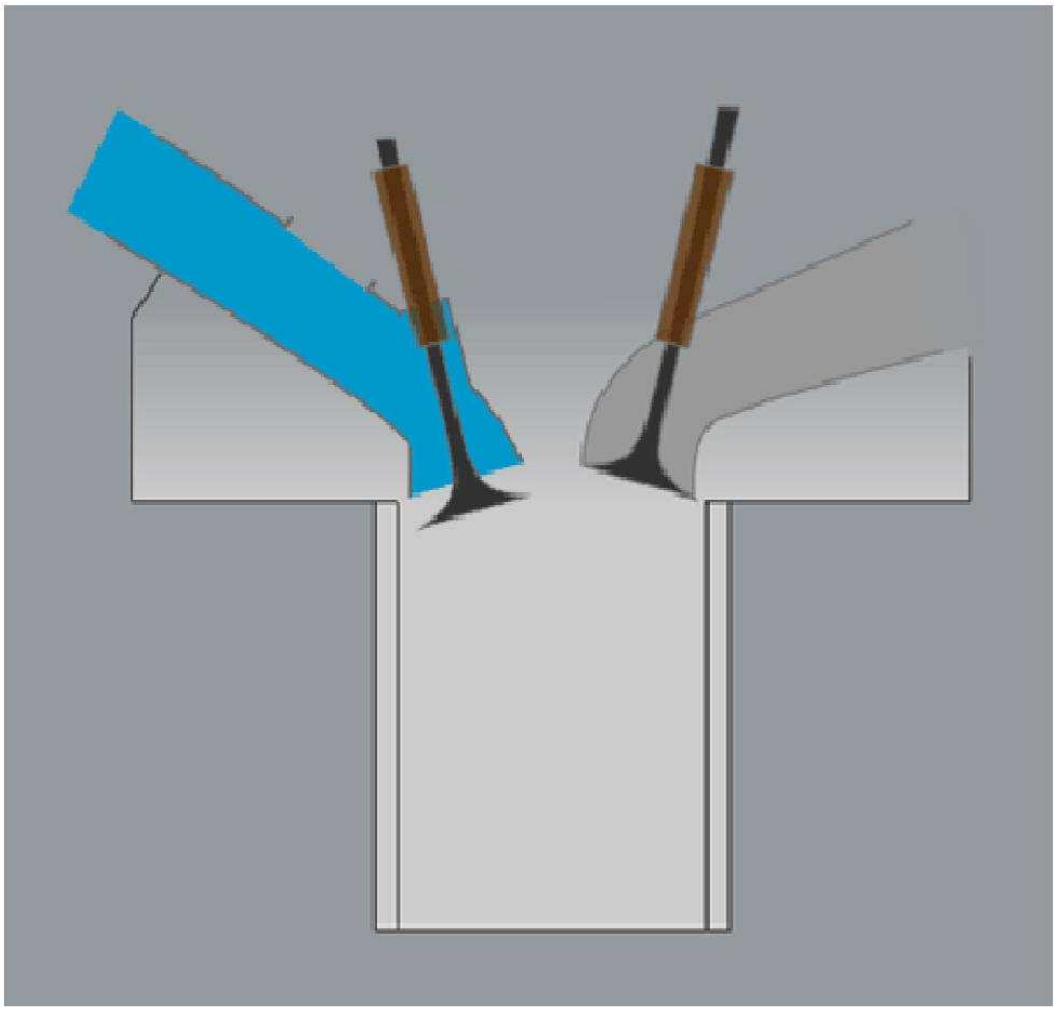
Once a problem cylinder is detected via a compression test or by other means, a cylinder leakage test is used to pinpoint the problem area.

The leakage test uses a gauge and compressed air to indicate the percentage of air loss. By listening and observing at key points, the problem can be narrowed down before the engine needs to be disassembled.

The piston (one or more) should be brought to TDC, compressed air should be introduced into the cylinder using the cylinder leakage tester. Be sure the engine does NOT rotate, if the engine rotates, the engine was not at true TDC.

Check the gauge on the tester, it should read in percentage of leakage. Check the engine specification for permissible leakdown. A general rule of thumb is 15 % or less for a good cylinder. However, some engine have a tighter tolerance. Most BMW engines should be at 8 % or less.

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Fig. 3: Testing Cylinder Leakage
Courtesy of BMW OF NORTH AMERICA, INC.

If any cylinder shows excessive leakdown, check for leakage by listening or observing the following points:

- Listen for air (hissing) at the tailpipe. This would indicate leakage at the exhaust valves on that cylinder.
- Listen for air (hissing) at the throttle. This would indicate leakage at the intake valves on that cylinder. (Be sure throttle is wide open and listen at throttle opening)
- Open the oil cap and listen for air. This would indicate air leakage into the crankcase. This would be piston rings or cylinder bore concerns.
- Observe the coolant reservoir and or remove the radiator cap. Bubbles in the coolant would most likely indicate head gasket leakage or cracked block/head.

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Workshop Hints on Cylinder Leakage Testing

When performing cylinder leakage tests, the following tips might be helpful:

Remove all spark plugs to allow easier rotation of the engine. (If this test is done after a compression test, the plugs should already be out).

- Perform the leakage test on all cylinders, not just the problem cylinder. This would indicate any other problems which can be rectified. This eliminates any repeat repairs and wasted diagnostic time.
- Perform the leakage test in cylinder firing order starting with cylinder #1. It takes two revolutions of the engine to complete the leakage test. Start at cylinder #1 and rotate the engine to the next cylinder in the firing order. Divide the number of cylinders into 720, the result is the number of degrees that each cylinder fires. For example, if you divide a 6 cylinder into 720, this equals 120 degrees. If you start at cylinder 1 and rotate the engine 120 degrees in the direction of rotation, you can check the next cylinder in the firing order. This process eliminates the need to rotate the engine an excessive amount.

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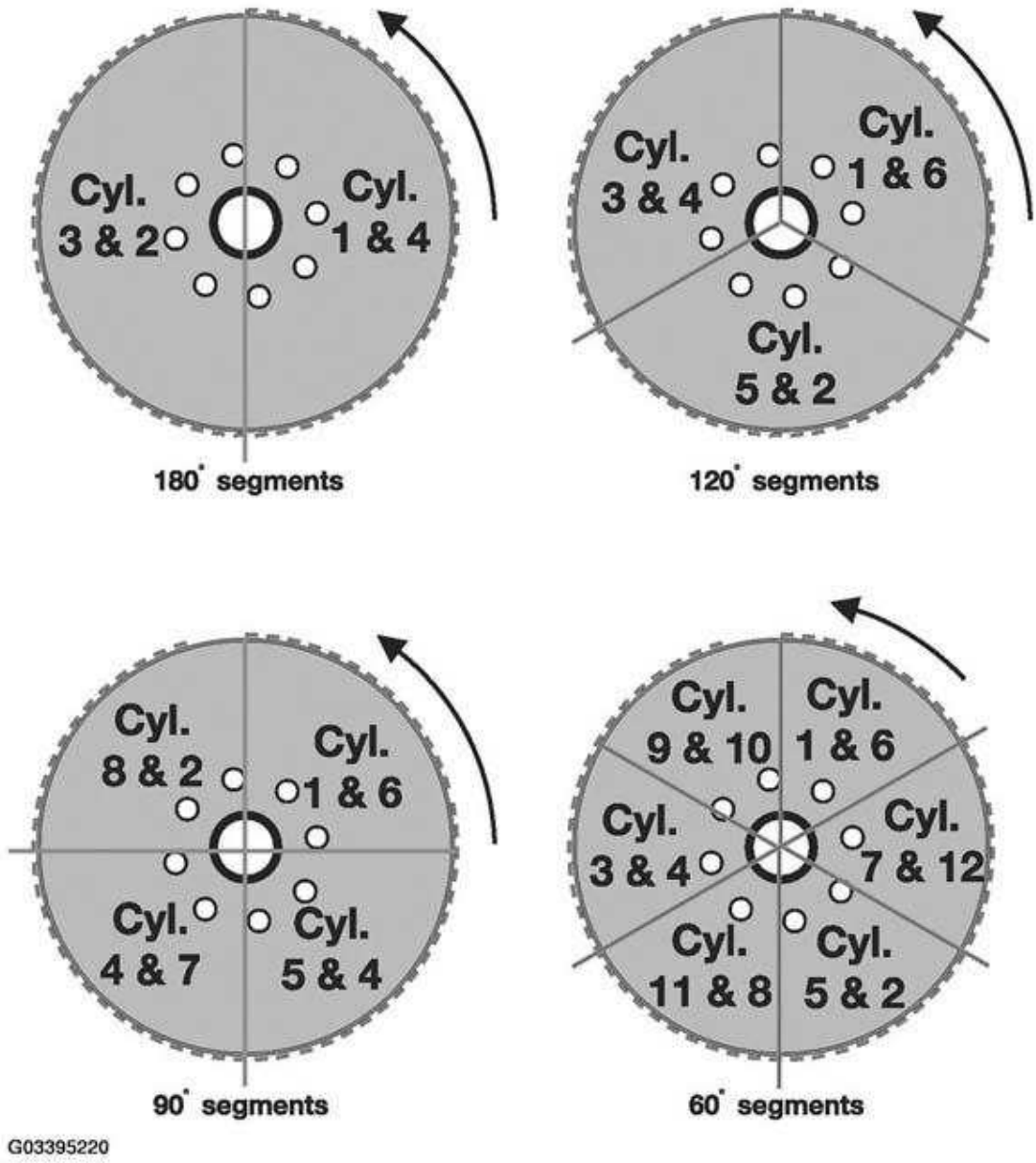


Fig. 4: Cylinder Leakage Testing Tips
Courtesy of BMW OF NORTH AMERICA, INC.

Cylinder Arrangement And Firing Order

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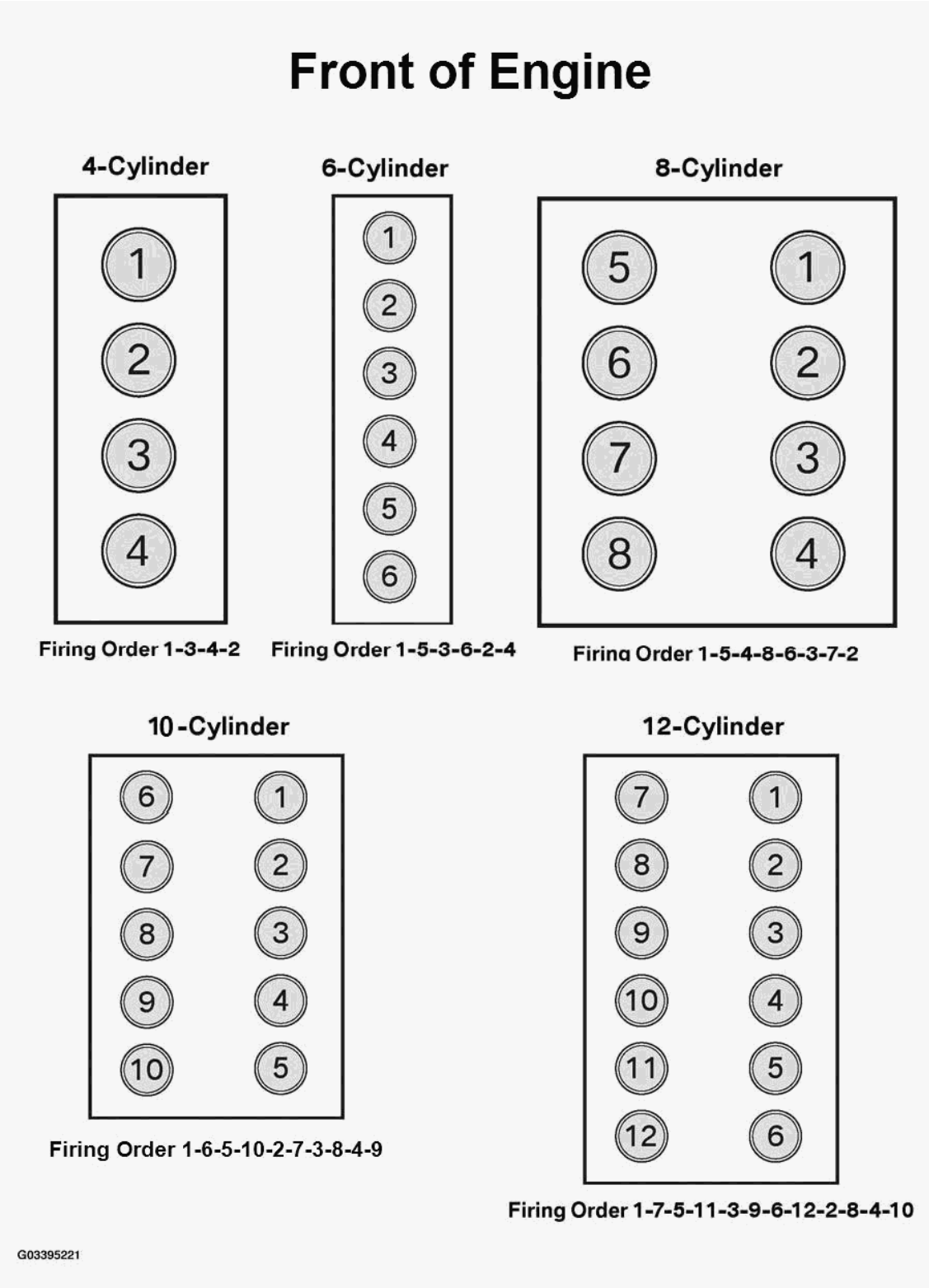


Fig. 5: Identifying Firing Order
Courtesy of BMW OF NORTH AMERICA, INC.

Ignition System Diagnosis

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The ignition system on modern BMW engines consist of one ignition coil per cylinder. This arrangement is known as RZV, or Direct Stationary Ignition. The ignition coil receives fused power usually from the DME main relay or IVM (N62).

The ignition coil primary circuit is controlled (triggered) by the engine control module (ECM). The ECM controls dwell and ignition timing on all cylinders individually. Electrical circuit faults on the primary circuit are recorded in the ECM and can be read out using the DISplus or GT-1.

Most new engines use the "pencil" type coil. This design houses the coil windings for the primary and secondary circuit as well as the spark plug boot which includes the secondary circuit resistance.



Fig. 6: Identifying Pencil Coil
Courtesy of BMW OF NORTH AMERICA, INC.

Due to the compact design of the ignition coil, much of the diagnosis is simplified. Misfire faults and/or ignition related faults can be easily diagnosed by swapping the coils between cylinders. If the fault moves with the coil, then it is obvious that the coil is at fault. If the fault stays in the cylinder, then the spark plug can be moved etc.

This greatly simplifies engine diagnosis. However sometimes, the diagnosis is not always as simple as swapping parts.

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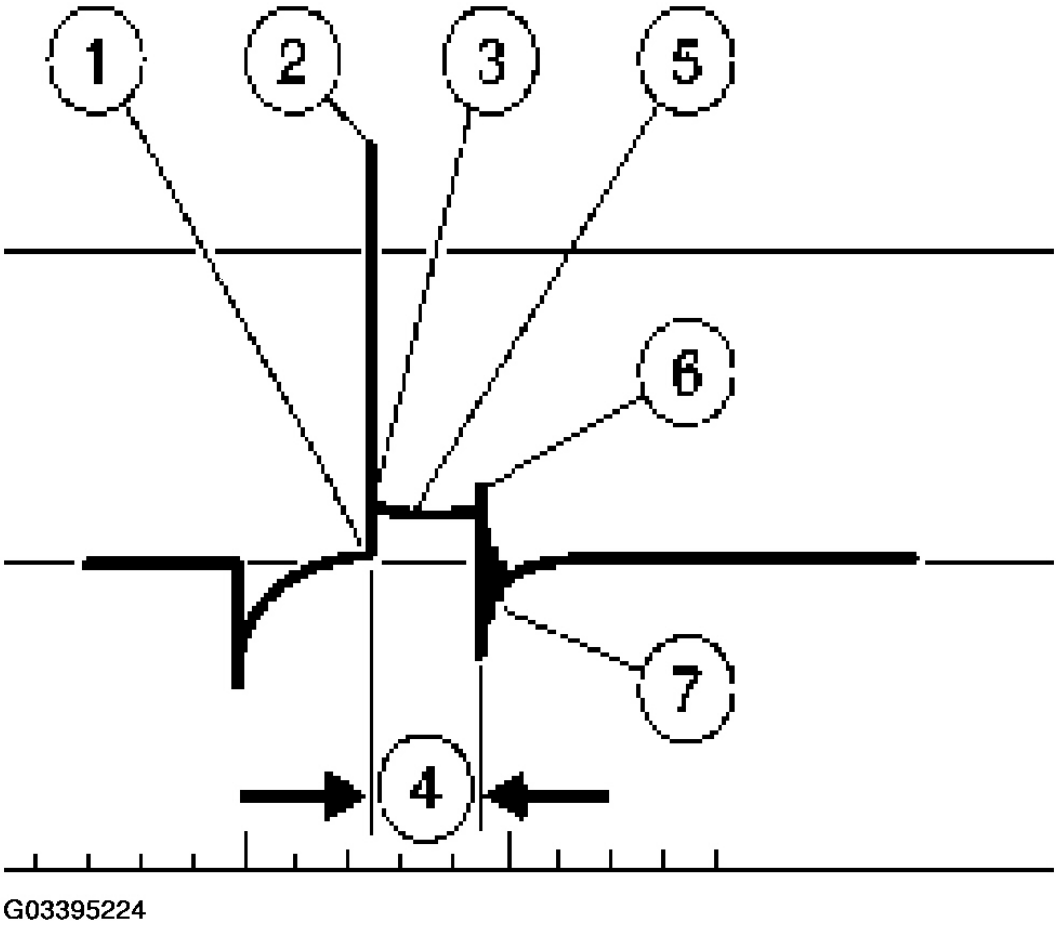


Fig. 7: Ignition Diagnosis Cyclic Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

This is where the oscilloscope function of the DISplus/GT-1 can aid in diagnosis. A good knowledge of fundamental ignition diagnosis can be helpful. The illustration above is broken down as follows.

1. This point represent the start of the ignition process, also known as "transistor off". The ECM turns off the primary circuit causing the magnetic field to collapse. This begins the production of the secondary voltage needed to fire the spark plug.
2. The is called the firing line as it represents the voltage needed to overcome the secondary resistance and cross the spark plug electrode gap. This voltage level will increase as secondary circuit resistance increases. Also lean mixture will cause this line to increase as well. On RZV ignition systems, this line should be around 3-5kV.
3. This line indicates the start of the combustion process. This is also referred to as the spark line. The line should start relatively level and should be about 1/3 to 1/2 of the height of the firing line. Also, there should be no rapid upward or downward slope.
4. This period of time represented here is the combustion period. This area indicates the integrity of the

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combustion event. Problems such as low compression, lean or rich mixture problem would be indicated here.

5. This line represent the voltage present during the combustion period. This line should be mostly level. Upward or downward sloping can indicate mixture or engine compression problems.
6. This point represents the end of the combustion process. Combustion has ended and the remaining voltage available is the coil will start to dissipate.
7. This is known as the coil or decay oscillation period. Any excess voltage not used in the combustion process will "decay" and dissipate. The number and pattern of the oscillations is dependent on the coil type. Different types of coils and different coil manufacturers will be a factor on this pattern. Anywhere from 2 to 6 oscillations may be seen here. If no oscillations are present, this would indicate ignition coil internal problems.

Most newer engine use a "multiple spark" discharge when the ignition coil is triggered. This is to aid in startup. When diagnosing these ignition systems, the additional peaks do not need to be factored into your diagnosis.

Referring to the illustration below, the relevant portion of the scope pattern is at point 1.

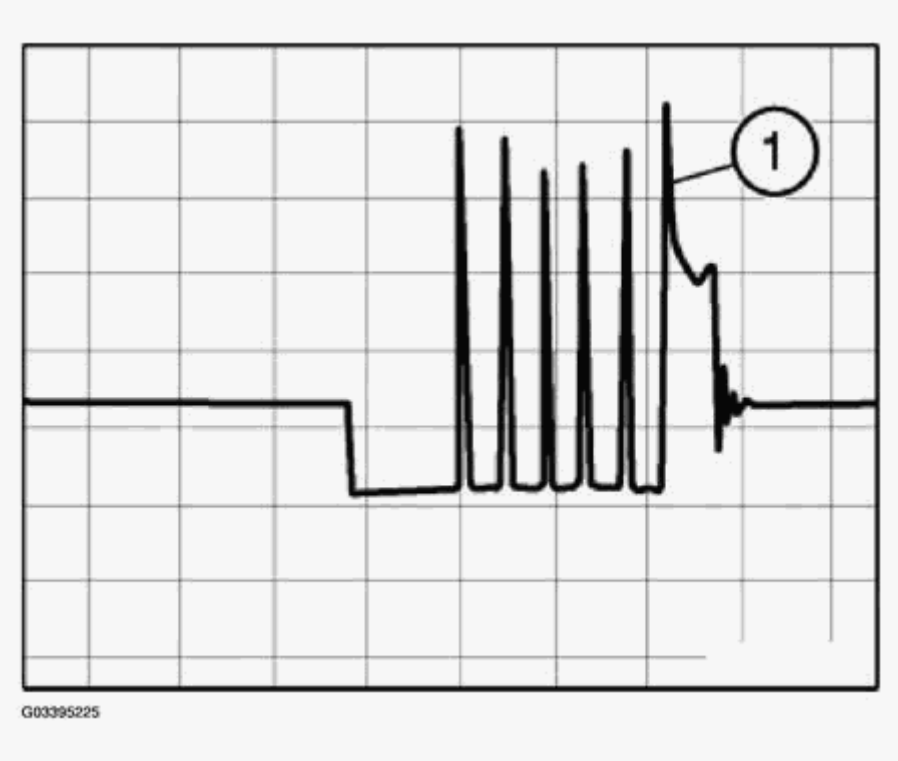


Fig. 8: Identifying Scope Pattern
Courtesy of BMW OF NORTH AMERICA, INC.

Fuel System Testing

Fuel systems need to be checked for proper fuel pressure as well as sufficient volume. When diagnosing fuel system complaints, you must take into account the type of fuel system and how the fuel is delivered to the engine.

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Malfunctions in the fuel system can cause driveability complaints which include:

- No start condition
- Hard start/extended cranking time
- Lack of power
- Check Engine (MIL) Light along with mixture related faults
- Excessive exhaust emissions (High CO and/or HC)

When a no start condition is experienced, it is important to start with the basics. Does the vehicle have any fuel in the tank? Don't assume that there is fuel, the fuel gauge or sender circuit may be faulty. Also, the siphon jet system may be defective. Check the fuel level using the instrument cluster test steps if necessary. Check to be sure that there is fuel available on the right side of the fuel tank.

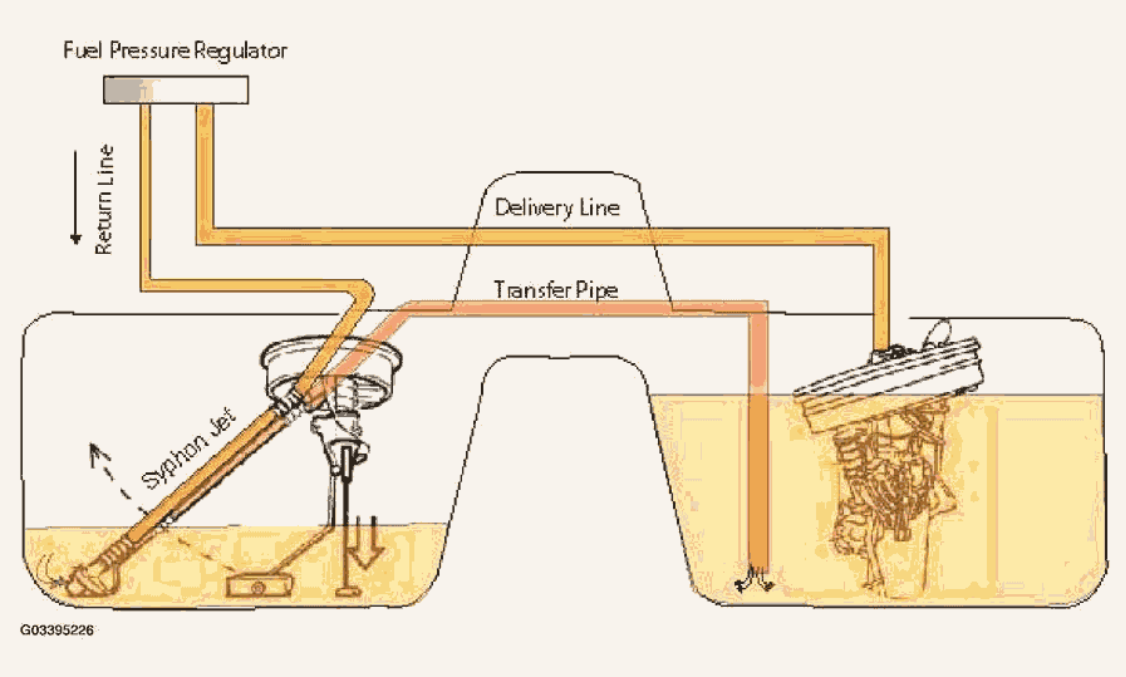


Fig. 9: Checking Fuel System
Courtesy of BMW OF NORTH AMERICA, INC.

Once is has been determined the there is fuel in the tank. The fuel system can be tested for proper pressure. Fuel pressure specifications vary between vehicles. Until recently, most fuel systems used a pressure of 3.5 bar. Some of the new systems use up to 5 or 6 bar. Direct injection systems use 6 bar for the fuel supply system and up to 120 bar pressure to the fuel injectors.

The fuel supply system should be tested using the appropriate fuel pressure gauge. Depending upon the vehicle, the testing methods and connections for the fuel pressure testing equipment differ.

Some vehicles have testing ports with a Schrader valve for easy hookup. Earlier vehicles did not have a test port. Testing fuel pressure required the use of a "T" connector to connect into the fuel system.

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Most recently, M56 equipped (SULEV) vehicles have a sealed fuel system which require the use of a special tool.

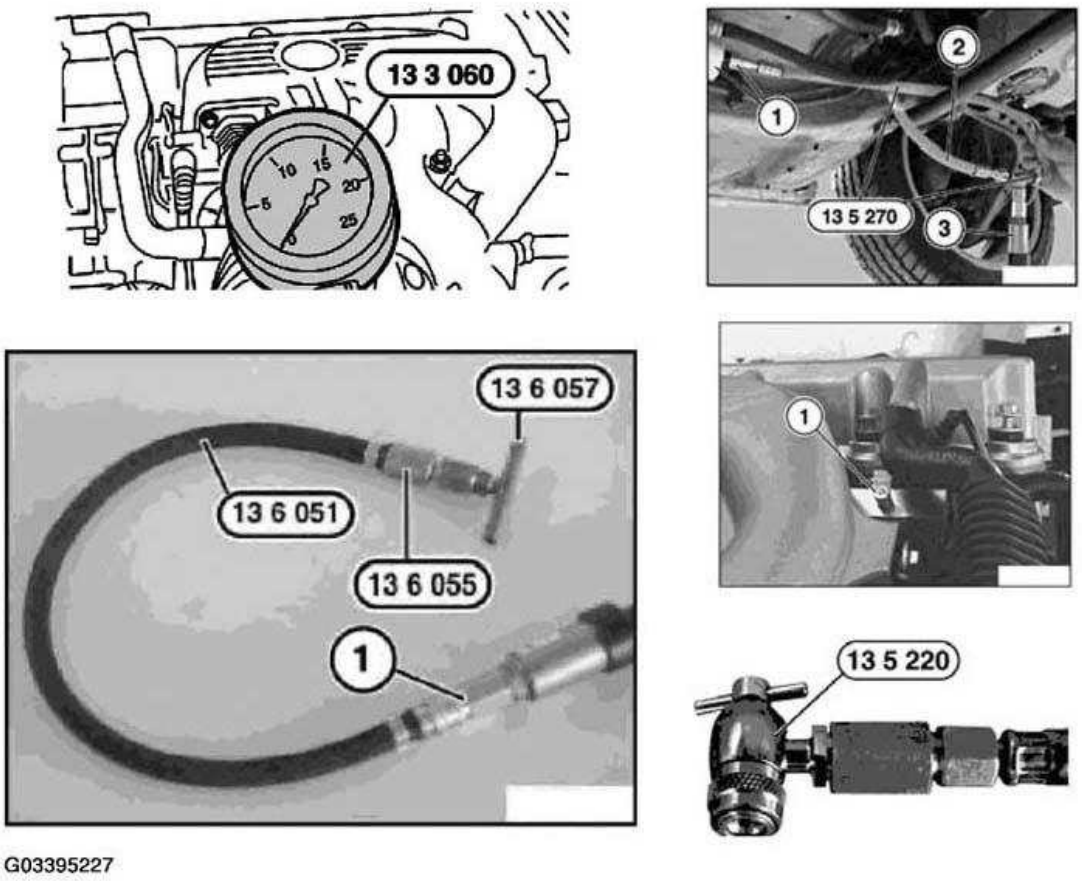


Fig. 10: Identifying "T" Connector
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: Always observe all safety regulations when working on fuel systems. Obey all local and state fire safety laws regarding fuel handling. Always have the proper fire extinguisher on hand when performing testing and/or repair to the fuel system.

Once it has been determined that what the fuel pressure is, compare your reading to the proper specification. If the fuel pressure is low or zero, the fuel circuit must be checked over.

See if the fuel pump is energized. Check the voltage supply and ground to the fuel pump using proper electrical testing procedures (i.e voltage drop etc.). Make sure that you analyze the fuel pump circuit. Check the fuses, connections and appropriate relays.

Also, understand the operation of the fuel pump circuit. Older vehicles were somewhat straightforward, on the other hand, the newer vehicles are using more elaborate circuits for fuel pump operation.

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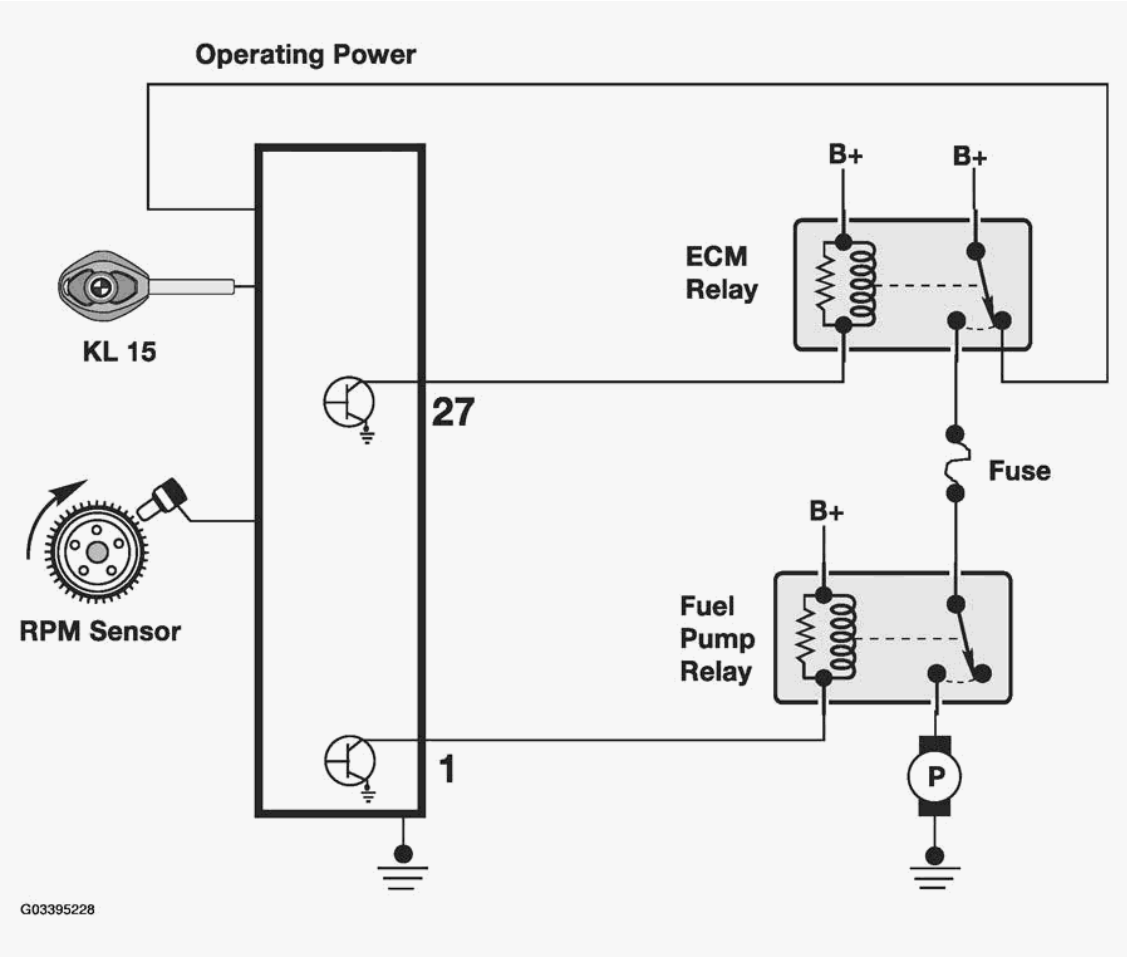


Fig. 11: Operating Power Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Some vehicles, now use a control module to control the speed and flow rate of the fuel pump. The M3, M5 and vehicles equipped with the M56 engine use a fuel pump control module. The E65/E66 uses the SBSR to control the fuel pump. Take this into consideration when performing diagnosis on these vehicles.

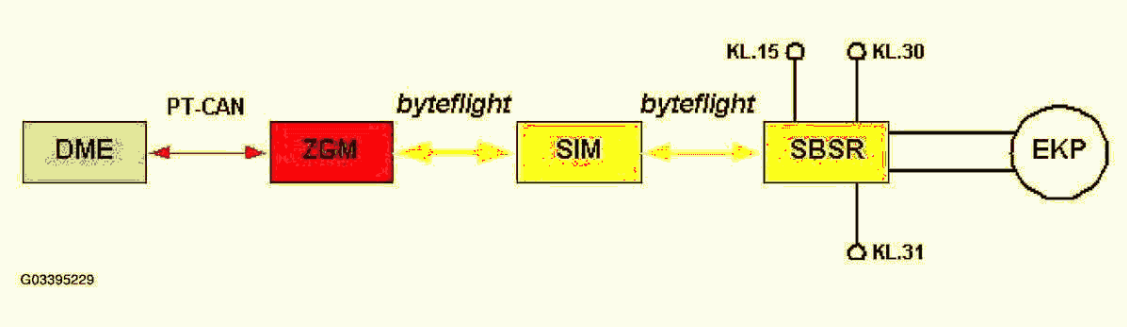


Fig. 12: Fuel Pump Control Module Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Always use available resources such as wiring diagrams, SI Bulletins and training material to better understand circuit operation.

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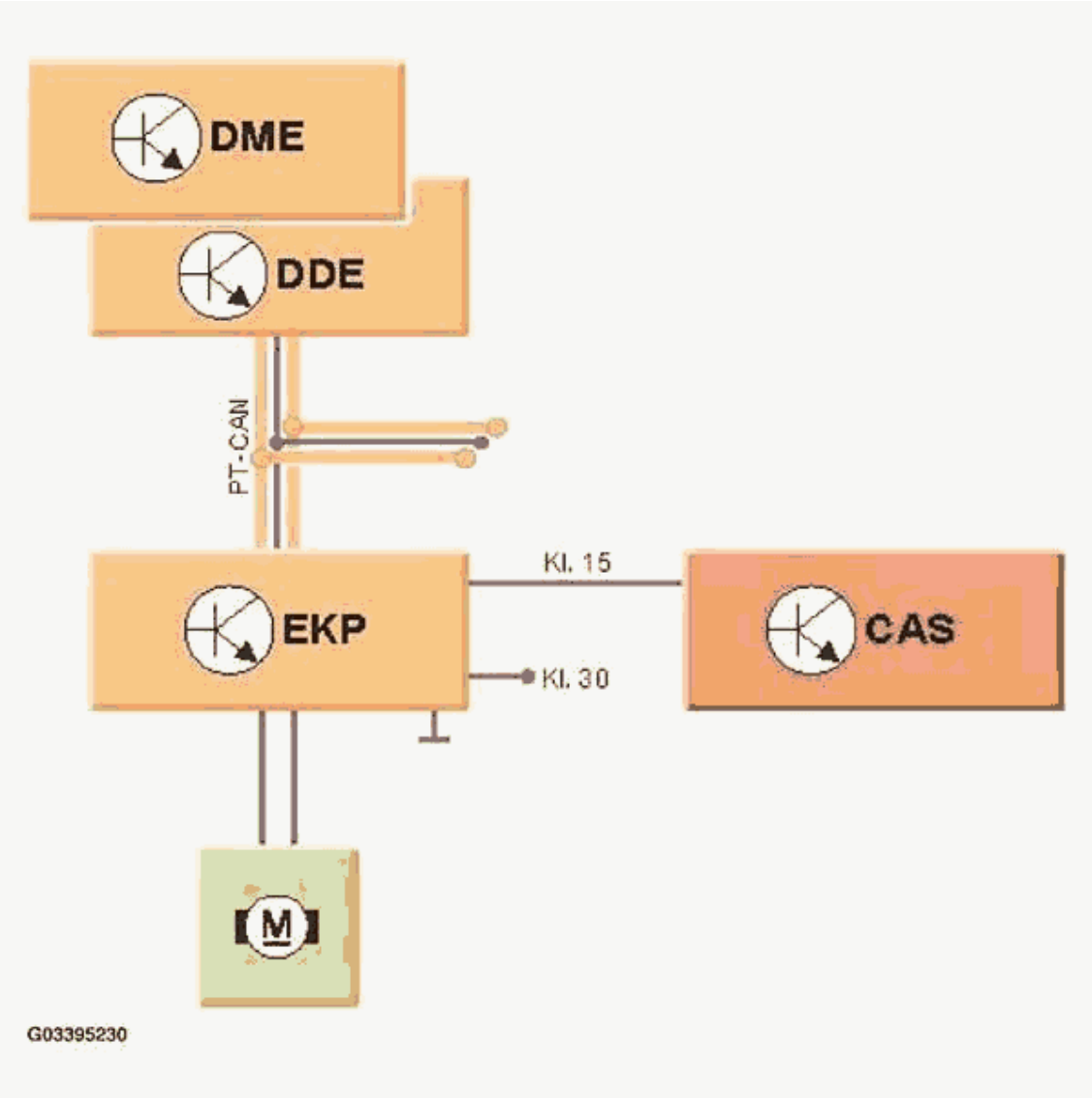


Fig. 13: Fuel System Circuit Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Fuel Volume Testing

Some driveability concerns are related to incorrect fuel volume. Vehicles with lack of power complaints and mixture related fault codes may have insufficient fuel volume supplied to the fuel injection system. These vehicles may actually pass a fuel pressure test.

Fuel volume issues can be caused by faulty fuel pumps, fuel pressure regulators, clogged or restricted fuel filters and/or fuel lines.

If these driveability concerns are present, then a fuel volume test should be performed. A fuel volume test measures the amount of fuel delivered in a specific time frame.

The fuel pump is activated during this test using the proper test leads to ensure no arcing sparks are present. The

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fuel feed line is directed to a non-breakable (fuel-proof plastic) measuring can that has graduations for measurement.

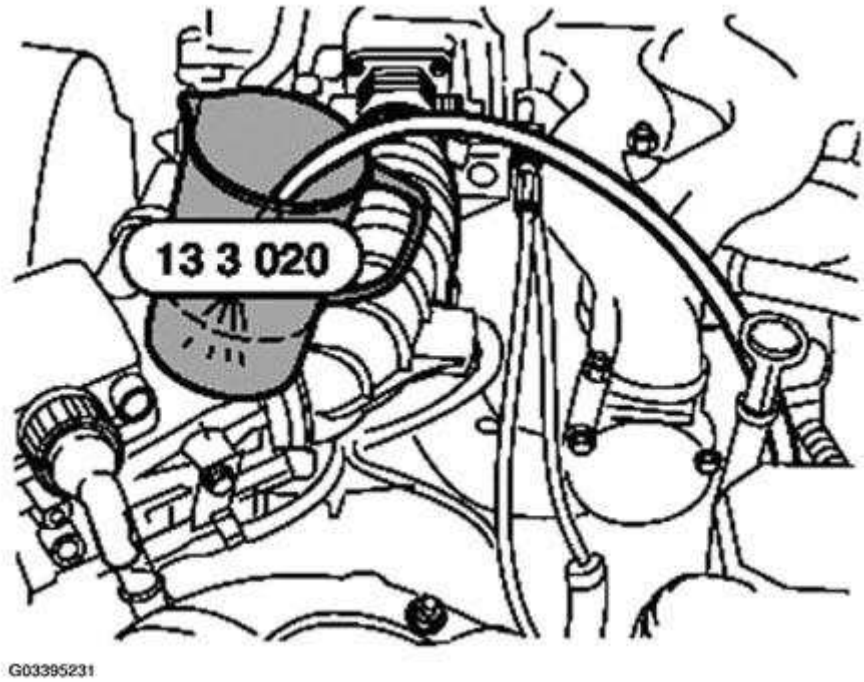


Fig. 14: Checking Fuel Volume Using Measuring Can
Courtesy of BMW OF NORTH AMERICA, INC.

A general specification for fuel volume would be approximately one liter in 30 seconds.

Residual Pressure

Fuel injection systems require a residual pressure to present after the engine is switched off. This allows the engine to start immediately after the vehicle has been parked.

If the residual fuel pressure diminishes after the vehicle has been shut off. Upon restart, there will be an extended cranking period before engine start. This is due to the fuel pump attempting to supply enough fuel for startup.

When the fuel system is at rest, there a three components which allow the fuel system to retain sufficient residual pressure. These items are, the fuel pump check valve, the fuel pressure regulator and the fuel injectors.

Fuel System - E32 with M60

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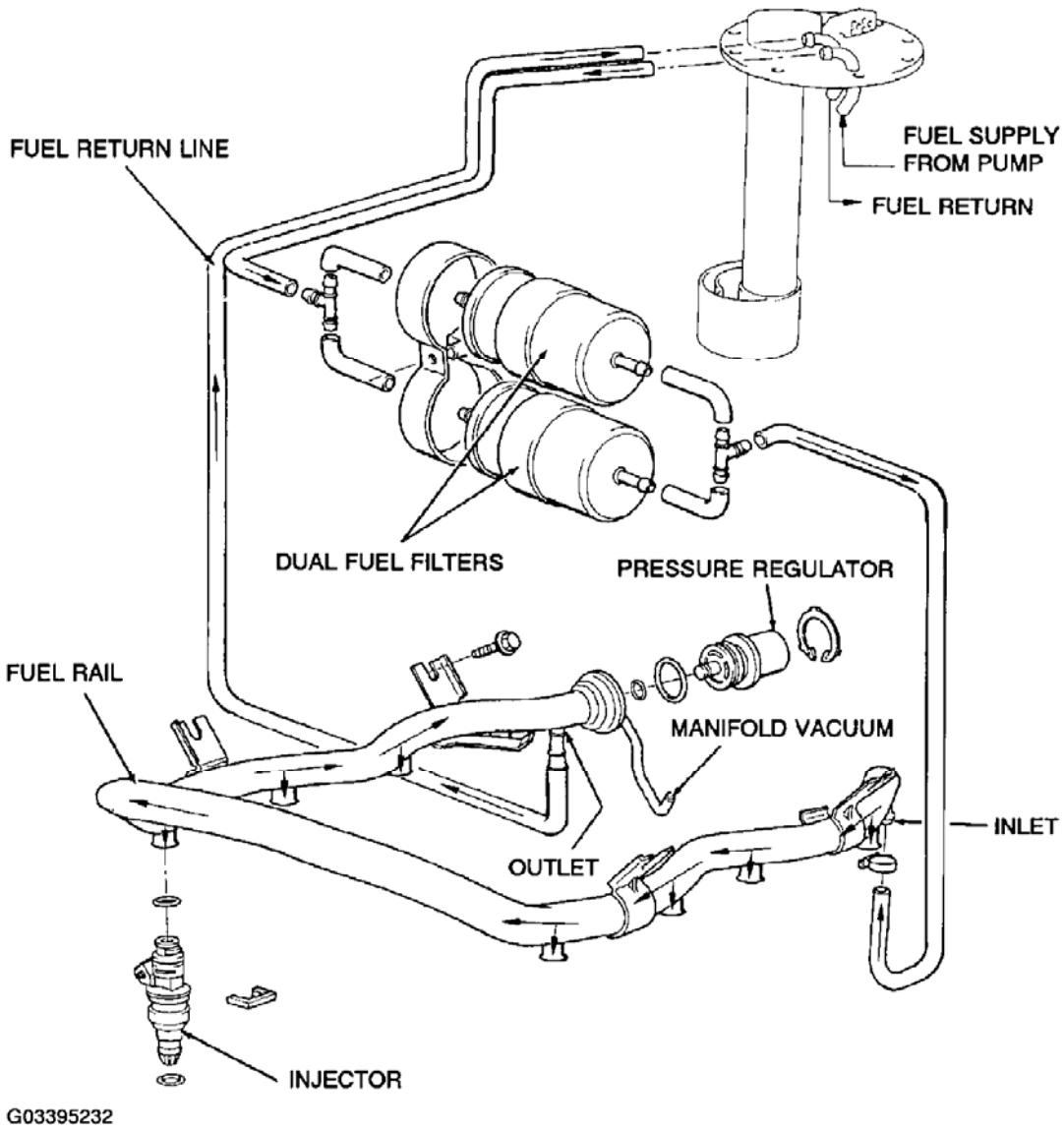


Fig. 15: Identifying Fuel System - E32 With M60 Components
Courtesy of BMW OF NORTH AMERICA, INC.

If any of these items are leaking and fail to hold pressure in the fuel rail, the vehicle will be difficult to start. The cranking time will be excessive and possibly not start at all. For example, If the fuel injectors are leaking, the vehicle will exhibit black smoke on startup.

Diagnosis of these concerns requires a fuel pressure gauge. The residual pressure is monitored on the fuel pressure gauge when the engine is shutoff. Diagnosis is determined by watching the drop in fuel pressure over time. The fuel pressure should not drop more than .5 bar in 30 minutes. If the pressure drops more than .5 bar, the concern should be investigated.

Fuel System - E39/E46 with M54

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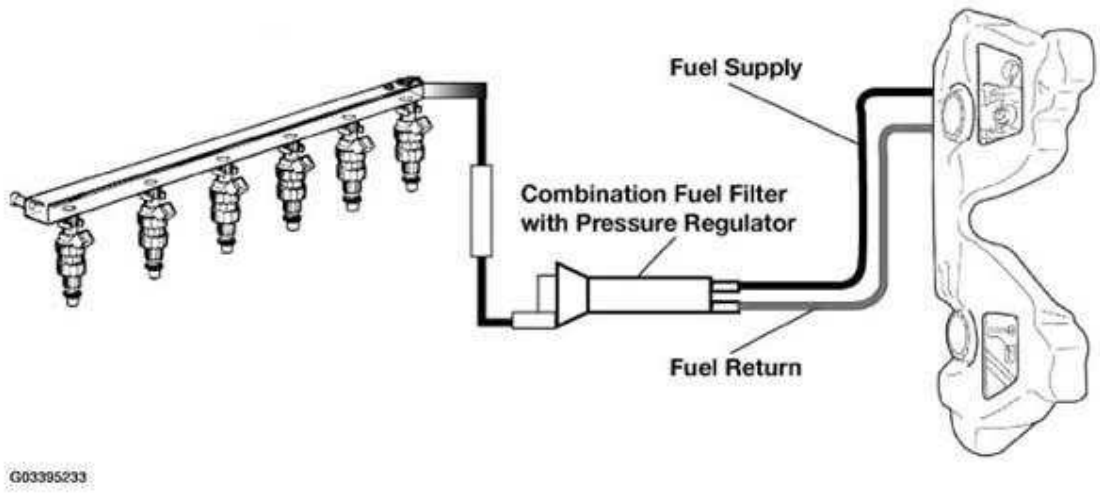
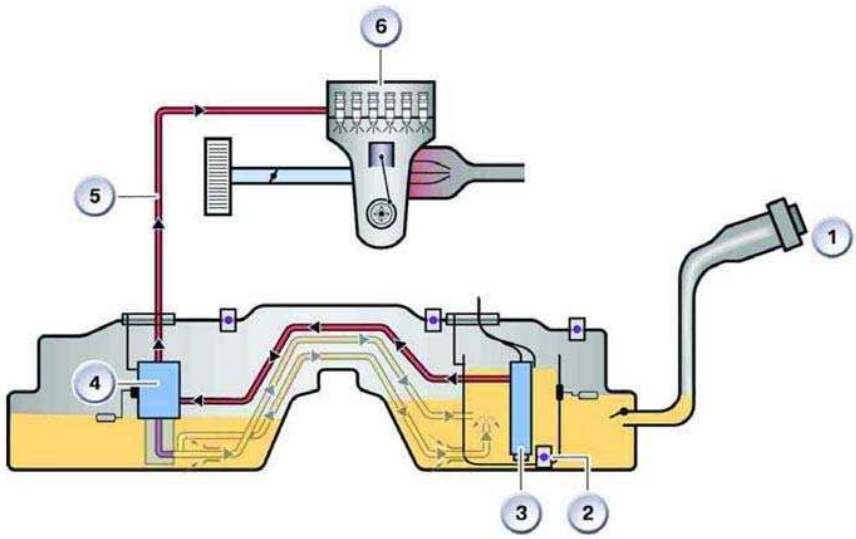


Fig. 16: Identifying Fuel System - E39/E46 With M54 System Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Depending on the type of fuel system used, diagnosis will vary. On older fuel systems, diagnosis is simplified due to the ability to clamp off certain components to determine, the origin of the leakdown.

Fuel System - E60

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Index	Explanation	Index	Explanation
1	Fuel Filler Pipe	4	Fuel FIlter
2	Outlet Protection Valve	5	Feed Line
3	Electric Fuel Pump	6	Fuel Injectors/Fuel Rail

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Fig. 17: Identifying Fuel System - E60 Components
Courtesy of BMW OF NORTH AMERICA, INC.

Newer fuel system use a non-return type fuel system with some components mounted externally. Most recently, many of the new vehicle have most of the fuel system components mounted in the fuel tank. This includes the fuel pump, fuel filter and fuel pressure regulator. The only fuel system component outside the fuel tank is the fuel feed line, fuel rail and fuel injectors.

This makes the diagnosis of residual pressure concerns more difficult. Diagnosis of this type of system sometimes requires process of elimination.

If one or more of the fuel injectors is suspected as the cause of the loss in residual fuel pressure. They can be tested using a special tool to "bubble test" the injectors.

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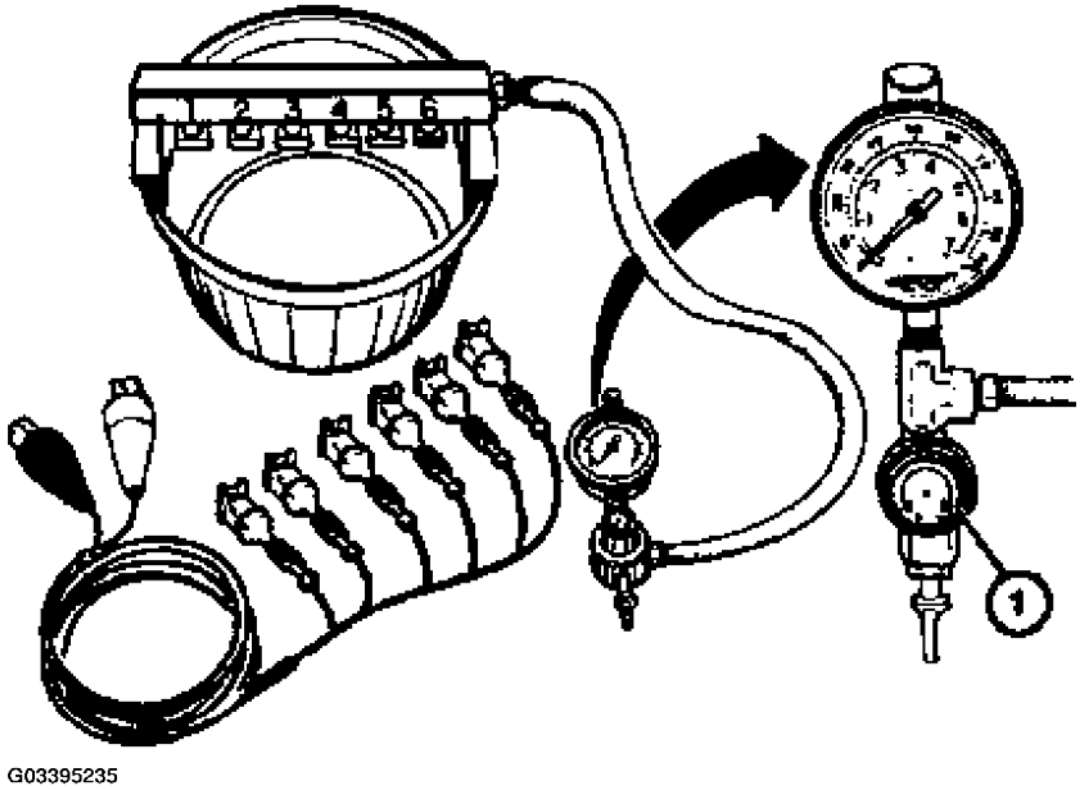


Fig. 18: Testing Bubbles In Injectors Using Special Tool
Courtesy of BMW OF NORTH AMERICA, INC.

First the injectors are connected to the test fuel rail supplied with the tool. Then, the fuel injectors are subjected to compressed air. The injectors are then triggered by the test harness to "blow out" any residual fuel.

The test harness is disconnected and the tips of the injectors are immersed in water. The injector tips are observed for any bubbles over time. Any excessive bubbles indicate a defective injector.

Engine Adaptation Values

Engine adaptation values can be broken down into two categories:

- **Additive Mixture Adaptation** - additive adaptation refers to "long term fuel trim". These adaptation are made by the ECM (DME) at idle during "closed loop" fuel control. These values are measured in milliseconds and are expressed in negative and positive values.
- **Multiplicative Mixture Adaptation** - multiplicative adaptation occurs during part load conditions and are performed by the ECM during "closed loop" fuel control. These values are measured in percent and are also expressed as negative and positive values. This is also referred to as "short term fuel trim".

Additive mixture adaptation corrects for variations in idle mixture. The ECM monitors the oxygen sensor signals to evaluate the exhaust mixture. When a lean (or rich) mixture is detected, the ECM increases (or

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decreases) the injector "on-time" to correct accordingly.

As long as the fuel trim correction is not excessive, the ECM will not register a fault code. The ECM will correct in increments of +/- .1 ms. When the fuel trim correction exceeds a predetermined threshold value, the check engine light (MIL) will illuminate and store appropriate fault codes for additive mixture adaptation.

Additive values which are excessively positive, would indicate a lean condition. This can be caused by:

- Un-metered air leaks - such as broken vacuum lines or a leaky intake manifold or gasket.
- Faulty crankcase ventilation system - crankcase vent valve stuck open.
- Low fuel pressure - Faulty fuel pressure regulator or fuel pump.
- Faulty HFM - can be sending erroneous load signal information which would cause the ECM to falsely enrich the mixture.

Additive values which are excessively negative, would indicate a rich condition. This can be caused by:

- An air restriction - any restriction to airflow such as a clogged air filter would create a rich fuel mixture. (this may also be indicated by negative multiplication values)
- Faulty crankcase ventilation system - crankcase vent valve stuck closed.
- High fuel pressure - Possible faulty fuel pressure regulator or restricted return line
- Faulty HFM - can be sending erroneous load signal information which would cause the ECM to falsely lean out the mixture.

NOTE: Some newer engine management systems use the term mg/stroke or milligrams per stroke. Treat these values as you would millisecond values.

Multiplicative mixture adaptation corrects for variations in fuel mixture under part load conditions. The ECM monitors the oxygen sensor signals to evaluate the exhaust gas mixture. When a lean (or rich) mixture is detected the ECM adjusts the injector "on-time" accordingly over a "short term" period to adapt for the existing situation.

Multiplicative values are expressed in percent and can be negative or positive. Negative values indicate a rich mixture and positive values indicate a lean mixture. When the Multiplicative values exceed a predetermined threshold value, the check engine light (MIL) will illuminate and store relevant fault codes for Multiplicative adaptation.

When multiplicative values are excessively positive, a lean condition exists. The ECM is attempting to add fuel to maintain the proper fuel mixture (close to lambda value 1). This situation can be caused by a faulty HFM, low fuel volume, restricted fuel filter or faulty fuel pressure regulator.

When the values are negative, the ECM is attempting to lean out (remove fuel) the fuel mixture to compensate for a rich condition. This can be caused by:

- Excessive fuel pressure - from a faulty fuel pressure regulator or restriction in the return line.
- A faulty HFM - the HFM can be sending erroneous load signal information which would cause the ECM

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to falsely enrich the mixture.

- An Air restriction - any restriction to airflow such as a clogged air filter would create a rich fuel mixture.
- Any system failure which would cause the mixture to be falsely enriched. This could be caused by erroneous signal information from sensors such as the engine coolant temperature sensor or intake air temperature sensor.

Engine Misfire Diagnosis

Engines which have been produced since 1996 are OBDII complaint. The CARB/OBD regulations require the ECM to be capable of detecting misfires. Also, the ECM must be able to determine if the misfires increase engine emissions and/or are catalyst damaging.

The ECM detects engine misfires by monitoring crankshaft speed. The ECM receives the input from the crankshaft sensor and determines if there is a misfire present by comparing crankshaft speed variations between combustion events on each cylinder.

The crankshaft must rotate 720 degrees (2 rotations) to fire all of the cylinders in an engine regardless of the number of cylinders. Therefore each firing event is spaced apart and occurs at a specific time. By monitoring the crankshaft signal the ECM can determine which cylinder is misfiring and also the severity of the misfire.

Misfires are classified in 2 levels of severity:

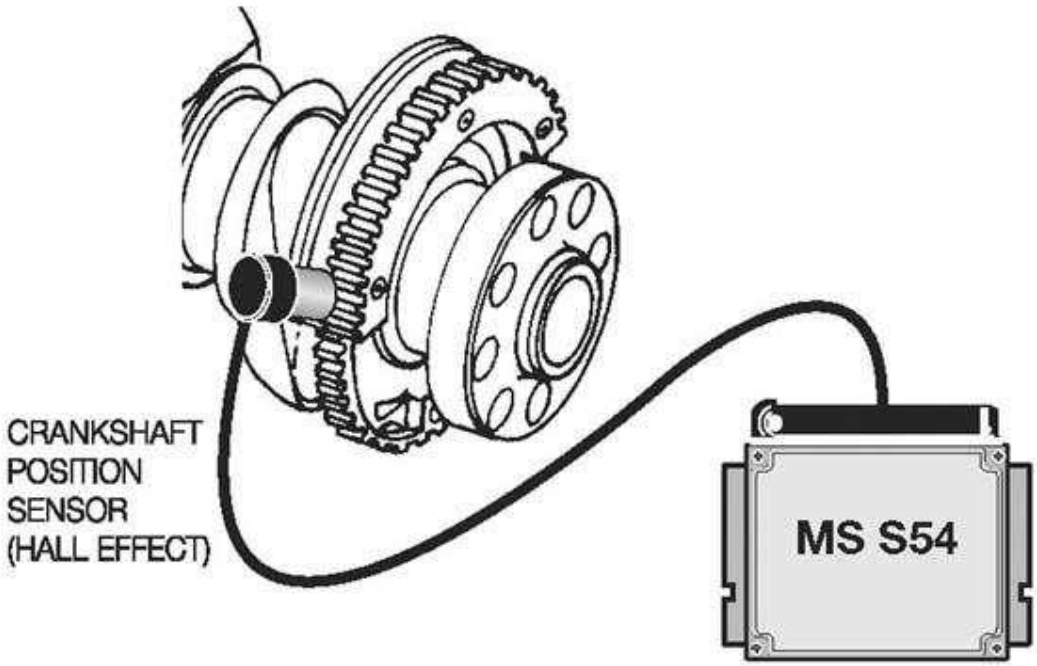
- Misfires which increase emission levels - These misfires occur within an interval of 1000 crankshaft revolutions. The ECM counts and adds the detected misfire events for each cylinder. If the sum of all cylinder misfire incidents exceeds the predetermined value, a fault code will be stored and the "MIL" will be illuminated.

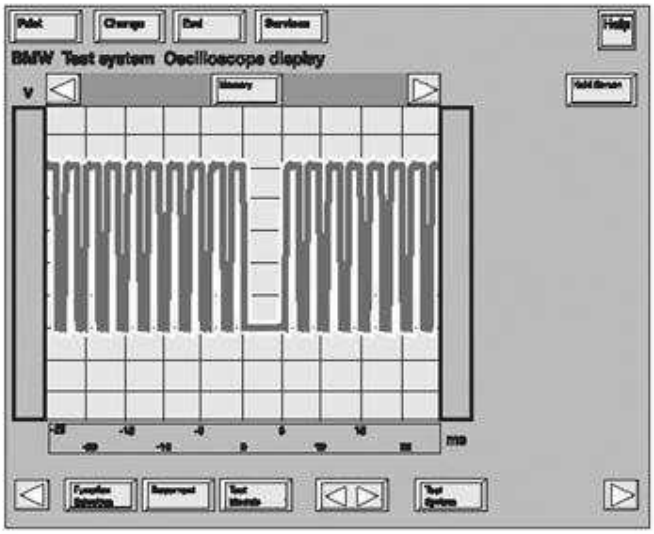
  If more than one cylinder is misfiring, all misfiring cylinders will be specified and the individual fault codes will be stored. The "MIL will be illuminated".

- Misfires which are catalyst damaging - These misfires are determined when the sum of the misfiring events occurs within 200 crankshaft revolutions. These misfires are considered catalyst damaging and the "MIL" will be illuminated.

The ECM will take the following measures - the oxygen sensor control will be switched to "open loop", a cylinder selective fault code will be stored for one or more cylinders and the relevant fuel injector(s) will be deactivated.

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SMOOTH RUNNING ENGINE
(NOTE SQUARE WAVE SIGNAL)

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Fig. 19: Identifying Crankshaft Positioning Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

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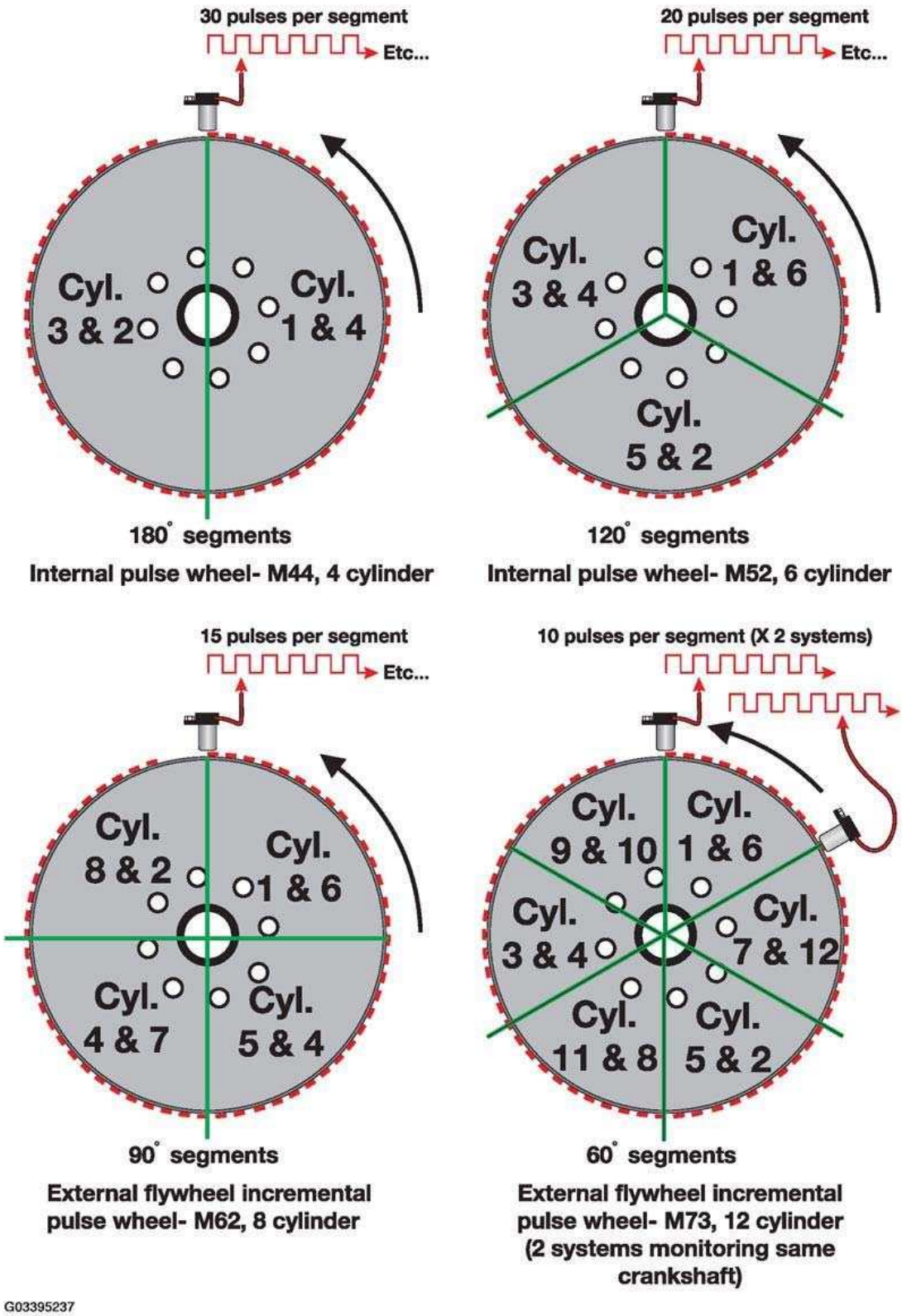


Fig. 20: Displaying Smooth Running Engine Waves

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Courtesy of BMW OF NORTH AMERICA, INC.

The causes of engine misfires include:

- Ignition System - spark plugs, ignition coils, secondary circuit components and primary/secondary circuit wiring.
- Engine Mechanical - piston, piston rings, valves, camshaft and any valvetrain related components including Valvetronic. Valvetronic components include eccentric shaft, intermediate levers etc.

  The crankcase ventilation system should also be considered. This includes the crankcase ventilation valve and if applicable, the hose connections as well.

- Fuel System - fuel injectors, fuel pump, fuel filter and pressure regulator etc. This includes fuel quality as well. Other fuel system components include fuel tank vent valve (purge) as well as running losses components such as the 3/2 valve etc.
- Engine Electronics - any implausible input from a sensor such as the crankshaft sensor and camshaft sensor. Also any sensor which affects fuel mixture including HFM, coolant/intake air temperature sensors etc.
- Other items include the catalyst which could be restricted and/or the muffler.

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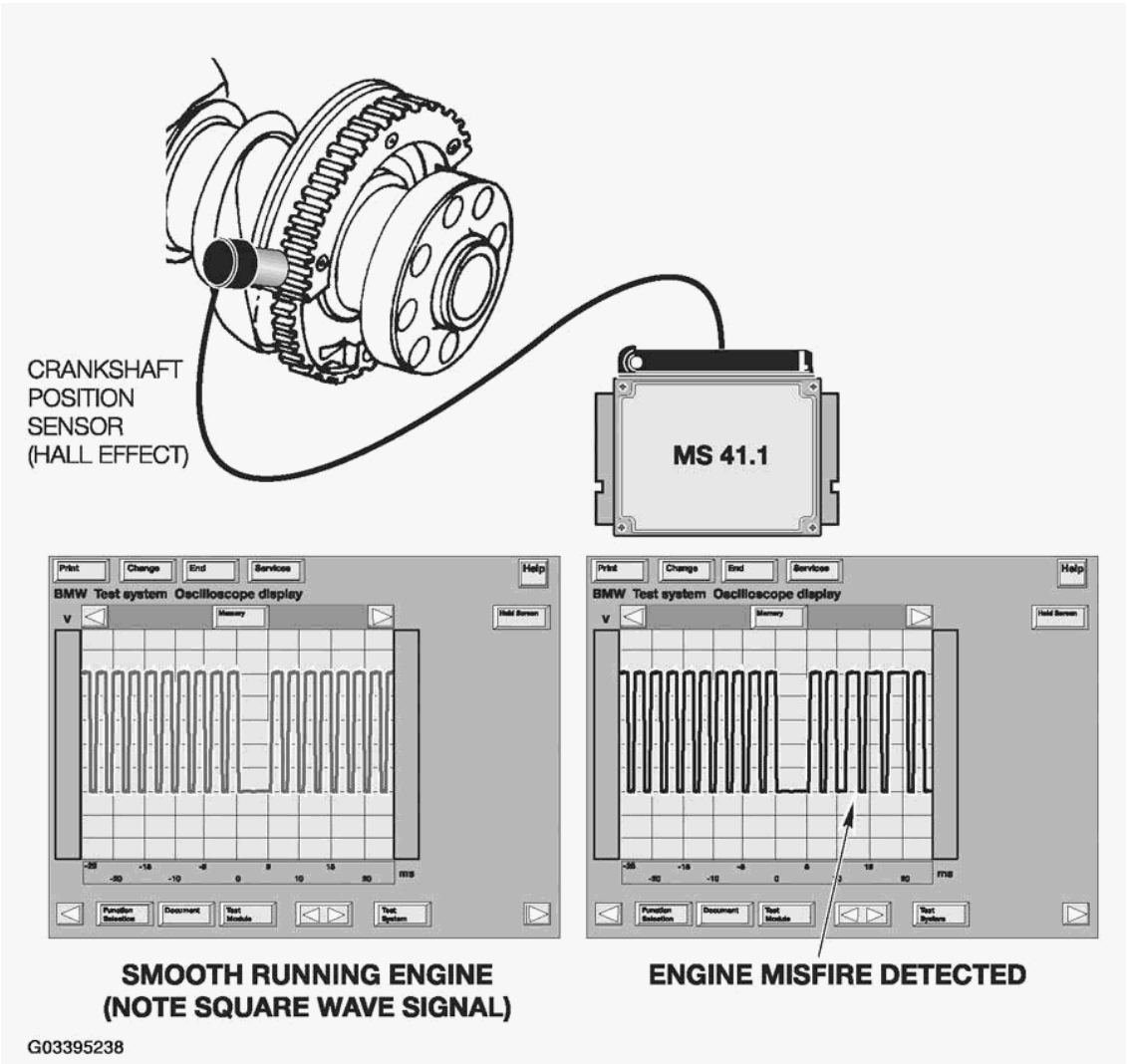


Fig. 21: Displaying Engine Misfire Waves
Courtesy of BMW OF NORTH AMERICA, INC.

Smooth Running Measurement

The DISplus/GT-1 are helpful in pinpointing the cause of an engine misfire. Once the short test is completed, the fault memory of the ECM can be read out to determine which cylinder or cylinders have set misfire faults. There may or may not be any faults present. The engine could be running rough, however no misfire thresholds may have been exceeded.

Engine smoothness can be further evaluated by looking at the smooth running values. In the "Control Unit Functions" screen under "Diagnosis Requests" there is a value indicated for each cylinder which can be compared for each cylinder. This value is an indication of crankshaft speed variations in each cylinder.

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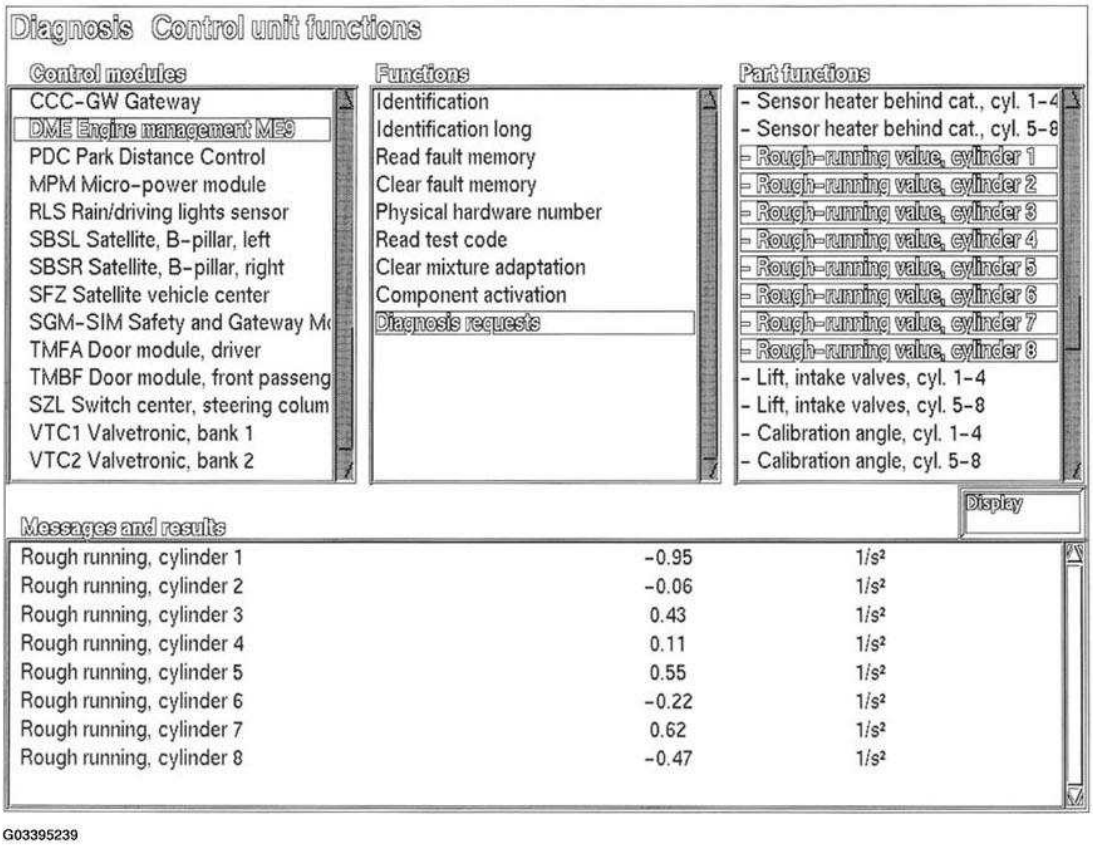


Fig. 22: Displaying Smooth Running Measurement
Courtesy of BMW OF NORTH AMERICA, INC.

Valvetronic N62

In addition to the usual valvetrain diagnosis, the Valvetronic system has some additional components which need to be taken into consideration during diagnosis. The tolerances on the eccentric shaft and intermediate levers are critical in maintaining proper cylinder filling especially at idle. Any deviations in tolerances of these components will contribute to rough running complaints.

The intermediate levers are available in 5 classifications, the classification numbers are marked on the levers. On the N62, each cylinder head must use intermediate levers with the same classification. It is not necessary to have the same classification between cylinder heads.

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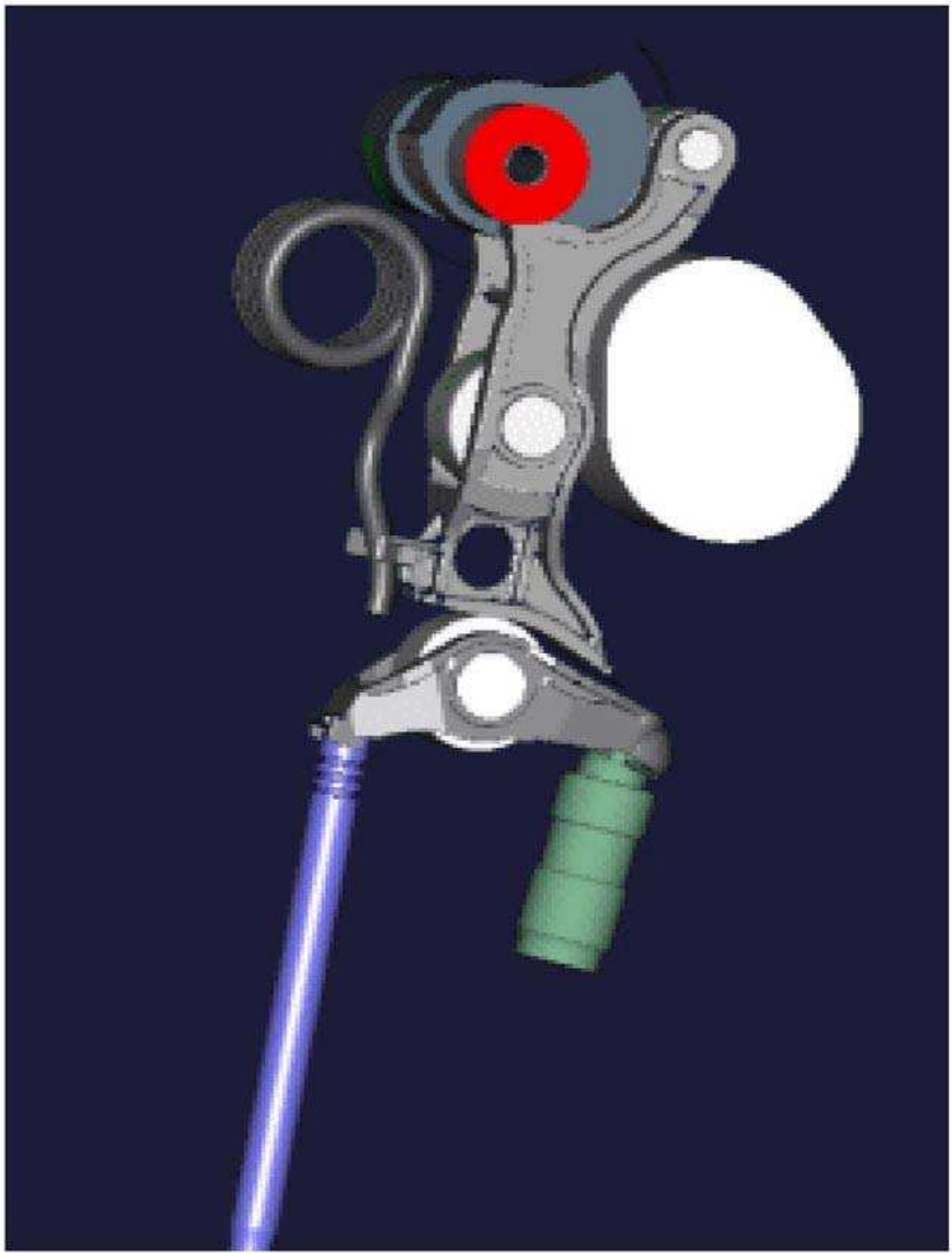


Fig. 23: Identifying Valvetronic N62
Courtesy of BMW OF NORTH AMERICA, INC.

Depending on the engine/vehicle, the minimum valve lift can be set from .3 to .8 mm. At these low valve lifts,

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any variation in tolerance will affect idle quality. When a diagnosis determines that there is a problem in the Valvetronic system, the components need to be inspected. The intermediate levers or eccentric shaft can be worn. The intermediate levers could be of the wrong classification.

The illustration below shows a worn eccentric shaft. The areas shown should be inspected for any wear. Grooves and scoring indicate a worn eccentric shaft which should be replaced.



Fig. 24: Identifying Camshaft Grooves
Courtesy of BMW OF NORTH AMERICA, INC.

The following pages contain testing information which will assist in the diagnosis of idle quality concerns on the N62.

N62 Engine Testing

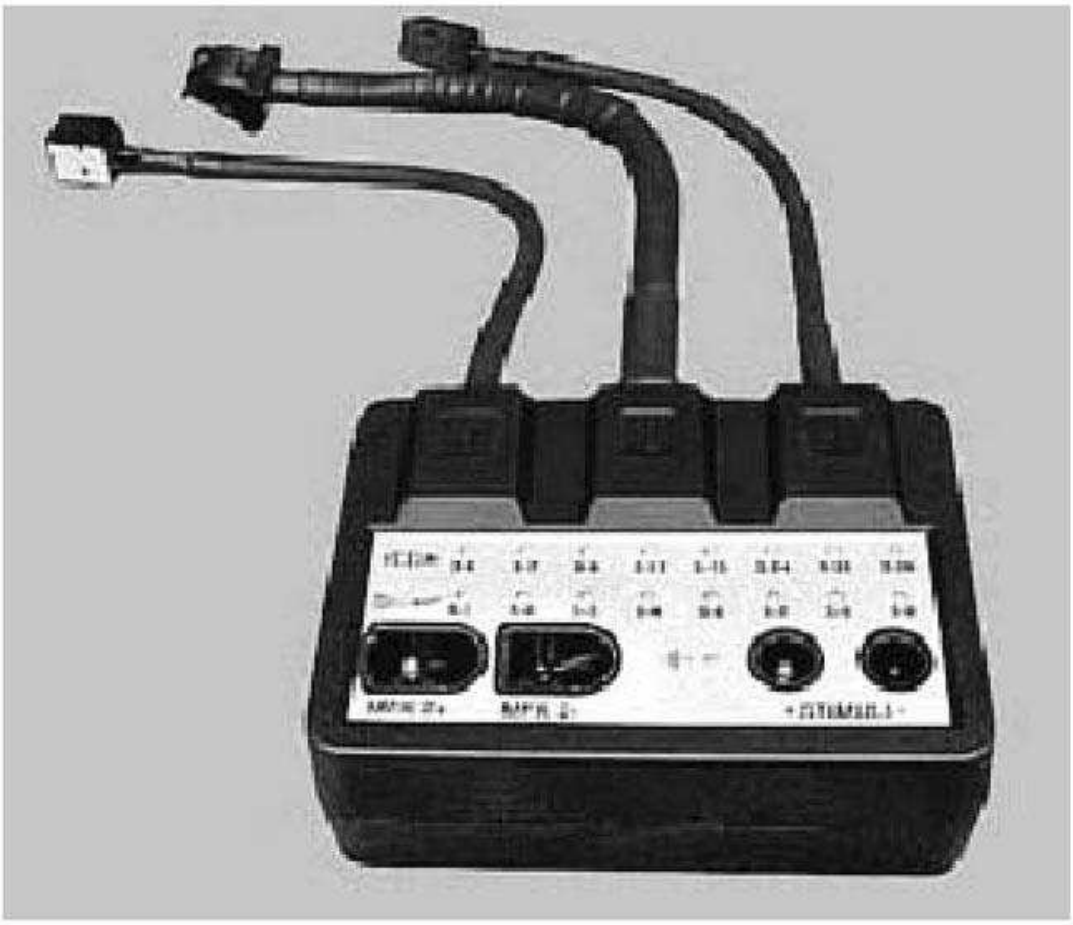
The N62 engine features Valvetronic which requires some specialized diagnostic procedures. Due the variable valve lift feature, there are some additional steps regarding engine and compression testing.

MKA Adapter

The Multi-Channel Adapter (MKA) tool is used in conjunction with the DISplus to diagnose ignition and injection system concerns on the N62 engine. The MKA adapter is installed (in series) between the ECM and the engine harness at connectors 1, 3 and 5. In addition the four cables of MFK 2 are plugged into the MKA as

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well.



G03395242

Fig. 25: Identifying MKA Adapter
Courtesy of BMW OF NORTH AMERICA, INC.

The MKA test module is found under the path > Service Functions > Drive > Engine Management ME9 > Test Runs > Ignition and Injection diagnosis N62.

The MKA engine test checks the integrity of the ignition system by looking at the primary ignition voltage on each cylinder.

The injection system is also checked by examining the voltage pattern of the injection circuit.

Compression Test N62

The compression can be tested on the N62 using the DISplus. The DISplus can perform a relative compression test and provide a comprehensive engine analysis report.

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The compression test can be done at minimum valve lift as well as at maximum valve lift. This difference between these reading can assist in determining the root cause such as wear in Valvetronic components.

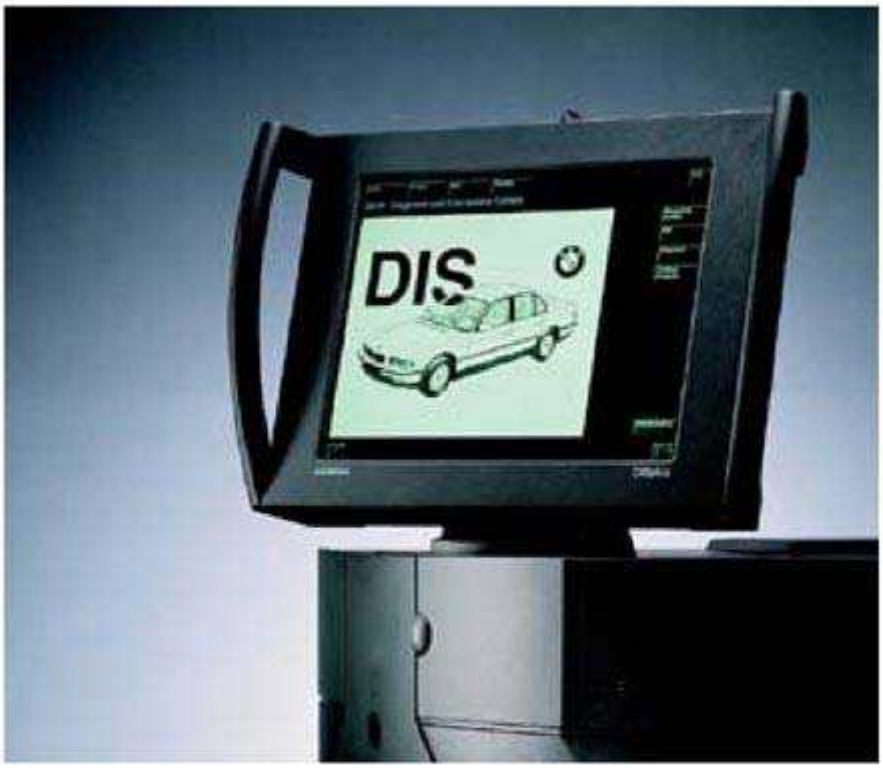


Fig. 26: Identifying DIS
Courtesy of BMW OF NORTH AMERICA, INC.

When performing this test the following connections/cables are needed:

- Diagnostic head (can be hardwired or wireless)
- TD Cable connection to diagnostic head
- 25 Bar Pressure transducer connected to pressure connection #2.
- Compression adapter (quick disconnect)
- 1000 Amp clamp

The test module will prompt you to warm up the engine to 90°C. Once warmed up, you will be directed to run the engine at idle to set the minimum valve lift. Follow the on screen prompts. Once the minimum valve lift has been obtained (0.2 to 0.4 mm), disconnect both VVT motors to lock in the minimum adjustment.

Once this step in completed, shut the engine off and remove the #1 spark plug. Install the compression adapter into the spark plug hole. (Note: any cylinder can be used as long as the DISplus is set to the cylinder in use).

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Follow prompts until test is completed.



Fig. 27: Identifying Compression Adapter
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 28: Identifying TD Cable
Courtesy of BMW OF NORTH AMERICA, INC.

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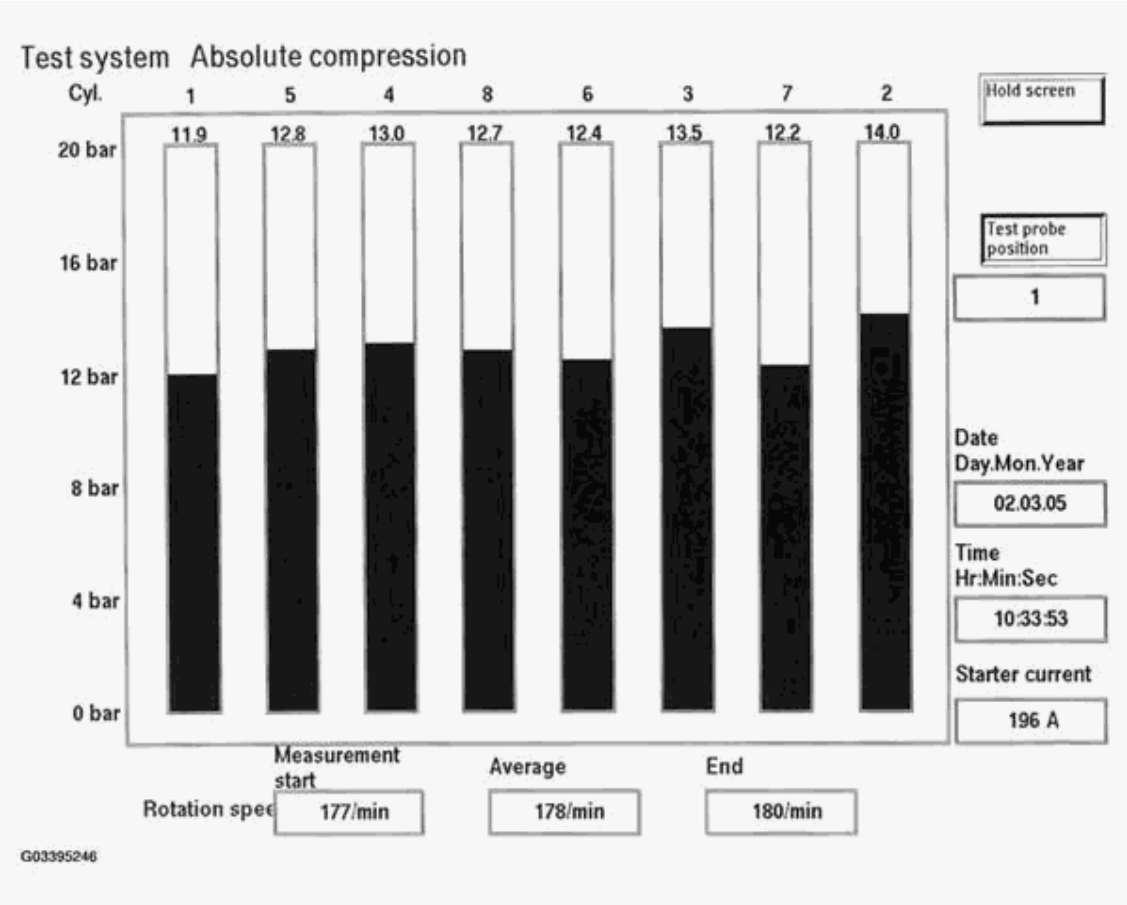


Fig. 29: Absolute Compression Bar Graph
Courtesy of BMW OF NORTH AMERICA, INC.

Once the test is completed, perform the same steps for the maximum valve lift. Compare the results, the results from the test at maximum valve lift should be slightly higher. Any cylinders that show low results on the minimum valve lift test which show improvements when the maximum valve lift test is performed should be checked for Valvetronic wear concerns.

During the final analysis potion of this test module, there may be on screen recommendations of repairs involving eccentric shaft or intermediate lever replacement. There may be a recommendation of changes to the classification of intermediate levers as well.

Manual Compression Test (N62)

Manual compression testing can also be done on the N62. However, the DISplus must still be used to set the minimum/maximum valve lift. To access the test module for manual compression testing, go to path > Service Functions > Drive > Engine Management ME9 > Test Runs > Compression Test.

Rough Running Diagnosis (N62)

Due to the design of the Valvetronic system, there are special diagnostic considerations when diagnosing rough running concerns on vehicles equipped with the N62 engine.

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The following diagnostic flow chart should be used as a diagnostic aid when attempting to rectify idle quality complaints when the engine is at operating temperature.

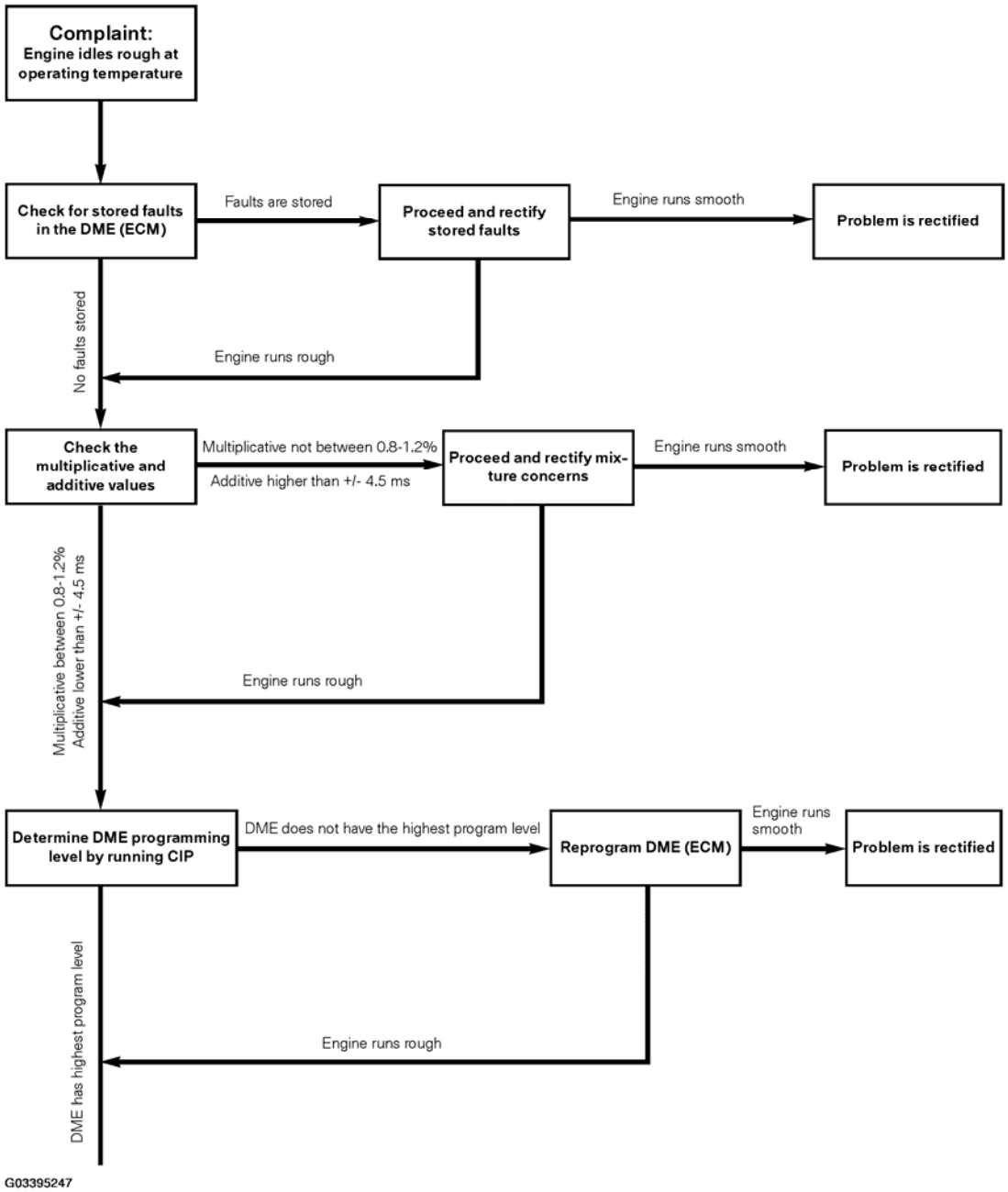


Fig. 30: Rough Running Diagnosis (N62) Diagnostic Flow Chart (1 Of 3)
Courtesy of BMW OF NORTH AMERICA, INC.

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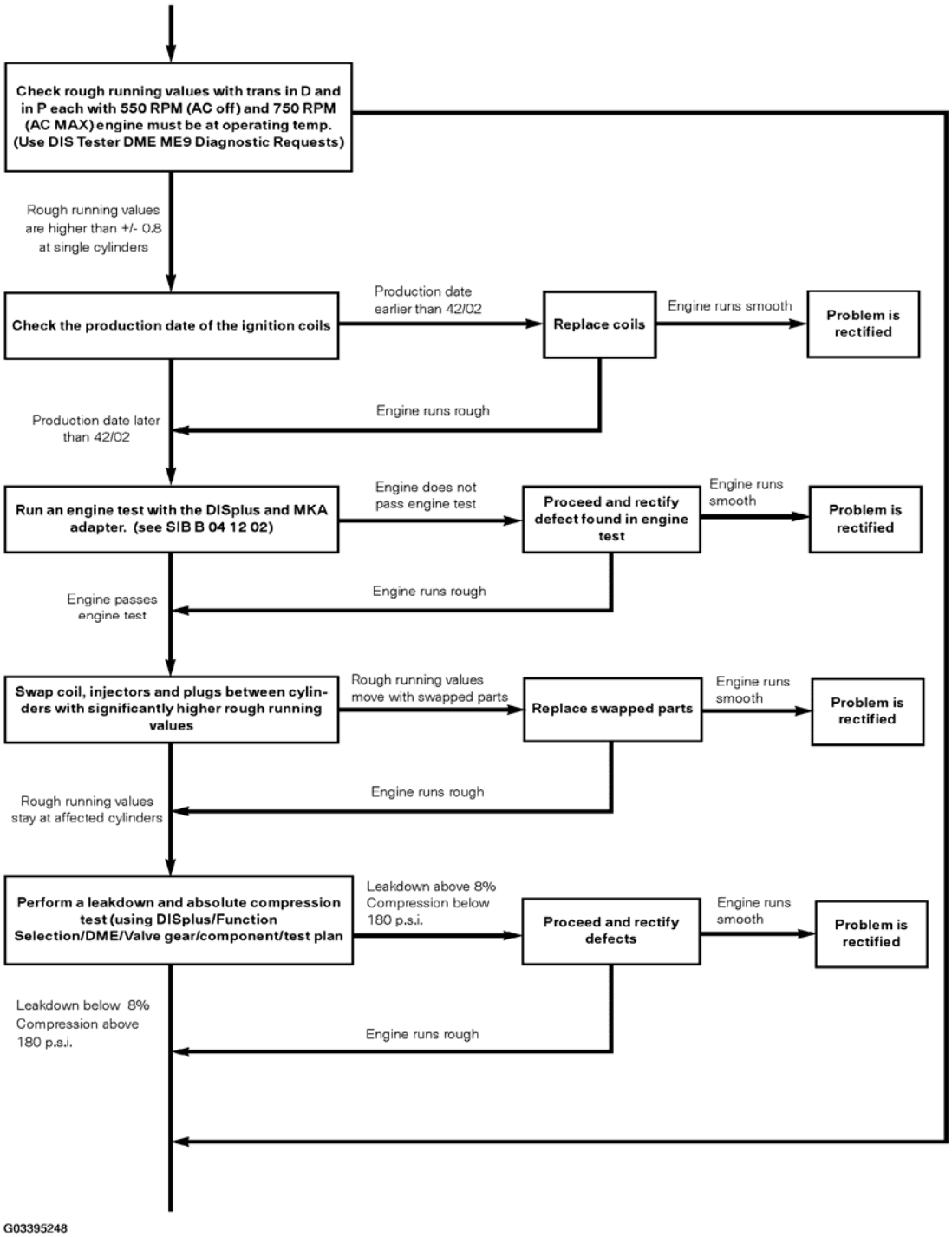


Fig. 31: Rough Running Diagnosis (N62) Diagnostic Flow Chart (2 Of 3)
Courtesy of BMW OF NORTH AMERICA, INC.

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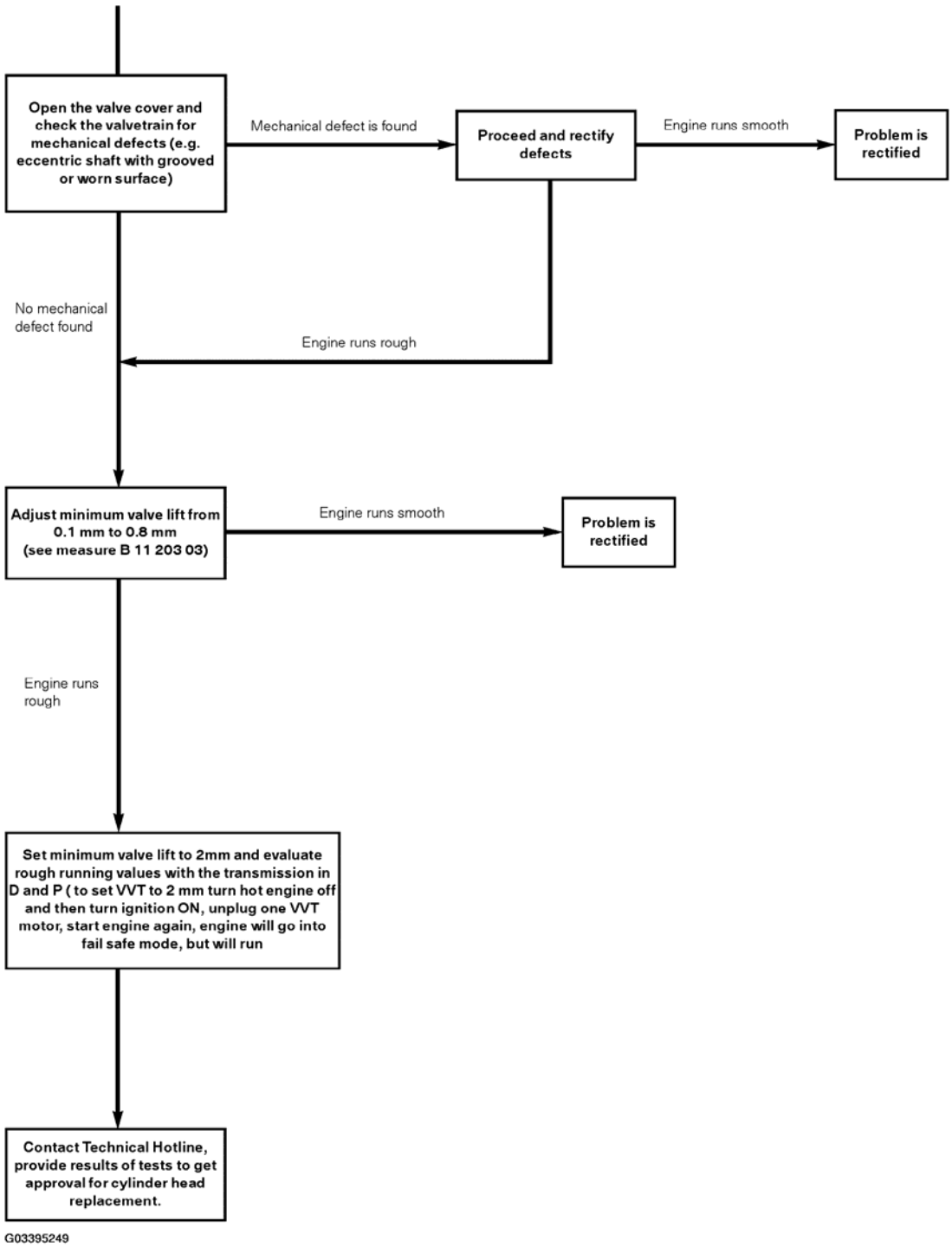


Fig. 32: Rough Running Diagnosis (N62) Diagnostic Flow Chart (3 Of 3)
Courtesy of BMW OF NORTH AMERICA, INC.

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GENERAL INFORMATION

Engine Service Information - 328i, 328xi, 335i, 335xi, X3, X5

2007 NG6 ENGINE

Model: All with NG6-cylinder from 2007

Production: from 9/2006

NG6 ENGINE

Previously in 2005, BMW introduced the beginning of a new generation of six cylinder engines with the N52. Now, for the 2007 model year, BMW has 3 new variations of the NG6 engine family.

The first of the new engines is the N54, which will debut in the new 3-series coupe in September 2006. The N54 engine is turbocharged and uses the second generation of direct injection (DI 2). This engine will power the new 335i coupe in the fall of 2006.



Fig. 1: Identifying Engines - N54
Courtesy of BMW OF NORTH AMERICA, INC.

The N52 will eventually be replaced by the new N52KP. The N52 KP engine is an improved and cost optimized version of the N52. The N52 KP will be available in the 328i and xi coupe from September and will replace the

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N52 in various models.

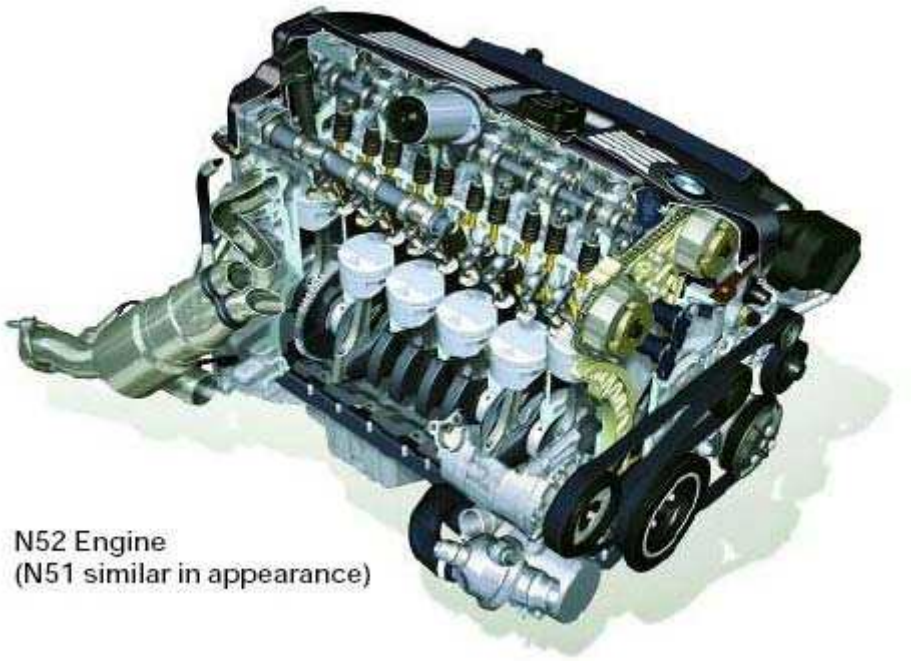


Fig. 2: Identifying Engine - N52
Courtesy of BMW OF NORTH AMERICA, INC.

Finally, the N51 which is a SULEV II compatible engine, will be phased into selected production models from 9/06. The N51 features many of the same features of the previous SULEV engine (M56) including a "Zero EVAP" system.

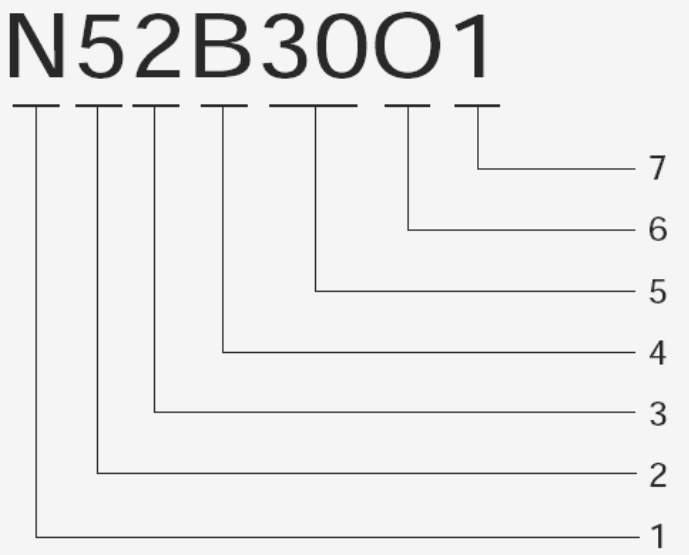
New Engine Designations

Along with the new engines for 2007, there is a new system for engine designations. The first few digits such as "N54B30" are familiar from the past, however the suffix has been changed.

The former "TU" designation has been dropped in favor of two additional digits.

The breakdown is as follows:

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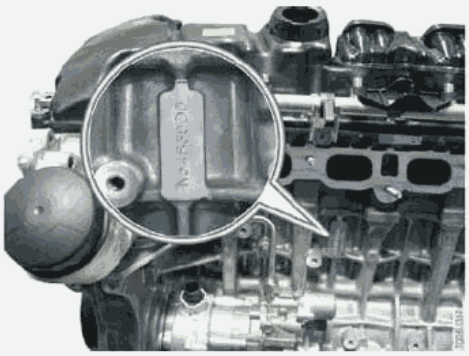
Index	Designation	Code	Description
1	Engine Generation	M	BMW Engines up to 2001
		N	BMW Engines from 2001 (New Generation)
		S	BMW M GmbH
		W	External Engines (i.e. Tritec MINI)
2	Engine Type	4	4-cylinder in-line engine
		5	6-cylinder in-line engine
		6	8-cylinder "V" engine
		7	12-cylinder "V" engine
		8	10-cylinder "V" engine
3	Engine System	0	Basic engine
		1	SULEV or PZEV
		2	Valvetronic
		3	Gasoline direct injection
		4	Gasoline direct injection with turbocharger
		5	Double VANOS with Valvetronic
		7	Diesel direct injection with turbocharger
4	Fuel type/ operating mode	B	Gasoline
		D	Diesel
		E	Electric
		G	Gas (natural)
		H	Hydrogen
5	Displacement in 1/10 liter	30	3.0 liter (example)
6	Power output class	T	Top
		O	Upper output class (standard)
		M	Medium output class
		U	Lower output class
		K	Lowest output class
		0	New development
7	Version	1-9	Redesign/facelift version (TU etc.)

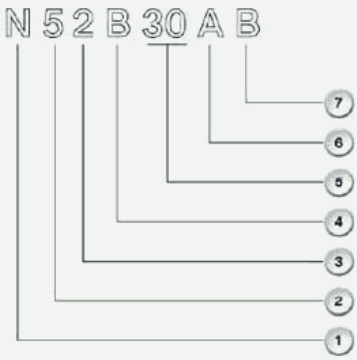
Fig. 3: Identifying Engine Identification Numbers (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Crankcase Identification

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The engine identification numbers are stamped on the block near the high pressure pump.





Index	Designation	Code	Description
1	Engine Generation	M	BMW Engines up to 2001
		N	BMW Engines from 2001 (New Generation)
		S	BMW M GmbH
		W	External Engines (i.e. Tritec MINI)
2	Engine Type	4	4-cylinder in-line engine
		5	6-cylinder in-line engine
		6	8-cylinder "V" engine
		7	12-cylinder "V" engine
		8	10-cylinder "V" engine
3	Engine System	0	Basic engine
		1	SULEV or PZEV
		2	Valvetronic
		3	Gasoline direct injection
		4	Gasoline direct injection with turbocharger
		5	Double VANOS with Valvetronic
		7	Diesel direct injection with turbocharger
4	Fuel type/ operating mode	B	Gasoline
		D	Diesel
		E	Electric
		G	Gas (natural)
		H	Hydrogen
5	Displacement in 1/10 liter	30	3.0 liter (example)
6	Fuel Grade		
7	Performance Class		

Fig. 4: Identifying Engine Identification Numbers (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

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New NG6 Versions

The new N54 engine is designated the "N54B3000". The "O" in the engine designation indicates the "upper" output range.

The last digit, which is a "0", indicates the first version in this range of engines (N54). If the N54 engine is updated, then the last digit will change to a "1" rather than the former "TU" suffix.

The N52KP, which replaces the N52, will have three possible variants as shown below:

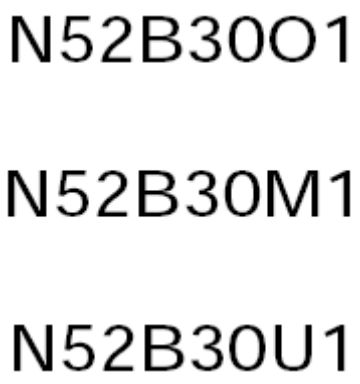


Fig. 5: Identifying NG6 Versions
Courtesy of BMW OF NORTH AMERICA, INC.

All of the N52KP engines have a last digit of "1", which indicates that "KP" engines are an updated version of the N52. There are three variants, the upper output (O), the medium output (M) and the lower output (U). Each engine has specific characteristics and power output. The "O" engine has 260 horsepower, while the "M" version has about 230 horsepower. The "U" engine is a possible future variant with 215 horsepower.

The N51 engine uses the designation - "N51B30M0". This engine is SULEV II compliant with 230 horsepower.

New Vehicles for 2007

The new engine variants will be initially installed into some new and updated vehicles for 2007. The new E92 coupe will be available with the N54B30O0 (335i) and the N52B30M1 (328i).

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Fig. 6: Identifying Vehicles For 2007
Courtesy of BMW OF NORTH AMERICA, INC.

The N52B3001 will be initially available in the E83 LCI (X3 3.0 si) from 9/2006 and the new E70 (X5 3.0 si) from SOP.



Fig. 7: Identifying E70 (X5)
Courtesy of BMW OF NORTH AMERICA, INC.

ENGINE MECHANICAL OVERVIEW

Crankcase

As far as the physical appearance and dimensions, the crankcase on the N54 is the same as the N52. The main change is in the materials, the N54 uses an all aluminum alloy crankcase. There is also cast iron cylinder liners similar to the previous M54 engine.

The reason for using the all aluminum configuration is to be more compatible with the increased torque output and cylinder pressure in the N54.

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Fig. 8: Identifying Aluminum Alloy Crankcase
Courtesy of BMW OF NORTH AMERICA, INC.

The N54 engine continues to use the "two-piece" crankcase featuring the "bedplate" design.

The N52KP and N51 engines continue to use the composite magnesium/aluminum alloy engine from the existing N52.

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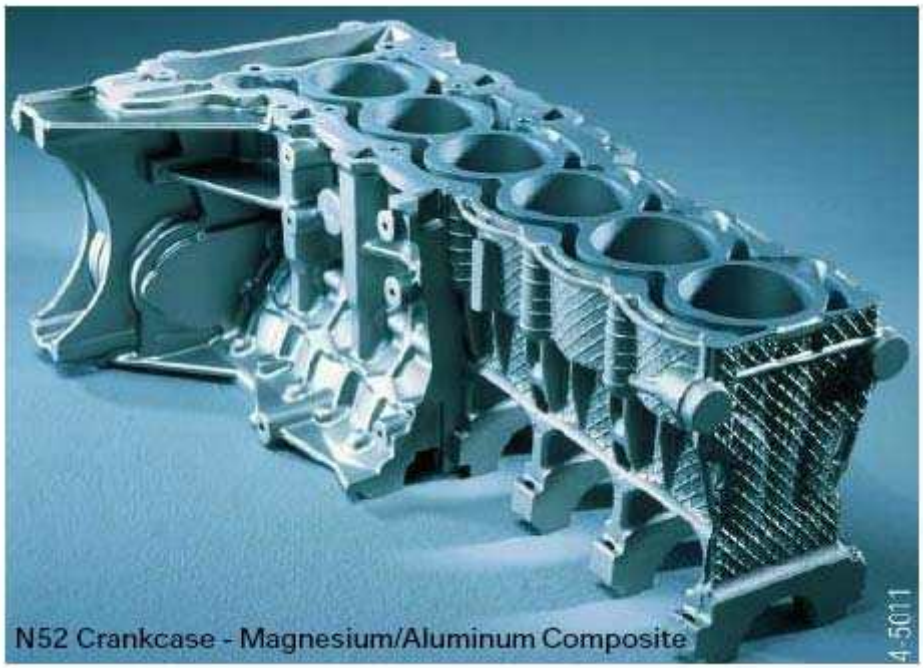


Fig. 9: Identifying "Two-Piece" Crankcase
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: **The N54 engine has a different bolt pattern on the transmission mounting (bellhousing) area.**

Therefore, a new special tool is needed to mount the engine to an engine stand. The new tool has slots which will accommodate all NG6 engines

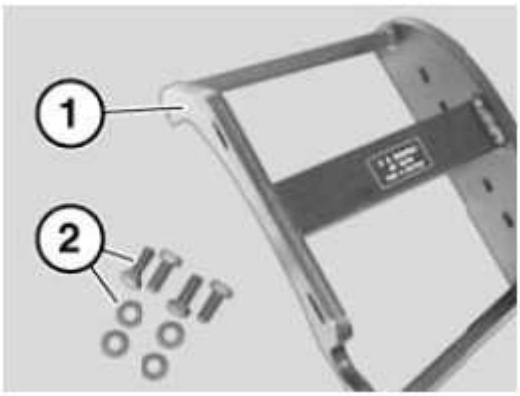


Fig. 10: Identifying Bolt Pattern On Transmission Mounting
Courtesy of BMW OF NORTH AMERICA, INC.

Bolts

Although, the N54 engine has an all aluminum crankcase, many of the bolts are still aluminum as on the N52. This is to reduce any potential confusion between steel and aluminum bolts. Some bolts, for example, are steel

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such as the cylinder head cover bolts. This is possible, due to the plastic cylinder head cover.



Fig. 11: Identifying Bolt
Courtesy of BMW OF NORTH AMERICA, INC.

The N52KP and N51 engines use the same aluminum bolt configuration as the N52 engine, with little change. The cylinder head cover bolts are like the N54 - steel, due to the plastic cylinder head cover.

The same rules apply to the handling of aluminum bolts as in the past.

Strict adherence to repair instructions is required to ensure proper connections.

Be sure to follow the proper torque/tightening angle sequence as outlined in the "tightening torques" section of TIS.

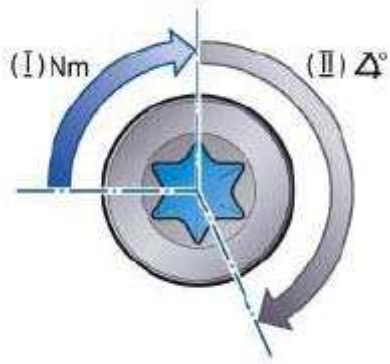


Fig. 12: Identifying Aluminum Bolt
Courtesy of BMW OF NORTH AMERICA, INC.

Cylinder Head Cover

As stated before, the cylinder head cover used on all of the new NG6 engines is made from plastic. However, the design differs between the engines due to engine equipment.

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For example, the N54 engine does not use Valvetronic and therefore does not need the accommodation for the VVT motor. Also, the crankcase ventilation system is different on the N54. Some of the crankcase venting components are integrated into the cylinder head cover such as the cyclone separator.

The N52KP and N51 engines have the same cylinder head cover. The cover also includes some of the crankcase venting system components.



Fig. 13: Identifying Cylinder Head Cover
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: Some engines with plastic cylinder head covers may have aluminum bolts.

Cylinder Head

Each of the new NG6 engines has a unique cylinder head design. Due to some of the technical requirements, the cylinder heads are not interchangeable between these engines. The cylinder head from the N52KP is carried over from the N52 with little change.

The cylinder head from the N54 engine does not have Valvetronic. The design of the engine also requires accommodation of the "direct" fuel injector in the combustion chamber. Most of the external dimensions are the same as the N52 to accommodate accessories and ancillary components.

The N51 engine is a SULEV II compliant design which has a lower compression ratio. The combustion chamber design has been modified to work in conjunction with the N51 piston to achieve the required emission goals.

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Fig. 14: Identifying Fuel Injector In Combustion Chamber
Courtesy of BMW OF NORTH AMERICA, INC.

Valvetrain

The valvetrain on the N52 introduced in 2006, used 5 mm valve stems on both the intake and exhaust. To increase durability, the exhaust valve stems were increased to 6 mm from 6/06 production.

All of the new NG6 engine have adopted the 6 mm valve stem for the exhaust, the intake stem remains at 5 mm. The valves are of the "solid" type design (not Sodium filled). The diameter of the valve head is engine specific.

Camshafts

The lightweight hydroformed camshaft will still be used on the NG6 engines. Be aware that some engines may use the "cast" camshaft design. This is for supply and production reasons.

Cast and hydroformed camshafts are completely interchangeable. For example, a replacement camshaft may differ from the original. This is no problem, they will fit and work properly without any modifications.

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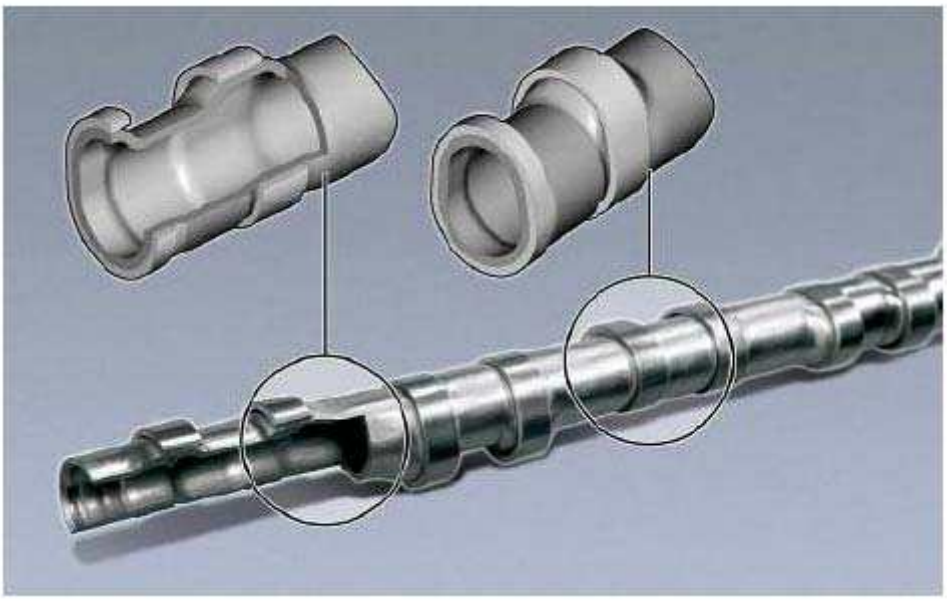
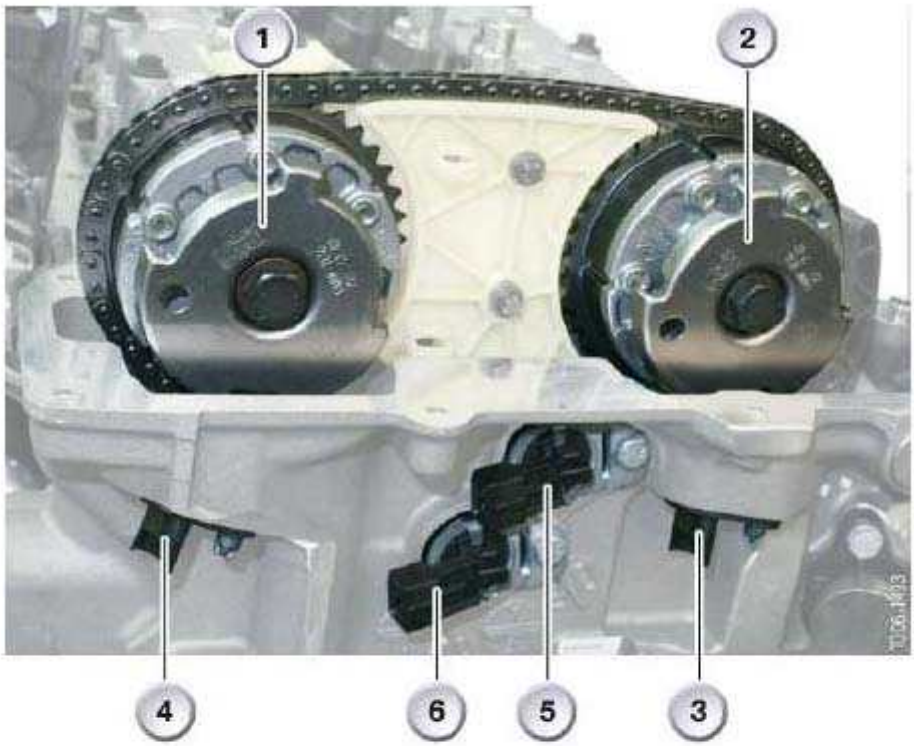


Fig. 15: Identifying Camshaft Diameter
Courtesy of BMW OF NORTH AMERICA, INC.

VANOS

The infinitely variable Bi-VANOS system is still in use on all NG6 engines. The VANOS system still retains the use of the lightweight VANOS adjusting units introduced on the N52. The only change to the system is that the N54 engine uses different spread ranges for compatibility with turbocharged engine operation.

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Index	Explanation	Index	Explanation
1	VANOS unit, exhaust	4	Exhaust camshaft sensor
2	VANOS unit, intake	5	VANOS solenoid valve
3	Intake camshaft sensor	6	VANOS solenoid valve

Fig. 16: Identifying Compatibility With Turbocharged Engine Operation
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: Do not mix up the intake and exhaust VANOS units. They appear similar, but have different spread ranges. Improper installation can result in valvetrain damage.

Valvetronic

The N51 and N52KP engines retain the already proven Valvetronic system from the N52. The only change for 2007 is an optimized VVT motor which has already been in production from 5/06.

The N54, on the other hand, does not use the Valvetronic system. Valvetronic is designed to reduce pumping losses and improve engine efficiency. The turbocharging system on the N54 is also designed to reduce pumping losses and increase engine efficiency.

Therefore, there is no need to have both systems on one engine. In summary, the efficiency of the N54 is gained through exhaust turbocharging and direct injection rather than Valvetronic.

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Fig. 17: Identifying Injection Rather Valvetronic
Courtesy of BMW OF NORTH AMERICA, INC.

Gaskets and Seals

Head Gasket

The head gasket design on the N54 is unique to that engine.

It features a multi-layer steel design. There is no silicone rubber perimeter "shelf" as on the N52. This is not needed due to the aluminum block on the N54.

The N52KP and N51 engines are still using the head gasket that is familiar from N52.

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Fig. 18: Identifying Head Gasket
Courtesy of BMW OF NORTH AMERICA, INC.

Oil Pan Gasket

All of the new NG6 engine use the same oil pan gasket as introduced on the N52.

The oil pan gasket design is compatible with the N54, therefore it was not necessary to create an additional part.



Fig. 19: Identifying Oil Pan Gasket
Courtesy of BMW OF NORTH AMERICA, INC.

Bedplate Sealing

The N54 continues to use the injected sealant method for the bedplate.

Crankshaft Drive Components

Crankshaft

The crankshaft on the N52KP and N51 remains a cast iron design. This crankshaft is carried over from the N52.

The additional torque generated by the N54 requires the use of a forged steel crankshaft.

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Piston and Connecting Rods

Due to the design requirements of each of the new NG6 engines, the piston design is unique to each version. For instance, the N54 is turbocharged and direct injected and requires a piston which meets the design requirements for compression and mixture formation.

The N51 engine need a piston which has lower compression and meets the SULEV II requirements for emission compliancy.

The N52KP and N52 engines both use the same piston design.

The connecting rods on the new engines use a thicker beam design which has been in production on the N52 since 6/06. The N54 has a special connecting rod with M9 bolts instead of the M8 bolts on the other engines.

Torsional Vibration Damper

The vibration damper has been updated to improve the damping of first order vibrations. The damper is secured with new bolts and has a revised tightening procedure. The procedure differs from the N52 and should therefore not me mixed up. Damage to the belt drive can result from improper tightening procedures.

Intake Manifold

The plastic intake manifold from the N52 is carried over to the new NG6 engines. However, the 3-Stage DISA version of the intake manifold is only used on the "O" version (high output).

The current N51 engine is designated as a medium output "M" version at 230 hp and does not require the 3-stage DISA. The same applies to the "M" version of the N52KP engine as well.

There are small modifications to these intake manifolds due to the fact that the crankcase ventilation system has been updated.

As far as the N54 engine is concerned, the intake manifold is designed specifically for the turbocharging system. The N54 does not require DISA as turbocharging supplies the necessary torque increase when needed.

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Fig. 20: Identifying 3-Stage DISA Intake Manifold
Courtesy of BMW OF NORTH AMERICA, INC.



Fig. 21: Identifying Intake Manifold N54
Courtesy of BMW OF NORTH AMERICA, INC.

Crankcase Ventilation

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One of the major changes on the new NG6 engines is that the crankcase ventilation system has been upgraded and improved. This applies to all of the new NG6 versions (N52KP, N51 and N54).

There are two distinct versions of crankcase ventilation. One type is unique to the N54 and the other applies to N51 and N52KP.

The N52, which is still in production continues to use the "external" crankcase ventilation system with the electrically heated crankcase ventilation valve/cyclone separator.



Fig. 22: Identifying Crankcase Ventilation System
Courtesy of BMW OF NORTH AMERICA, INC.

Crankcase Ventilation (N51 and N52KP)

The crankcase ventilation system on the N51 and N52KP has been modified as compared to the N52. The system is integrated into the plastic cylinder head cover.

The crankcase gases are regulated by a crankcase ventilation valve similar to the design used on the N62. The crankcase vent valve is currently part of the cylinder head cover and is not replaceable as a separate component.

Oil separation is carried out via a "labyrinth" system and two cyclone separators which are incorporated into the cylinder head cover. By having the system components integrated into the cylinder head cover, the crankcase gases are heated by the engine rather than an electric heater as on the N52. However, there is still one electric

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heating element at the manifold inlet.

Once the liquid oil is separated from the crankcase vapors, the oil is allowed to drain back through check valves back into the engine.

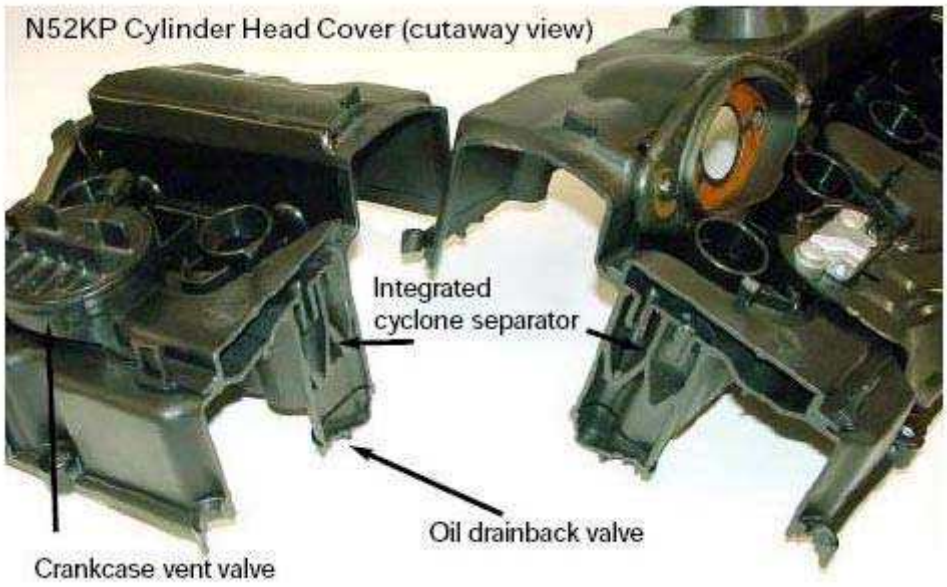


Fig. 23: Cylinder Head Cover Components Location
Courtesy of BMW OF NORTH AMERICA, INC.

Crankcase Ventilation (N54)

Since the N54 is a turbocharged engine, the crankcase ventilation system has to meet certain design requirements. For example, when the engine is in turbocharged mode, the increased manifold pressure should not have an adverse effect on the crankcase venting. This is why, there is no crankcase ventilation valve in the system.

The system consists of four small cyclone separators which are integrated into the plastic cylinder head cover. The flow of crankcase gases is metered through a series of restrictions which control the ultimate crankcase pressure.

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Cyclone Separator Operation

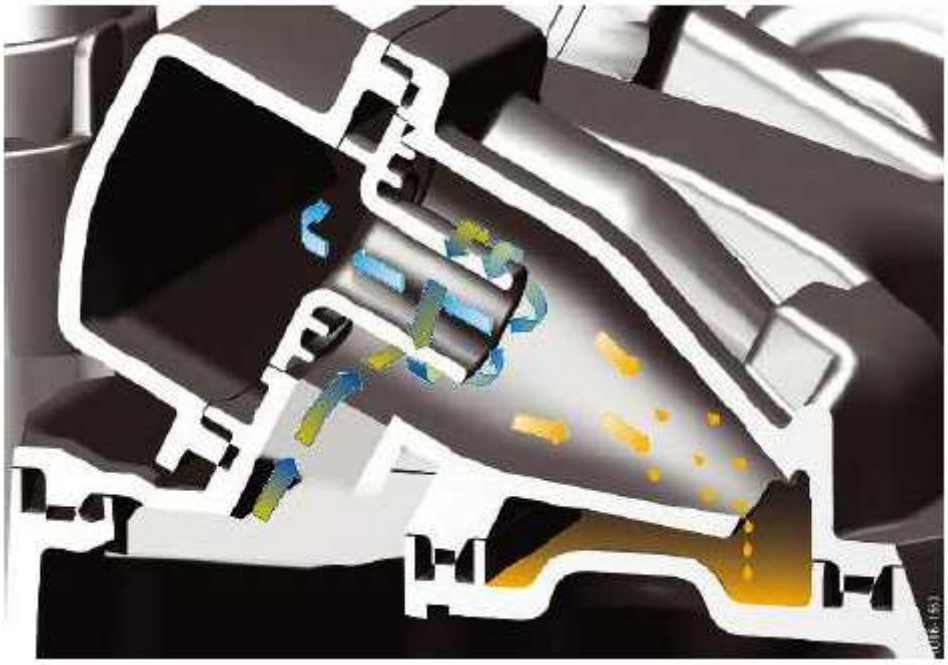
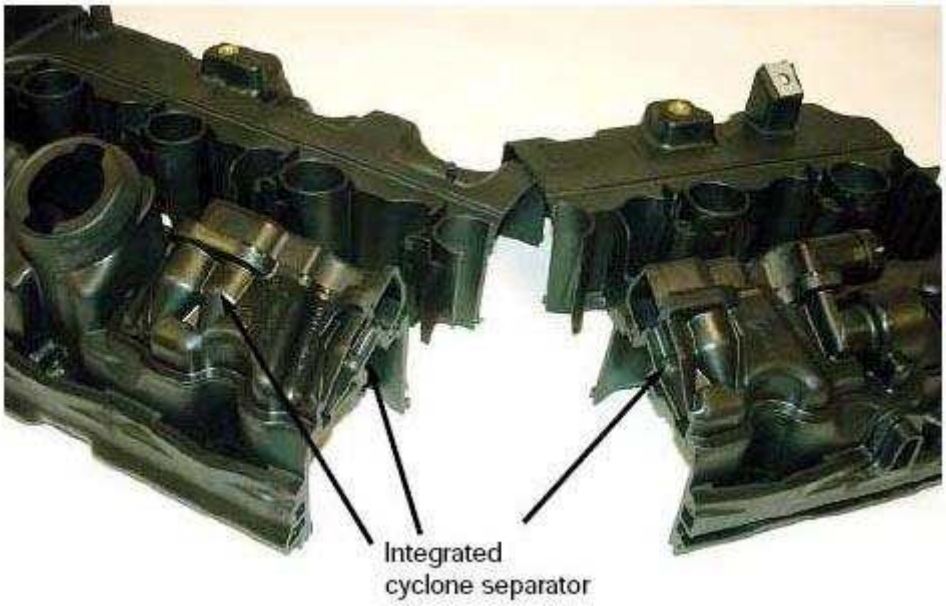


Fig. 24: Cyclone Separator Operation
Courtesy of BMW OF NORTH AMERICA, INC.

One of the main operating principles behind the crankcase venting system on the N54 is that there are two strategies - one for the turbocharged mode and one for "non-turbocharged" operation such as decel. These strategies are dependent upon the intake manifold pressure.

N54 Cylinder Head Cover (cutaway view)



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Fig. 25: Cutaway View - Cylinder Head
Courtesy of BMW OF NORTH AMERICA, INC.

Crankcase Ventilation System Overview (N54)

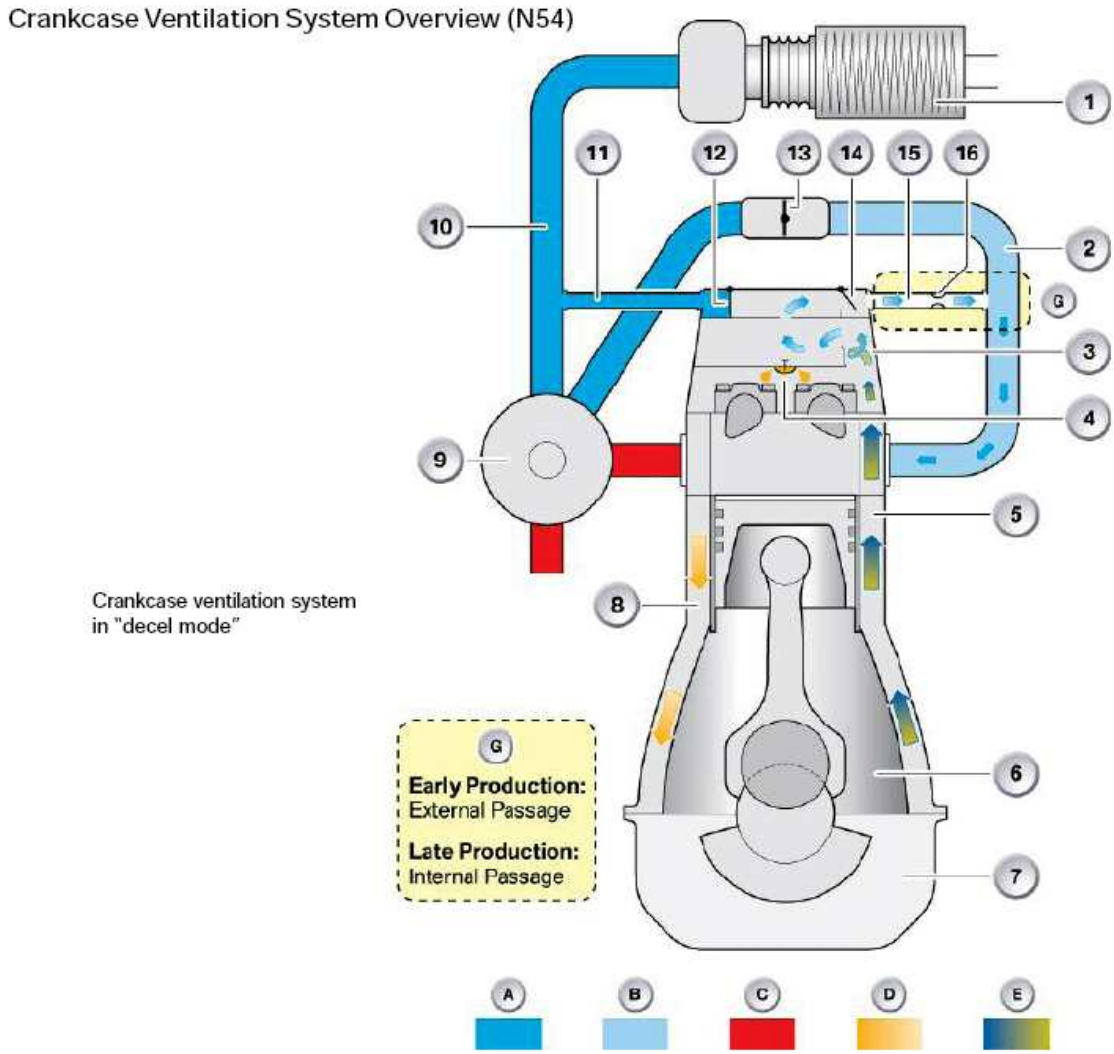


Fig. 26: Identifying Crankcase Ventilation System Diagram - Decel Mode
Courtesy of BMW OF NORTH AMERICA, INC.

Crankcase Ventilation System Overview (N54)

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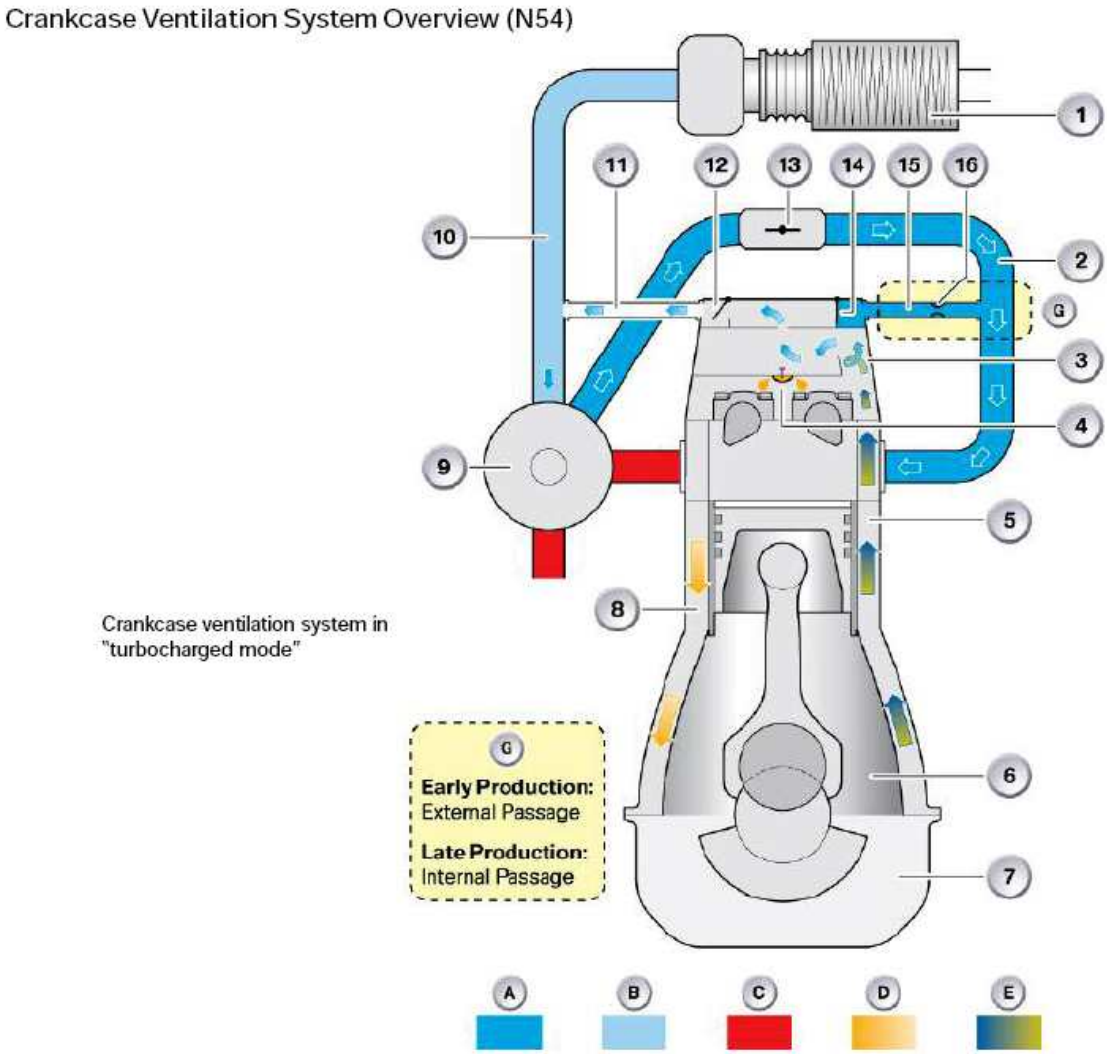


Fig. 27: Identifying Crankcase Ventilation System Diagram - Turbocharged Model
Courtesy of BMW OF NORTH AMERICA, INC.

CRANKCASE VENTILATION COMPONENTS INDEX

Index	Explanation	Index	Explanation
A	Overpressure	7	Oil Sump
B	Low pressure (vacuum)	8	Oil return channel
C	Exhaust gas	9	Turbocharger
D	Liquid oil	10	-
E	Blow-by gases	11	-
1	Air cleaner	12	-
2	Intake manifold	13	Throttle valve
3	-	14	-
4	-	15	-
5	Venting channel	16	-
6	Crankshaft cavity	-	-

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Fig. 28: Identifying Charge Air Suction Pipe
Courtesy of BMW OF NORTH AMERICA, INC.

Name the components above and their purpose:

Summary of Mechanical Changes

SUMMARY OF MECHANICAL CHANGES

Component/System	N52 Engine	N52KP	N51	N54
Crankcase	Composite magnesium/aluminum	Composite magnesium/aluminum	Composite magnesium/aluminum	All aluminum alloy
Cylinder Head	Aluminum	Aluminum (same as N52)	Aluminum - Specific to N51 due to combustion chamber modifications	Aluminum - specific to N54
Cylinder Head Gasket	Silicone rubber perimeter to prevent contact corrosion	Same as N52	Same as N52	Specific to N54 - multi-layer with no silicone rubber perimeter
Cylinder Head Cover	Magnesium	Plastic with integrated crankcase ventilation	Plastic with integrated crankcase ventilation (same as N52KP)	Plastic with integrated crankcase ventilation (specific to N54)
Crankcase	External crankcase	Crankcase vent valve and "labyrinth" and	Crankcase vent valve and "labyrinth" and	No crankcase vent valve - uses calibrated orifice with

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Ventilation	vent valve with cyclone separator.	cyclone oil separation integrated into cylinder head cover.	cyclone oil separation integrated into cylinder head cover.	cyclone separation integrated into cylinder head cover.
Valvetrain	5 mm intake and exhaust valve stems (6 mm exhaust valve stem from 6/06)	5 mm intake and 6 mm exhaust valve stems	5 mm intake and 6 mm exhaust valve stems	5 mm intake and 6 mm exhaust valve stems
VANOS	Infinitely variable Bi-VANOS	Infinitely variable Bi-VANOS	Infinitely variable Bi-VANOS	Infinitely variable Bi-VANOS
Valvetronic	Valvetronic II	Valvetronic II	Valvetronic II	No Valvetronic
Intake Manifold	Plastic with 3-stage DISA on high output version (OL)	Plastic with 3-stage DISA on high output version (O)	Plastic	Plastic (no DISA)
Fuel System	Manifold injection	Manifold injection	Manifold injection	High Precision Injection (HPI)
Cooling System	Electric coolant pump - 200 W	2nd Generation electric coolant pump - 200 W	2nd Generation electric coolant pump - 200 W	2nd Generation electric coolant pump - 400 W
Exhaust System	"Near Engine" catalysts	"Near Engine" catalysts with underbody catalysts (ULEV II)	"Near Engine" catalysts with underbody catalysts (SULEV II)	"Near Engine" catalysts with underbody catalysts (ULEV II)
Pistons/Compression Ratio	10.7 to 1	10.7 to 1	10 to 1	10.2 to 1
Connecting Rods/Crankshaft	Forged Steel with 8 mm bolts "cracked design" (Cast Crankshaft)	Forged Steel (stiffened) with 8 mm bolts "cracked design" (Cast crankshaft)	Forged Steel (stiffened) with 8 mm bolts "cracked design" (Cast crankshaft)	Forged Steel (stiffened) with 9 mm bolts "cracked design" (Forged steel crankshaft)
HFM	Analog	Digital	Digital	Digital

MSD80 ENGINE MANAGEMENT OVERVIEW (E9X)

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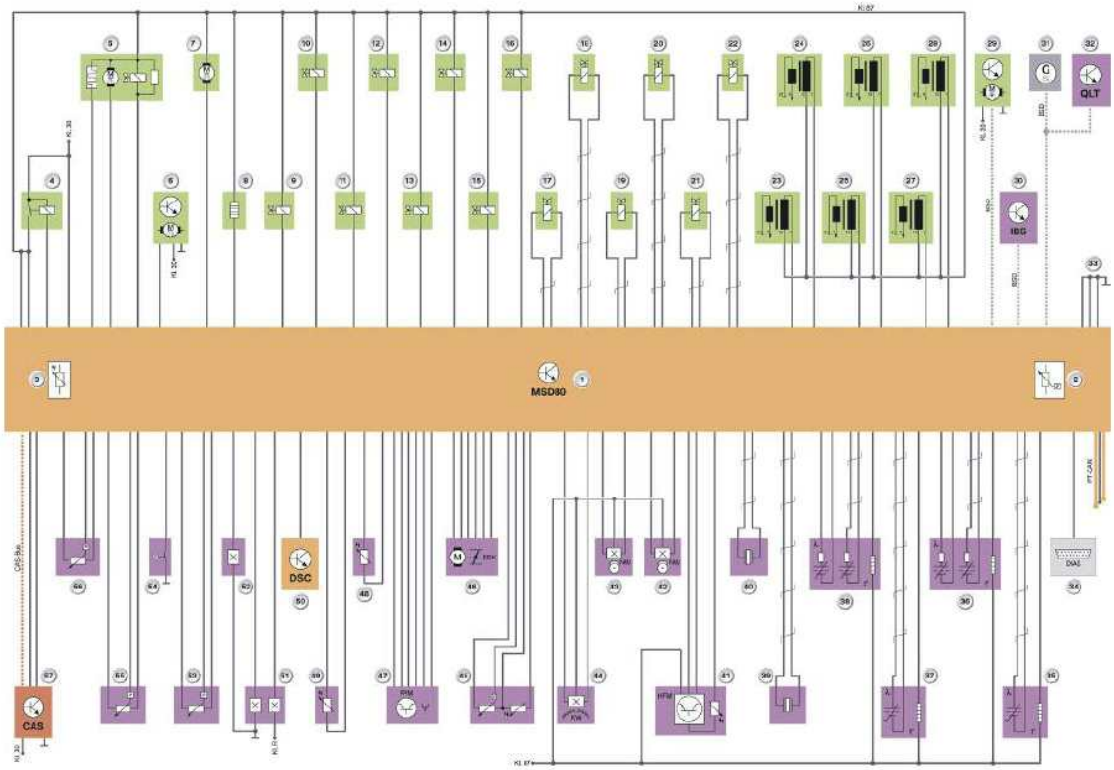


Fig. 29: Identifying Engine Management Communication Diagram - E9X (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

Legend for MSD80 Overview

Index	Explanation
1	ECM (DME - MSD80)
2	Temperature sensor in DME control unit
3	Ambient-pressure sensor in DME control unit
4	DME main relay
5	Diagnosis module for fuel tank leakage (DMTL)
6	Electric fan (engine cooling)
7	E-box fan
8	Characteristic map thermostat
9	Fuel tank vent valve (TEV)
10	VANOS solenoid valve, inlet
11	VANOS solenoid valve, exhaust
12	Sound flap
13	Exhaust flap
14	Fuel-supply control valve
15	Wastegate valve, bank 1
16	Wastegate valve, bank 2
17-22	Piezo-injectors
23-28	Ignition coils
29	Electric coolant pump
30	Intelligent battery sensor
31	Alternator
32	Oil condition sensor
33	Ground connection

Index	Explanation
34	Diagnostics connection
35	Oxygen sensor (secondary O2 sensor with discontinuous characteristic)
36	Oxygen sensor (primary O2 sensor with continuous characteristic)
37	Oxygen sensor (secondary O2 sensor with discontinuous characteristic)
38	Oxygen sensor (primary oxygen sensor with continuous characteristic)
39-40	Knock sensors
41	Hot-film air-mass sensor (HFM)
42	Camshaft sensor, inlet
43	Camshaft sensor, exhaust
44	Crankshaft sensor
45	Pressure/temperature sensor before throttle valve (boost pressure)
46	Throttle valve
47	Accelerator pedal module
48	Coolant-temperature sensor at engine outlet
49	Coolant-temperature sensor at radiator outlet
50	DSC control unit (Dynamic Stability Control)
51	Brake-light switch
52	Clutch switch
53	Pressure sensor after throttle valve (intake-manifold pressure)
54	Oil pressure switch
55	Low-pressure fuel sensor
56	High-pressure fuel sensor (rail pressure sensor)
57	CAS control unit (Car Access System)

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Fig. 30: Identifying Engine Management Communication Diagram - E9X (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

MSV80 ENGINE MANAGEMENT OVERVIEW (E70)

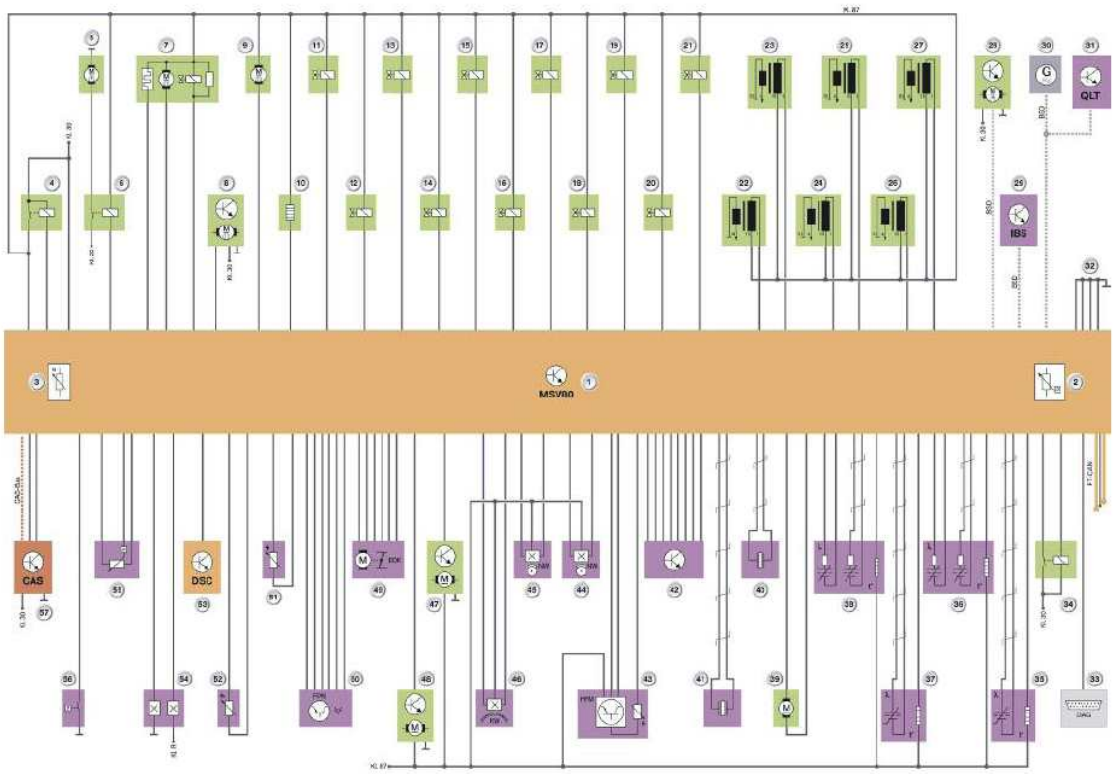


Fig. 31: Identifying Engine Management Communication Diagram - E70 (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

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Legend for MSV80 Overview

Index	Explanation
1	ECM (DME - MSD80)
2	Temperature sensor in DME control unit
3	Ambient-pressure sensor in DME control unit
4	DME main relay
5	Electric Fuel Pump (EKP)
6	EKP Relay
7	DM-TL
8	Electric fan (engine cooling)
9	E-box fan
10	Characteristic map thermostat
11	Fuel tank vent valve (TEV)
12	VANOS solenoid valve, inlet
13	VANOS solenoid valve, exhaust
14	Sound flap
15	Exhaust flap
16-21	Fuel injectors
22-27	Ignition coils
28	Electric coolant pump
29	Intelligent battery sensor
30	Alternator
31	Oil condition sensor
32	Ground connection
33	Diagnostics connection

Index	Explanation
34	Valvetronic Relay
35	Oxygen sensor (secondary O2 sensor with discontinuous characteristic)
36	Oxygen sensor (primary O2 sensor with continuous characteristic)
37	Oxygen sensor (secondary O2 sensor with discontinuous characteristic)
38	Oxygen sensor (primary oxygen sensor with continuous characteristic)
39	Valvetronic actuator motor (VVT)
40-41	Knock sensors
42	Eccentric shaft sensor
43	Hot-film Air Mass Meter (HFM)
44	Camshaft sensor, inlet
45	Camshaft sensor, exhaust
46	Crankshaft sensor
47	DISA Actuator motor
48	DISA Actuator motor
49	Throttle valve
50	Accelerator pedal module
51	Coolant-temperature sensor at engine outlet
52	Coolant-temperature sensor at radiator outlet
53	DSC control unit
54	Brake light switch
55	Differential pressure sensor
56	Oil pressure switch
57	CAS control unit (Car Access System)

Fig. 32: Identifying Engine Management Communication Diagram - E70 (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

AIR MANAGEMENT

Air Management N52KP and N51

As far as the air management system on the N52KP and N51 engines is concerned, the previous intake manifold system on the N52 is carried over. Depending upon application, the engines will use the 3-stage DISA or the single stage (No DISA) intake manifold.

For more information on the DISA system refer to the previous training material in the training course "ST501 - New Engine Technology".

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Fig. 33: Identifying Intake Manifold System
Courtesy of BMW OF NORTH AMERICA, INC.

Throttle Valve

All variants of the new NG6 engines receive the new EGAS 08 throttle by Siemens/VDO. The new throttle uses a plastic throttle valve and magneto-resistive feedback to the ECM.

The previous system used a potentiometer, whereas the new throttle uses a "contactless" system featuring magneto-resistive technology which is familiar from the eccentric shaft sensor on Valvetronic systems.



Fig. 34: Identifying Throttle Valve

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Courtesy of BMW OF NORTH AMERICA, INC.

The magneto-resistive sensors are integrated into the housing cover. The sensors are also non-wearing.

For plausibility, the one sensor outputs the analog signal in the range from 0.3 to 4.6 V and the other sensor inverts it again from 4.6 to 0.3 V.

Consequently, the contact force is 10 times greater than that of a conventional plug connector.

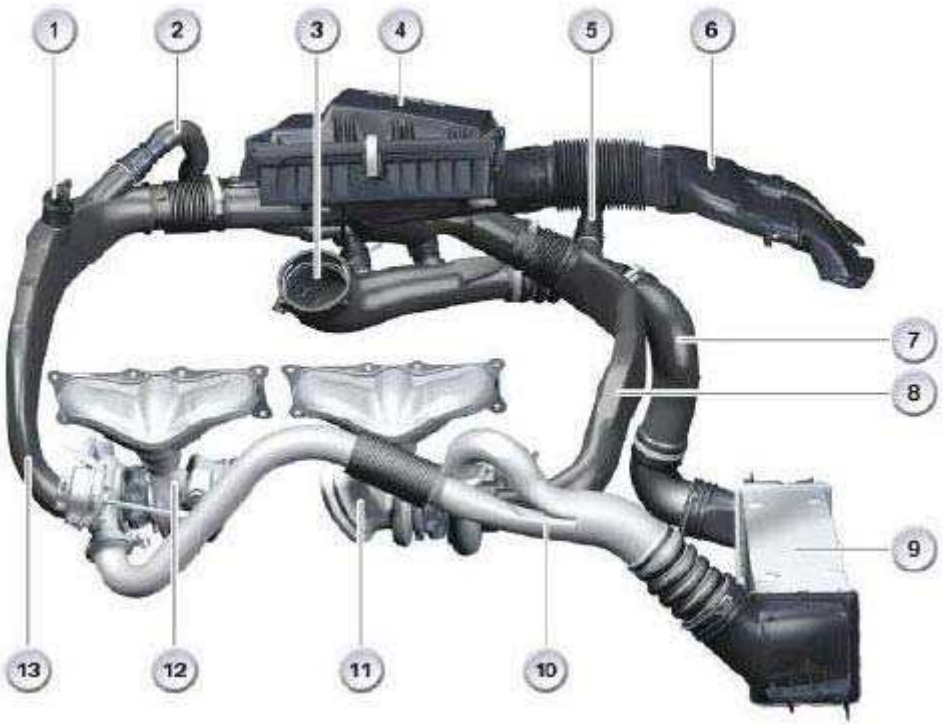
NOTE: It is possible to twist the connector before plugging it in. This can cause damage to the harness and connector.

Air Intake Ducting

With regard to the N54 engine, the air intake ducting plays a significant role due to the requirements of a turbocharged engine.

In principle, the energy of the escaping exhaust gases is utilized to "pre-compress" the inducted fresh air and thus introduce a greater air mass into the engine. This is only possible if the air intake ducting is "leak-free" and installed properly.

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Index	Explanation	Index	Explanation
1	PTC heater, blow-by gases (in turbo mode)	8	Charge air suction line, bank 1
2	Recirculated air line, bank 2	9	Intercooler
3	Connecting flange, throttle valve	10	Charge air manifold
4	Air cleaner	11	Turbocharger, bank 1
5	Recirculated air line, bank 1	12	Turbocharger, bank 2
6	Air-intake snorkel	13	Charge air suction line, bank 2
7	Charge air pressure line		

Fig. 35: Identifying Air Intake Ducting Components
Courtesy of BMW OF NORTH AMERICA, INC.

It is important to note, when carrying out work on the air-intake ducting, it is important to ensure that the components are installed in the correct position and that all pipes are connected with tight seals.

A leaking system may result in erroneous boost pressure. This would be detected by the engine management system and will ultimately result in "limp-home" operation. There would also be a noticeable reduction in

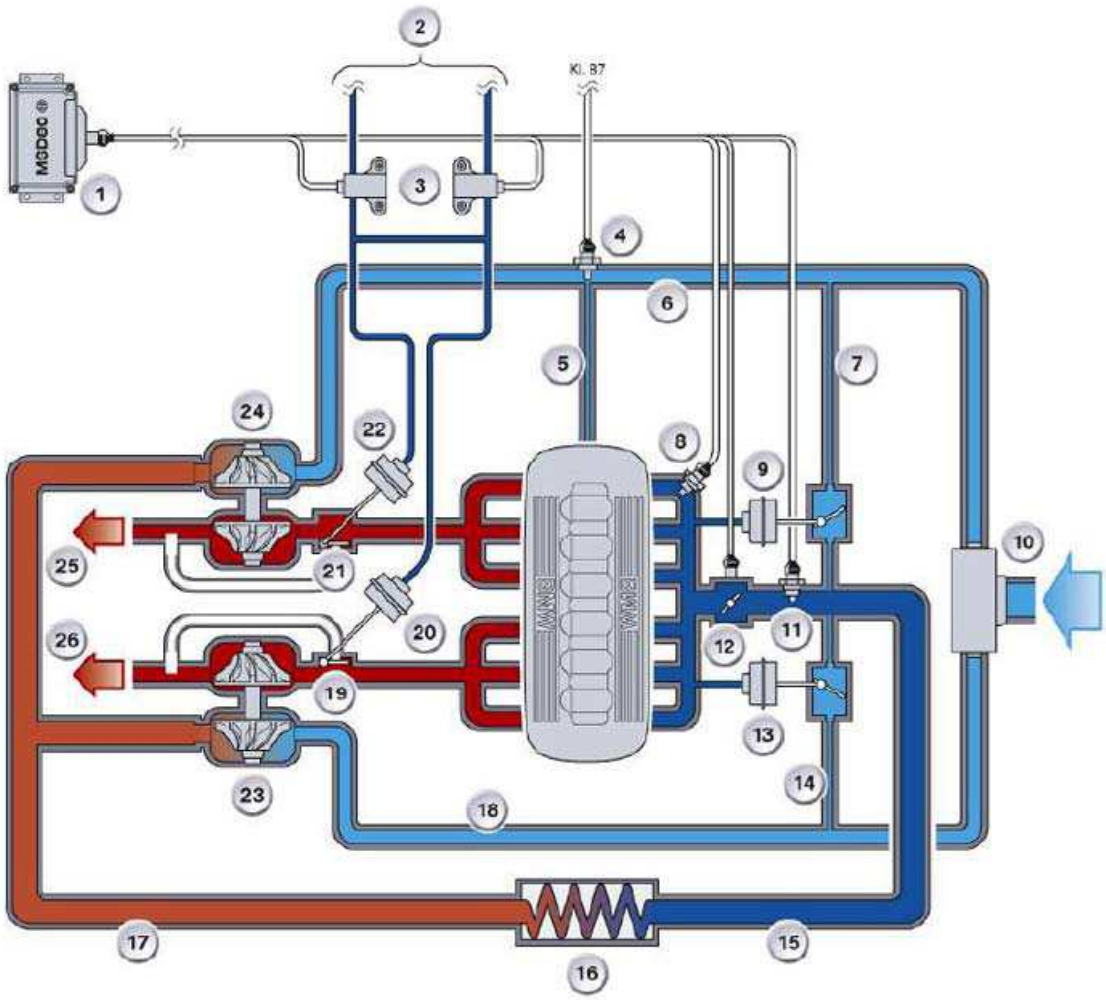
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engine power.

For some of the duct work, there are special tools to ensure proper connections.

Air Intake Ducting Function

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Legend for Air Intake Ducting Function

Index	Explanation	Index	Explanation
1	MSD80 Engine control module	14	Recirculated-air line, bank 1
2	Lines to vacuum pump	15	Charge air pressure line
3	Electro-pneumatic pressure transducer	16	Intercooler
4	PTC heater, blow-by gases	17	Charge air manifold
5	Blow-by line turbocharged operation mode	18	Charge air suction line, bank 1
6	Charge air suction line, bank 2	19	Wastegate flap, bank 1
7	Recirculated-air line, bank 2	20	Wastegate actuator, bank 1
8	Intake manifold pressure sensor	21	Wastegate flap, bank 2
9	Blow-off valve, bank 2	22	Wastegate actuator, bank 2
10	Air cleaner	23	Turbocharger, bank 1
11	Charge air pressure and temperature sensor	24	Turbocharger, bank 2
12	Throttle valve	25	To catalytic converter, bank 2

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Fig. 36: Identifying Air Intake Ducting Function Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

The fresh air is drawn in via the air cleaner (10) and the charge-air suction lines (6 + 18) by the compressors of turbochargers (23 + 24) and compressed.

Because the turbochargers can get very hot during operation, they are connected with the engine's coolant and engine-oil circuits. The charge air is greatly heated when it is compressed in the turbocharger, making it necessary for the air to be cooled again in an intercooler (16).

The compressed and cooled charge air is routed from the intercooler via the throttle valve (12) into the intake manifold.

The system is equipped with several sensors and actuators in order to ensure that the load of fresh air is optimally adapted to the engine's respective operating conditions. How these complex interrelationships are controlled is discussed in the following sections.



Fig. 37: Identifying Air Intake Ducting
Courtesy of BMW OF NORTH AMERICA, INC.

Exhaust Gas Turbocharging

The turbocharger is driven by the engine's exhaust gases, i.e. exhaust gases under pressure are routed by the

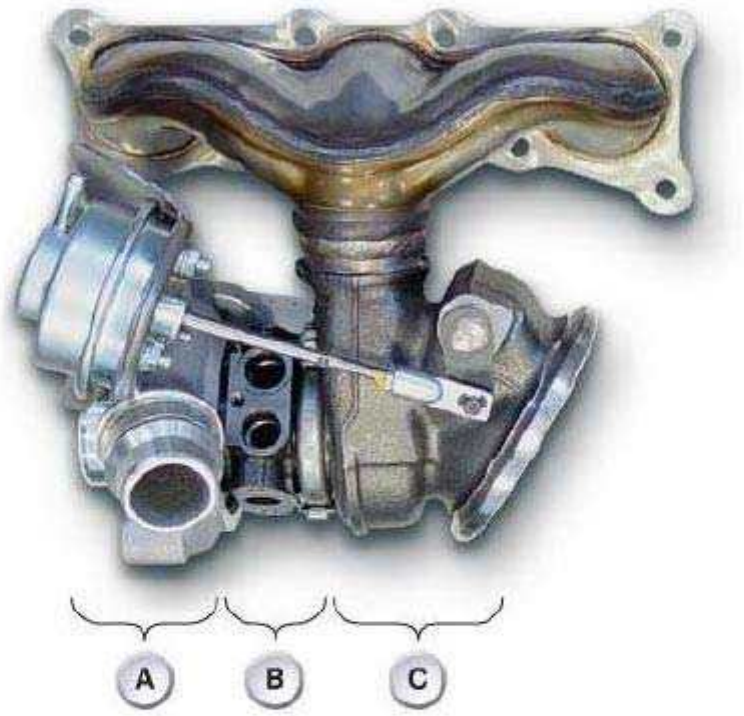
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turbocharger turbine and in this way delivers the motive force to the compressor, which rotates on the same shaft.

It is here that the induction air is precompressed in such a way that a higher air mass is admitted into the engine's combustion chamber. In this way, it is possible to inject and combust a greater quantity of fuel, which increases the engine's power output and torque.

The turbine and the compressor can rotate at speeds of up to 200,000 RPM. The exhaust inlet temperature can reach a maximum of 1050°C. Because of these high temperatures, the N54 engine's turbochargers are not only connected with the engine-oil system but also integrated in the engine-coolant circuit.

It is possible in conjunction with the N54 engine's electric coolant pump even after the engine has been switched off to dissipate the residual heat from the turbochargers and thus prevent the lube oil in the bearing housing from overheating.



Index	Explanation
A	Compressor
B	Cooling/Lubrication
C	Turbine

Fig. 38: Identifying Exhaust Gas Turbocharging
Courtesy of BMW OF NORTH AMERICA, INC.

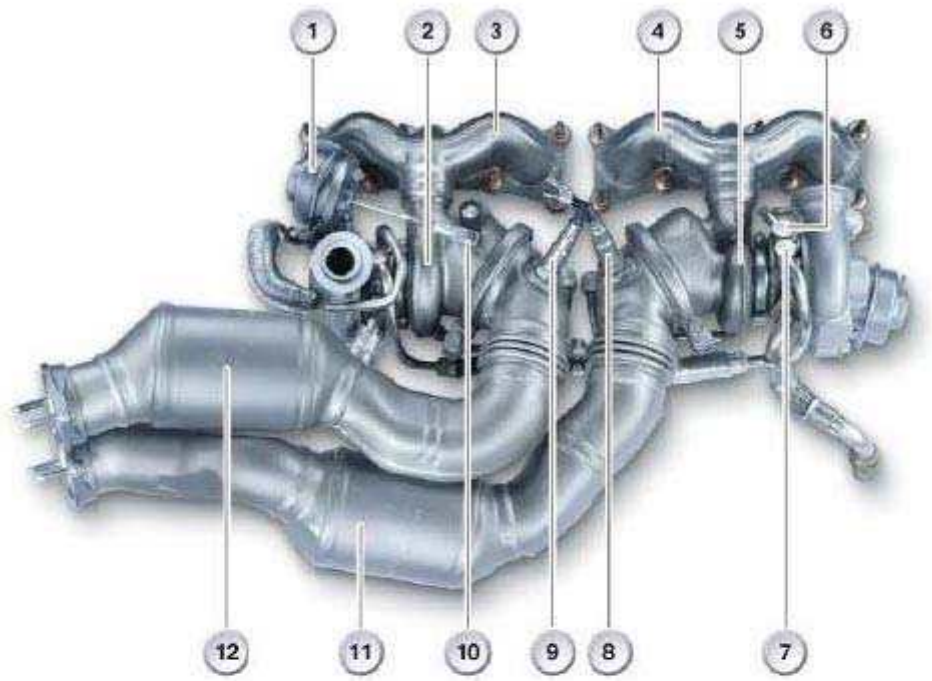
Bi-turbocharging

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Utmost importance is attached to turbocharger response in the N54 engine. A delayed response to the driver's command, i.e. the accelerator-pedal position, is not acceptable. The driver therefore must not experience any so-called "turbo lag".

This requirement is met in the N54 engine with two small turbochargers, which are connected in parallel. Cylinders 1, 2 and 3 (bank 1) drive the first turbocharger (5) while cylinders 4, 5 and 6 (bank 2) drive the second (2).

The advantage of a small turbocharger lies in the fact that, as the turbocharger runs up to speed, the lower moment of inertia of the turbine causes fewer masses to be accelerated, and thus the compressor attains a higher boost pressure in a shorter amount of time.



Index	Explanation	Index	Explanation
1	Wastegate actuator, bank 2	7	Coolant supply
2	Turbocharger, bank 2	8	Planar broad-band oxygen sensor, bank 1
3	Exhaust manifold, bank 2	9	Planar broad-band oxygen sensor, bank 2
4	Exhaust manifold, bank 1	10	Wastegate actuating lever
5	Turbocharger, bank 1	11	Catalytic converter, bank 1
6	Coolant return	12	Catalytic converter, bank 2

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Fig. 39: Identifying Turbocharging Components
Courtesy of BMW OF NORTH AMERICA, INC.

Boost-pressure Control

The boost pressure of the turbochargers is directly dependent on the flow of exhaust gas which reaches the turbocharger turbines. Both the velocity and the mass of the exhaust-gas flow are directly dependent on engine speed and engine load.

The engine-management system uses wastegate valves to control the boost pressure. These valves are operated by vacuum-pressure actuators, which are controlled by the electro-pneumatic pressure transducers via the engine-management system.



Index	Explanation	Index	Explanation
1	Oil return, bank 1	5	Coolant return, bank 2
2	Oil supply	6	Wastegate valve
3	Coolant supply	7	Coolant return, bank 1
4	Oil return, bank 2	8	

Fig. 40: Identifying Boost-Pressure Control
Courtesy of BMW OF NORTH AMERICA, INC.

The vacuum pressure is generated by the permanently driven vacuum pump and stored in a pressure accumulator. The system is designed to ensure that these loads and consumers do not have a negative influence on the brake-boost function.

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The exhaust-gas flow can be completely or partially directed to the turbine wheel with the wastegate valves. When the boost pressure has reached its desired level, the wastegate valve begins to open and direct part of the exhaust-gas flow past the turbine wheel.

This prevents the turbine from further increasing the speed of the compressor. This control option allows the system to respond to various operating situations.

In the idle phase, the wastegate valves of both turbochargers are closed. This enables the full exhaust-gas flow available to be utilized to speed up the compressor already at these low engine speeds.

When power is then demanded from the engine, the compressor can deliver the required boost pressure without any noticeable time lag. In the full-load situation, the boost pressure is maintained at a consistently high level when the maximum permissible torque is reached by a partial opening of the wastegate valves. In this way, the compressors are only ever induced to rotate at a speed which is called for by the operating situation.

The process of the wastegate valves opening, removes the drive energy from the turbine such that no further increase in boost pressure occurs, which in turn improves overall fuel consumption.

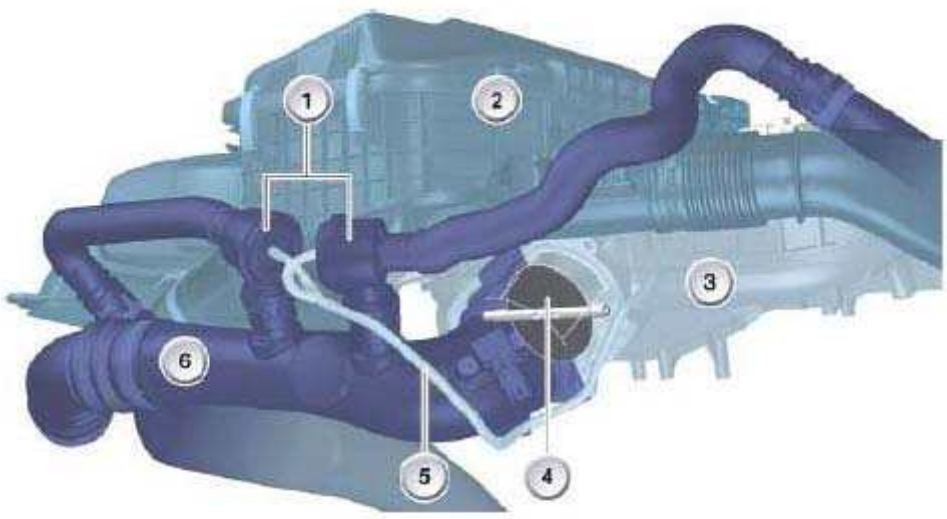
At full-load the N54 engine operates at an overpressure of up to Index Explanation Index Explanation 0.8 bar in the intake manifold.

Blow-off Control

The blow-off valves in the N54 engine reduce unwanted peaks in boost pressure which can occur when the throttle valve closes quickly. They therefore have an important function with regard to engine acoustics and help to protect the turbocharger components.

A vacuum pressure is generated in the intake manifold when the throttle valve is closed at high engine speeds. This leads to a build-up of high dynamic pressure after the compressor which cannot escape because the route to the intake manifold is blocked.

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Index	Explanation	Index	Explanation
1	Blow-off valves	4	Throttle valve
2	Air cleaner (ambient pressure)	5	Control line, blow-off valves
3	Intake manifold	6	Charge air pressure line

Fig. 41: Identifying Turbocharger Components
Courtesy of BMW OF NORTH AMERICA, INC.

This leads to a "pumping up" of the turbocharger which means that:

- a clearly noticeable, disruptive pumping noise can be heard,
- and this pumping noise is accompanied by a component-damaging load being exerted on the turbocharger, since high-frequency pressure waves exert axial load on the turbocharger bearings.

The blow-off valves are mechanically actuated spring-loaded diaphragm valves which are activated by the intake-manifold pressure as follows:

In the event of a pressure differential before and after the throttle valve, the blow-off valves are opened by the intake-manifold pressure and the boost pressure is diverted to the intake side of the compressor. The blow-off valves open starting from a differential pressure of 0.3 bar. This process prevents the disruptive and component-damaging pumping effect from occurring.

The system design dictates that the blow-off valves are also opened during operating close to idle (pressure differential Pcharger/Psuction = 0.3 bar). However, this has no further effects on the turbocharging system.

The turbocharger is pressurized with the full exhaust-gas flow at these low speeds and already builds up a certain level of induction-air precharging in the range close to idle.

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If the throttle valve is opened at this point, the full boost pressure required is very quickly made available to the engine.

One of the major advantages of the vacuum pressure-actuated wastegate valves is that they can be partially opened in the mid-range in order not to allow excessive induction-air precharging to the detriment of fuel consumption. In the upper load range, they assume the required control position corresponding to the necessary boost pressure.

Charge-air Cooling

Cooling the charge air in the N54 engine serves to increase power output as well as reduce fuel consumption. The charge air heated in the turbocharger by its component temperature and by compression is cooled in the intercooler by up to 80°C.

This increases the density of the charge air, which in turn improves the charge in the combustion chamber. This results in a lower level of required boost pressure. The risk of knock is also reduced and the engine operates with improved efficiency.



Fig. 42: Identifying Charge-Air Cooling Operations Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Load Control

Load control of the N54 engine is effected by means of the throttle valve and the waste gate valves.

The throttle valve is the primary component in this process. The wastegate valves are actuated to bring about a fine tuning of the boost pressure. At full load the throttle valve is completely open and load control is undertaken by the wastegate valves.

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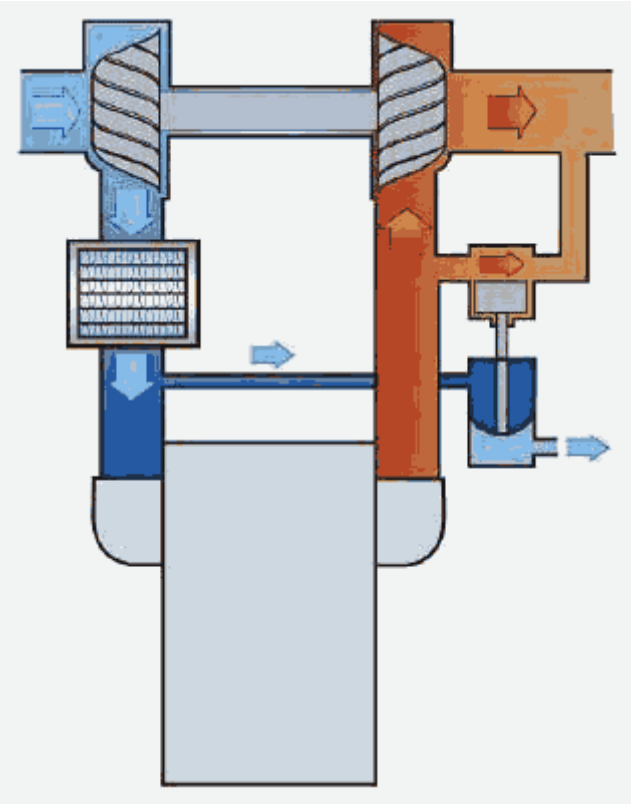


Fig. 43: Identifying Load Control Operations Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Controlled Variables

The following variables, among others, influence control of the N54 engine's boost pressure:

- Intake-air temperature
- Engine speed
- Throttle-valve position
- Ambient pressure
- Intake-manifold pressure
- Pressure before the throttle valve (reference variable)

The electropneumatic pressure transducers are activated by the engine control unit on the basis of these variables. The result of this activation can be checked from the boost pressure achieved, which is measured before the throttle valve.

There follows a comparison of the boost pressure achieved with the set point data from the program map, which can if necessary give rise to an activation correction. The system therefore controls and monitors itself during operation.

Limp-home Mode

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In the event during operation of malfunctions, implausible values or failure of any of the sensors involved in turbocharger control, activation of the wastegate valves is shut down and the valve flaps are thus fully opened. Turbocharging ceases at this point.

The list below sets out those components or functional groups of the N54 engine in which a failure, a malfunction or implausible values result in boost-pressure control being deactivated.

The driver is alerted to a fault of this type via an EML indication.

- High-pressure fuel system
- Inlet VANOS
- Exhaust VANOS
- Crankshaft sensor
- Camshaft sensor
- Boost-pressure sensor
- Knock sensors
- Intake-air temperature sensor

One principle of vehicle repair is particularly important in this respect:

It is important to focus on the causes rather than the effects.

With regard to diagnosis of the turbocharging system, always check the basics first. Look at such items as the vacuum hoses, the solenoids and the vacuum reservoir.

Don't overlook the fundamentals. Check compression, fuel system pressure (low and high), secondary ignition components etc.

The turbochargers are usually the last item to fail, but often one of the first items to be replaced.

Turbocharger Diagnosis

There are three "Golden Rules" to adhere to when diagnosing concerns on the N54 engine:

1. When diagnosing cases of smoke from the exhaust, it is important to avoid unnecessary replacement of the turbochargers. Smoke can be caused by oil consumption such as the crankcase ventilation system. Always evaluate the crankcase venting system completely before condemning any turbocharger components. Also, any engine is also subject to the usual causes such as valve guide wear or piston ring issues as on non-turbocharged engines.
2. Turbocharger damage is usually caused by -
    - Insufficient lubrication and subsequent bearing and seal failure.
    - Foreign bodies can damage the turbine and/or impeller.
    - Oil contamination
    - Restricted air filter

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- Ensure that all duct work connections are tight and "leak-free". This situation can also result in engine noise.

3. Do not make any alterations or modifications to the turbocharger. Do not make any adjustments to the boost control linkage or any part of the turbocharger. Higher than normal boost pressure may have adverse and detrimental effects on the engine. Any modification will cause the engine management to enter in the "limp-home" program and will reduce performance and engine reliability.

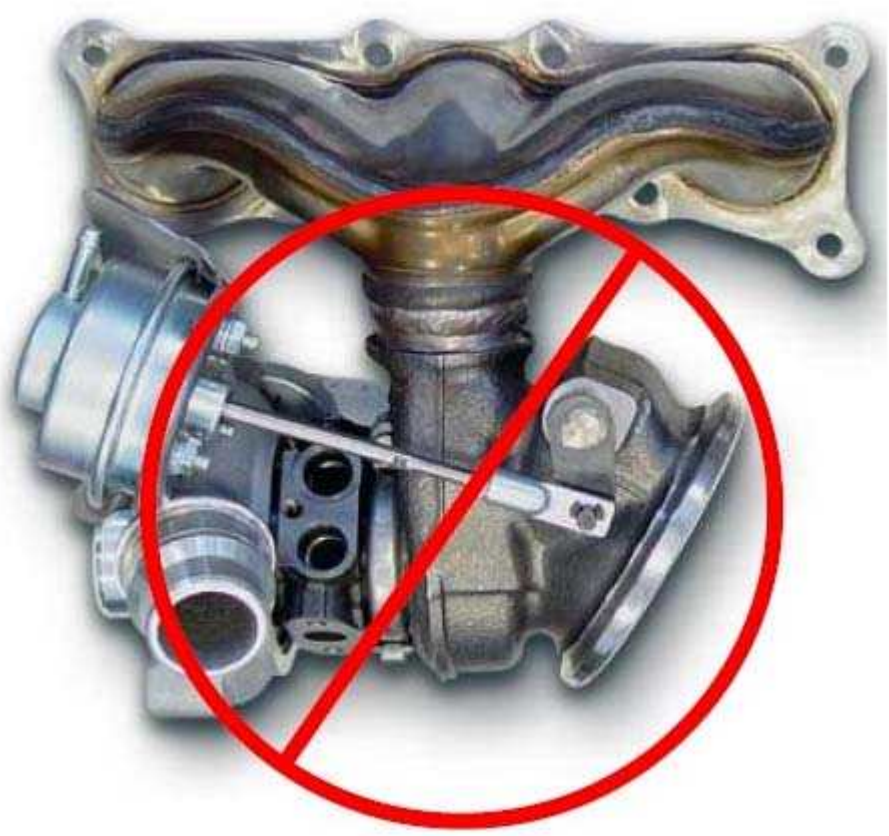


Fig. 44: Identifying Modifications To Turbochargers
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: No Modifications to the turbochargers are permitted.

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Date:	Model:	Chassis:	Prod Date:	DISplus/GT-1 Software:

Using the BMW diagnostic equipment, identify any available diagnostic options that can be used to troubleshoot the listed functions or components and mark each category accordingly.	Component Activation	Status Request	Test Plan	Signal Measurement	Notes/comments: (example: pin and connector assignments, "Function Selection" Path, Notes on Test Plans)	Service Function
Function/System/Component	Diagnosis Options				Additional Information	Purpose
Charge-air pressure control/Wastegate valves						
Charge-air pressure control/Blow-off valves						
Charge-air pressure sensor						
Intake manifold pressure sensor						
Intake manifold temperature sensor						

Measure and record the following values for the listed components under the indicated operating conditions:

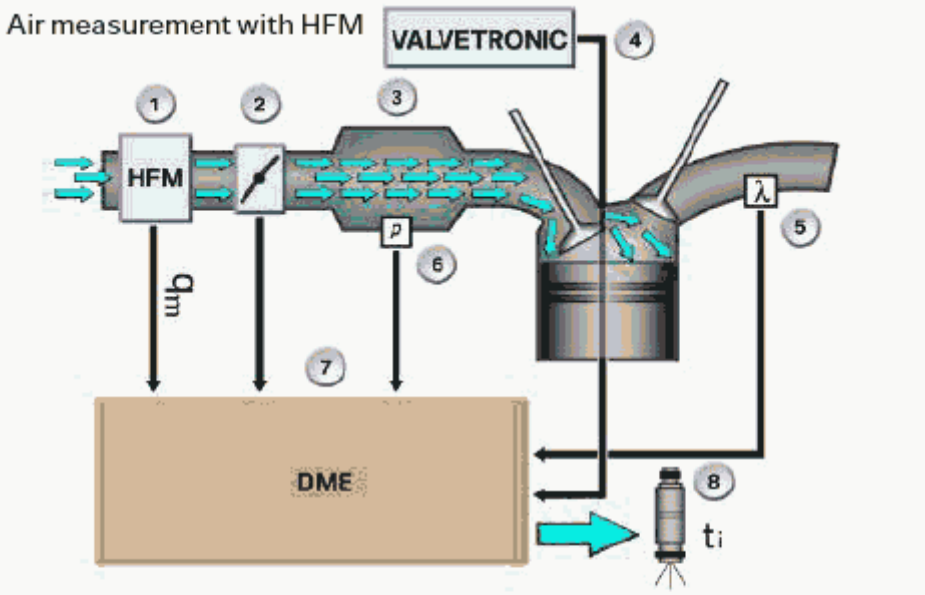
Component		Operating Condition			
		High manifold vacuum	Atmospheric pressure	Low to high boost	
Wastegate Control Valve	Volts				
	Hz				
	Duty Cycle				
Charge-air Pressure Sensor	Volts				
	Hz				
	Cycle				
Intake Manifold Pressure Sensor	Volts				
	Hz				
	Duty Cycle				

Fig. 45: Identifying Diagnosis Function Table
Courtesy of BMW OF NORTH AMERICA, INC.

Hot-Film Air Mass Meter

Some new NG6 engines use a digital HFM. The output of the sensor is converted to a digital signal. This eliminates the need for signal conversion in the ECM. The signal corresponds proportionally to changes in air mass. The N54 engine uses a virtual HFM. The signal is "calculated" in the ECM from various parameters such as engine speed, intake air temperature, throttle position etc.

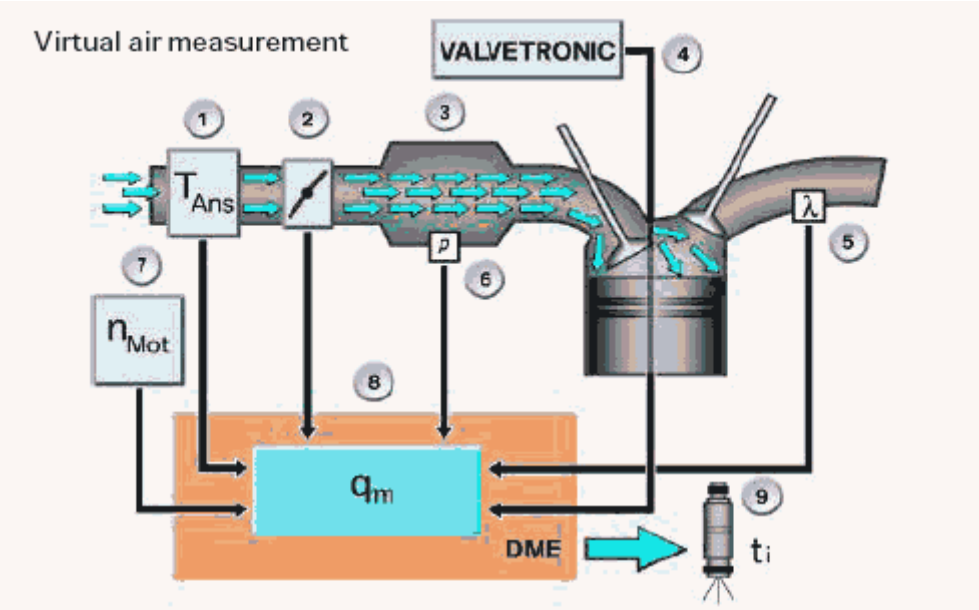
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Index	Explanation	Index	Explanation
1	Measurement of intake air temperature and air mass	5	Residual O2 content in exhaust gas
2	Throttle valve position	6	Intake manifold vacuum
3	Intake manifold	7	Engine speed
4	Intake valve lift (from VVT)	8	Injection Timing

Fig. 46: Identifying Hot-Film Air Mass Meter Diagram (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

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Index	Explanation	Index	Explanation
1	Intake air temperature	6	Intake manifold vacuum
2	Throttle valve position	7	Engine speed
3	Intake manifold	8	ECM (DME) with characteristic map for air mass calculation
4	Intake valve lift (VVT if equipped)	9	Injection Timing
5	Residual O2 content in exhaust (O2 sensor)		

Fig. 47: Identifying Hot-Film Air Mass Meter Diagram (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

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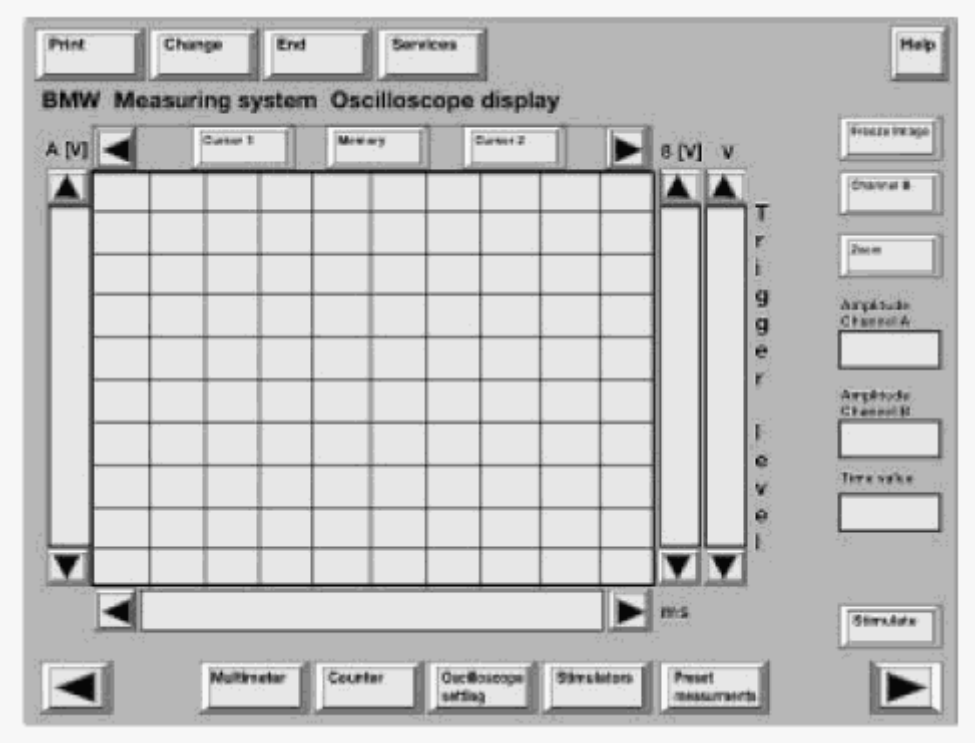


Fig. 48: Identifying BMW Measuring Oscilloscope Display Screen
Courtesy of BMW OF NORTH AMERICA, INC.

Oscilloscope Settings						
	Channel A			Channel B		
Test Connection	MFK 1	MFK 2	KV	MFK 1	MFK 2	Trigger clip
Type of Measurement	AC	DC		AC	DC	
Frequency Range						
Trigger Source	Channel A	Channel B		Trigger Clip	KL1 (TD)	

Fig. 49: Identifying Oscilloscope Settings Table
Courtesy of BMW OF NORTH AMERICA, INC.

FUEL SUPPLY AND MANAGEMENT

N52KP and N51 Fuel System

The N52KP and N51 engine continue to use the conventional "manifold injection" system carried over from the N52. The fuel supply components are also carried over with regard to the EKP module, fuel pump etc.

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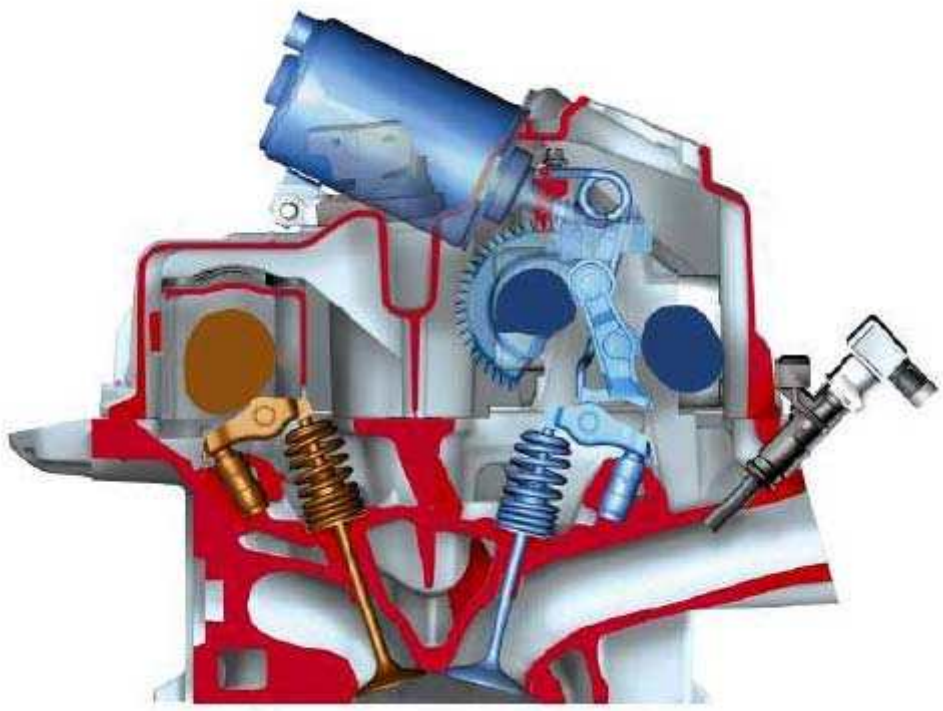


Fig. 50: Identifying Fuel Supply System
Courtesy of BMW OF NORTH AMERICA, INC.

N54 Engine

The N54 engine uses the new High Precision Injection (HPI) system. The HPI system is a "direct" fuel injection system which represents the second generation "DI" system from BMW. The first generation was on the N73 engine from 2003.

The N73 engine used a "wall guided" method of injection which used a recess in the piston to aid in mixture formation. The HPI system on the N54 uses a "spray guided" process which allows the mixture to form and ignite without the aid of any "walls" (i.e piston, cylinder wall etc.).

The spray guided system allows for more efficiency by cooling the cylinder charge without excessive cooling of the associated engine components. The wall guided system cools the piston crown which reduces thermal efficiency.

The HPI system also uses the new "piezo-electric" fuel injectors which are a vital components of the spray guided process. These new injectors open in an outward direction, which forms a precise tapered spray pattern.

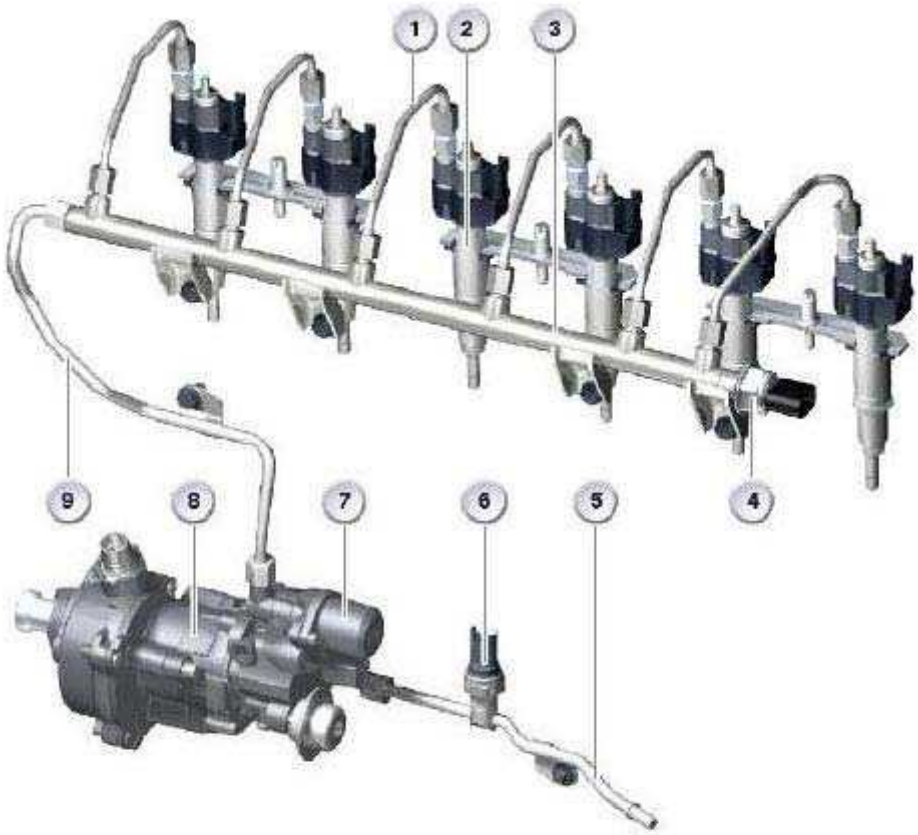
With the aid of high system pressure (200 bar), the HPI system is now capable of providing new levels of efficiency which were not achievable with previous manifold injection systems.

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Fig. 51: Identifying Manifold Injection Systems
Courtesy of BMW OF NORTH AMERICA, INC.

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Index	Explanation	Index	Explanation
1	High-pressure line to injector (6)	6	Low-pressure sensor
2	Piezo injector	7	Fuel supply control valve
3	Fuel rail	8	Three plunger high pressure pump
4	High pressure sensor	9	High pressure line (pump to rail)
5	Feed line from in-tank pump		

Fig. 52: Identifying HPI Function Systems
Courtesy of BMW OF NORTH AMERICA, INC.

HPI Function

The fuel is delivered from the fuel tank by the electric fuel pump via the feed line (5) at an "feed" pressure of 5 bar to the high pressure pump. The feed pressure is monitored by the low-pressure sensor (6). The fuel is delivered by the electric fuel pump in line with demand.

If this sensor fails, the electric fuel pump continues to run at 100% delivery with terminal 15 ON.

The high pressure pump is driven "in-tandem" with the vacuum pump which is driven by the oil pump chain drive assembly.

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The fuel is compressed in the permanently driven three-plunger high-pressure pump (8) and delivery through the high-pressure line (9) to the rail (3). The fuel accumulated under pressure in the rail in this way is distributed via the high-pressure lines (1) to the piezo injectors (2).

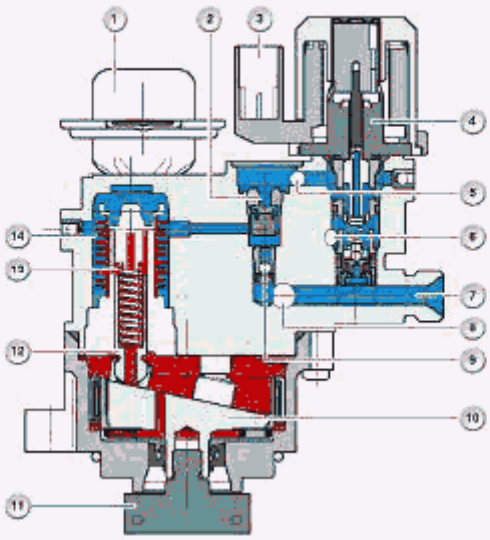
The required fuel delivery pressure is determined by the engine-management system as a function of engine load and engine speed. The pressure level reached is recorded by the high-pressure sensor (4) and communicated to the engine control unit.

Control is effected by the fuel-supply control valve (7) by way of a setpoint/actual-value adjustment of the rail pressure. Configuration of the pressure is geared towards best possible consumption and smooth running of the N54 engine. 200 bar is required only at high load and low engine speed.

High Pressure Pump Function and Design

The fuel is delivered via the supply passage (6) at the admission pressure generated by the electric fuel pump to the high-pressure pump. From there, the fuel is directed via the fuel supply control valve (4) and the low-pressure non-return valve (2) into the fuel chamber (14) of the plunger-and-barrel assembly. The fuel is placed under pressure in this plunger-and-barrel assembly and delivered via the high pressure non-return valve (9) to the high pressure port (7).

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Index	Explanation	Index	Explanation
1	Thermal compensator	8	Supply passage, pressure limiting valve
2	Low pressure non-return valve (check valve)	9	High pressure non-return valve (x 3)
3	Connection to engine management	10	Pendulum disc
4	Fuel supply control valve	11	Drive flange, high pressure pump
5	Return, pressure limiting valve	12	Plunger (x 3)
6	Supply from electric fuel pump (in-tank)	13	Oil filling, high pressure pump
7	High pressure port to fuel rail	14	Fuel chamber (x 3)

Fig. 53: Identifying High Pressure Pump Function & Design
Courtesy of BMW OF NORTH AMERICA, INC.

The high-pressure pump is connected with the vacuum pump via the drive flange (11) and is thus also driven by the chain drive, i.e. as soon as the engine is running, the three plungers (12) are permanently set into up-and-down motion via the pendulum disc (10).

Fuel therefore continues to be pressurized for as long as new fuel is supplied to the high-pressure pump via the fuel-supply control valve (4). The fuel-supply control valve is activated by means of the engine management connection (3) and thereby admits the quantity of fuel required.

Pressure control is effected via the fuel-supply control valve by opening and closing of the fuel supply channel. The maximum pressure in the high-pressure area is limited to 245 bar.

If excessive pressure is encountered, the high-pressure circuit is relieved by a pressure-limiting valve via the ports (8 and 5) leading to the low-pressure area.

This is possible without any problems because of the non-compressibility of the fuel, i.e. the fuel does not change in volume in response to a change in pressure. The pressure peak created is compensated for by the

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liquid volume in the low-pressure area.

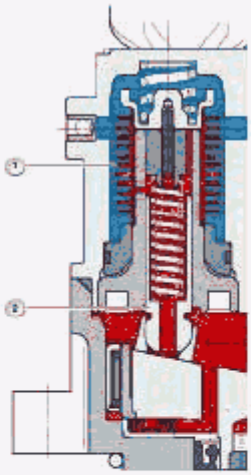
Volume changes caused by temperature changes are compensated for by the thermal compensator (1), which is connected with the pump oil filling.

Pressure Generation in High-pressure Pump

The plunger (2) driven by the pendulum disc presses oil (red) into the metal diaphragm (1) on its upward travel. The resulting change in volume of the metal diaphragm thereby reduces the available space in the fuel chamber. The fuel thereby placed under pressure (blue) is forced into the rail.

The fuel-supply control valve controls the fuel pressure in the rail. It is activated by the engine management system via a pulse-width modulated (PWM) signal.

Depending on the activation signal, a restrictor cross-section of varying size is opened and the fuel-mass flow required for the respective load point is set. There is also the possibility of reducing the pressure in the rail.



Index	Explanation
Red	Oil filling
Blue	Fuel
1	Metal diaphragm
2	Plunger

Fig. 54: Pressure Generation In High-Pressure Pump
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 55: Identifying High-Pressure Pump Location (HDP)
Courtesy of BMW OF NORTH AMERICA, INC.

Limp-Home Mode

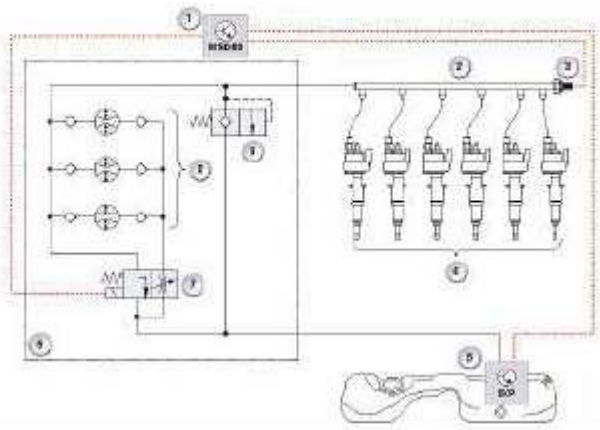
If a fault is diagnosed in the system, such as e.g. failure of the high-pressure sensor, the fuel-supply control valve is de-energized; the fuel then flows via a so-called bypass into the rail.

In the event of HPI limp-home mode, turbocharging is deactivated by an opening of the wastegate valves.

Causes of HPI limp-home mode can be:

- Implausible high-pressure sensor values
- Failure of the fuel-supply control valve
- Leakage in the high-pressure system
- Failure of the high-pressure pump
- Failure of the high-pressure sensor

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Index	Explanation	Index	Explanation
1	Engine control module (MSD80)	6	High-pressure pump
2	Fuel rail	7	Fuel supply control valve
3	High pressure sensor	8	High pressure pump with non-return valves
4	Piezo injectors	9	Pressure liming valve with bypass
5	Electric fuel pump		

Fig. 56: Identifying Limp-Home Mode Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

Fuel System Safety

Working on this fuel system is only permitted after the engine has cooled down. The coolant temperature must not exceed 40°C. This must be observed without fail because otherwise there is a danger of fuel sprayback on account of the residual pressure in the high-pressure system.

When working on the high-pressure fuel system, take particular care to ensure conditions of absolute cleanliness and follow the work sequences described in the repair instructions. Even the tiniest contaminant's and damage to the screw connections on the high-pressure lines can cause leaks.



Fig. 57: Identifying Fuel System Safety Label
Courtesy of BMW OF NORTH AMERICA, INC.

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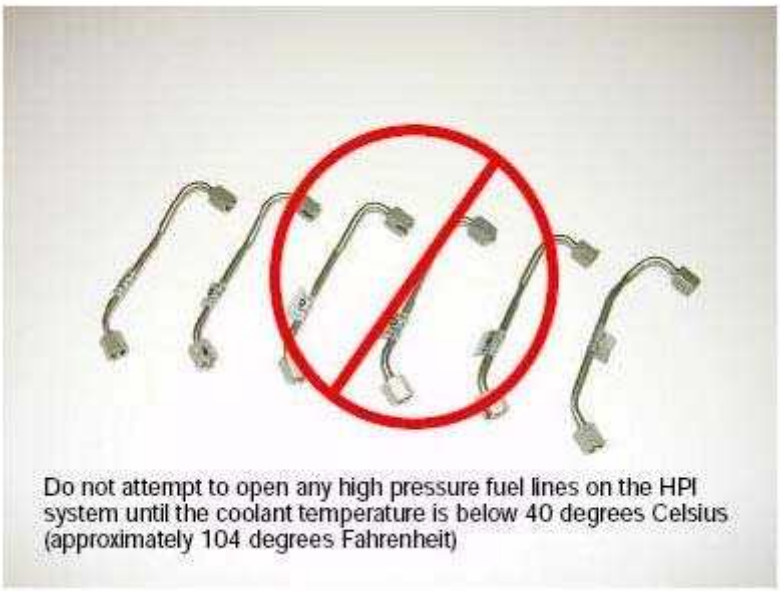


Fig. 58: Identifying High-Pressure Fuel Lines
Courtesy of BMW OF NORTH AMERICA, INC.

Piezo Fuel Injectors

It is the outward-opening piezo-injector that renders possible spray-directed direct injection and thus the overall innovations of the N54 engine. Due to the fact that only this component ensures that the injected fuel spray cone remains stable, even under the prevailing influences of pressure and temperature in the combustion chamber.

This piezo-injector permits injection pressures of up to 200 bar and extremely quick opening of the nozzle needle. In this way, it is possible to inject fuel into the combustion chamber under conditions released from the power cycles limited by the valve opening times.

The piezo-injector is integrated together with the spark plug centrally between the inlet and exhaust valves in the cylinder head. This installation position prevents the cylinder walls or the piston crown from being wetted with injected fuel. A uniform formation of the homogeneous air/fuel mixture is obtained with the aid of the gas movement in the combustion chamber and a stable fuel spray cone.

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Fig. 59: Identifying Piezo Fuel Injectors
Courtesy of BMW OF NORTH AMERICA, INC.

The gas movement is influenced on the one hand by the geometry of the intake passages and on the other hand by the shape of the piston crown.

The injected fuel is swirled in the combustion chamber with the boost air until a homogeneous mixture is available throughout the compression space at the point of ignition.

NOTE: When working on the fuel system of the N54 engine, it is important to ensure that the ignition coils are not fouled by fuel. The resistance of the silicone material is significantly reduced by heavy fuel contact. This can cause secondary ignition misfires.

- **Before performing any repairs to the fuel system, remove the ignition coils without fail and protect the spark-plug slot against the ingress of fuel with a cloth.**
- **Before refitting the piezo-injector, remove the ignition coils and ensure conditions of absolute cleanliness.**
- **Ignition coils heavily fouled by fuel must be replaced.**

Injector Design and Function

The piezo-injector essentially consists of three sub-assemblies. The expansion of the energized piezo-element lifts the nozzle needle outwards from its valve seat. To be able to counter the different operating temperatures with comparable valve lifts, the injector has a thermal compensating element.

The nozzle needle is pressed outwards from its tapered valve seat. This opens up an annular orifice. The

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pressurized fuel flows through this annular orifice and forms a hollow cone, the spray angle of which is not dependent on the backpressure in the combustion chamber.



Index	Explanation
1	Outward opening nozzle needle
2	Piezo-element
3	Thermal compensator

Fig. 60: Identifying Injector Design & Function
Courtesy of BMW OF NORTH AMERICA, INC.

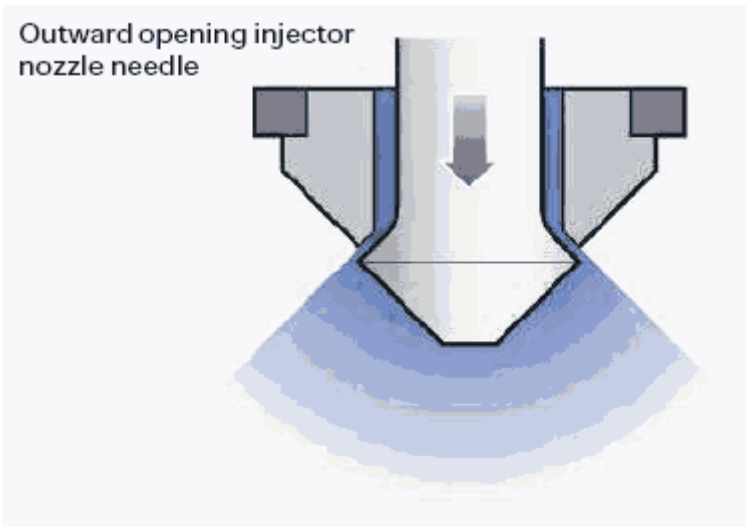
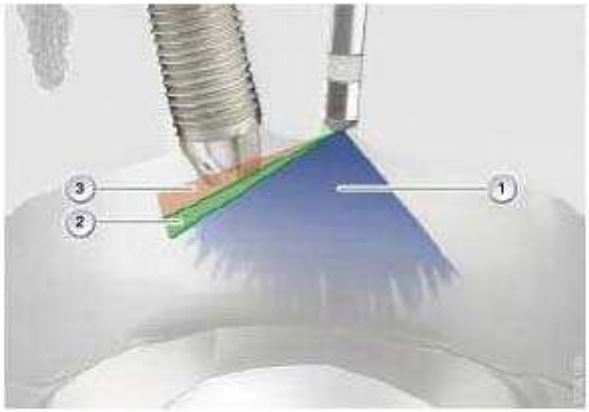


Fig. 61: Identifying Outward Opening Injector Nozzle Needle
Courtesy of BMW OF NORTH AMERICA, INC.

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The spray cone (1) of a piezo-injector can diverge during operation (2). Due to the formation of soot inside the engine, such divergence is perfectly normal and acceptable to a certain extent.

If, however, spray divergence reaches the stage where it begins to spray the spark plug wet, the spark plug may incur damage.



Index	Explanation
1	Ideal "spray" cone
2	Permitted divergence of spray cone
3	Non-permitted divergence of spray cone

Fig. 62: Identifying Spray Piezo-Injector Operation
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: Do not attempt to clean the injectors in any way.

This may result in damage which can effect the spray pattern. Any divergence in the spray pattern can cause damage to the spark plug or the engine itself.

NOTE: Replace the Teflon sealing ring when fitting and removing the piezo-injector. This also applies when an injector that has just been fitted has to be removed again after an engine start. A piezo-injector provided with a new Teflon sealing ring should be fitted as quickly as possible because the Teflon sealing ring could swell up. Please observe the repair instructions and follow without fail.

When fitting, make sure that the piezo injector is correctly seated. The hold-down element for securing the piezo-injectors must rest on both injector tabs, otherwise the necessary force is not applied to the piezo-injector.

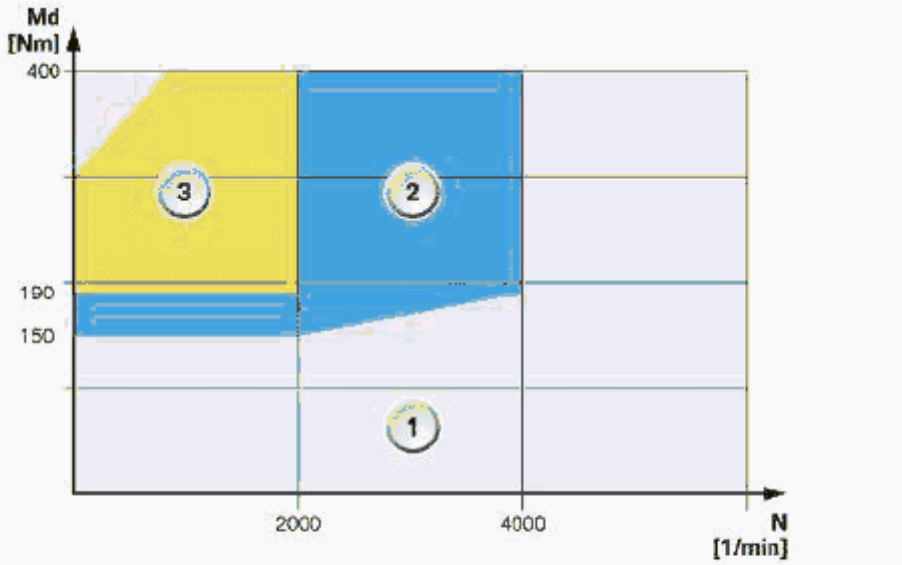
Injection Strategy

Injection of the fuel mass required for the operating situation can take place in up to three individual injections. Which option is used in the relevant operating situation is dependent on engine load and speed. Here, the actual time resulting from the engine speed available for metering the fuel is an important framework quantity.

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A special situation during the operation of any engine is the range in which a high load occurs at low engine speed, so-called "Low End Torque" operation. In this operating situation, the required fuel mass is metered to the engine in three individual injections.

This results in a highly effective mixture formation which in the final analysis has the effect of both increasing power output and saving fuel.



Index	Explanation
1	Single injection event
2	Double injection event
3	Triple injection event

Fig. 63: Identifying Injection Strategy
Courtesy of BMW OF NORTH AMERICA, INC.

In order to bring the catalytic converters up to operating temperature as quickly as possible, the N54 engine has a catalyst-heating mode for when the engine is started from cold. In this mode, combustion heat is intentionally introduced into the exhaust train and not used first and foremost to develop power output.

The point of ignition is moved to 30° (crankshaft degrees) after TDC. The main quantity of the required fuel is injected before TDC and mixed with the boost air. The piston is situated after TDC in its downward travel such that the air/fuel mixture is already expanding again, which reduces the ignitability of the mixture.

In order to ignite the mixture reliably, a small residual quantity of fuel is injected 25° after TDC and this guarantees an ignitable mixture at the spark plug. This small fuel quantity therefore provides for ignition of the residual charge in the combustion chamber.

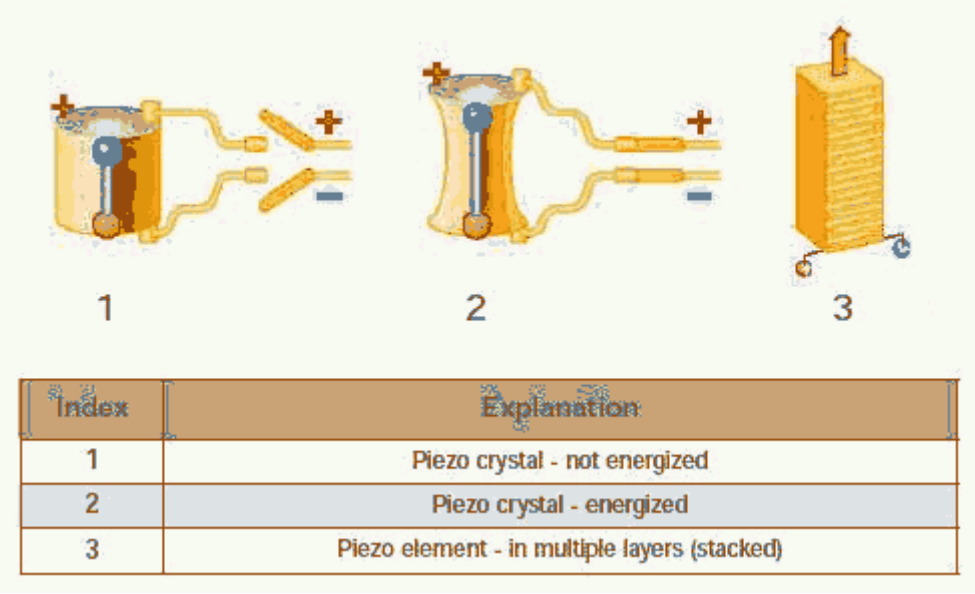
This operating mode is set by the engine-management system after a maximum period of 60 seconds from engine starting but is terminated if the catalytic-converter response temperature is reached earlier.

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Piezo Element

The movement of the nozzle needle in the injector is generated no longer by a solenoid coil but rather by a piezo-element.

A piezo-element is an electromechanical converter, i.e. it consists of a ceramic material which converts electrical energy directly into mechanical energy (force/travel). A familiar application is the piezo cigarette lighter - when a piezo-crystal is pressed, voltage is generated until a spark flashes over and the gas ignites.



Index	Explanation
1	Piezo crystal - not energized
2	Piezo crystal - energized
3	Piezo element - in multiple layers (stacked)

Fig. 64: Identifying Piezo Element
Courtesy of BMW OF NORTH AMERICA, INC.

In the case of the piezo-actuator, voltage is generated so that the crystal expands. In order to achieve greater travel, it is possible to design a piezo-element in several layers.

The actuator module consists of layers of the piezo-ceramic material connected mechanically in series and electrically in parallel. The deflection of a piezo-crystal is dependent on the applied voltage up to a maximum deflection; the higher the voltage, the greater the travel.

Injector Adjustment

When the injectors are manufactured, a multitude of measurement data is recorded at specific points in the factory. In this way, the tolerance ranges for injector-quantity adjustment are determined and specified in a six-digit number combination.

Information on the lift performance of the injector is also added for injector voltage adjustment. Injector adjustment is required because of the individual voltage demand of each piezo actuator. An allocation is made to a voltage demand category, which is included in the number combination on the injector.

These data items are transmitted to the ECM. During engine operation, these values are used to compensate for deviations in the metering and switching performance.

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NOTE: When replacing an injector, it is absolutely essentially to carry out an injector adjustment.



Fig. 65: Identifying Tolerance Range Numbers
Courtesy of BMW OF NORTH AMERICA, INC.

Injector Control and Adaptation

The fuel mass required for the operating situation is injected by the piezo-injector into the combustion chamber. This mass can be influenced by three correcting variables:

- the rail pressure
- the injector opening time
- and the injector opening lift

The injector opening time and the injector opening lift are activated directly at the piezo injector. The opening time is controlled via the ti signal and the opening lift via the energy quantity in the activation of the piezo-injector.

Injector Adaptation

The fuel masses and injection cycles determined from the load/speed map are included in a pilot-control program map. Here, while further framework parameters are taken into consideration, the energy quantities and injector opening times required to activate the injectors are determined.

The N54 engine can be safely and reliably operated with these program-map values.

Optimization

For optimization of:

- Emission values

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- Smooth running
- Fuel consumption
- Power output

The controlled variables of energy quantities and injector opening times are continuously monitored. This occurs on a bank-selective basis by way of lambda closed-loop control.

The residual oxygen in the exhaust gas is measured in each case for cylinder bank 1 and cylinder bank 2. This measurement result is compared with the values expected from the set correcting variables. The result of a deviation is that the injector opening signal is adapted. This adaptation is stored in the control unit and is therefore available for subsequent engine operation.

However, these stored values are lost when the system is flashed and must be relearned. A further adaptation of the injector activation takes place depending on time and use. This cylinder-selective adaptation involves a check of the residual-oxygen content with a conclusion as to the cylinder causing the situation. To this end, it is necessary for part of the exhaust-gas flow not to be swirled in the turbocharger. For this reason, the flap of the wastegate valve must be fully opened, i.e. swung out of the exhaust-gas flow.

This wastegate-flap position extends beyond its normal opening position in engine operation. Based on the result of this cylinder-selective monitoring, the energy quantity is adapted if necessary to activate the injectors.

Furthermore, the cylinder-selective adaptation includes if necessary an adaptation of the injector opening signal based on smooth running monitoring of the N54 engine. Overall adaptation of the injectors is limited to a 15% additional quantity.

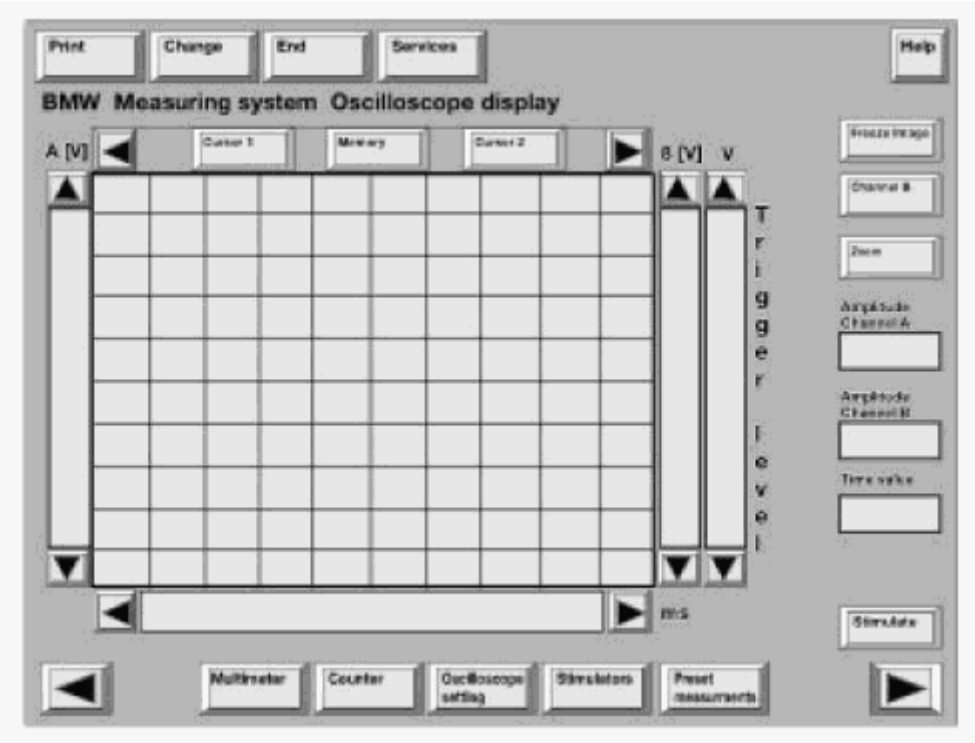


Fig. 66: Identifying BMW Measuring Oscilloscope Display Screen

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Courtesy of BMW OF NORTH AMERICA, INC.

Oscilloscope Settings						
	Channel A			Channel B		
Test Connection	MFK 1	MFK 2	KV	MFK 1	MFK 2	Trigger clip
Type of Measurement	AC	DC		AC	DC	
Frequency Range						
Trigger Source	Channel A	Channel B		Trigger Clip	KL1 (TD)	

Fig. 67: Identifying Oscilloscope Settings Table
Courtesy of BMW OF NORTH AMERICA, INC.

Date:	Model:	Chassis:	Prod Date:	DISplus/GT-1 Software:

Using the BMW diagnostic equipment, identify any available diagnostic options that can be used to troubleshoot the listed functions or components and mark each category accordingly.	Component Activation	Status Request	Test Plan	Signal Measurement	Notes/comments: (example: pin and connector assignments, "Function Selection" Path, Notes on Test Plans)	Service Function
Function/System/Component	Diagnosis Options				Additional Information	Purpose
Injection control/fuel injectors						
Low pressure fuel system/ In-tank fuel pump						
Low pressure fuel system/ Pressure sensor						
High pressure fuel system/Pressure control valve						
High pressure fuel system/Pressure sensor						

Can injectors be interchanged from one cylinder to another for testing purposes? _____

What requirements would be necessary in order to accomplish this? _____

or

Why is this not recommended? _____

Component		Operating Condition			
		Start	Cold Idle	Warm Idle	High Load
High pressure control valve	Volts				
	Hz				
	Duty Cycle				
Rail pressure sensor	Volts				
	Hz				
	Cycle				
Inlet pressure sensor	Volts				
	Hz				
	Duty Cycle				

Fig. 68: Identifying HPI Injection Testing Table
Courtesy of BMW OF NORTH AMERICA, INC.

IGNITION MANAGEMENT

Most of the ignition system components have remained the same for all NG6 engines for 2007. There are some minor changes to the ignition coils that apply to all versions. The coils have been optimized for more durability.

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Spark Plugs

The spark plugs for the N51 and N52KP remain the same as N52. However, the N54 uses a completely new spark plug from Bosch. The spark plug design consists of a 12 mm thread which contrasts from the 14 mm design on the N52 which prevents any possibility of improper installation.

The hex on the spark plug is also a 12 point design which requires a special tool. The tool (socket) has a "thinwall" design to facilitate access in the confined area of the N54 cylinder head.



Fig. 69: Identifying Spark Plugs
Courtesy of BMW OF NORTH AMERICA, INC.

Spark Plug Diagnosis (N54)

Due to the proximity of the spark plug to the fuel injector nozzle, any divergence in the fuel spray may cause possible spark plug damage. This makes spark plug diagnosis an important part of N54 service concerns. Information gained by the spark plug diagnosis may indicate possible fuel injector faults. Spark plug replacement interval has been reduced to 45,000 miles for the N54.

The **Fig. 70** below can be used to assist in diagnosis:

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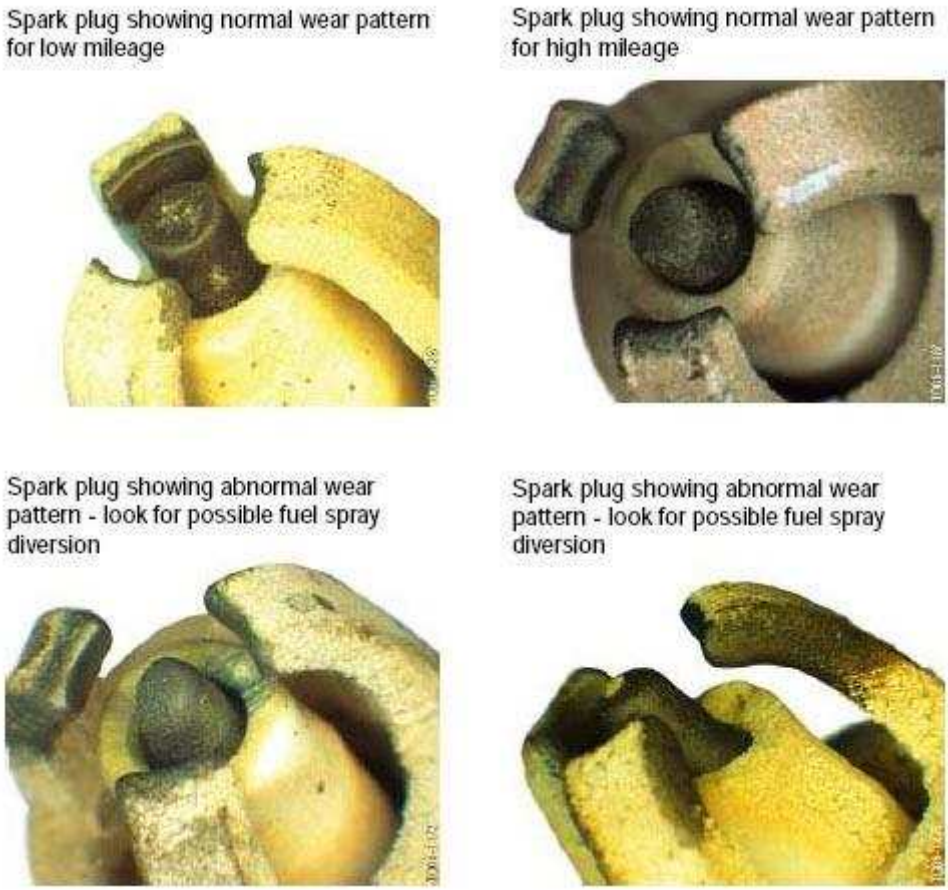


Fig. 70: Identifying Spark Plug Wear Pattern
Courtesy of BMW OF NORTH AMERICA, INC.

EMISSIONS MANAGEMENT

The N54 and N52KP meet ULEV II requirements for 2007. There are not many changes to the emission systems on these engines. The N54 engine has 2 underbody catalysts in addition to the "near engine" catalysts already in use from the N52.

The N51 engine, however, is a SULEV II compliant engine which meets the 2007 requirements. In addition to the 5 existing SULEV states of California, New York, Maine, Massachusetts, and Vermont - four states have been added for 2007. These states include, Connecticut, Rhode Island, Oregon and Washington State.

The N51 emissions measures include:

- Secondary Air System with mini-HFM
- Radiator with "Prem-air" coating
- Lower compression ratio (10:1) via modified combustion chamber and pistons
- Underbody catalyst in addition to "near engine" catalyst
- Activated carbon air filter in air filter housing
- Steel fuel lines with threaded fittings and sealed fuel tank

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- Crankcase ventilation system integrated into cylinder head cover
- Purge system piping made from optimized plastic

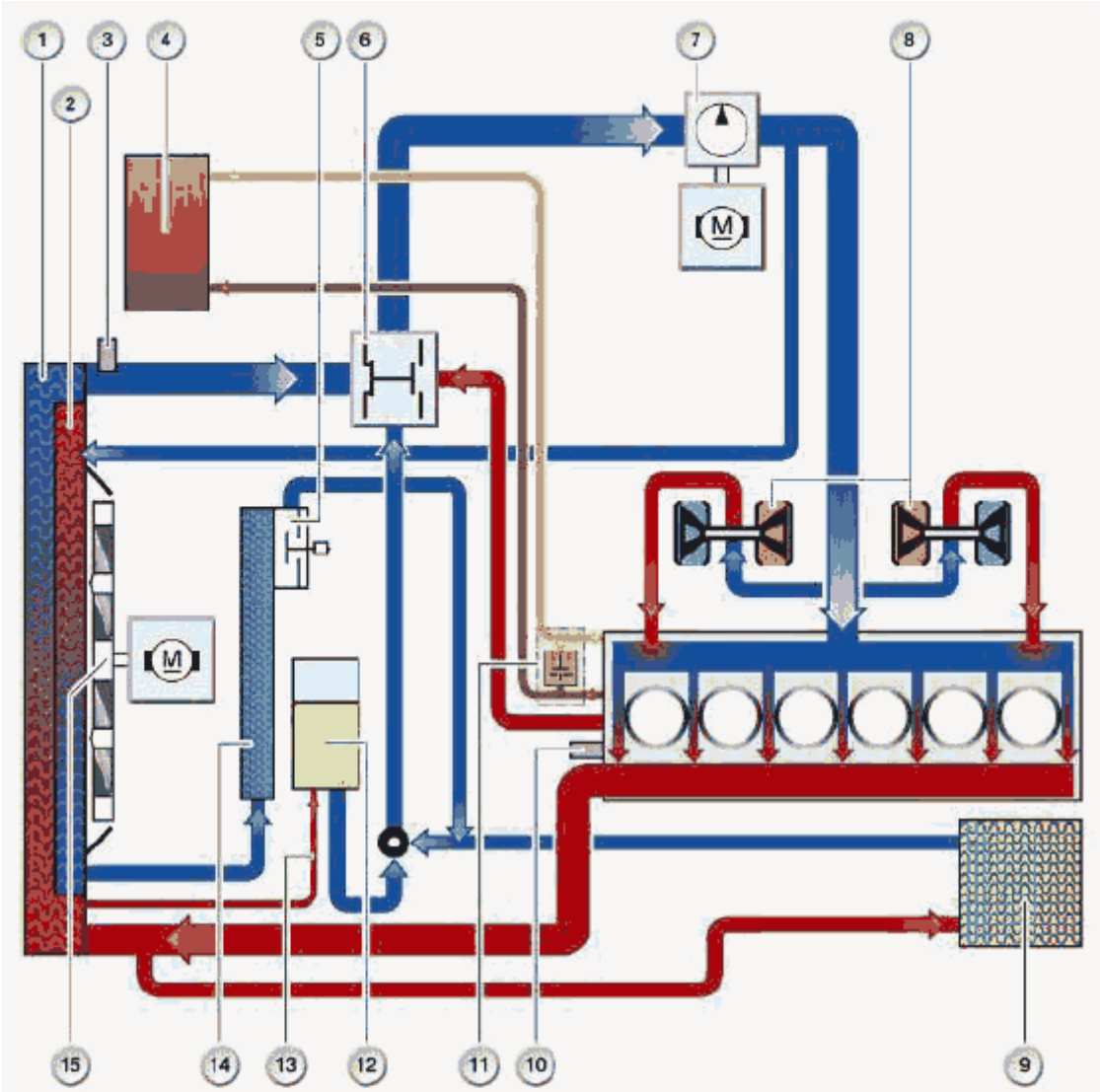
NOTE: The SULEV II information above is only preliminary and is accurate as of 8/06. Additional information will be released as it becomes available.

PERFORMANCE CONTROLS

Cooling System

The cooling system of the N54 engine consists of a radiator circuit and an isolated oil cooling circuit. The fact that there is an isolated oil-cooling circuit ensures that heat is not introduced via the engine oil into the engine's coolant system.

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Index	Explanation	Index	Explanation
1	Radiator	9	Heat exchanger
2	Gear-box oil cooler	10	Outlet temperature sensor, cylinder head
3	Outlet temperature sensor	11	Thermostat, engine oil cooler
4	Engine oil cooler	12	Coolant expansion tank
5	Thermostat for gearbox oil cooler	13	Vent line
6	Map thermostat	14	Gearbox oil cooler
7	Electric coolant pump	15	Fan

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Fig. 71: Identifying Cooling System Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

There is a significantly greater quantity of heat on account of this engine's increased power of 75.5 kW/l in comparison with other 3-liter spark-ignition engines.

This boundary condition is satisfied by the engine cooling system with its increased performance. This increase in power was to be realized in spite of some factors less advantageous to cooling.

Factors to be mentioned here are:

- Approximately 15% less flow area is available on account of the intercooler located below the radiator.
- The already small amount of space provided by the engine compartment is further limited by the accommodation of further components.
- Because the exhaust turbochargers are cooled by the coolant, an additional quantity of heat is introduced into the system via these turbochargers.

Measures for increasing cooling-system performance:

- Coolant pump with increased power - 400 W/9000 l/h
- Separation of water and engine-oil cooling
- Radiator with increased power
- Electric fan with increased power 600W for all gearbox variants

The structure of the coolant circuit is the same as that of the N52 engine. The engine is flushed through with coolant in accordance with the cross-flow concept. Cooling output can be influenced as a function of load by activating the following components:

- Electric fan
- Electric coolant pump
- Map thermostat

It is also possible that an N54 engine equipped with an automatic gearbox to utilize the lower area of the radiator to cool the gearbox by means of the gearbox oil cooler. This is achieved as in the N52 engine with control sleeves, which are introduced into the radiator tank.

Engine-oil Cooling

The N54 engine is equipped with a high-performance engine oil cooler. The pendulum slide pump delivers the oil from the oil sump to the oil filter. A thermostat flanged to the oil filter housing admits the oil to the engine-oil cooler. The engine oil cooler is located in the right wheel arch in the E92. The thermostat can reduce the resistance opposing the oil by opening the bypass line between the feed and return lines of the engine oil cooler. This ensures that the engine warms up safely and quickly.

Radiator

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Design measures have been used to increase the performance of the radiator itself. The performance of a radiator is dependent on its radiation surface. However, the intercooler location had to be underneath the radiator, and this meant that is was necessary to compensate for the smaller flow area available.

Compared with the N52 engine, the radiator used in the N54 engine has a block depth which has been increased to 32 mm. In addition, the water pipes are situated closer together than in previously used radiators. The upshot of this is an increase in the utilizable radiation surface.

Electric Coolant Pump

The coolant pump of the N54 engine is an electrically driven centrifugal pump with a power output of 400W and a maximum flow rate of 9000 l/h. This represents a significant increase in power of the electric coolant pump used in the N52 engine, which has a power output of 200 W and a maximum flow rate of 7000 l/h.

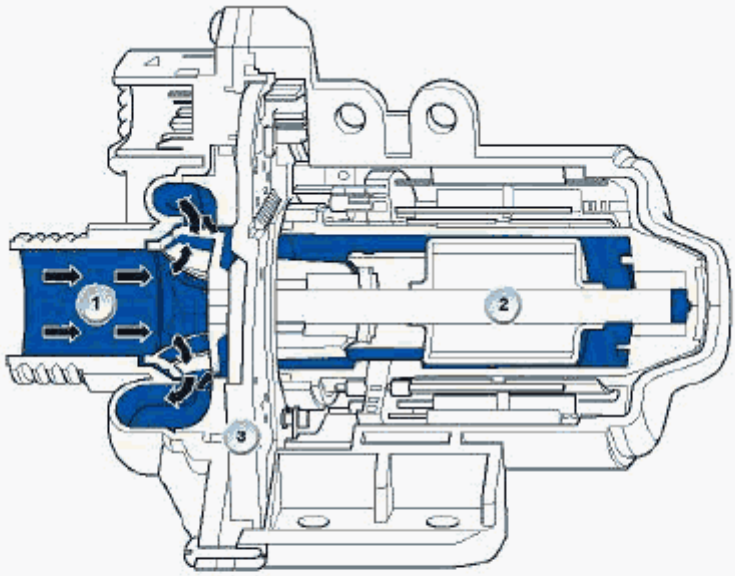
The power of the electric wet-rotor motor is electronically controlled by the electronic module (3) in the pump. The electronic module is connected via the bit-serial data interface (BSD) to the MSD80 engine control unit.

The engine control unit uses the engine load, the operating mode and the data from the temperature sensors to calculate the required cooling output.

Based on this data, the engine control unit issues the corresponding command to the electric coolant pump. The electric coolant pump regulates its speed in accordance with this command.

The system coolant flows through the motor of the coolant pump, thus cooling both the motor as well as the electronic module. The coolant lubricates the bearings of the electric coolant pump.

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Index	Explanation
1	Pump
2	Pump motor
3	Electric Water Pump module

Fig. 72: Identifying Engine-Oil Cooling Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: **The same rules apply to all electric coolant pumps. The pump must be filled with coolant when removed for service to prevent any corrosion. Also, the pump impeller must be turned by hand before installation to ensure the pump is not seized.**

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GENERAL INFORMATION

New Engine Technology - Overview

BASIC MEASURING TECHNIQUES

Model: All

BASIC ENGINE MEASUREMENTS

During the course of engine repairs some basic engine measurements are required to verify engine diagnosis as well as to complete proper repairs. These measurements are made by precision measuring tools such as micrometers, Vernier calipers, cylinder bore gauges and dial indicators.

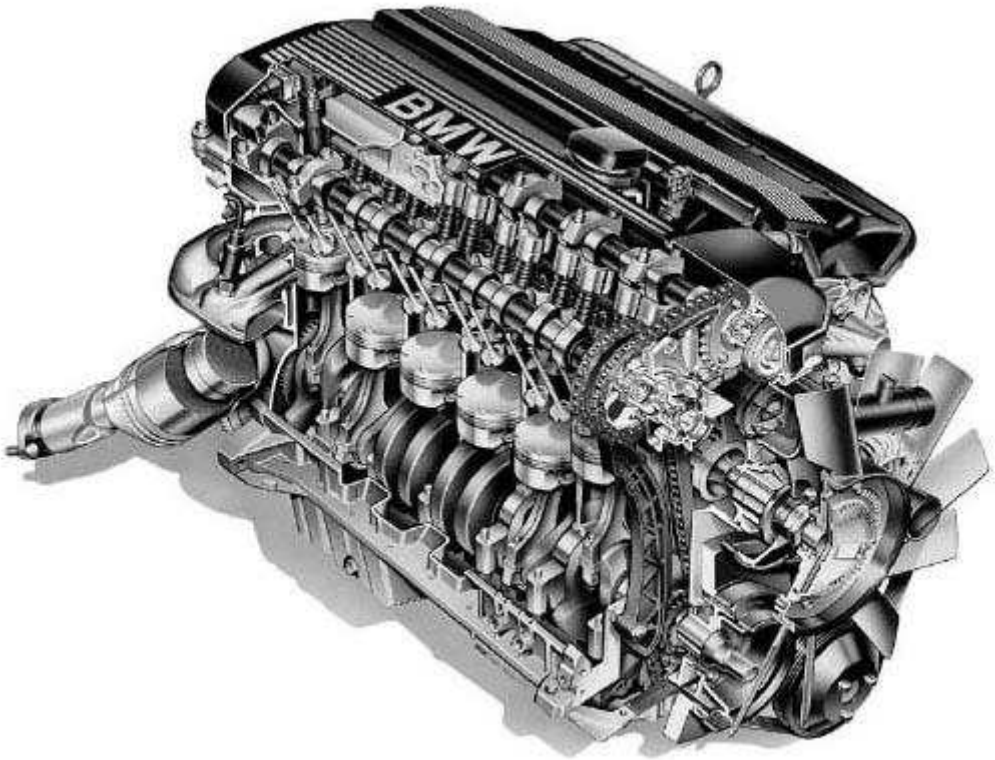


Fig. 1: Identifying Basic Engine Measurements
Courtesy of BMW OF NORTH AMERICA, INC.

Also, a working knowledge of the metric system is also a vital skill that is needed by the technician. All BMW engine measurements consist of metric specifications. Some of the routine engine measurements performed include:

- Valve Guide Wear (Tilt Angle K)
- Cylinder Bore Measurements (Taper and Out-of-Round)
- Cylinder Head Warpage and Thickness

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- Axial and Radial Endplay Measurements (Crankshaft/Camshaft etc).

Among all of the skills possessed by a modern technician, basic measuring techniques are perhaps the most overlooked and least used. This is why it is important to review these skills from time to time as a refresher.

Also, it is necessary to access technical data to obtain the proper specifications for these measurements. This course is designed to review measuring techniques to assist in engine diagnosis.

Vernier Measurement

The Vernier scale is used on various measuring tools such as the Vernier caliper and the Depth Gauge. The Vernier scale can be used with Fractional (US) and Metric systems. For the purposes of this training module we will always refer to the Metric Vernier scale.

The Vernier scale consists of a fixed scale and a sliding scale. The fixed scale is divided with graduations in 1 millimeter increments. The sliding scale has 10 graduations in increments of .5.

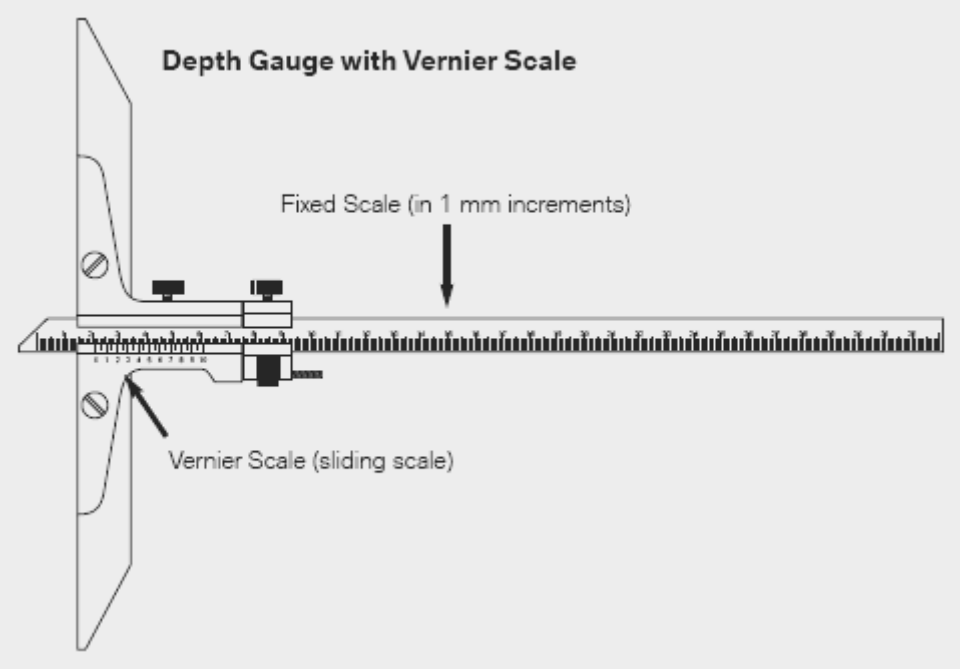


Fig. 2: Identifying Depth Gauge With Vernier Scale
Courtesy of BMW OF NORTH AMERICA, INC.

In order to read a measurement, use the zero mark on the left end of the vernier scale to use as a guide to read a measurement on the fixed scale.

In the example shown at the right, the zero mark is resting between 26 and 27 mm. Therefore the base measurement is 26 mm.

Next, the decimal measurement must be taken. For this, find a line on the Vernier that most closely matches any line on the fixed scale.

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Using the example drawing, the "4" on the Vernier scale is lining up directly with a line on the fixed scale.

Combining the previous reading with this reading, the result would be 26.4 mm.

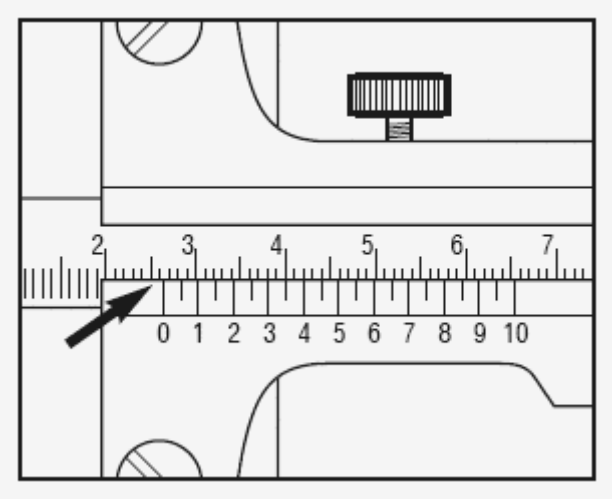


Fig. 3: Identifying Read Measurement, Zero Mark On Left End Of Vernier Scales
Courtesy of BMW OF NORTH AMERICA, INC.

The designations on the Vernier scale are in increments of .5. For example, if a reading on the Vernier scale falls on the .5 (i.e. 2.5, 3.5 etc) designation this would indicate 5/100th's of a millimeter.

MIcrometer Measurements

Another valuable measuring tool is the micrometer, which can be used for measurements such as bearing journal diameter, cylinder head thickness, valve shim thickness and brake rotor thickness etc. Micrometers also come in configurations for inside measurements as well.

The micrometer scale comes in both fractional and metric varieties. We will cover only the metric micrometer scale in this course.

First you must familiarize yourself with the construction of the micrometer in order to understand how measurements are made.

Metric Micrometer Construction

The micrometer is constructed of a few basic parts. The actual item to be measured is placed between the anvil and the spindle. The micrometer can be adjusted to the approximate size using the thimble. The thimble should only be used for the coarse adjustment. In order to make the actual measurement, the micrometer should only be turned using the ratchet (a.k.a. the friction stop). Do not attempt to make a measurement using the thimble. This will give an inaccurate measurement and ultimately damage the micrometer.

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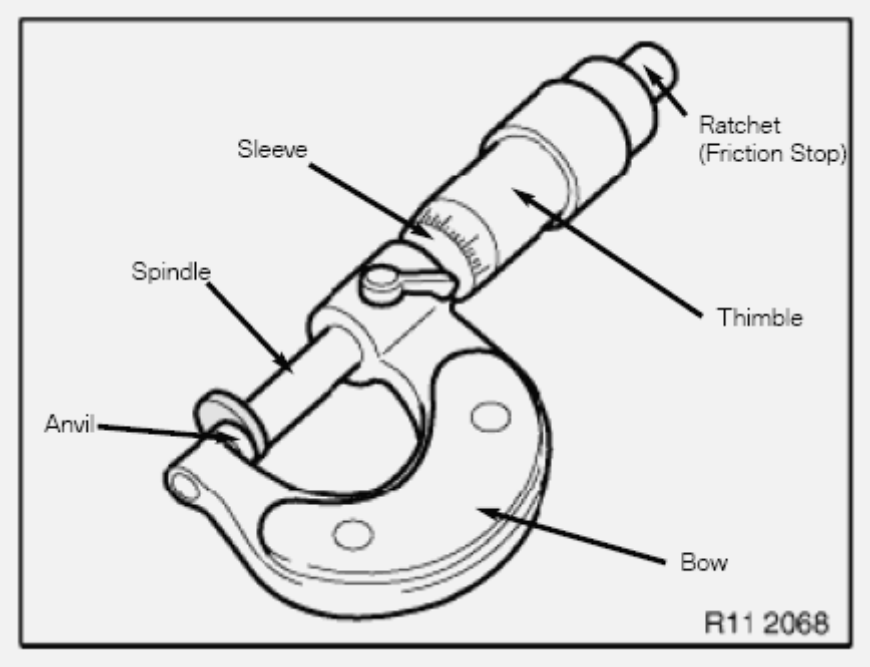


Fig. 4: Identifying Metric Micrometer Construction And Spindle
Courtesy of BMW OF NORTH AMERICA, INC.

Micrometers are available in various sizes for outside as well as inside measurements. The more common variation is the outside micrometer. They are usually available in 25 millimeter increments such as 0-25 mm, 25-50 mm, 50-75 mm etc.

The metric micrometer can measure in increments of one hundredth of a millimeter (.01mm). One hundredth of a millimeter is equal to 0.0003937 inch which is less than one thousandth of an inch.

The measurement area of the micrometer consists of the sleeve scale and the thimble scale. The sleeve scale is used to read whole and half millimeters. The thimble scale (which rotates) reads in hundredths (.01) of a millimeter from zero to fifty. Two complete revolutions of the thimble equals one millimeter.

On the sleeve scale, each scale mark above the center line indicates whole millimeters. Below the center line, half of a millimeter (or .5mm) increments are indicated.

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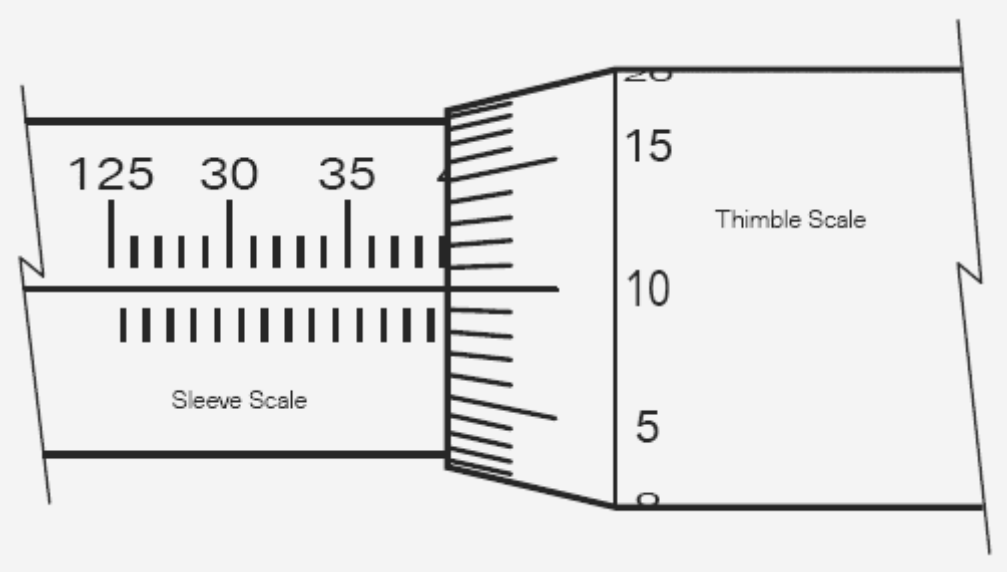


Fig. 5: Identifying Sleeve Scale
Courtesy of BMW OF NORTH AMERICA, INC.

Using the example shown above, the micrometer is a 125-150mm micrometer. To read this micrometer, first take the basic reading from the sleeve scale. The thimble is past the 139 mm mark. Therefore the reading is a least 139 mm. Next, look at the thimble scale and note the reading on the centerline. The "10" on the thimble scale is lined up with the centerline. This indicates a reading of .10 mm. If you add the two readings; 139 + .10 = 139.10 mm.

Dial Indicator Measurements

The dial indicator is used to measure the travel or movement of a specific item. It can also be used to measure axial and radial runout. In engine measurement applications, the dial indicator can be used to measure valve guide wear, axial movement of the crankshaft (thrust), and runout of flywheels and harmonic balancers.

First, it is important to familiarize yourself with Dial Indicator construction. The face of the dial indicator consists of a moveable bezel which is also attached to the large measuring scale. This allows the tool be be brought to the "zero point" when needed.

The main measuring device is the contact point. The contact point (1) is placed against the object to be measured. Usually, the contact point is rounded or has a ball bearing. This allows for a more accurate measurement.

The measuring face of the dial indicator consists of 2 scales. The smaller scale is for the "coarse" measurement which is in graduations of 1 millimeter. One revolution of the small scale is 10 millimeters.

The large scale is in graduations of .01 millimeter and the scale goes from zero to one hundred. Therefore, one revolution of the large scale is one millimeter.

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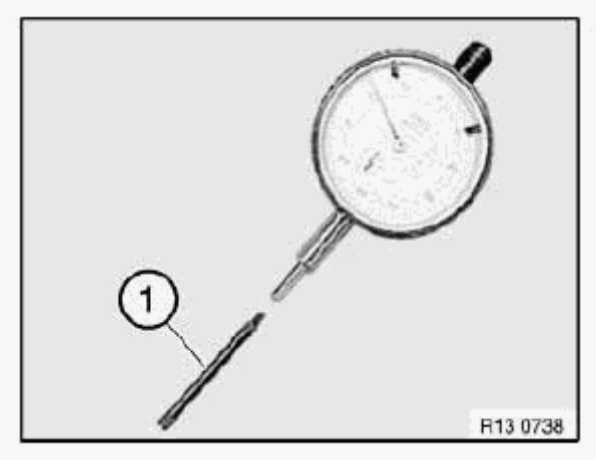


Fig. 6: Identifying Device Is Contact Point
Courtesy of BMW OF NORTH AMERICA, INC.

The dial indicator also needs to be held in place when taking a measurement. This requires a stand or base. Depending upon the application, these stands can be a clamp type, magnetic or a threaded base.

When taking a measurement, place the contact point on the object to be measured. The dial indicator must be pre-loaded slightly to prevent the measurement from bottoming out.

When reading the scale, be sure to "zero" the dial indicator first. If the readings to be taken are less than 1 millimeter, you do not need to use the small scale. If the readings are larger than 1 millimeter, be sure to factor the small scale into your measurement.



Fig. 7: Identifying Dial Indicator
Courtesy of BMW OF NORTH AMERICA, INC.

Examples of Dial Indicator Measurements

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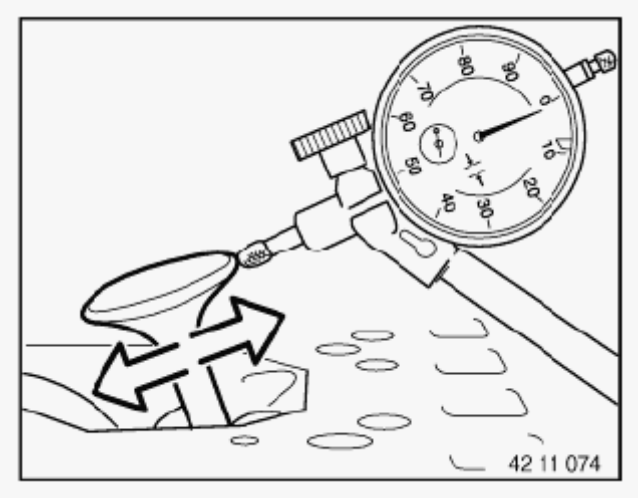


Fig. 8: Identifying Valve Guide Wear - Tilt Angle (K)
Courtesy of BMW OF NORTH AMERICA, INC.

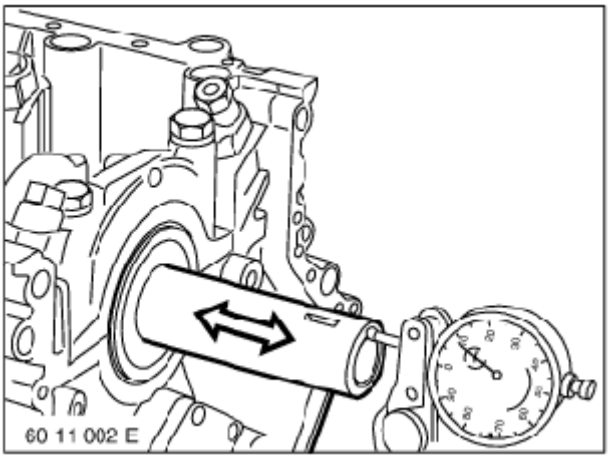
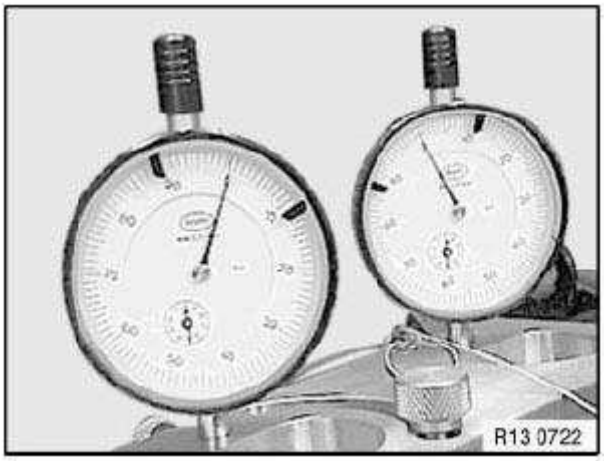


Fig. 9: Identifying Crankshaft Endplay - Axial
Courtesy of BMW OF NORTH AMERICA, INC.



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Fig. 10: Identifying S62 Engine - Basic Throttle Setting
Courtesy of BMW OF NORTH AMERICA, INC.

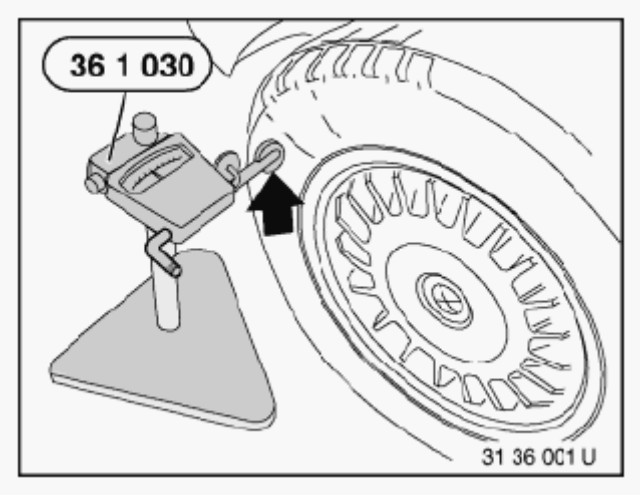


Fig. 11: Identifying Wheel Runout - Axial
Courtesy of BMW OF NORTH AMERICA, INC.

ADDITIONAL ENGINE MEASUREMENTS

During engine repair procedures it is sometimes necessary to assess engine wear to make determinations on parts replacement. Also, some engine measurements are needed to verify a previous diagnosis.

For example, a cylinder leakdown test could indicate a cylinder sealing concern. Once the engine is disassembled, it would be necessary to verify this condition by checking the piston and piston ring condition. If OK, the next step would be to determine the condition of the cylinder bore. At this point, the cylinders should be checked for taper (conicity) and for out-of-round. The correct measurements could mean the difference between just replacing the rings and/or pistons or replacing the engine block. This is why it is necessary to make accurate measurements when needed.

Some of the other routine engine measurements include:

- Cylinder head warpage
- Cylinder head thickness (on some applications)
- Piston rings - end gap and axial clearance

* Cylinder bore - including out-of-round and taper

Cylinder Head Measurement

If a repair requires removal of the cylinder head, a few basic measurements can be performed to save time and unnecessary machine shop costs. If an engine has been overheated or has an internal or external fluid leakage (coolant/oil), it is a good idea to check the cylinder head for warpage.

This can be done by using a commercially available machinists straight edge and a feeler gauge. by sliding the

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feeler gauge under the straight edge in various locations, it can determine if there are any low spots or warpage. The specifications for warpage are found in WebTIS under Technical Data. Usually, the specification is about .05 mm.

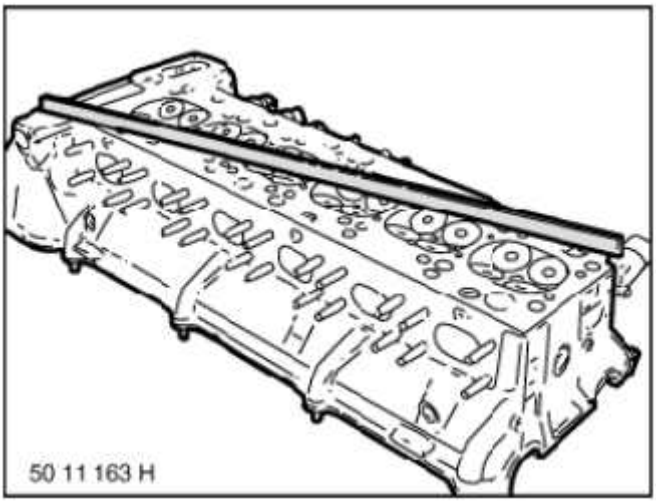


Fig. 12: Checking Cylinder Head Warpage
Courtesy of BMW OF NORTH AMERICA, INC.

Also, check to see if the cylinder head has a specification for machining limit. If so, it may be possible to have the cylinder head re-surfaced. Depending on the amount of material removed during the machining process, it may be necessary to install a thicker head gasket. There are some "service" head gaskets available through the part s department.

The cylinder head can be checked for minimum thickness. This is done using a micrometer or a vernier caliper. This is not possible on all engines, the example shown below is a 6-cylinder (M52TU/M54).

If the minimum thickness is not met, the head will need to be replaced.

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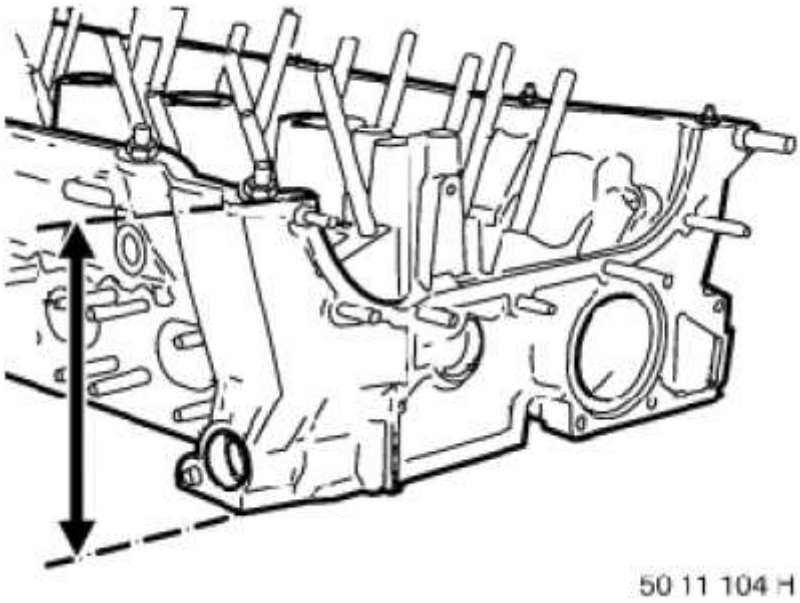


Fig. 13: Identifying Cylinder Head Minimum Thickness
Courtesy of BMW OF NORTH AMERICA, INC.

Piston Measurements

When replacing pistons and/or piston rings, there are some basic measurements that need to be made. When fitting a piston to a cylinder bore, the piston diameter should be checked to ensure a proper fit.

The piston diameter is measured using a micrometer. The measurement is taken at a specified point (A) which is 90 degrees from the piston pin axis. Each engine has a specific location to measure piston diameter. For example, the illustration below shows measuring Point A. The specification for this engine (N62) is 18 mm. So the piston diameter is measured 18 mm from the bottom of the piston skirt.

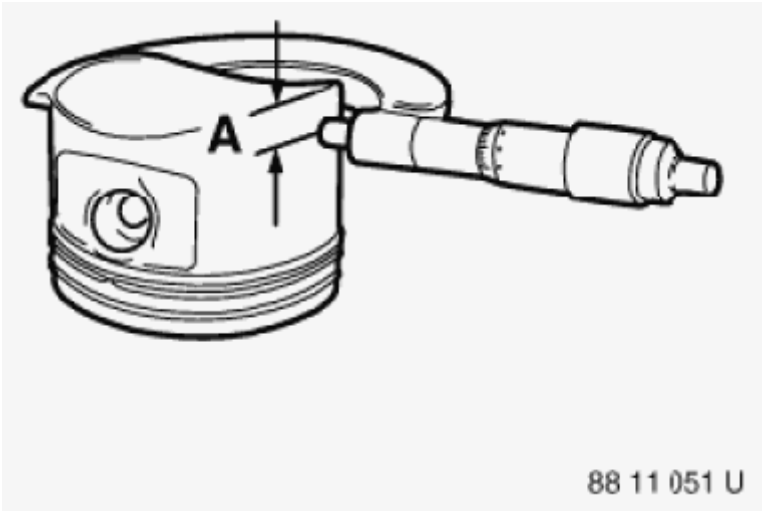


Fig. 14: Checking Piston Diameter Is Measured Using Micrometer
Courtesy of BMW OF NORTH AMERICA, INC.

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The piston diameter, when subtracted from the cylinder bore equals the cylinder wall to piston clearance. If the clearance measurement obtained is not correct, re-check your readings.

Piston Ring Measurements

There are some important specifications to check when installing piston rings. One of the measurements in axial clearance. Axial clearance is the distance between the piston ring and ring land. This prevents the rings from binding in the ring land at operating temperature. Axial clearance is measured using a feeler gauge.

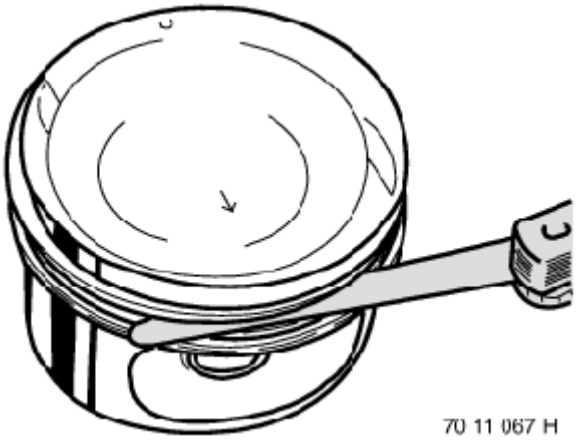


Fig. 15: Checking Piston Ring Of Feeler Gauge
Courtesy of BMW OF NORTH AMERICA, INC.

Also the piston ring end gap has to be checked. This measurement is checked using a feeler gauge.

This clearance is critical in order to prevent the end gaps from contacting each other when the engine is at operating temp.

When installing the piston rings, always stagger the end gaps as per the repair instructions.

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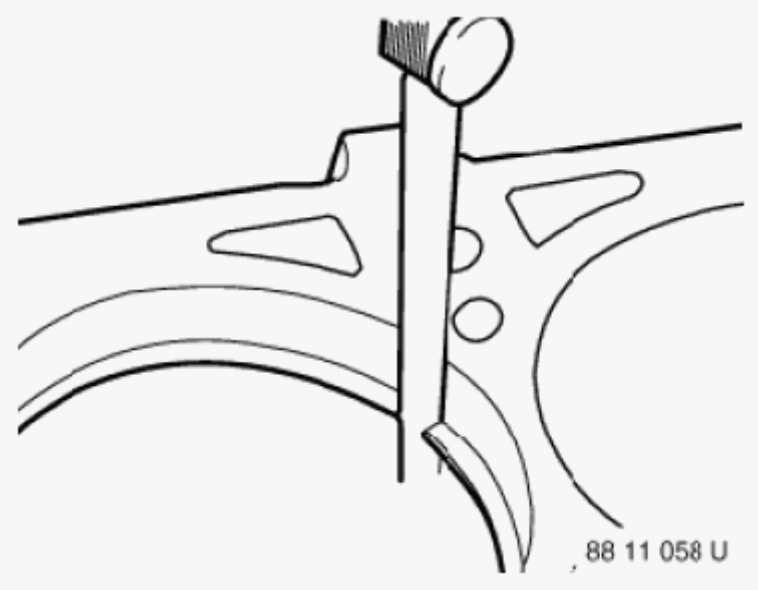


Fig. 16: Identifying Piston Ring End Gap
Courtesy of BMW OF NORTH AMERICA, INC.

Cylinder Bore

In order for the cylinder bore to be considered acceptable, it must not be excessively tapered or out-of-round. Once the cylinder has been checked for obvious damage and the surface finish is OK, the integrity of the bores must be verified. If cylinder wear is suspected, it must be checked using the proper cylinder bore gauge.

Each cylinder must be checked at three position in the bore - top, middle and bottom. Also there must be two opposing dimensions that should be checked. The difference between the top and bottom measurements will indicate the taper of the bore. The opposing dimensions will indicate the out-of-round specification.

If these measurements are out of specification, the cylinder bore must be re-finished or overbored. New pistons and rings must be fitted as well.

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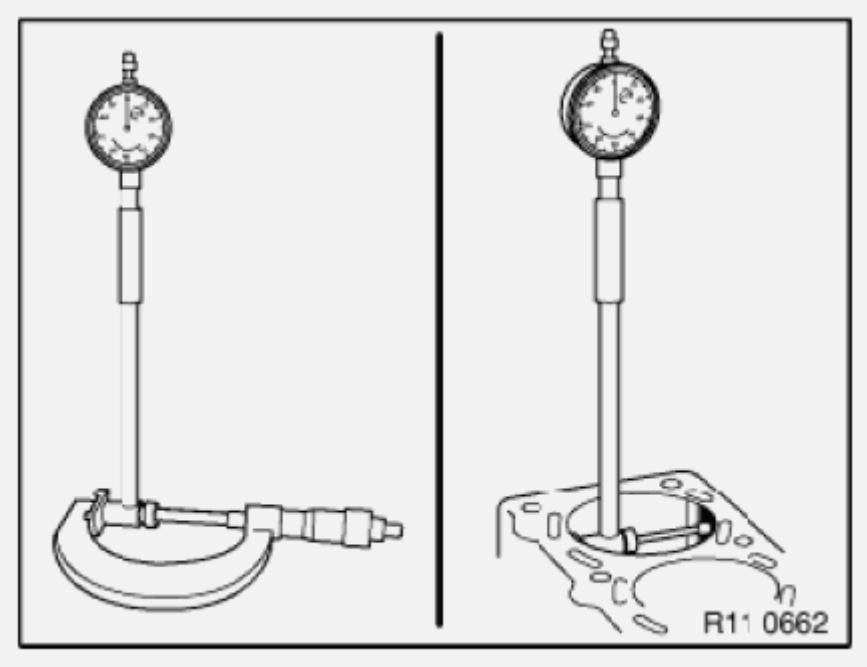


Fig. 17: Measuring Proper Cylinder Bore Gauge
Courtesy of BMW OF NORTH AMERICA, INC.

METRIC SYSTEM

All BMW specifications are metric. Therefore, a thorough knowledge of those areas on the metric system which apply to BMW vehicles is vital to a BMW Service Technician.

The unit of length, and the basis for all other metric units of measurement is the meter. The meter (1 meter), as a point of reference, is slightly longer that a yard (39.37 inches).

The divisions of a meter are hundredths and thousandths. One hundredth of a meter is called a centimeter, and is equal to .3937 inch or about half the diameter of a nickel.

One thousandth of a meter is called a millimeter. The small marks between the centimeter increments are each one millimeter, or one tenth of a centimeter. And as a point of reference, a standard paper clip is about one millimeter thick.

Metric System Denominations

Throughout the metric system, common to all units of measurement, are prefixes which designate multiples or fractions of the unit.

For automotive applications, the most common prefixes are centi; designating one-hundredth; milli; for one thousandth and kilo-for one thousand.

There are letters uniformly used throughout the system to label the divisions or multiples of each unit of measurement. The letter "m" represents milli, "c' is for centi and "k" is for kilo. These are then combined with the letter representing the unit of measurement.

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For example, mm is millimeter, cm is centimeter and km is kilometer. The same applies to liter which is the unit of volume and gram which is the unit of weight.

One kilogram is equal to one thousand grams which is equal to 2.2 pounds.

All metric measurements are directly related. For example, one thousand cubic centimeters, or 10cm x 10cm x 10cm of water weighs one kilogram. The volume of those one thousand cc's is one liter.

Metric Reference Chart

METRIC REFERENCE CHART

Weight			
1 kilogram	= 1 kg	= 1000 grams	= 1000 g
1 hectogram	= 1 hg	= 100 grams	= 100 g
1 dekagram	= 1 dag	= 10 grams	= 10 g
1 gram	= 1g		
1 decigram	= 1dg	= .1 gram	= 0.1 g
1 centigram	= 1 cg	= 0.01 gram	= 0.01 g
1 milligram	= 1 mg	= 0.001 gram	= 0.001 g
Length			
1 kilometer	= 1 km	= 1000 meters	= 1000 m
1 hectometer	= 1 hm	= 100 meters	= 100 m
1 dekameter	= 1 dam	= 10 meters	= 10 m
1 meter	= 1m		
1 decimeter	= 1dm	= .1 meter	= .1 m
1 centimeter	= 1 cm	= 0.01 meter	= 0.01 m
1 millimeter	= 1 mm	= 0.001 meter	= 0.001 m
Volume			
1 kiloliter	= 1 kl	= 1000 liters	= 1000 l
1 hectoliter	= 1 hl	= 100 liters	= 100 l
1 dekaliter	= 1 dal	= 10 liters	= 10 l
1 liter	= 1l		
1 deciliter	= 1dl	= .1 liter	= .1 l
1 centiliter	= 1 cl	= 0.01 liter	= 0.01 l
1 milliliter	= 1 ml	= 0.001 liter	= 0.001 l

Metric System Conversion Charts

METRIC SYSTEM CONVERSION CHARTS

Linear Measure to Metric	Linear Measure (Metric) to English
1 inch = 2.54 cm	1 mm = 0.03937 inch
12 inches = 1 foot = 30.48 cm	1 cm = 0.39 inch
3 feet = 1 yard = 0.91 m	1 m = 39.37 inch

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5.5 yards = 1 rod = 5.03 m	1 km = 0.62 miles
5280 feet = 1 mile = 1.61 km	
Square Measure to Metric	**Square Measure (Metric) to English**
1 in^2 = 6.45 cm^2	1 mm2 = 0.002 in^2
144 in^2 = 1 ft^2 = 0.09 m^2	1 cm^2 = 0.16 in^2
9 ft^2 = 1 yd^2 = 0.84 m^2	1 m^2 = 1549 in^2
640 acres = 1mi^2 = 2.59 km^2	1 km^2 = 0.39 mi^2 = 247.10 acres
Cubic Measure to Metric	**Cubic Measure (Metric) to English**
1 in^3 = 16.39 cm^3	1 mm^3 = 0.000061 in^3
1728 in^3 = 1 yd^3 = 0.76 m^3	1 cm^3 = 0.061 in^3
27ft^3 = 1 yd^3 = 0.76 m^3	1 m^3 = 35.32 ft^3
	1 km^3 = 0.24 mi^3
Liquid Measure to Metric	**Liquid Measure (Metric) to English**
1.81 in^3 = 1 fluid oz. = 30 ml	1 ml = 0.03 fluid oz = 0.061 in^3
1 pint = 0.47 l	1000 cm^3 = 1 l = 61.02 in^3 = 1.06 qt
57.75 in^3 = 1 quart = 0.95 l	1 ft^3 water = 62.5 lb
231 in^3 = 1 gal = 3.79 l = 0.0038 m^3	
1 ft^3 = 7.48 gal = 28.35 l	
Weights to Metric	**Weight (Metric) to English**
1 0z = 28.35 g	1 g = 0.035 oz
1 lb = 453.59 g	1 kg = 2.20 lb
1 lb = 0.45 kg	1 metric ton = 1000 kg = 1.102 tons = 2205 lb
1 ton = .91 metric ton	
Temperature to Metric	**Temperature to Fahrenheit**
F = 9/5C +32	C = 5/9 (F-32)

Pressure Conversion Chart

PRESSURE CONVERSION CHART

Bar	kPa	psi	in.Hg.
6.0	600	87.0	
5.9	590	85.5	
5.8	580	84.0	
5.7	570	82.5	
5.6	560	81.0	
5.5	550	79.0	
5.4	540	78.5	
5.3	530	77.0	
5.2	520	75.5	

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5.1	510	73.5	
5.0	500	72.5	
4.9	490	71.0	
4.8	480	69.5	
4.7	470	68.0	
4.6	460	66.5	
4.5	450	65.5	
4.4	440	64.0	
4.3	430	62.5	
4.2	420	61.0	
4.1	410	59.5	
4.0	400	58.0	
3.9	390	56.5	
3.8	380	55.0	
3.7	370	53.5	
3.6	360	52.0	
3.5	350	51.0	
3.4	340	49.5	
3.3	330	48.0	
3.2	320	46.5	
3.1	310	45.0	
3.0	300	43.5	
2.9	290	42.0	
2.8	280	40.5	
2.7	270	39.0	
2.6	260	37.5	
2.5	250	36.5	
2.4	240	35.0	
2.3	230	33.5	
2.2	220	32.0	
2.1	210	30.5	
2.0	200	29.0	
1.9	190	27.5	
1.8	180	26.0	
1.7	170	24.5	
1.6	160	23.0	
1.5	150	22.0	
1.4	140	20.5	
1.3	130	19.0	
1.2	120	17.5	35.90
1.1	110	16.0	32.91
1.0			

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	100	14.5	29.92
0.9	90	13.0	26.93
0.8	80	11.5	23.94
0.7	70	10.0	20.94
0.6	60	9.0	17.95
0.5	50	7.5	14.96
0.4	40	6.0	11.97
0.3	30	4.5	8.98
0.2	20	3.0	5.98
0.1	10	1.5	2.99
0.0	0	0.0	0.0

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GENERAL INFORMATION

Passive Safety System

INTRODUCTION TO PASSIVE SAFETY

Model: All with Passive Safety Systems

Production: All

INTRODUCTION

History of BMW Safety Systems

BMW has a long history of being at the forefront of passenger safety technology. Before the introduction of airbag systems, seatbelts provided the primary restraint for protection of the occupants during an impact. Three point seatbelts provided the greatest level of occupant safety at that time.

Many other safety innovations were already is use before airbag systems were introduced. Energy absorbing body structures with "crumple zones" uphold the integrity of the passenger safety cell. Some of the other features are "breakaway" engine and transmission mountings, collapsible steering column, door mounted impact beams and a hood that is designed to fold on impact rather than penetrate the windshield.

There are many other safety innovations which are transparent to the driver, but are crucial to providing a safe environment for the vehicle occupants.



Fig. 1: Identifying History Of BMW Safety Systems
Courtesy of BMW OF NORTH AMERICA, INC.

Since 1986, when BMW first introduced the Supplementary Restraint System (SRS) to their US model line, BMW has continuously improved the level of occupant protection.

The driver's side airbag was standard on all US production models from 1986. Later, the passenger side airbag became standard on the 1992 models.

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These first systems were made by Cipro and Siemens and consisted of mechanical crash sensors located on the inner fenders. An airbag was mounted on the steering wheel and a control unit containing a mechanical safing sensor was located in the passenger compartment. The vehicle wiring harness was modified to accommodate these systems.

Later versions included a standard passenger side airbag from 9/91 production. These system were designated Siemens 2C. These systems were replaced by ZAE.

Beginning with the 1994 model year, the ZAE system was introduced on US models. The E31, E34, E36 and E38 all used the ZAE I system. ZAE I used crash sensors which were integral to the control unit and eliminated the mechanical fender mounted sensors on previous models. Also the passenger seat occupancy detection system (SBE) was introduced at this time. ZAE 2 was introduced later and now included the detection of rear impacts.

The Multiple Restraint System (MRS) addressed the need for side impact protection. Starting with the E39, door mounted side airbags were added on the front driver and passenger side. The MRS system also utilized side impact sensors which were externally mounted near the b-pillar. In combination with the MRS control unit, the side impact sensors allowed the MRS system to differentiate between front, rear and side impacts.



Fig. 2: Identifying Multiple Restraint (MRS) System
Courtesy of BMW OF NORTH AMERICA, INC.

Subsequent versions of MRS introduced new technology and enhancements to MRS I. MRSII utilized the new head protection system (HPS) and also the new Safety Battery Terminal.

MRS III has new features including the 2-stage airbag and the rear head protection system. Also, the MRS III control unit was now connected to the K-bus for diagnosis, improved crash signalling and for the fuel pump cut-off feature.

The only changes to MRS IV were improved software and triggering algorithms. It was introduced in 4/01 production on the E46 and E53 and later phased into E38 and E39.

The latest version of MRS is the MRS4RD system. The "RD" designation indicates a redesign over the previous MRSIV system. Numerous modifications include additional crash sensors mounted in the front of the vehicle and pressure sensors mounted in the front doors. Also, the new passenger seat occupancy detection system (OC-3) which is capable of determining the approximate size of the occupant based on weight distribution. To accommodate these changes, the MRS control unit was increased to 75 pins from the previous 50 pin control

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unit.



Fig. 3: Identifying Latest Version Of MRS MRS4RD System
Courtesy of BMW OF NORTH AMERICA, INC.

The introduction of the E65 brought about a new era in passive safety technology.

The new passive safety system on the E65 was a departure from the MRS philosophy. Instead of having the triggering electronics located centrally in the MRS module. The new method was to decentralize the triggering electronics by locating the trigger circuits in the satellite sensors which are closer to potential impact points.

The new system is referred to as the Intelligent Safety and Information System (ISIS). ISIS consists of a series of satellites connected by an optical bus network called ***byte-flight.*** The ***byteflight*** network was specifically designed a high speed network for use on safety related systems.

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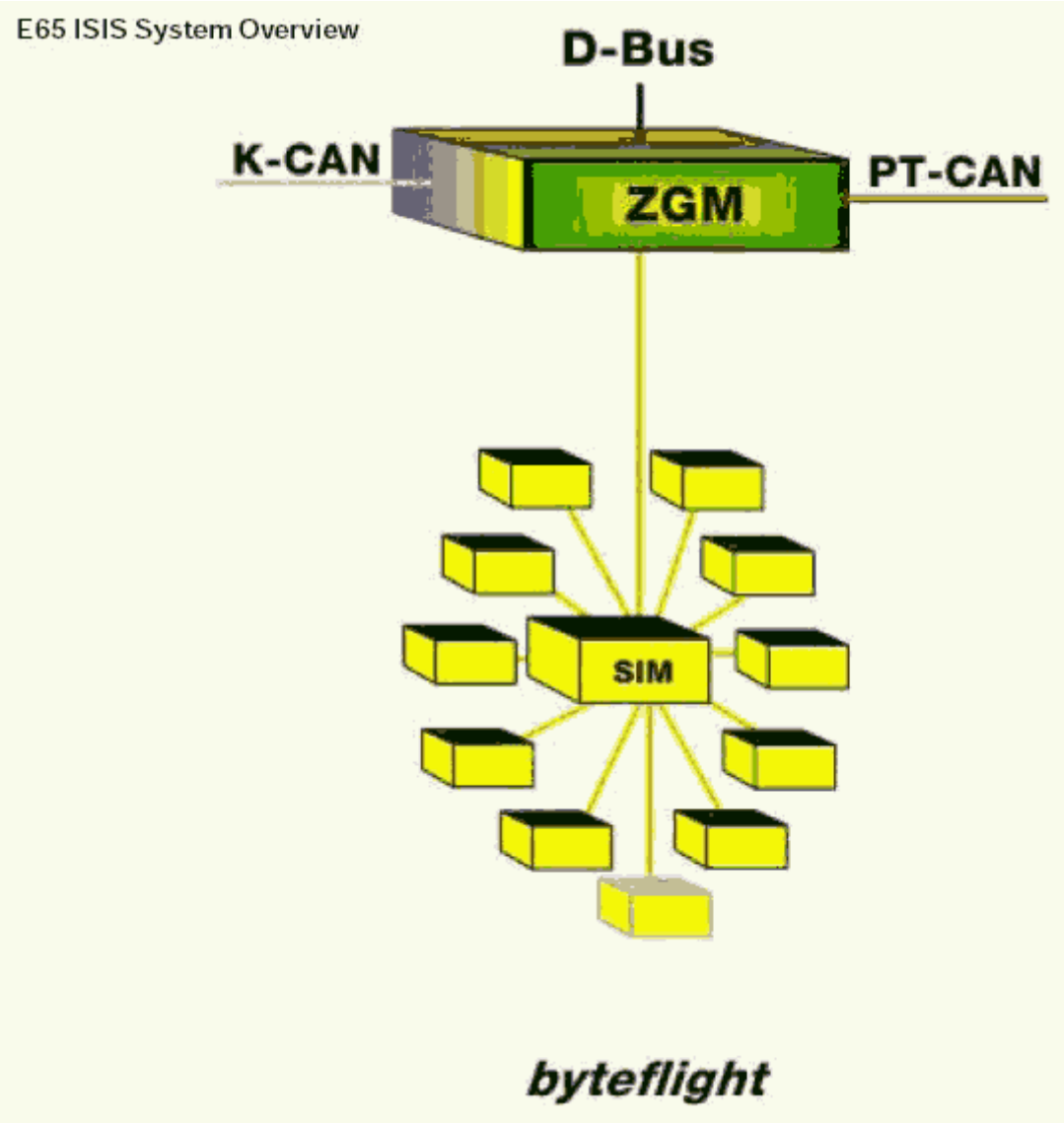


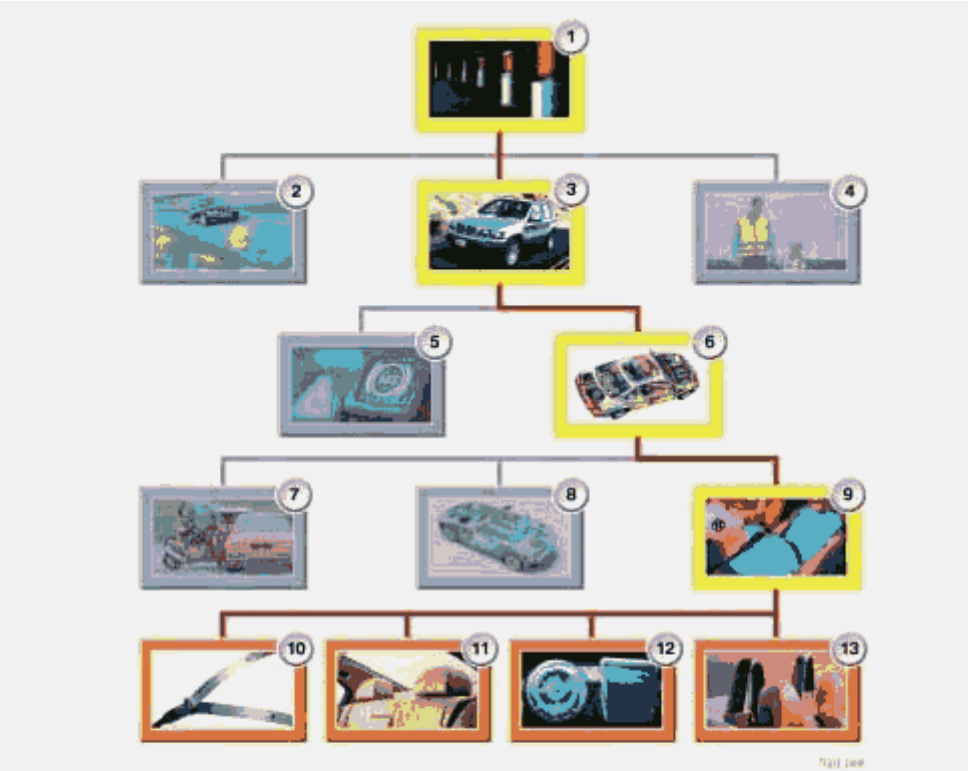
Fig. 4: Identifying E65 (ISIS) System Overview
Courtesy of BMW OF NORTH AMERICA, INC.

The ISIS concept was also adopted on the new Advanced Safety Electronic (ASE) systems which was introduced on the E85. The ASE system is also used on the new E60, E63 and E64 vehicles. ASE is similar in design to ISIS, and uses the byteflight fiber optic network. However the total number of satellites is reduced as compared to ISIS.

Fully Integrated Road Safety Technology (F.I.R.S.T.)

The BMW FIRST safety concept incorporates the environmental considerations (traffic, road conditions), the vehicle (active and passive safety), and the people involved. During the design process, all of these things are taken into to consideration to create a safe environment for the passengers as well as considering the durability of the vehicle during an impact to comply with federal law and insurance regulations.

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Index	Explanation	Index	Explanation
1	Traffic Conditions	8	Vehicle Protection
2	Environment	9	Occupant Protection
3	Vehicle	10	Seat Belt
4	People	11	Head Restraints
5	Active Safety	12	Airbag
6	Passive Safety	13	Rollover Protection
7	Partner Protection		

Fig. 5: Identifying Fully Integrated Road Safety Technology (F.I.R.S.T.) System
Courtesy of BMW OF NORTH AMERICA, INC.

F.I.R.S.T. is the cornerstone behind BMW's safety philosophy. This technology consists of *active* and *passive* safety features designed to help the driver avoid accidents as well as protect the occupants in the event of an unavoidable accident.

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Fig. 6: Identifying F.I.R.S.T. Cornerstone Behind BMW'S Safety Philosophy
Courtesy of BMW OF NORTH AMERICA, INC.

Active Safety features are designed to help the driver avoid accidents. In other words these features allow the driver to actively avoid potentially dangerous situations. These features consist of consist of a responsive engine, stable suspension, precise steering and excellent all around vision. Systems such as Dynamic Stability Control (DSC) and ABS also help the driver retain precise control of the vehicle.

Traffic and adverse environmental conditions can be offset by systems such as RLS (rain sensing wiper control), X-Drive, climate control with mist sensor and driving lights etc.

Other features which are "transparent" to the driver include the multi-function steering wheel which allows the driver to control the cruise control and audio systems while still focusing on the road. The seating position and location of switches and controls are also taken into consideration during the design process. The new HUD also allows the driver to access important driving information while maintaining concentration.

Passive Safety features provide vehicle occupant protection when an accident cannot be avoided. Today's BMW Passive Safety systems consist of the following features:

- Energy absorbing body structures
- Seatbelts with Automatic tensioners and force limiters
- Dual front airbags with 2-stage deployment
- Head Protection Systems (front as well as rear on some models)
- Side Impact Airbags (standard) and Rear Side Airbags (optional
- Active Knee Protection Airbags (On some models)
- Battery Safety Terminal
- Active Head Restraints (on some models)
- Rollover Protection on Convertibles (E36, E46 and E64) and fixed rollover bars on the Z3 and Z8 and Z4.

Energy Absorbing Body Structures

One of the first considerations in designing a safe vehicle is the body and chassis design. It is vital to protect the passenger in the event of an impact. This is accomplished by maintaining the integrity of the "passenger cell" during an accident.

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The main consideration during an impact is to avoid transferring crash energy to the vehicle occupants. By adding energy absorbing crash elements to the vehicle, this energy transfer is reduced considerably.

Passenger Safety Cell E60



Fig. 7: Identifying Passenger Safety Cell E60 And Energy Absorbing Body Structures System
Courtesy of BMW OF NORTH AMERICA, INC.

In addition to having energy absorbing structures in the front and rear of the vehicle, there are also side impact protection structures in the doors. These structures not only help prevent impact intrusion into the safety cell, but also allow the door to be opened after most impacts.

Engine Support Arm showing "Crumple Zone"



Fig. 8: Identifying Engine Support Arm System (1 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 9: Identifying Engine Support Arm System (2 Of 2)
Courtesy of BMW OF NORTH AMERICA, INC.

SMART Airbags

Front driver and passenger airbags have been in use with single stage activation since 1986. Once an impact is detected, the airbags are triggered with one specific level of deployment force.

From 1999, BMW developed the SMART airbag which is designed to deploy in 2 stages.

There are 4 triggering thresholds which are dependent upon the severity of impact detected, the status of the seatbelts and whether the passenger seat is occupied.

Driver's side SMART Airbag (Rear view)



Fig. 10: Identifying Driver Side SMART Airbag System
Courtesy of BMW OF NORTH AMERICA, INC.

Passenger side SMART Airbag (Rear view)

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Fig. 11: Identifying Passenger Side SMART Airbag System
Courtesy of BMW OF NORTH AMERICA, INC.

The two stage airbags are used for both the front driver and front passenger which allows for a softer cushioning effect when the bags are triggered at lighter impacts.

The 2-stage airbags also employ the "cold-gas" inflation method which differs from the previous single stage airbags. The gas generators contain an inert gas mixture which is released when the airbags are triggered.

Also, the cold gas inflation method was incorporated into the side airbags and the ITS assemblies.

Side Airbags

Since the introduction of MRS, side airbags have been standard equipment. Rear airbags on some vehicles are part of an option package.

Side airbags are designed to prevent injury to the thorax (chest) region of the occupants.

Side Airbag with Inert Gas Inflation (Rear view)

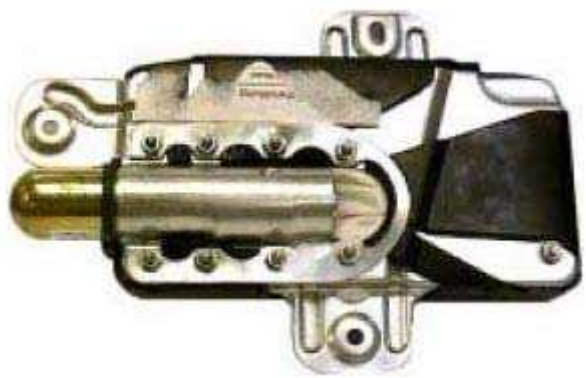


Fig. 12: Identifying Side Airbag With Inert Gas Inflation System
Courtesy of BMW OF NORTH AMERICA, INC.

Seatbelts

Of all of the safety innovations brought forth by the automotive industry, the safety belt is universally recognized as the single most effective safety device. Specifically, the 3-point safety belt provides passengers

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with safety as well as comfort.

The effectiveness of the 3-point seat belt depends upon the correct positioning of the safety belt on the body.

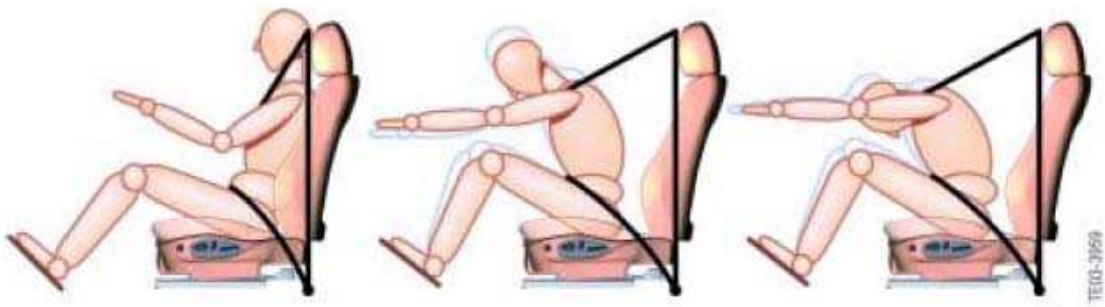


Fig. 13: Identifying Seat Belt Depends Correct Position Of Safety Belt On Body
Courtesy of BMW OF NORTH AMERICA, INC.

BMW safety belt systems use an upper anchor point which is height adjustable. In addition, the tensioning mechanisms allow the belt to remain relatively slack to increase comfort while driving.

The seat belt tensioning device is designed to remove slack in the seatbelt during an impact. This increases the effectiveness of the seatbelt and reduces the bio-mechanical load on the passenger.

There are 4 different belt tensioning systems which have been in use on BMW vehicles.

The 4 systems are as follows:

- Pyrotechnic automatic tensioners/end fitting tensioners
- Mechanical seat belt tensioners
- Pyrotechnic seat belt tensioners
- SGS (Seat Integrated Belt System)

More information on the seat belt tensioning systems will be covered in the forthcoming training modules.



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Fig. 14: Identifying Mechanical Seat Belt Tensioners
Courtesy of BMW OF NORTH AMERICA, INC.

Battery Safety Terminal

The Battery Safety Terminal (BST) is designed to minimize the risk of short circuits in severe accidents. The BST protects the B+ cable from the battery to the starter and generator by disconnecting the main connections via a pyrotechnic device.

The rest of the power distribution circuits are protected by various fuses etc. This allows those circuits to remain available for SOS calls, power window and lock operation.

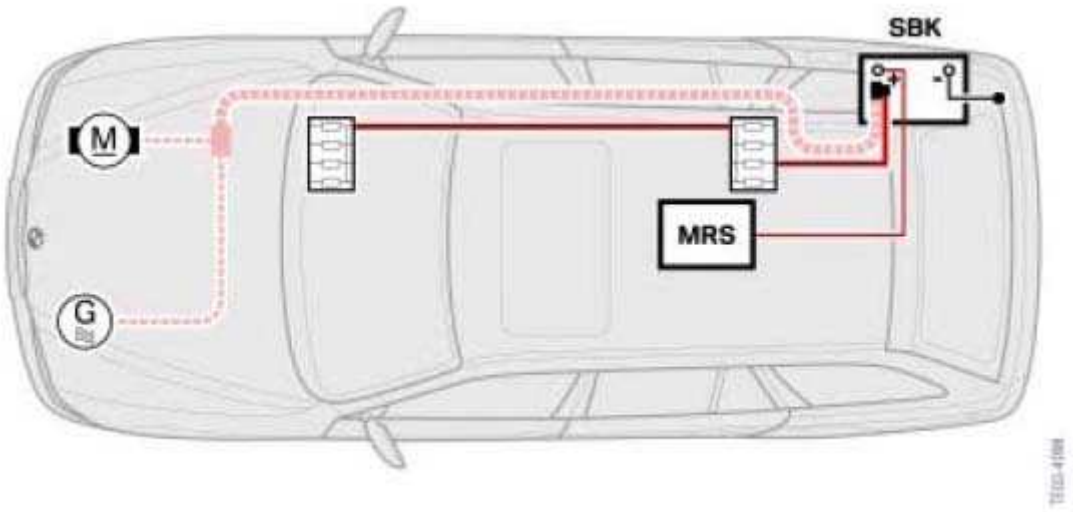


Fig. 15: Identifying Battery Safety Terminal
Courtesy of BMW OF NORTH AMERICA, INC.

The BST assembly is bolted to the positive battery terminal. It consists of a conventional battery terminal and a contact sleeve attached to the surface of the terminal. The sleeve houses an igniter pellet which contains a small amount of solid propellant.

Upon impact, the propellant is ignited which separates the battery cable from the positive terminal of the battery.

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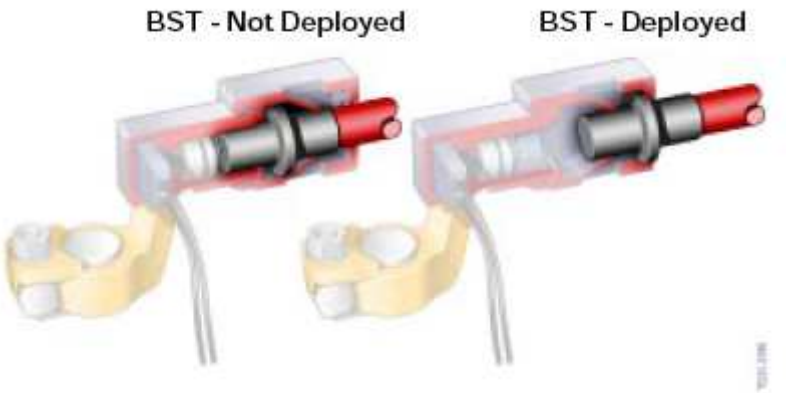


Fig. 16: Identifying BST - Not Deployed
Courtesy of BMW OF NORTH AMERICA, INC.

Once the BST is deployed, it must be replaced. Depending upon application, the entire B+ cable must be replaced or there are repair kits available on some models.

Head Protection System

Head injuries account for a large portion of overall accident statistics. To address this statistic BMW added the Head Protection System to complement the side airbags already in use. HPS was developed by BMW to offer increased occupant protection during a side impact and lower the instance of head injuries.

The original HPS, introduced on the E38, consisted of an Inflatable Tubular Structure (ITS) which was mounted in the headliner between the A and B pillars.

The ITS assembly consists of a woven fabric tube containing an inner tube of polyurethane. A gas generator is used to inflate the ITS assembly. When deployed, the ITS increases in diameter and overall length decreases by approximately 100mm. This causes the ITS assembly to emerge from the headliner trim.

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Fig. 17: Identifying Head Protection System
Courtesy of BMW OF NORTH AMERICA, INC.

The ITS is designed as a sealed unit, unlike an airbag which deflates immediately. The ITS assembly deflates as the gas cools over a period of time, which allows the ITS to remain inflated in the event of secondary impacts.



Fig. 18: Identifying ITS Assembly Deflates Gas Cools
Courtesy of BMW OF NORTH AMERICA, INC.

Rear HPS was introduced later as part of a special rear side airbag option on the E38 and E39. The rear HPS does not use a conventional ITS assembly, but rather an "cushion" type airbag located in the C-pillar. A vehicle with rear HPS can be identified by observing "HPS" in the C-pillar cover.

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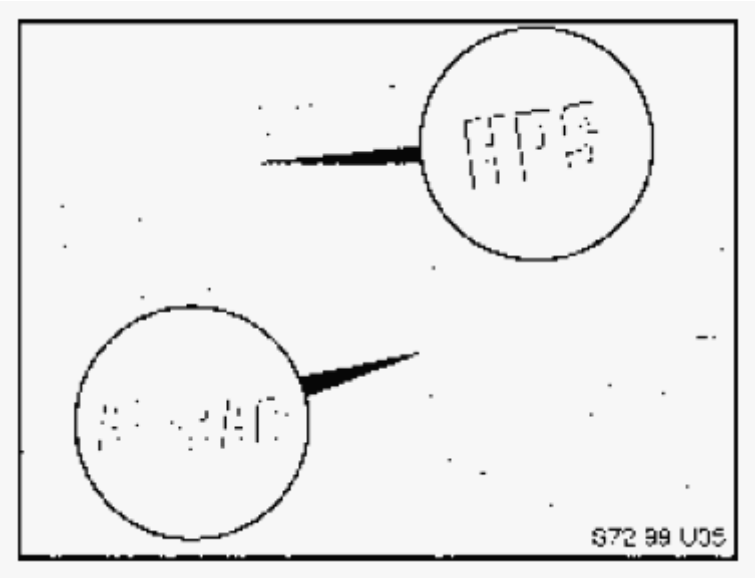


Fig. 19: Identifying Vehicle With Rear HPS Identified By Observing In C-Pillar Cover
Courtesy of BMW OF NORTH AMERICA, INC.

The Head Protection System was further developed to increase the level of occupant protection. The Advanced Head Protection System was introduced on the E65. It consists of a modified ITS which is now extended by a curtain. There are 2 versions of AHPS available. The first, AHPS I, extends from the A-pillar to the B-pillar and protects the front passengers.

The second version, AHPS II, is part of an option for rear passenger head protection. The AHPS II extends for the A-pillar to the C-pillar to protect front and rear passengers simultaneously. The advantages of AHPS include protection from glass splinters and protruding objects as well as optimized coverage for occupants of all sizes.



Fig. 20: Identifying AHPS II And AHPS I Part
Courtesy of BMW OF NORTH AMERICA, INC.

Active Knee Protection

The Active Knee Protection consists of a knee airbag located on the front driver and passenger sides of the vehicle. The knee airbag prevent the driver from sliding under the seat belt during an impact. This effect is

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known as "submarining". This effect is counteracted by the knee airbag and initiates a controlled forward shift of the upper body.

This increases the effect of the seatbelt and the airbag.

The knee airbag is available on the E65, E85 and E63/64.

E65 Driver's Side Knee Airbag



Fig. 21: Identifying E65 Driver Side Knee Airbag System
Courtesy of BMW OF NORTH AMERICA, INC.

E65 Passenger Side Knee Airbag



Fig. 22: Identifying E65 Passenger Side Knee Airbag System
Courtesy of BMW OF NORTH AMERICA, INC.

Active Head Restraint System (AKS)

In a rear end collision, the risk for cervical vertebrae injuries (whiplash) is high. To prevent this, the objective would be to position the head as close as possible to the headrest. This prevents excessive rearward motion.

On the E65/E66 and E60, the basic seat option only allows for a fixed position between the backrest and head and eliminates the need for the AKS. However, on vehicles equipped with the multi-function seat option, the adjustability of the headrest and backrest allows for the possibility of a large gap between the headrest and the occupants head.

For this reason AKS was developed. The AKS is located in the backrest of the multifunction seat. It is deployed by a pyrotechnic device, similar to an airbag.

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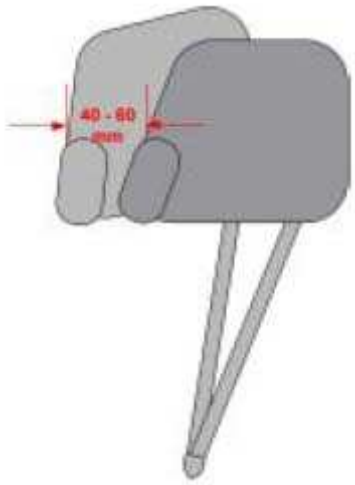


Fig. 23: Identifying Active Head Restraint (AKS) System
Courtesy of BMW OF NORTH AMERICA, INC.

Rollover Protection Systems

In order to protect the passengers of a convertible in the event of a rollover, BMW has developed the Rollover Protections System (RPS). Convertible models with RPS include the E36, E46 and E64. BMW roadsters use fixed steel rollover bars, these vehicle include the E52 (Z8), E36/7 (Z3), and the E85 (Z4).

The RPS consists of a set of automatically deployable rollbars which are triggered when the vehicle exceeds certain criteria. This criteria is based on the amount of tilt which is monitored by a rollover sensor.

When an impending rollover is detected, the rollover bars lock into place to provide the necessary head clearance to protect the occupants.

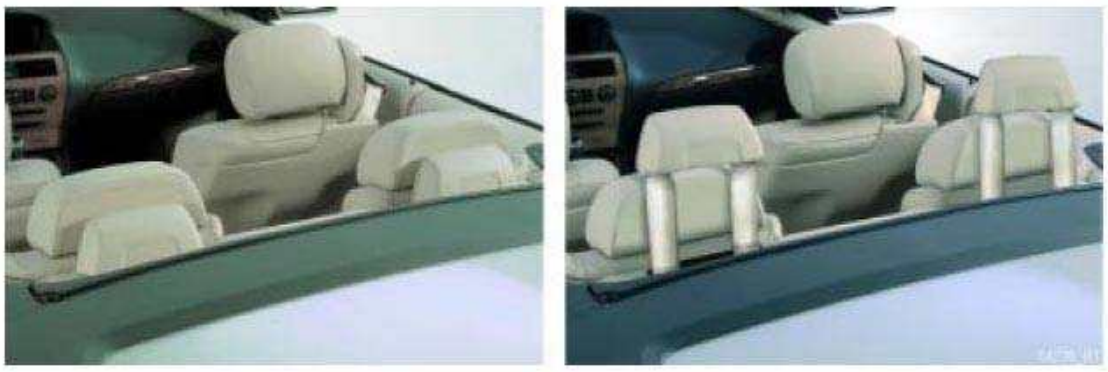


Fig. 24: Identifying Rollover Protection (RPS) Systems
Courtesy of BMW OF NORTH AMERICA, INC.

Also, the rollover bars can be deployed by the diagnostic equipment for testing. There is also a reset procedure for each model which is done manually. This allows the bars to be reset in the event of an erroneous deployment.

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Fig. 25: Identifying Rollover Bars
Courtesy of BMW OF NORTH AMERICA, INC.

Summary of BMW Passive Safety Systems

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	3 Series				Z4	5 Series				7 Series				6 Series		8 Series		SAV AWD	
	E30	E36	E46	E90/91	E85	E28	E34	E39	E60/E61	E23	E32	E38	E65/66	E24	E63/E64	E31	E52	E53	E83
Cipro	x					x				x				x					
Siemens 2A	x													x					
Siemens 2B		x					x				x					x			
Siemens 2C		x 9/93					x				x					x			
ZAE		x					x					x				x			
ZAE II		x					x					x				x			
MRS		x						x 3/96				x 3/96							
MRSII			x					x 9/97				x 5/97							
MRSIII			x 3/99					x 3/99				x 3/99					x	x	
MRSIV			x 4/01					x 8/01				x 8/01						x 4/01	
MRS 4RD																			x
MRS 5				x															
ISIS													x						
ASE					x				x						x				

Fig. 26: Identifying Summary Of BMW Passive Safety Systems
Courtesy of BMW OF NORTH AMERICA, INC.

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2004-05 GENERAL INFORMATION

Safety Systems - Overview - X3

SAFETY SYSTEMS

HISTORY OF MULTIPLE RESTRAINT SYSTEMS

Multiple restraint systems have a long history at BMW. The first multiple restraint system, the MRS 1, was introduced as long ago as 1996.

MRS 1

With the introduction of the side airbags in March 1996, the MRS 1 replaced the ZAE/BAE control unit used until then on the E38/E39. When the side airbags were introduced, two MRSA external sensors were also added for improved side-impact detection. Because of the required number of inputs/outputs, the number of pins had to be increased from 30 to 50.

MRS 2

The addition of the ITS head airbag and rear side airbags on the E38 in May 1997 saw the introduction of the MRS2. On the E39, the MRS2 was first used when the ITS head airbag was fitted in September 1997. September 1998 saw the introduction of the 2-stage front-passenger airbag (SMART airbag).

MRS 3

The MRS3 system was launched with the arrival of the 2-stage driver's airbag in March 1999. Another innovation on the MRS3 was its connection with the K-bus. The previous MRS systems had been hooked up to the diagnostic bus. The exception in that regard was the E36/7 (Z3). Since the Z3 has no K-bus, the MRS3 on the Z3 remained connected to the diagnostic bus.

MRS 4

The changes on the MRS4 as compared with the MRS3 consisted of a modified processor and new software for calculating the restraint system triggering algorithm. The MRS4 was first used in April 2001 with the launch of the MINI as well as on the E46 and E53. The E38 and E39 models were fitted with the MRS4 for the first time in August 2001.

MRS4RD

The multiple restraint system 4 redesign MRS4RD is a development of the MRS4 on the E46. The MRS4RD has had its interfaces expanded to 75 pins.

The job of the MRS4RD is to detect accident scenarios that are critical for the vehicle occupants and to selectively activate the necessary restraint systems according to the severity of the crash.

The MRS4RD has been further optimized and equipped with the following sensors:

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- Up-front sensors
- Door-compression sensors
- B-pillar satellites

The job of the up-front sensors is to detect frontal impacts. This allows the restraint systems such as seatbelt tensioners and airbags to be activated.

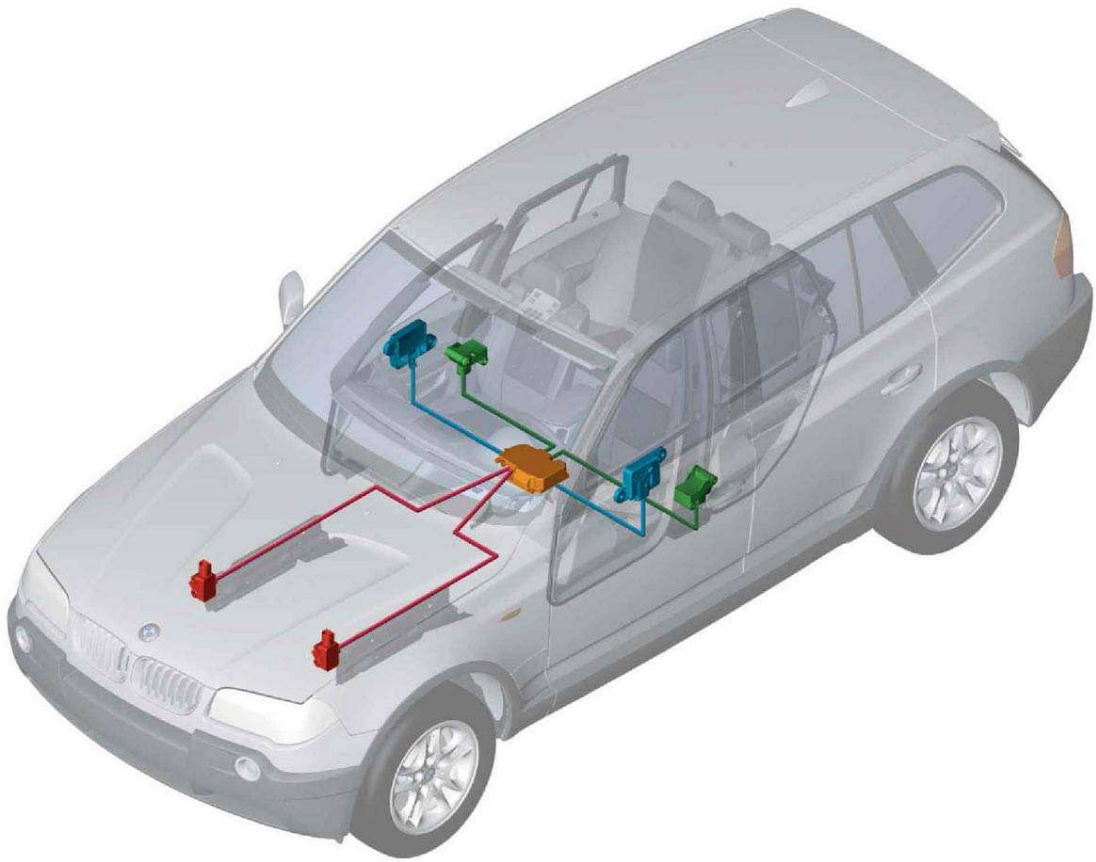
The job of the door-compression sensors is to detect side impacts The MRS4 satellites (MRSA) under the front seats have been moved to the B-pillars. The B-pillar satellites contain acceleration sensors for linear and lateral acceleration.

The MRS4RD performs a self-diagnosis and monitors all input and output signals. Any faults detected are stored in a non-volatile memory and indicated to the driver by the airbag warning lamp (AWL).

Communication with other control units in the vehicle's network of systems takes place via the K-bus.

The MRS4RD can be programmed/encoded via the K-bus.

MRS4RD Equipped E83

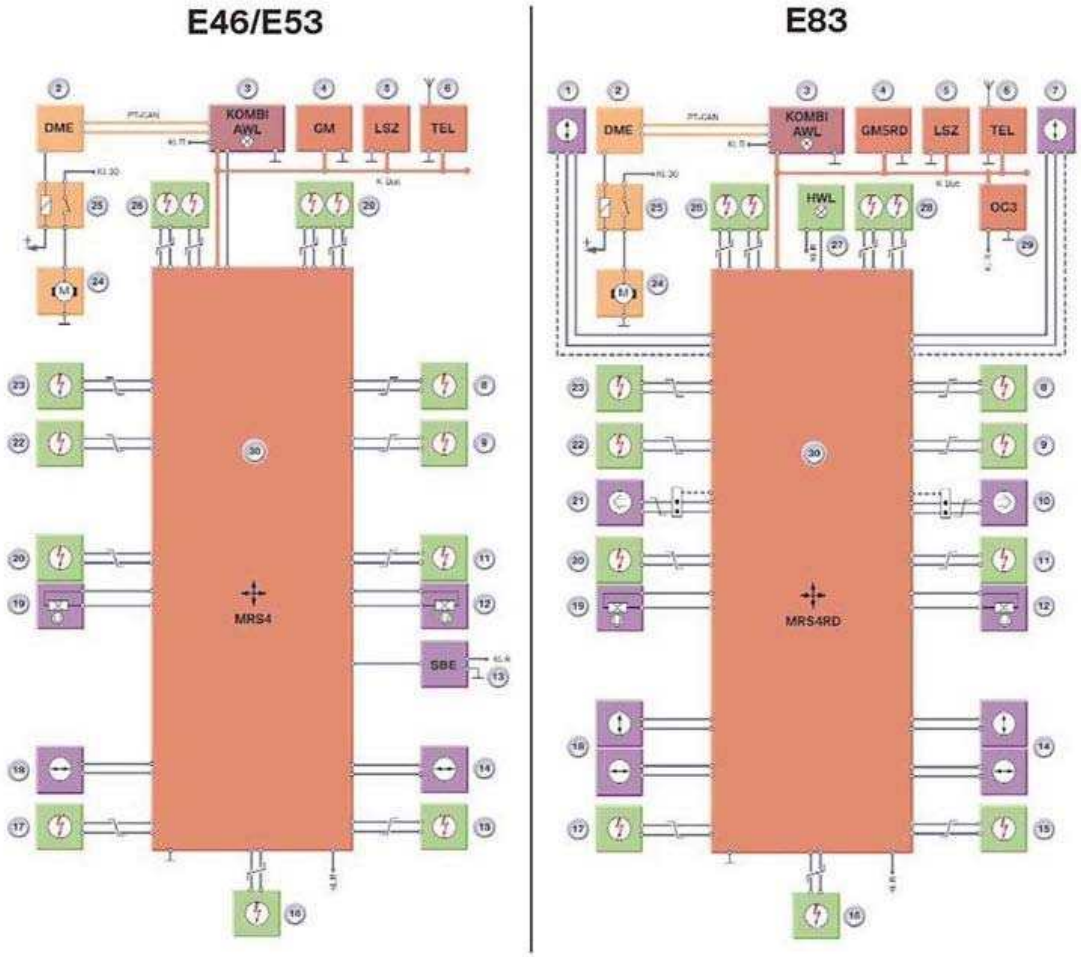


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Fig. 1: Identifying MRS4RD Equipped E83
Courtesy of BMW OF NORTH AMERICA, INC.

Comparison E46/E53 MRS W/E83 MRS4RD



1. Up-front Sensor, Left (E83)	11. Seat-belt tensioner, Right	21. Door Pressure Sensor, L (E83)
2. DME	12. Seat Belt Switch, Right	22. Side Airbag, LF
3. Instrument Cluster	13. Seat Occupation Sensor	23. ITS, Left (E83 Curtain Airbag)
4. GM5 (E83 GM5RD)	14. B-Pillar Satellite, Right (E83)	24. Electric Fuel Pump
5. LSZ	15. Side Airbag, RR	25. Fuel Pump Relay
6. Telephone	16. BST	26. Driver Airbag
7. Up-front Sensor, Right (E83)	17. Side Airbag, LR	27. Airbag Indicator Lamp (E83)
8. ITS, Right (E83 Curtain Airbag)	18. B-Pillar Satellite, Left (E83)	28. Passenger Airbag
9. Side Airbag, RF	19. Seat Belt Switch, Left	29. OC3 Mat (E83)
10. Door Pressure Sensor, R (E83)	20. Seat-belt Tensioner, Left	30. MRS Control Unit

Grayed Items X3 only

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Fig. 2: Comparison E46/E53 MRS W/E83 MRS4RD Circuit Diagram

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Courtesy of BMW OF NORTH AMERICA, INC.

SYSTEM COMPONENTS

The MRS4RD multiple restraint system consists of the following components:

- MRS4RD control unit
- Sensors and switches
- Actuators

MRS4RD Control Unit

The number of pins on the MRS4RD control unit has been increased from 50 (MRS4) to 75 because of the greater number of interfaces.

The MRS4RD control unit is located centrally in the vehicle on the transmission tunnel. Integrated in the MRS4RD control unit are two acceleration sensors set right-angles to one another. The linear acceleration sensor (X-axis) is positioned at 0 degrees to the vehicle's longitudinal axis, and the lateral acceleration sensor (Y-axis) at 90 degrees to that axis.

All acceleration sensors sense acceleration in two directions, i.e. they register both positive and negative acceleration. The polarity of the acceleration signals depends on the direction of impact. That means it is possible to distinguish between a front or rear impact and between a left or right side impact.

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Fig. 3: Identifying MRS4RD Control Unit
Courtesy of BMW OF NORTH AMERICA, INC.

Sensors

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The MRS4RD multiple restraint system has more sensors than its predecessor system.

They include the following sensors:

- Up-front sensors
- Door-compression sensors
- B-pillar satellites with lateral and linear acceleration sensors

Up-Front Sensors

The job of the up-front sensors is to detect frontal impacts. The up-front sensors are located in the front end above the longitudinal subframe members. The up-front sensors provide the MRS control unit with the initial information on the progression and severity of the impact.

An up-front sensor consists of an acceleration sensor for detecting deceleration, a signal converter and a microprocessor for data transmission.

The up-front sensors are supplied with power via a current-signal interface. The up-front sensors are supplied with a current of 5 - 10 mA. When a data message is transmitted, the level jumps vertically by 20 mA.

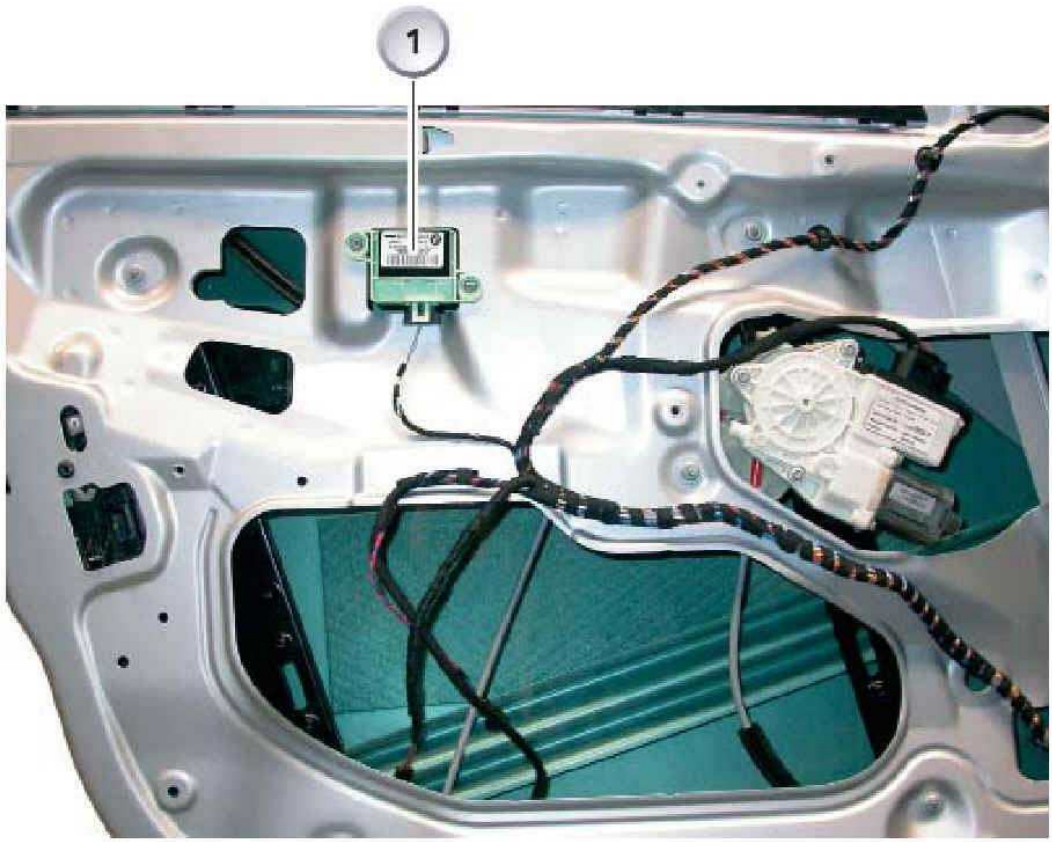
The advantage of the current-signal interface is its constant supply of current which prevents corruption of the signal. A change of resistance in the lead does not affect the signal.

A power supply with a voltage signal would be corrupted by changes in resistance in the lead. The signal could equally be corrupted by EMC interference from other leads.

Door Pressure Sensors

The function of the door pressure sensors (1) is to provide supplementary detection of side impacts in addition to the information supplied by the lateral acceleration sensors in the B-pillar satellites and the MRS4RD control unit. The door pressure sensors are located on the inner door panel and measure the pressure inside the door.

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Fig. 4: Identifying Door Pressure Sensors
Courtesy of BMW OF NORTH AMERICA, INC.

In the event of a side impact, the outer door panel may be pushed inwards, thus compressing the space inside the door and increasing the pressure. That pressure increase is detected by the door pressure sensors. At the same time, the side impact is detected by the acceleration sensors in the B-pillar satellite. The B-pillar satellite then also transmits a data message. The MRS4RD control unit in the center of the vehicle processes the two signals and is able to trigger the restraint systems on the basis of the information provided.

B-Pillar Satellites

The two MRSA modules (multiple restraint system external satellites) which were previously positioned under the seats, have been replaced by B-pillar satellites. Each B-pillar satellite consists of a lateral acceleration sensor and a linear acceleration sensor.

As with the up-front sensors, signal transmission is cyclic. The B-pillar satellites detect side, front and rear impacts.

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The left and right B-pillar satellites are identical.



Fig. 5: Identifying B-Pillar Satellites
Courtesy of BMW OF NORTH AMERICA, INC.

Seat Occupancy Detector (OC-3 Mat)

Because of the legal situation in the USA, the presence of a child seat for a child up to one year old must be automatically detected and the passenger airbags then deactivated. The OC3 mat detects a child seat that conforms to the relevant standard (NHTSA FMVSS 208) by virtue of the pattern of the impression it makes on the seat and deactivates the passenger airbags.

A straightforward seat occupancy detector recognizes a certain weight as proof that the seat is occupied. In order to meet legislative requirements, the seat occupancy detector (SBE) has been developed into an intelligent occupant classifier (OC). This was achieved by means of the following measures:

- By a larger number of sensor elements
- By sensing a larger area of the seat
- By an intelligent electronic analyzer

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Fig. 6: Identifying OC3 Mat
Courtesy of BMW OF NORTH AMERICA, INC.

OC3 Mat

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Fig. 7: Identifying Convention Seat Occupancy Detector
Courtesy of BMW OF NORTH AMERICA, INC.

Convention Seat Occupancy Detector

The OC-3 mat is capable of distinguishing between a one-year-old child in a child's seat and a light person.

The OC-3 mat is integrated into the seat area of the passenger seat. The OC-3 mat consists of conductors with pressure-dependent resistor elements (FSR, or Force Sensitive Resistance elements). The conductors are

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connected to the electronic analyzer.

The FSR elements are wired in such a way that they can be sampled individually. When the mechanical load on a sensor element increases electrical resistance decreases and the measurement current changes accordingly.

By analyzing the signals from the individual sensors, the analyzer maps the occupancy of the seat surface and can identify the local concentrations of weight. The distances between the areas where pressure is applied and the concentrations of pressure reveal whether the seat is occupied by a person (A) or a child seat (B).

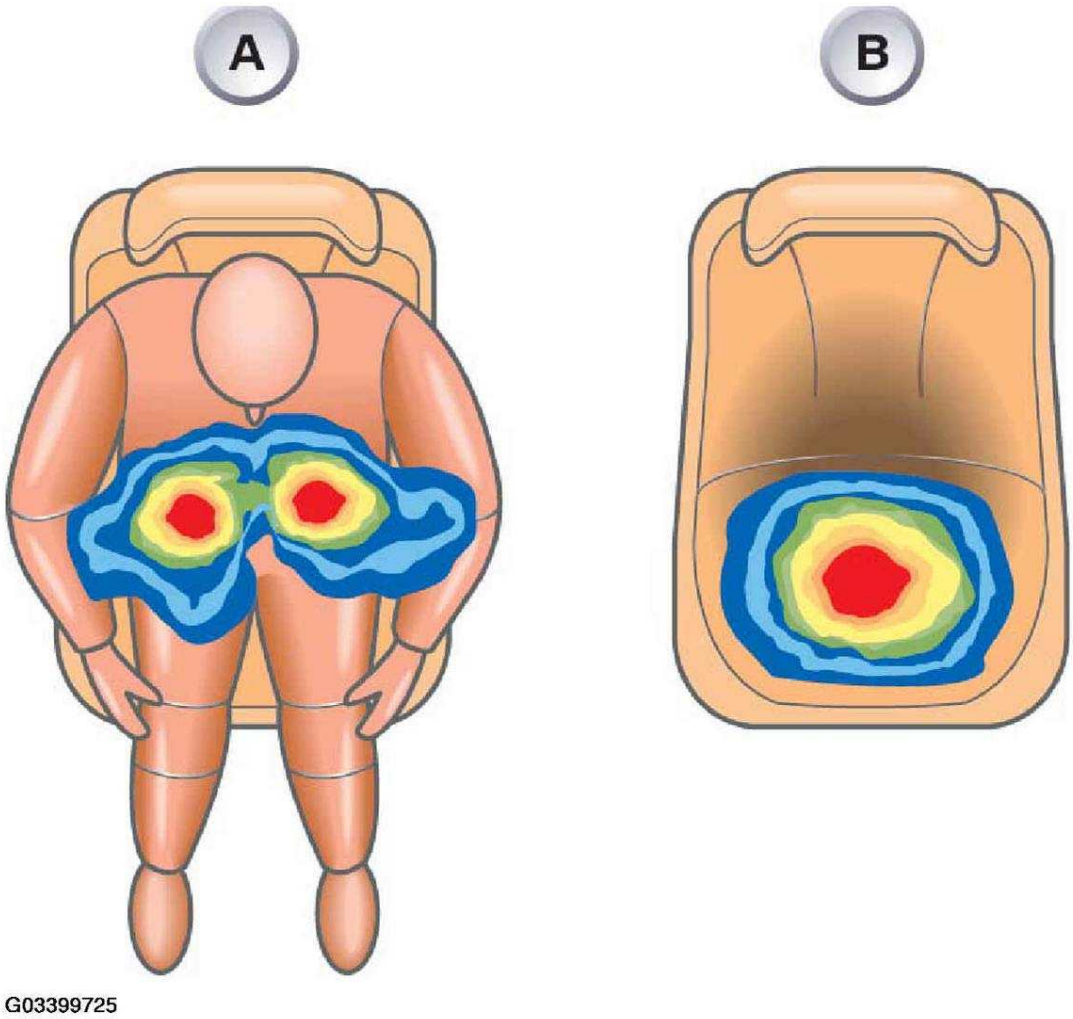


Fig. 8: Identifying Local Concentrations Of Weight
Courtesy of BMW OF NORTH AMERICA, INC.

The analyzer of the OC3 mat sends a message to the MRS4RD control unit via the K-bus. If the system detects that the seat is unoccupied or that a child seat for a child up to one year old is fitted, the airbags on the passenger side are deactivated. The MRS4RD control unit switches on the airbag warning light. The airbag warning light indicates that the airbags on the passenger side are deactivated.

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NOTE: The airbag warning light is switched on if the seat is unoccupied.

Belt Buckle Switch

The belt buckle switch is used to detect whether the seatbelt has been fastened or not. The detection signal is sent to the MRS4RD control unit. The signal is used as a criterion for selective triggering of the actuators in the event of a crash. The belt buckle switch is located in the seatbelt buckle on the driver and passenger seat.

The belt buckle switch is a two-wire Hall switch. The Hall switch is supplied by the MRS4RD control unit via a current-signal interface. The current draw of the switch is the signal for the switch position. The belt buckle switch is permanently diagnosed and monitored in all electrical system statuses from Terminal R "ON" onwards.

Actuators

The Multiple Restraint System 4 Redesign is responsible for activation of the following actuators:

- Front airbag, 2-stage, driver's side
- Front airbag, 2-stage, passenger side
- Head air bag (curtain airbag), left and right
- Side airbag, front door, left and right
- Side airbag, rear door, left and right
- Seatbelt tensioner, front, left and right
- Safety battery terminal
- Airbag warning lamp

Driver's Airbag

The purpose of the driver's front airbag in conjunction with the seatbelt is to reduce the risk of serious or fatal injury to the driver in the event of a head-on collision. The front airbag for the driver's side is located in the impact pad of the steering wheel. The front airbag for the driver is equipped with a 2-stage gas generator.

Depending on the crash severity, the two stages of the airbag are ignited with a delay. The two stages of the gas generator permit the airbag to perform its restraining function in a manner appropriate to the severity of the collision, thus avoiding additional trauma to the driver during the deployment stage. The gas flowing into the airbag inflates it, and in combination with the seat belt this reduces the risk of injury in an accident.

Passenger Airbag

The purpose of the passenger front airbag in conjunction with the seatbelt is to reduce the risk of serious or fatal injury to the front passenger in the event of a head-on collision. The 2-stage passenger front airbag is located underneath the dashboard.

In a crash and depending on crash severity, the two stages of the airbag are triggered with a delay. In this way the restraining effect is matched to the severity of the crash situation. Another effect is to reduce the strain on the occupant during the airbag-deployment phase.

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When the passenger airbag inflates, a hinged flap that is attached to the dashboard opens. The passenger airbag inflates towards the windscreen. The front passenger's airbag emerges upwards and supports itself on the windscreen glass and the dashboard.

Head Airbag (Curtain Airbag)

On the E83, a new head protection system, the curtain airbag, is introduced as standard equipment for the first time. It differs from the head-protection system used on the E46/E53 as follows:

- Continuous head airbag extending all the way from the A-pillar to the C-pillar

The curtain airbag extends all the way from the A-pillar to the C-pillar, covering the entire side-window area. The curtain airbag inflates between the vehicle occupants and the side windows and pillar trims. In conjunction with the side airbags in the front and rear doors, it provides optimum protection for all passengers in the event of a side on impact.

The curtain airbag reduces the risk of occupants' heads or other extremities protruding through the windows in a sideways collision. This leads to less severe neck backlash forces and less severe head injuries.

Advantages of the system:

- Extended covered area for side windows front and rear.
- Protection against glass splinters and penetrating objects.
- Optimized protective area offering protection for occupants of differing sizes.



Fig. 9: Identifying Head Airbag (Curtain Airbag)
Courtesy of BMW OF NORTH AMERICA, INC.

The curtain airbag is positioned along the line of roof side member, folded up. It consists of a gas generator, the two gas lances and the curtain.

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In the event of a side-on collision, the generator is detonated and the gas flows through the two gas lances into the curtain. Simultaneous inflation of the curtain at the front and back achieves more even deployment.

The attachment of the curtain airbag to the A-pillar and the C-pillar pulls it into position. The curtain airbag inflates between the vehicle occupants and the side windows and pillar trims.

Being a sealed system, the curtain airbag retains its shape and strength for several seconds.

Curtain Airbag

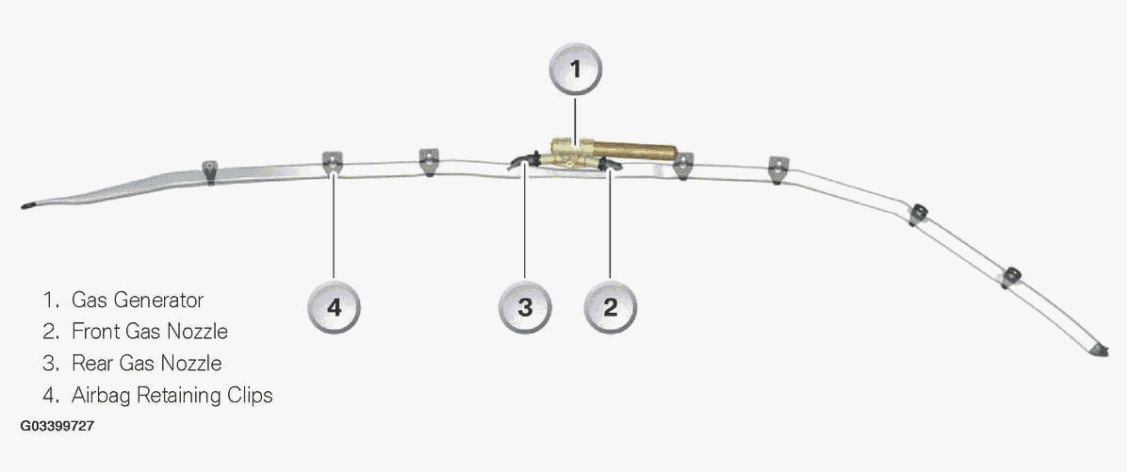


Fig. 10: Identifying Curtain Airbag
Courtesy of BMW OF NORTH AMERICA, INC.



Fig. 11: Identifying Gas Generator
Courtesy of BMW OF NORTH AMERICA, INC.

Side Airbag

The side airbags in the front and rear doors reduce the risk of occupant injury in the torso region of the body in the event of a side-on impact.

The side airbags are folded up inside an aluminum casing with a plastic cover behind the door trim panels. In the area of the side airbag in the door trim is a tear seam. The side airbags are fixed to the door trims as well as by a single screw to the inner door panel.

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The plastic cover has defined breaking points. In a side impact of sufficient severity, the side airbag is triggered. The side airbag exits through the split line and deploys between the door and the sear occupants.

Seatbelt Tensioner

The pyrotechnic seatbelt tensioner has the task in the event of a crash to minimize any belt slack in the pelvic and shoulder region.

The seatbelt tensioner is located on the driver's and/or passenger seat. In combination with the mechanical force limiter in the inertia reel, this reduces the chest load for the seat occupants.

BST

If the MRS detects an impact of sufficient severity, the safety battery terminal is deployed. When this happens, the starter/alternator cable is electrically and mechanically disconnected. The alternator is deenergized. The safety battery terminal is located directly at the positive terminal of the battery.



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Fig. 12: Identifying BST

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Courtesy of BMW OF NORTH AMERICA, INC.

SYSTEM FUNCTIONS

The MRS4RD control unit has to perform the following functions:

- Crash detection and calculation of deployment timing
- Activation of deployment output stages
- Documentation of time sequence of actuator deployment
- Pre-drive check
- Cyclic monitoring
- Indication of system readiness
- Indication and storage of faults
- Output of fault data (diagnosis)
- Output of crash signal for other members of the communication network
- Activation of the warning lamp if the passenger airbag is deactivated

Deployment

For the deployment output stages to be activated, the appropriate signals must be received from two different sensors, i.e. the B-pillar satellite and the MRS control-unit sensor.

In electrical-system statuses from Terminal R "ON" onwards, the MRS4RD control unit is supplied with power and is ready for operation on completion of the pre-drive check. The deployment capacitor, which acts as a power reserve, is charged to approx. 26 V via a switching regulator. The deployment capacitor provides the back-up power supply in the event of a crash in which the battery power supply is cut off.

The deployment capacitor, which provides the deployment power for the deployment output stages is controlled by a safety switch (trigger switch). The safety switch is operated by the microprocessor.

The deployment output stages consist of a high-side and a low-side power switch. The high-side power switch switches the deployment current and the low-side power switch switches the earth current. The high-side and low-side power switches are also used to check the deployment circuits as part of the pre-drive check.

The incoming sensor signals are analyzed by the analyzer module and passed on to the microprocessor. The microprocessor performs the deployment-algorithm calculations. The calculation results are compared with the event/deployment matrix and a decision reached as to the deployment of the various detonator pellets.

Pre-Drive Check

As of system status Terminal R "ON," the MRS4RD performs a pre-drive check (system test). While the pre-drive check is in progress, the airbag warning lamp is switched on for 3 - 5 seconds. Once the pre-drive check has been completed, and assuming no faults have been detected, the airbag warning lamp is switched off and the system is ready for operation.

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The following tests are performed as part of the pre-drive check:

- Comparison of programmed equipment with actual equipment fitted
- Testing of deployment circuits
- Testing of resistance of deployment circuits
- Testing of internal components
- Testing of external components
- Checksum calculation for algorithm parameters

Cyclic Check

Once the pre-drive check has been successfully completed and the system is ready for operation, a cyclic check for the purposes of fault monitoring is performed. The cyclic check continues to be carried out as long as the system status is Terminal R "ON."

The following tests are performed as part of the cyclic check:

- Monitoring of resistance of deployment circuits
- Communication capability and status of components
- Power supply

System Readiness

The MRS4RD indicates that the system is ready for operation by extinguishing the airbag warning lamp (AWL).

Fault Storage

If there is a fault in the system, it is indicated by the airbag warning lamp.

If a fault occurs on the MRS4RD, it must be stored in a non-volatile memory (EEPROM). When faults are recorded, a distinction is made between internal and external faults.

If an internal fault has been detected, the record of the fault cannot be deleted, i.e. the control unit has to be replaced. The only exception in that regard is incorrect programming data.

External faults on system components are also recorded in the fault memory. Once such faults have been rectified, the record can be removed from the fault memory.

Crash Signal

In the event of a crash involving deployment of the restraint systems, the MRS4RD control unit sends a crash signal to the members of the bus network.

On receipt of that signal, the control units concerned perform the following functions according to the severity of the crash:

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- Switch off electric fuel pump
- Switch off alternator
- Unlock central locking system
- Switch on hazard warning flashers
- Make emergency call (only if Professional phone option fitted)

EMERGENCY CALL (IF EQUIPPED W/TELEMATICS)

The E83 offers the customer a number of emergency call functions and a breakdown call function if the vehicle is equipped w/Telematics. The emergency call functions include a manual emergency call as well as the automatic emergency call activated as a result of a crash of appropriate severity.

Even if the vehicle is not equipped with the Motorola Everest telephone, every vehicle has a Telematic Control Unit TCU (if equipped w/Telematics), a telephone aerial, a hands-free unit as well as a GPS aerial for localization.

Manual Emergency Call

The emergency call switch (4) is connected directly to the telephone. Pressing the emergency call switch sets up a voice connection with the provider "Cross Country." The voice connection is indicated by a flashing LED in the switch.

Breakdown Call

The Breakdown call button in the Central Information Display can be activated by means of the controller. If the breakdown call button is activated, a connection to the BMW Emergency Service of the relevant country is set up.

Automatic Emergency Call

In the event of a crash of the appropriate severity, the MRS4RD control unit transmits a crash telegram to the TCU. The TCU places an emergency call, which at the same time contains the location of the vehicle.

If a navigation system is installed, the location of the vehicle is notified to the TCU. If no navigation system is installed, the location of the vehicle is determined by the internal GPS receiver of the TCU.

A voice connection is set up with the provider "Cross Country" to obtain more information on the accident (severity of the accident, number of injured) so that rescue operations can be initiated.

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GENERAL INFORMATION

Starting Systems - Overview

STARTING SYSTEMS

Model: All

Production Date: All

PURPOSE OF STARTING SYSTEM

The purpose of the starting system is to convert chemical energy stored in the battery into electrical energy, then into mechanical energy in the starter motor. This mechanical energy is then transferred through gears and drives from the starter motor to the engine flywheel.

After the transfer and conversion of all this energy the engine flywheel begins to rotate.

The rotation must be of sufficient speed to allow the engine to form the combustible air-fuel mixture required for starting. It must be maintained during initial combustion long enough until the engine can sustain operation.

To accomplish this a starter or cranking motor is used.

The starting system consists of the following components:

- Battery.
- Ignition Switch.
- Starter Motor Assembly.
- EWS (if equipped).
- Starter Safety Switch.
- Cables and Wiring Harness.

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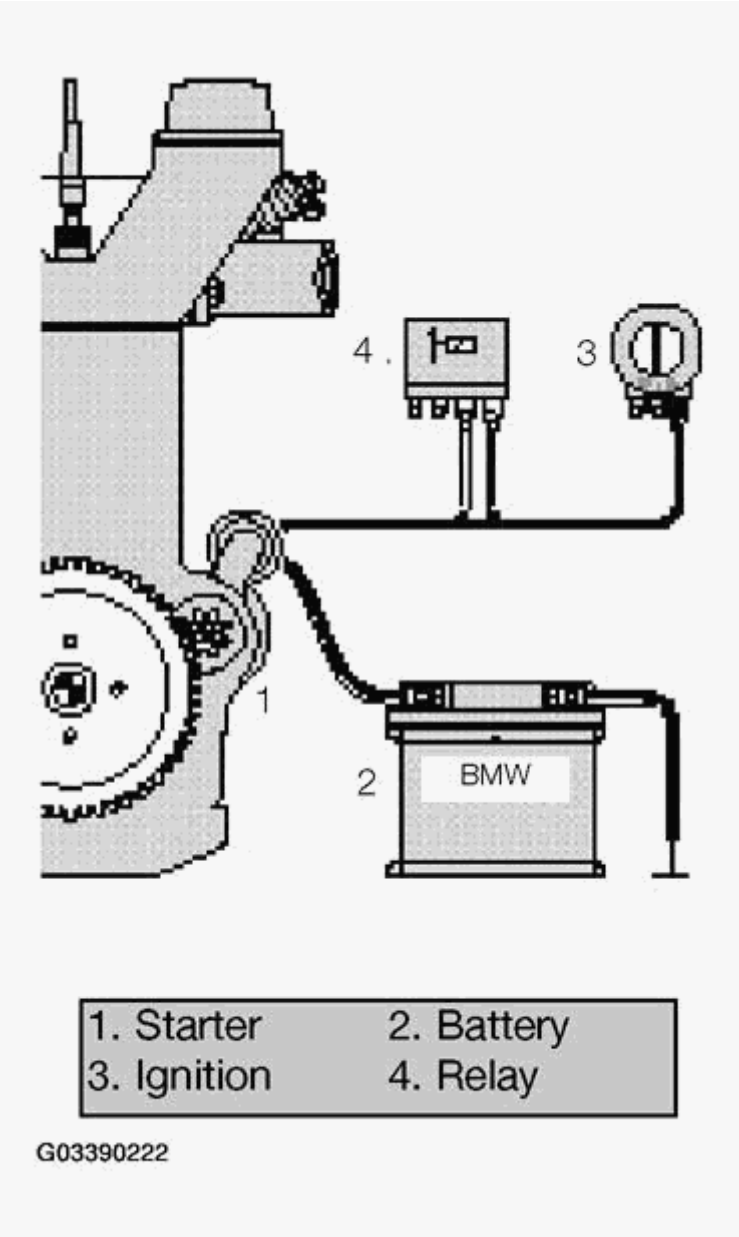


Fig. 1: Identifying Starting System
Courtesy of BMW OF NORTH AMERICA, INC.

SYSTEM COMPONENTS

Battery

The Battery is the primary EMF source in the automobile. The automotive battery is an electromechanical device that provides the potential difference (voltage). The battery does not store electrical energy. It stores chemical energy that is converted to electrical energy as it discharges.

All energy for starting the car is drawn from the battery. State-of-charge, and capacity of the battery are important factors in the ability of the engine to start, especially in cold and harsh conditions.

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Ignition Switch

The Ignition Switch provides a request to the starting system to engage the starter motor. This request is handled differently depending on the year of the vehicle and particular systems the vehicle is fitted with.

In non EWS systems the ignition switch provided power directly to the starter solenoid or a starter relay. Beginning with EWS I the start request (KL50) is passed to an Immobilizer control module or an EWS module (EWS II/III).

On vehicles with one touch starting the KL50 signal is passed to the DME.

Starter Motor Assembly

The Starter Motor Assembly is a DC motor which uses the interaction of magnetic fields to convert electrical energy into mechanical energy.

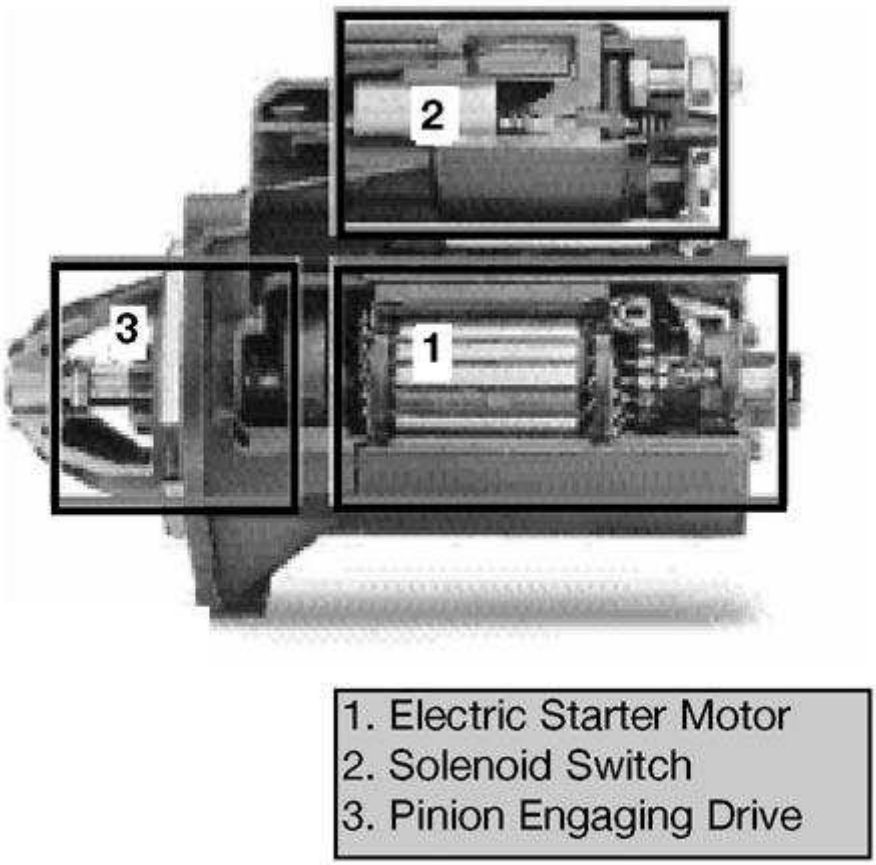


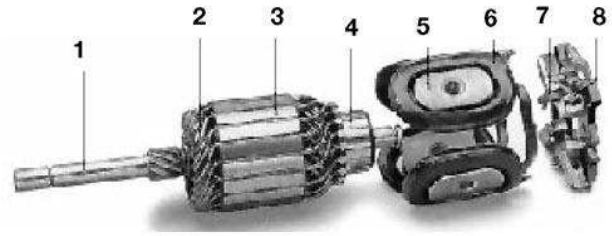
Fig. 2: Identifying Starter Motor Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

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Electric Starter Motor

The Starter Motor provides the mechanical energy to rotate the engine through a direct or a gear reduction drive.

- Armature Shaft (1)
- Armature Winding (2)
- Armature Stack (3)
- Commutator (4)
- Poles Shoes (5)
- Field Coil (6)
- Carbon Brushes (7)
- Brush Holder (8)

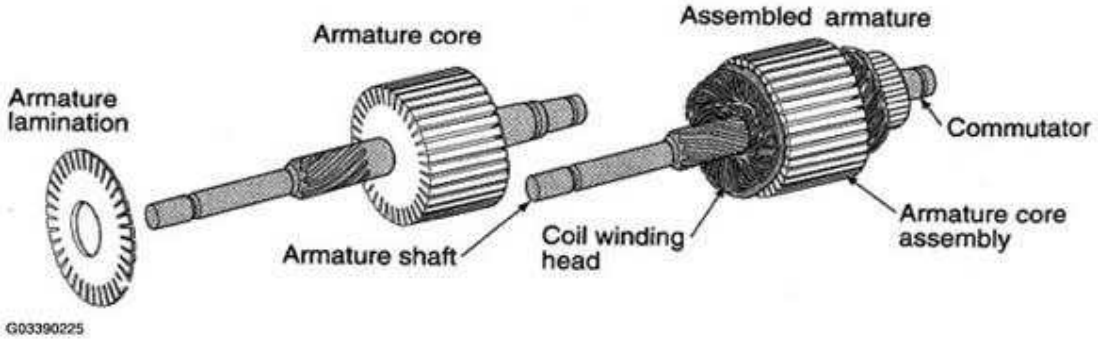


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Fig. 3: Identifying Major Components Of Starter Motor
Courtesy of BMW OF NORTH AMERICA, INC.

Armature

The Armature assembly is comprised of the armature shaft, armature winding, armature stack and commutator. Thin iron stampings are laminated together to form the stack or core. The slots on the outside of the laminations hold the armature windings. The windings loop around the core and are connected to the commutator. Each commutator segment is insulated from the adjacent segments. The commutator may have up to 30 segments. A steel shaft is insert in the center hole of the laminations with the commutator insulated from the shaft.



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Fig. 4: Expanded View Of Armature Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

Field Coils

There are two types of field coils:

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- Electromagnetic.
- Permanent magnet.

Electromagnetic

Wire ribbons or coils wrapped around a pole shoe, attached to the inside of the starter housing. The iron pole shoes and the iron starter housing work together to increase and concentrate the strength of the field coils. When current flows thought the field coils strong electromagnetic fields with North and South poles are created.

Permanent

Multiple permanent magnets manufactured from an alloy of boron, neodymium and iron are positioned in the starter housing. Use of permanent magnets allow for the elimination of the field circuit and windings and realize a 50% weight savings.

Brushes

Brushes are electrically conductive sliding contacts, usually made of copper and carbon. The brushes make contact with the commutator and as the starter begins to rotate the brushes reverse the flow of current to the armature. Starter brushes carry the full flow of current through the motor.

Solenoid

The Solenoid assembly is an integral part of the starter and is actually a combined relay and engagement solenoid.

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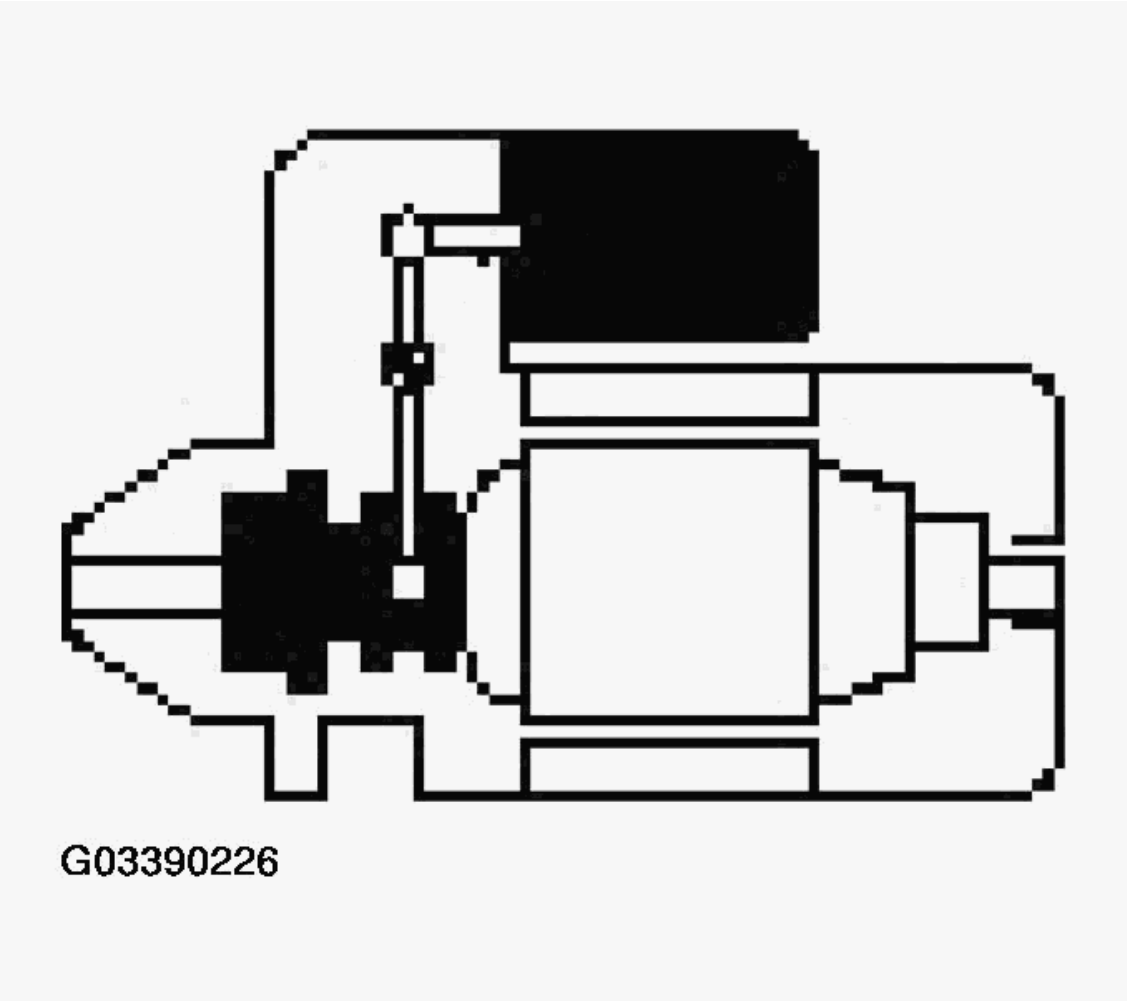


Fig. 5: Identifying Solenoid Switch And Pinion Engaging Drive
Courtesy of BMW OF NORTH AMERICA, INC.

Solenoid switch and pinion engaging drive.

The solenoid has two functions:

- Pushing the pinion forward so that it engages in the ring gear of the engine.
- Closing the moving contact, providing the main current path for the starter.

The solenoid has two windings.

- Pull-in winding.
- Holding-in winding.

Both windings are used to draw in the plunger and engage the pinon, only the hold-in winding is used to hold the plunger in position.

Pinion Engaging Drive

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The starter's end shield assembly contains the Pinion Engaging Drive with pinion, overrunning clutch, engagement lever and spring. The drive mechanism is responsible for coordinating the thrust motion of the solenoid switch and the rotary motion of the electric starter motor and transferring them to the pinion.

The starter engages the ring gear on the flywheel by means of the pinion. A high conversion ratio of pinion teeth to flywheel teeth (between 10:1 and 15:1) make it possible to overcome the high cranking resistance of the engine using a relatively small but high speed starter motor.

As soon as the engine starts and accelerates past cranking speed, the pinion must automatically demesh in order to protect the starter. For this reason, the starter incorporates an overrunning clutch.

STARTER DRIVES

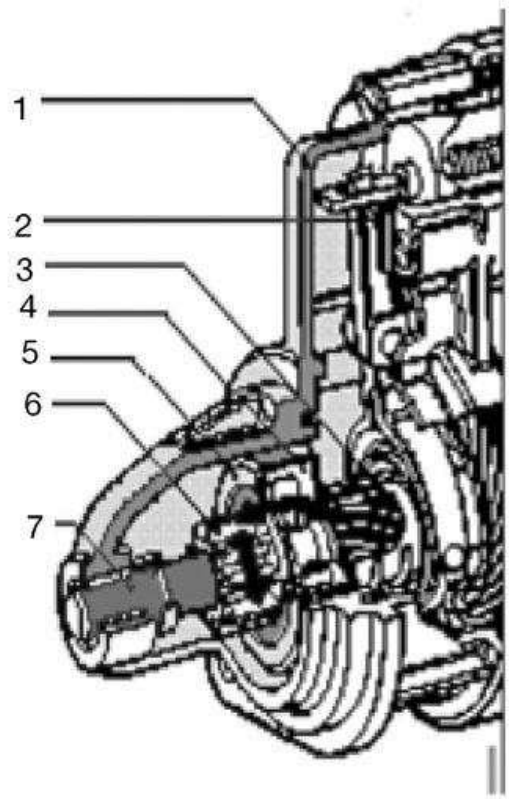
Conventional Drive

In a Conventional Drive starter the pinion gear is located directly on the armature shaft.

The pinion and overrunning clutch form the driver assembly.

The driver assembly rides on a helical spline on the armature shaft so that when the driver is thrust by the solenoid, a combined axial and rotary motion occurs which greatly facilitates the meshing of the pinion.

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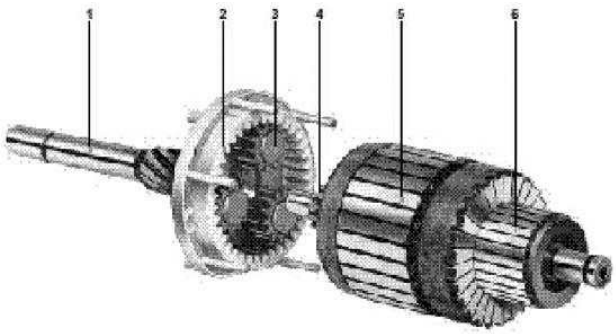
1. Drive End Shield
2. Engaging Lever
3. Meshing Spring
4. Driver
5. Roller Type Overrunning Clutch
6. Pinion
7. Armature Shaft

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Fig. 6: Identifying Conventional Drive Starter Pinion Gear
Courtesy of BMW OF NORTH AMERICA, INC.

Gear Reduction Drive

In their design and function, Gear Reduction Drives are much the same as conventional drive starters. The main difference in the gear reduction drive starter is a planetary gear set added between the field frame and the drive end shield. This design allows for the use of smaller and lighter starters.



1. Planetary-Gear Carrier Shaft with Helical Spline.
2. Internal Gear (Ring Gear).
3. Planet Gears
4. Sun Gear on Armature Shaft
5. Armature
6. Commutator

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Fig. 7: Identifying Gear Reduction Drive
Courtesy of BMW OF NORTH AMERICA, INC.

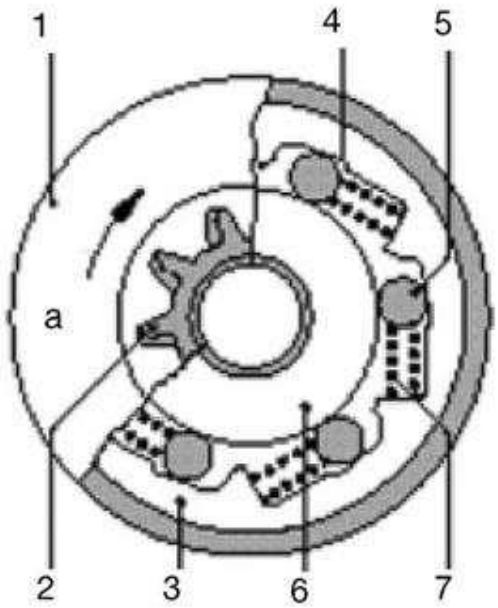
OVERRUNNING CLUTCH

In all starter designs the rotary motion is transmitted via an Overrunning Clutch. The overrunning clutch allows the pinion to be driven by the armature shaft (or planetary gear set), however it breaks the connection between the pinion and the armature shaft as soon as the accelerating engine spins the pinion faster than the starter.

The overrunning clutch is located between the starter motor and the pinion and prevents the starter motor armature from being accelerated to an excessive speed when the engine starts.

1. Clutch Cover
2. Pinion
3. Driver with Clutch Shell
4. Roller R-ace
5. Roller
6. Pinion Shaft
7. Coil Spring

a Direction of Rotation for Clutch Locking Action



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Fig. 8: Identifying Overrunning Clutch Components
Courtesy of BMW OF NORTH AMERICA, INC.

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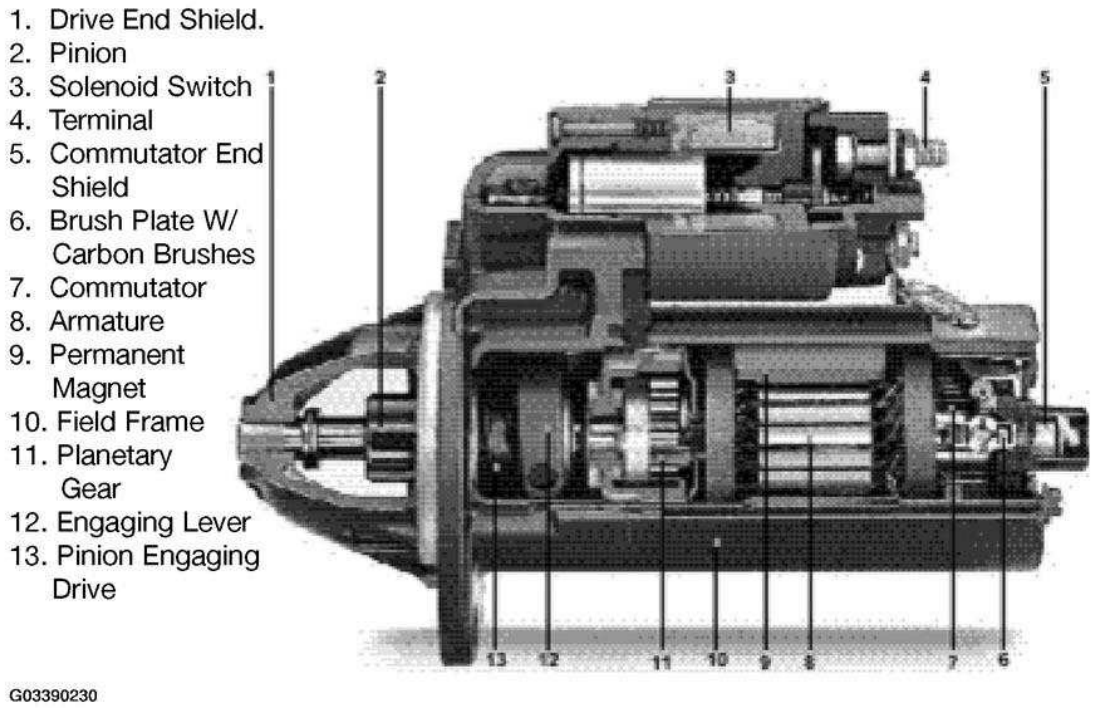


Fig. 9: Cross Sectional View Of Starter Motor
Courtesy of BMW OF NORTH AMERICA, INC.

Fully assembled permanent magnet gear reduction starter.

EWS

The EWS system(s) is designed to provide electronic anti-theft protection for the vehicle through the use of coded keys and coded data communication between the EWS and the engine control module. The starter and engine control module are locked out until a properly coded key is recognized and the proper code is established between the EWS and the engine control modules.

Starter Safety Switch

The Starter Safety Switch is part of the transmission range switch on automatic transmission vehicles and a clutch switch on manual transmission vehicles (beginning MY 1997). The purpose of the switch is to prevent engine start-up with the vehicle in gear or the clutch not depressed. On vehicles with EWS, this signal is sent directly to the EWS module for processing.

Cable and Wiring Harness

Cables to the starter from the battery must carry large amounts of current. The wiring harness from the ignition switch and/or EWS carry little current as they are control signals to a relay or starter solenoid. Minimum voltage drop in starter cables is necessary to ensure sufficient starter speed and torque.

PRINCIPLE OF OPERATION

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Electric Starter Motor

The Electric Starter Motor converts electrical current into rotary motion. In doing so it converts electrical energy into mechanical energy. The interaction of two magnetic fields produce this rotational force.

The field coils (either electromagnetic or permanent) located in the housing produce magnetic flux lines. Within the stationary field coils is the armature, a loop of wire (a conductor) with one end connected to B+, the other to B-. When current is applied to the armature flux lines circle the loop in one direction on one side and in the opposite direction on the other side. The interaction of the flux lines on the armature and the flux lines from the field coil cause the armature to rotate.

The armature will only rotate to the point where the magnetic force is equal on both sides. (Armature 90° to magnetic flux lines of field) For the armature to continue to rotate, the polarity or direction of current flow must be reversed.

Through the brushes and the commutator, the current flow is reversed as the magnetic forces become equal, causing the armature to continue to rotate.

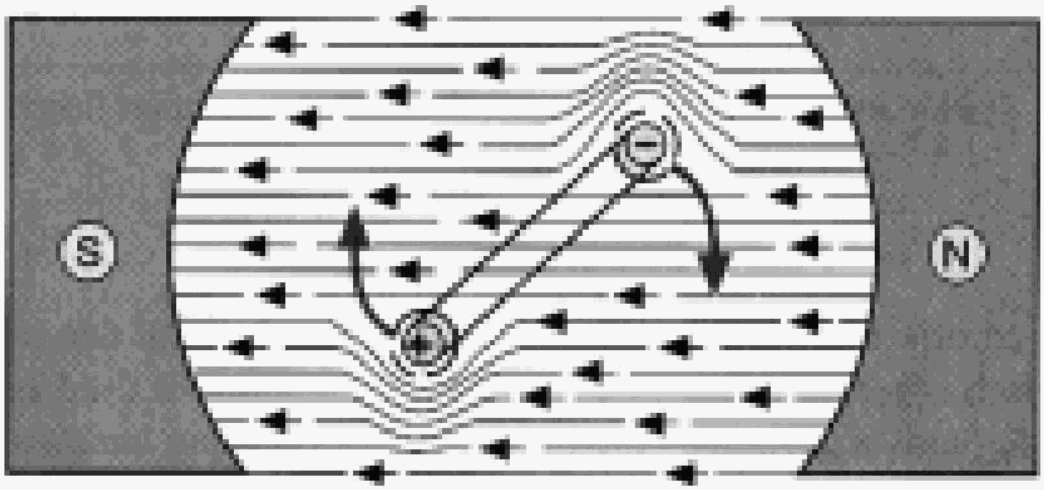


Fig. 10: Identifying Magnetic Flux Lines
Courtesy of BMW OF NORTH AMERICA, INC.

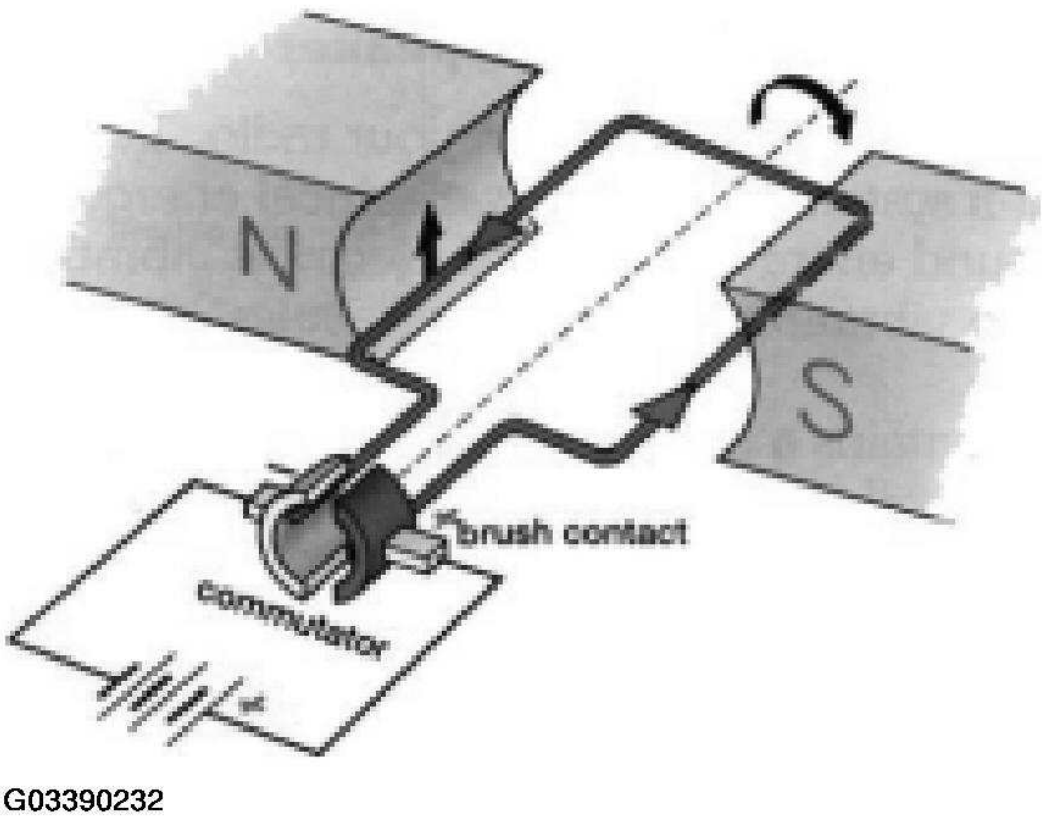
This constant reversal of current flow in the armature provides continual rotation.

Direction of rotation is determined using **Flemings Left Hand Rule.**

- Point your First finger in the direction of the magnetic Field (from N to S).
- Rotate your hand about that finger until your second finger points in the direction of the Current

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(conventional current, from + to -).



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Fig. 11: Identifying Magnetic Field
Courtesy of BMW OF NORTH AMERICA, INC.

Loop symbolizes force out of magnetic field.

- Then your thumb points in the direction of the Movement of the wire.

To increase the force on the wire (armature) do one of the following:

- Use a larger current.
- Use a stronger magnetic field.
- Use a greater length of wire in the field.

To increase torque and speed in the starter motor, more windings in the armature are added, and the field has more pairs of magnets (either permanent or electromagnetic).

Flemings left hand rule:

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The basic law of motors, the direction of force on a wire that is carrying current when it is in a magnetic field.

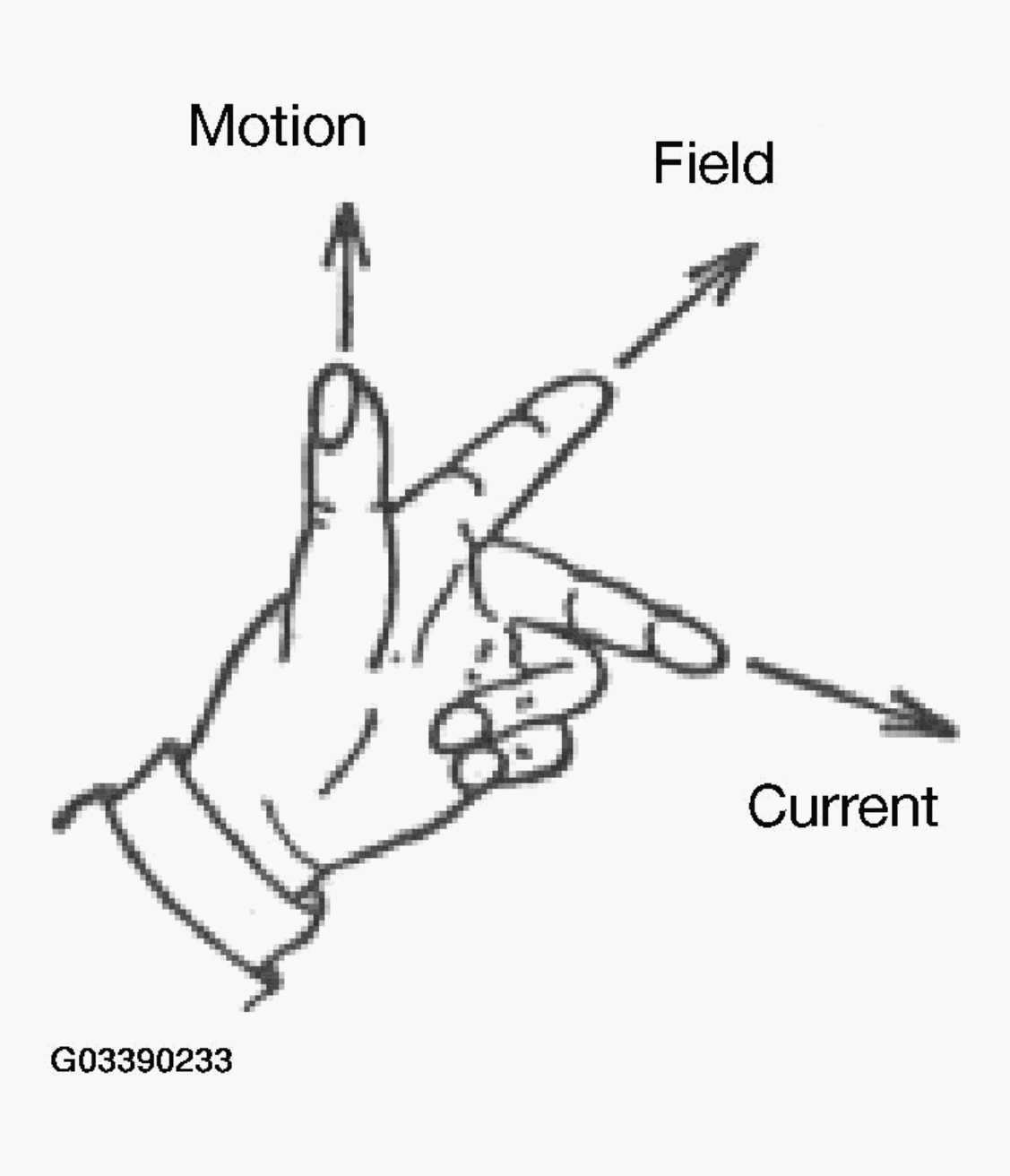


Fig. 12: Illustrating Flemings Left Hand Rule
Courtesy of BMW OF NORTH AMERICA, INC.

MOTOR WINDINGS

Torque and speed of the starter motor is dependent on the wiring of the field coils (electromagnetic coils).

There are three types of Motor Windings:

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- Shunt Wound.
- Series Wound.
- Compound.

Shunt Wound Motors

In Shunt Wound Motors, the field coil is connected in parallel with the armature. The shunt motor does not decrease its torque as speed increases. Shunt motors do not produce high torque.

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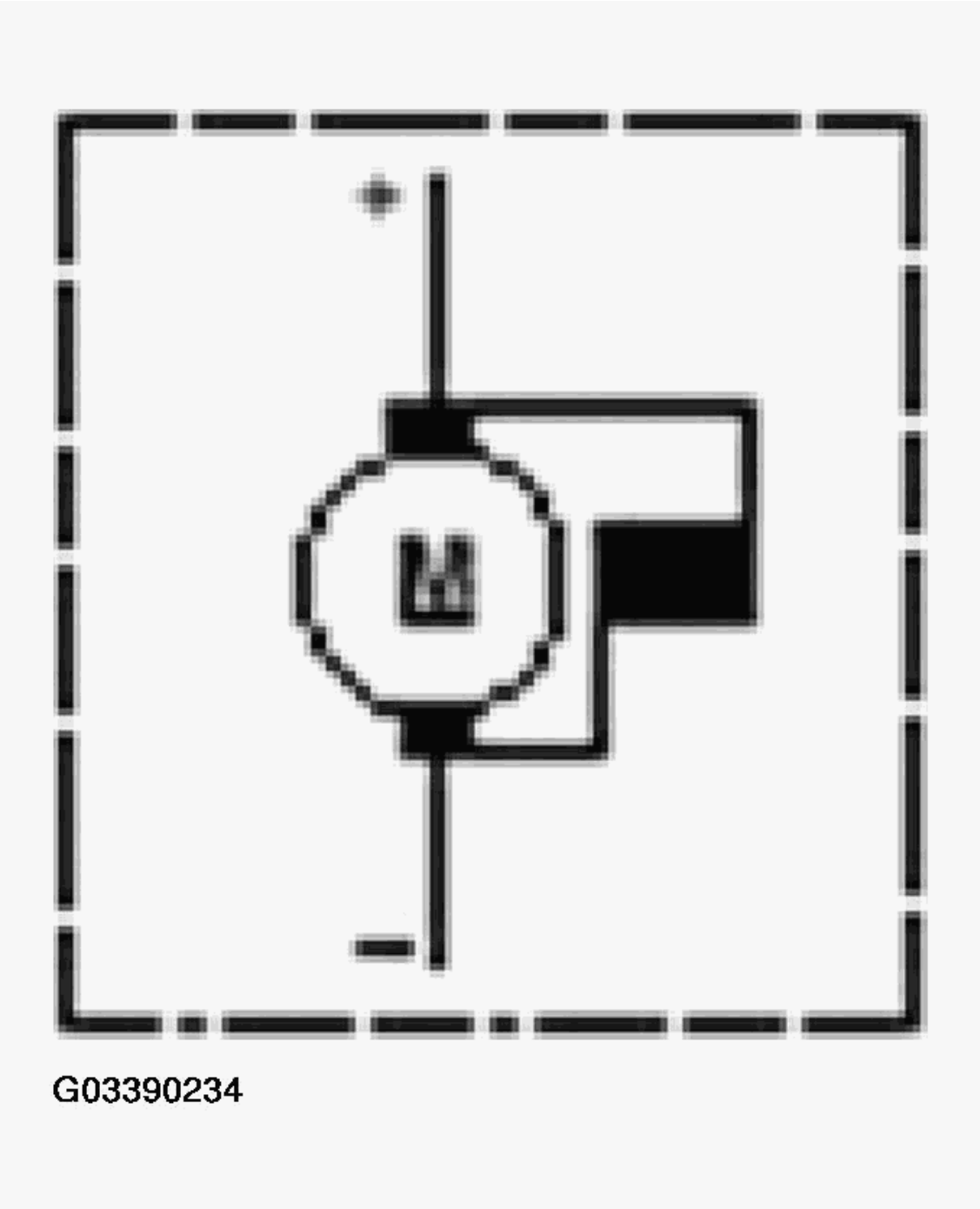


Fig. 13: Identifying Shunt Wound Motors
Courtesy of BMW OF NORTH AMERICA, INC.

Series Wound Motors

In Series Wound Motors, the field coil is in series with the armature.

The current flows to the field windings, then to the brushes, commutator, and armature back again to the ground side brush. A series wound motor will develop maximum torque output at the time of initial start, then as motor

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speed increases, torque falls off rapidly due to the CEMF.

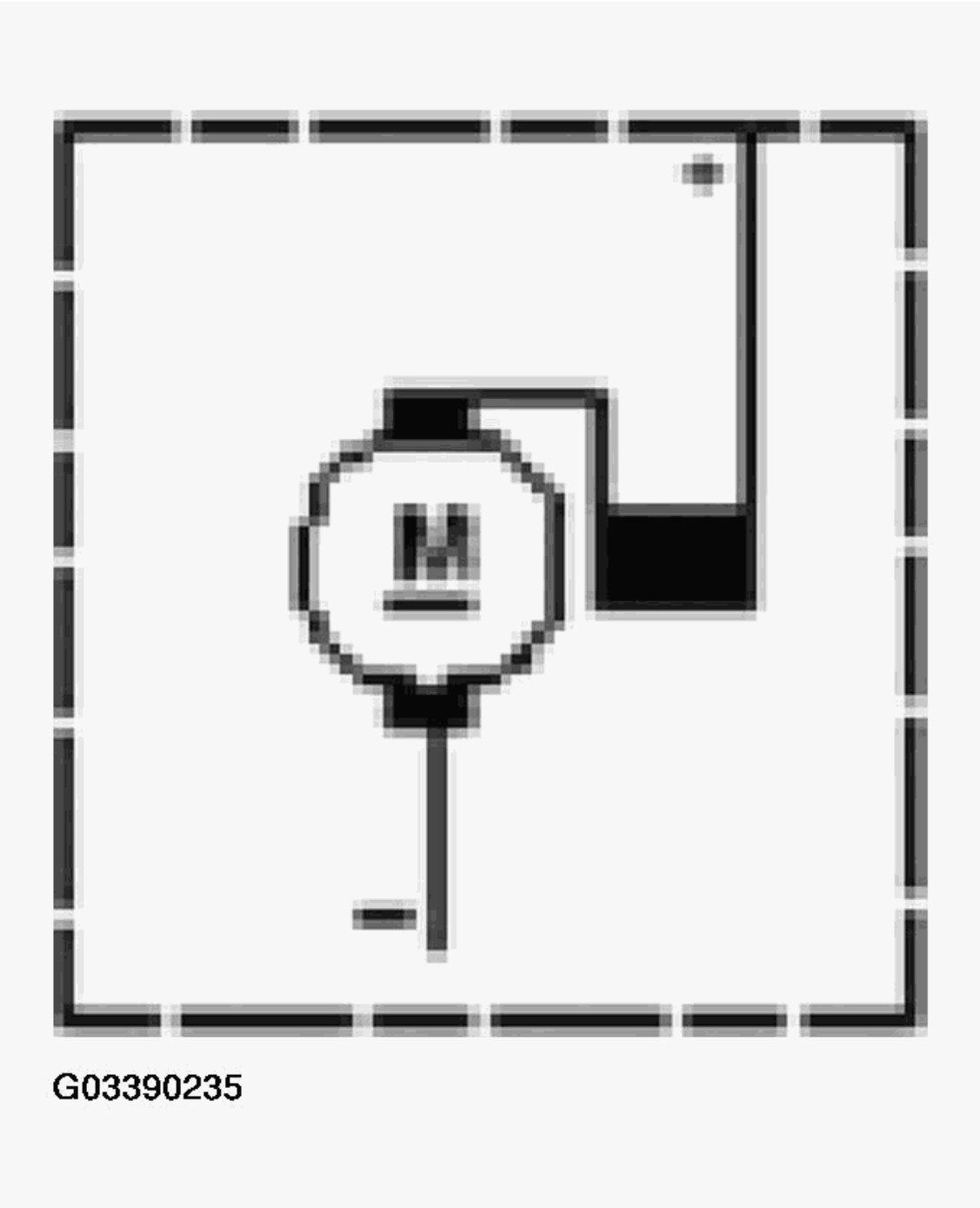


Fig. 14: Identifying Series Wound Motors
Courtesy of BMW OF NORTH AMERICA, INC.

Compound Wound Motors

Compound Wound Motors have some of the field coils wired in series to the armature and some in parallel. This configuration allows the compound motor to develop good starting torque and constant operating speed.

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CEMF:

Counter Electromotive Force.

The voltage produced in the starter motor itself through electromagnetic induction.

This voltage acts against the supply voltage from the battery.

Motors must be designed to control the CEMF for optimum operation.

Permanent Magnet Motors

Permanent Magnet Motors eliminate all wiring to the field coils. The magnetic field is generated by the permanent magnet without the need for winding and pole shoes. The magnets use flux-concentrating pieces to direct the magnetic field.

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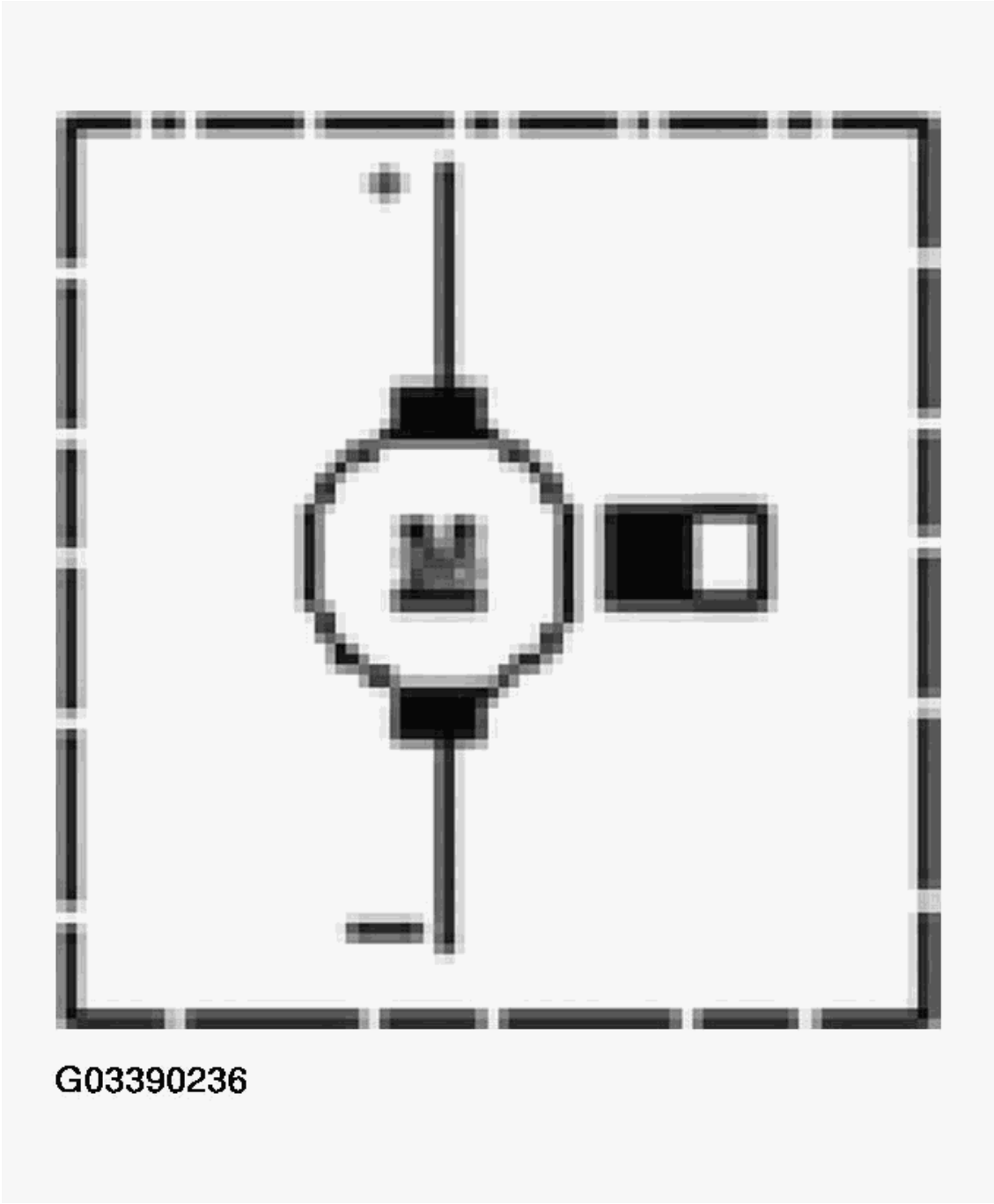


Fig. 15: Identifying Permanent Magnet Motors
Courtesy of BMW OF NORTH AMERICA, INC.

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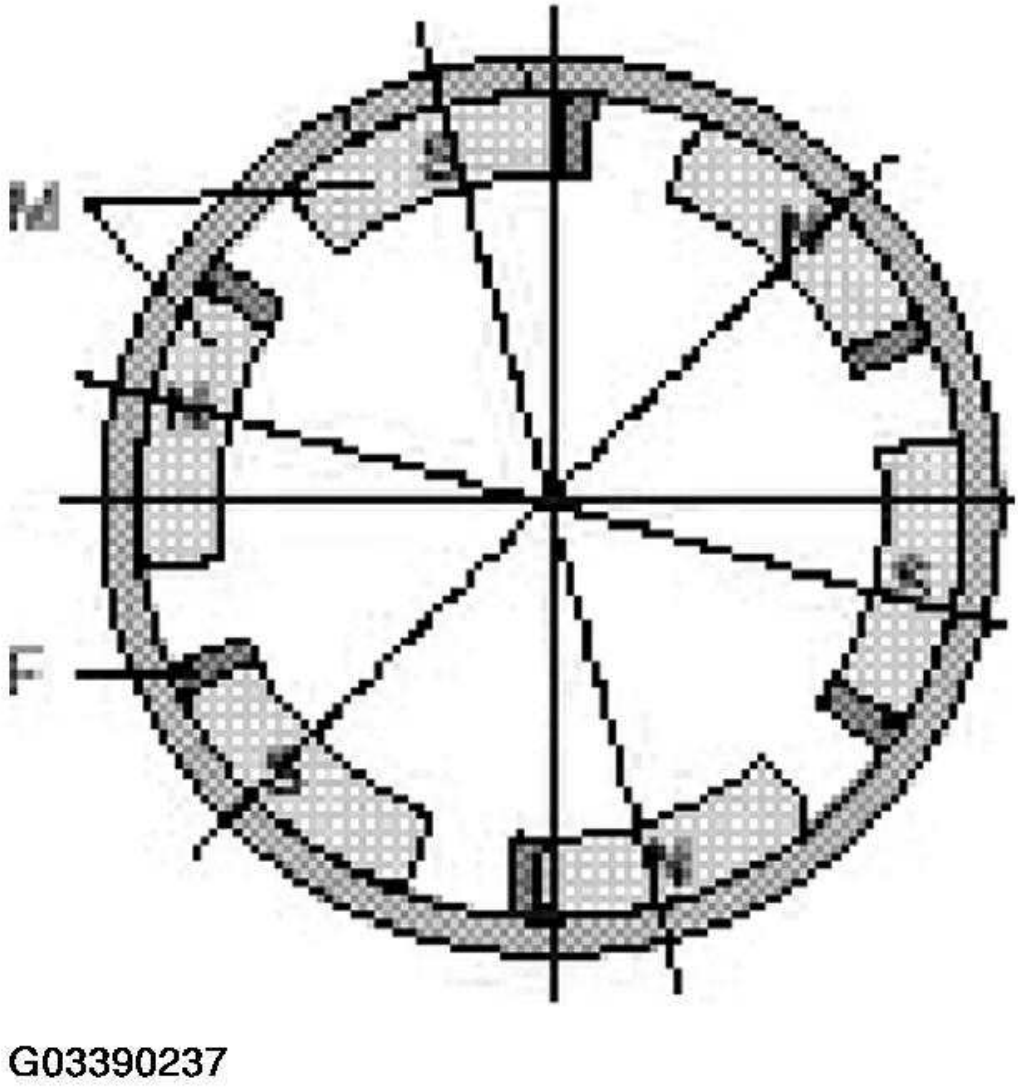


Fig. 16: Identifying Permanent Magnets With Flux Concentrating Pieces
Courtesy of BMW OF NORTH AMERICA, INC.

Arrangement of permanent magnets (M) with flux concentrating pieces (F).

SOLENOID

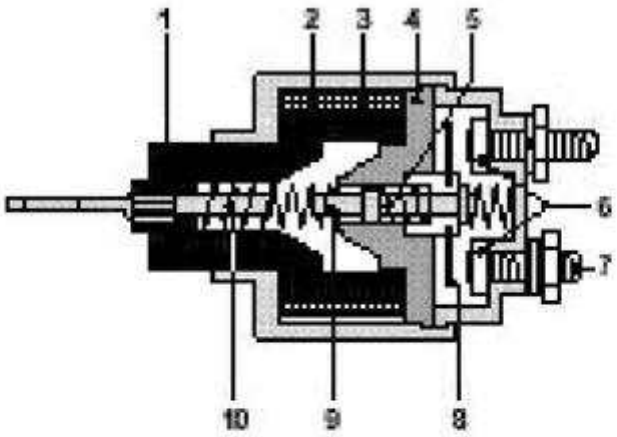
The Solenoid performs the following functions:

- Pull the pinion to engage the flywheel.

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- Hold the pinion engaged with the flywheel during starting rotation.
- Complete the electrical circuit from the battery to the brushes of the starter.
- Cause the pinion to retract from the flywheel.

Two windings are used to pull and hold the pinion engaged to the flywheel.



1. Armature (relay)	2. Pull-in winding
3. Hold-in winding	4. Solenoid armature
5. Contact spring	6. Contacts
7. Terminal	8. Moving contact
9. Switching pin	10.Return spring

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Fig. 17: Identifying Solenoid Components
Courtesy of BMW OF NORTH AMERICA, INC.

Pull-In Winding- The stronger of the two windings, used to pull the pinion into engagement. This winding is released when the starter circuit is completed.

Hold-In Winding- Used to help the pull-in winding move the pinion initially, then holds the pinion engaged to the flywheel.

Signal 50 is received at the solenoid, energizing both windings. The windings cause the armature to be drawn into the coils, pressing on a spring, causing the moving contacts to close. The pull-in winding is released, the starter begins to turn. When signal 50 is released, the power is lost to the hold-in winding, spring pressure forces the armature out of the coil, the moving contacts are opened and the pinion returns to the rest position.

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Workshop Hint:

The starter motor does not begin to spin until after the pinion is engaged in the flywheel.

This aids in the meshing of the pinion and flywheel

Workshop Hint:

Battery voltage is critical.

The combination of the pull-in winding and the hold-in winding may have sufficient power to engage the pinion. When the moving contacts are completed and the increased load of the starter motor is added to the system, low voltage will cause the hold-in winding to release the pinion. If signal 50 is still present the pull-in winding will again assist in pulling the pinion into engagement and the cycle starts over again. This gives the "clicking" noise from the starter.

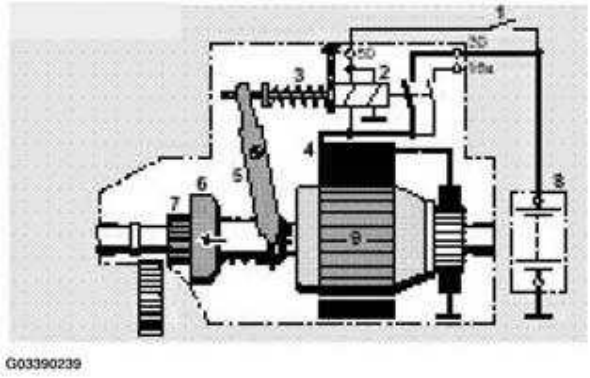
Pinion Drive

The Pinion Drive gear is attached to the roller-type overrunning clutch which is splined via a helical shaft to the starter armature. At rest the spring pressure in the overrunning clutch wedge rollers between the pinion shaft and the clutch hub race. This locks the pinion to the clutch. During start-up the clutch and pinion rotate as one.

As the engine speed exceeds starter speed, the pinion pushes the rollers, against the spring pressure, into a wider area. This movement of the rollers allow the pinion to turn independently of the starter armature, not causing the armature to overspeed.

When the solenoid windings are released the clutch assembly is pulled away from the flywheel through spring pressure.

Phases of Starter Operation



1. Start Request Signal (KL50)
2. Solenoid Switch
3. Return Spring
4. Field Windings
5. Engaging Lever
6. Overrunning Clutch
7. Pinion
8. Battery
9. Armature

Fig. 18: View Of Starter At Rest
Courtesy of BMW OF NORTH AMERICA, INC.

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Starter at rest, no current supplied.

Pull-in and hold-in winding energized.

Pinion tooth meets gap in ring gear and meshes.

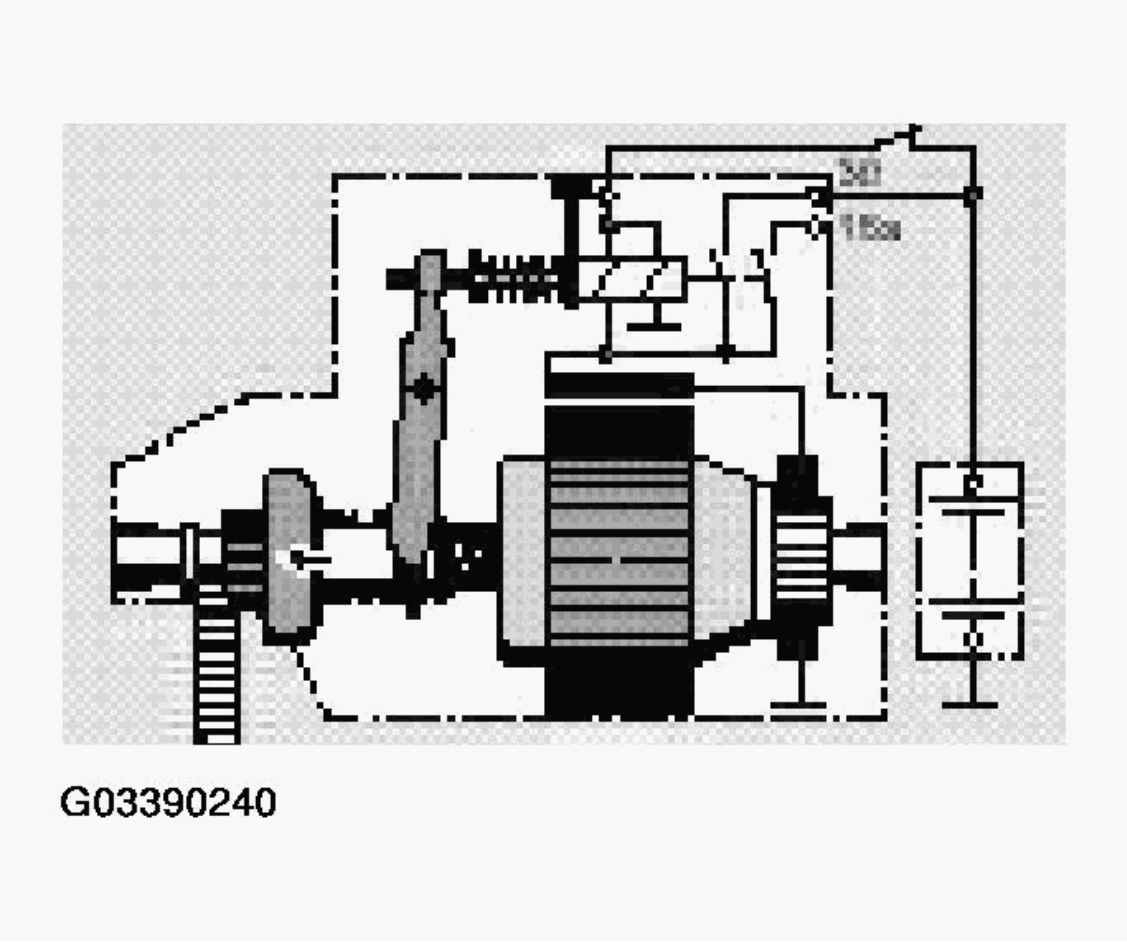


Fig. 19: Identifying First Phase Of Starter Operation
Courtesy of BMW OF NORTH AMERICA, INC.

Starter position just before Main current is switched on.

Engaging lever in end position.

Pull-in winding released.

Pinion meshed.

Main current flows.

Engine is rotated.

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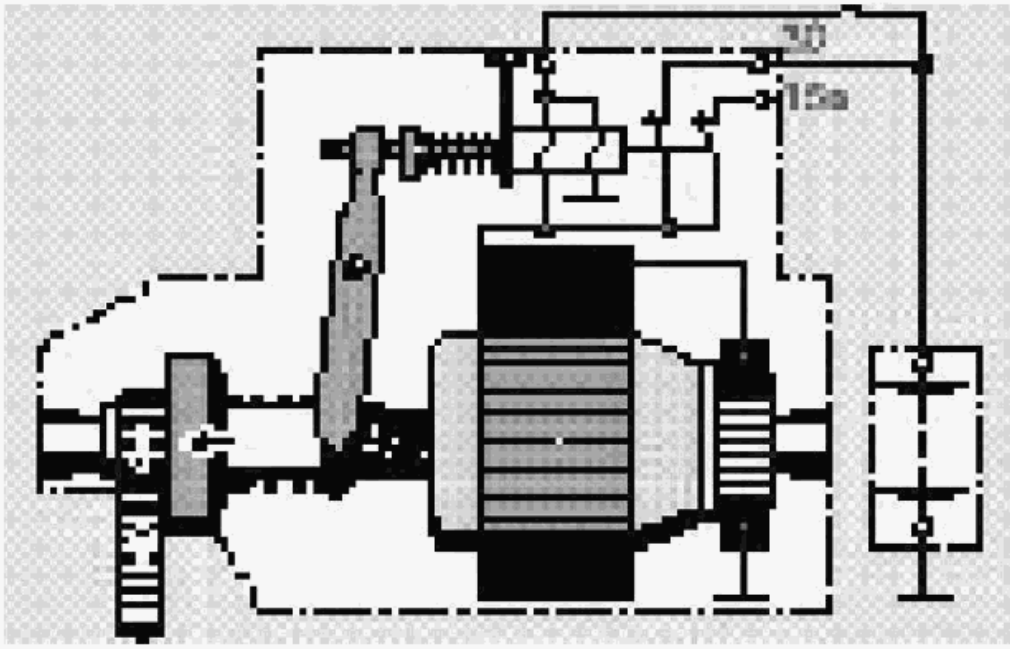


Fig. 20: View Of Starter Operation
Courtesy of BMW OF NORTH AMERICA, INC.

Engine is cranked.

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GENERAL INFORMATION

Telephone Diagnostics - Overview - All Models

TELEMATICS

FREQUENTLY ASKED QUESTIONS

1. **What is telematics?**

   Telematics combines wireless voice and data to provide location-specific security, information, productivity, and in-vehicle entertainment services to drivers and their passengers.

2. **How does a telematics system work?**

   The heart of a telematics system within the car is a telematics Communications Unit (TCU) that is connected (wirelessly) to a central service center. The TCU serves as the central platform of a telematics system, where all telematics-related technologies are deeply integrated. It communicates location-specific information to a central service center and in turn the center helps deliver telematics services to a driver via the cellular phone.

   These services can include dispatching ambulance services to a driver in an emergency situation, or sending roadside assistance to a driver whose car has broken down. Other services include the ability of a central server to deliver navigation assistance and real-time traffic information, among others. What's more, the TCU is also connected to the engine control unit (or the onboard computer) which enables enhanced services such as remote engine diagnostics and automatic airbag notification.(01)

3. **What is the difference between telematics and navigation systems?**

   A telematics system provides numerous services to drivers, and navigation is simply one of the services offered. Navigation systems that are starting to appear in highend cars today are referred to as autonomous navigation systems. Here, the navigation database resides in the car on a CD. These systems are relatively expensive. telematics systems provide navigation assistance "off-board". This means that the database resides outside the car, making the service far more affordable to a wider number of people.

4. **Where does the word "telematics" come from?**

   The term originated in Europe and remains widely used in the European automotive industry to describe automotive communications technologies.

5. **Can you explain a telematics system in technological detail? What are its components?**

   The main component in a telematics system is the telematics Communications Unit (TCU). In North America, a TCU contains a Motorola GPS receiver, cellular transceiver, and modem/transceiver control board. In Europe, a TCU contains a Motorola GPS receiver and GSM transceiver. Motorola's European telematics systems do not require a modem due to the already existing digital data transfer services, such as SMS (short message service) available with GSM.

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Every telematics system developed by Motorola contains Motorola's automotivegrade telematics software, which is uniquely programmed to deeply integrate the components of a TCU, enabling simplified delivery of telematics services from one centralized area.

6. **What services does a telematics system offer today?**

   Today, telematics systems offer drivers emergency and roadside assistance, air bag deployment notification, navigation, remote door unlock, vehicle security notification and stolen vehicle tracking services.(01) (02)

7. **What services will telematics offer in the future?**

   Just as today's telematics safety and security features are a direct result of initial consumer demand, future telematics services will also be a direct result of what drivers want in their cars. These systems may provide customized services such as travel information (traffic updates, parking availability, airline status), messaging (voice mail and email retrieval), information (sports, weather, stock market updates and Internet access) and entertainment (audio games, books, magazines and newspapers). These are only a few of the applications which will evolve with telematics to keep drivers and their passengers in touch.

   Eventually, telematics will even reach outside the car and communicate with the office and home, extending far beyond voice conversations. Drivers will be able to turn on home lights, start and stop the sprinkler system, set their office security system - all via their telematics systems.

8. **How does a driver interact with a telematics system?**

   Drivers activate telematics systems via buttons located on the dashboard or the overhead console of the car. Motorola works with each automaker to help develop a purpose-built system for the projected ergonomic desires of drivers. The BMW Mayday telematics system has an emergency and roadside assistance button located on a cellular handset. The Mercedes TeleAid system has an S.O.S. button located behind the rear view mirror and "Information" and "Roadside Assistance" buttons located in the armrest.

9. **Can a Global Positioning System (GPS) phone handle telematics services?**

   We have several concerns about integrating GPS functionality into a phone handset, instead of the vehicle itself.

   Our first issue is the ability of a GPS phone to operate inside of the automobile without an external GPS or cellular antenna. GPS antennas must have an unrestricted view of the sky to track satellites. So the decision must be made whether it's more cost-effective to have the GPS in the phone or in the car.

   Furthermore, integrating telematics into a portable phone may be very attractive from a cost and convenience perspective, but does not support the stolen vehicle alarm, door lock/unlock, and other features that require the device to remain in the car when the occupants have left.

   Finally, GPS is only one part of the locating solution. In addition, cellular infrastructure positioning, such as cell tower triangulation, can help. Given current technology, GPS does not operate as effectively inside multiple story, concrete or metal buildings, where many emergency calls originate.

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All of these issues, and many others, are taken into account when designing telematics systems and service.

10. **How does the airbag deployment notification feature work?**

The TCU is constantly "listening" or on the lookout for any sign of emergency. Because the TCU is connected to the engine control unit, when the airbag sensor sends a message to the engine controller to deploy the airbag, the controller alerts the TCU as well. Automotive-grade software that enables these functions and assures their reliability.

Once the TCU is alerted, it automatically makes a cellular call to the response center. The call gets priority call status and jumps ahead of other telematics calls, and the operator is alerted that a call has been received from an airbag deployment. That way, emergency crews can be sent immediately to the scene. (01)

11. **What services do consumers really want in their cars?**

Initially, autonomous navigation-only systems caught the fancy of drivers in Europe and Japan, while in North America, consumers were more interested in emergency response or emergency call systems. Increasingly, consumers are attracted to the broader spectrum of telematics services, such as the delivery of personalized information and entertainment.

12. **Do Motorola's systems use digital cellular technology?**

Yes. In Europe, Motorola's telematics systems use the European digital standard, GSM.

In North America, however, only AMPS offers the broad geographic coverage essential for reliable emergency response services. That's why it's the system being utilized in North American telematics right now.

13. **What do telematics systems cost?**

While each automotive company determines its own pricing, system prices currently range from $500 to $2000 in Europe and North America. Some GM vehicles include the OnStar system at no additional equipment charge, and require only a low monthly service fee. Monthly service costs vary, depending on the services offered. Like other new technologies, we anticipate that consumer demand will ultimately drive these costs down.

14. **Do European and North American drivers expect different features?**

It's clear that Europeans and Americans are all interested in navigation, safety and security services. But the degree to which they prioritize these services varies.

In Europe, there is a greater emphasis on navigation. At the same time, frequent cross-border travel creates language barriers, making familiar navigation and security services even more welcome. In the United States and Canada, safety and security are the most desired services. North Americans are also interested in navigation, but the need for it is not as great. All drivers are interested in getting real-time traffic information.

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15. **When will North American telematics make the shift to digital?**

    In North America, the growth of telematics depends on digital cellular standards providing service over a larger geographic area, especially in cities. Unlike the European-wide GSM standard, North America has multiple standards including AMPS, TDMA, CDMA, GSM and iDEN®.

    Today, only AMPS offers wide enough geographic cellular coverage for emergency response services. That's why it is utilized in the Motorola telematics systems Motorola currently installed in North America. For data transmission on analog AMPS, modems can be added to the telematics hardware and central service center. In the future, systems will be based on digital wireless, to allow a richer array of features in metropolitan areas.

    In addition, as the industry endeavors to deliver comprehensive data services such as Internet access and customized entertainment services, the migration to digital communications technology will be even more essential.

    Companies such as Motorola, Nokia, Ericsson and Unwired Planet are addressing these issues for a wide variety of wireless devices. Through the Wireless Applications Protocol (WAP) consortium, we are working together to ensure a reliable and standard method of transferring data over wireless networks worldwide.

16. **What new technologies will help deliver greater telematics services?**

    An important, ongoing initiative that will help drive telematics growth is the ITS Data Bus, or IDB. IDB is based on an open protocol for networking car audio, video, communication and computing devices. Lead by the Society of Automotive Engineers (SAE) and supported by several corporations (including Motorola), IDB will allow seamless integration of multiple technologies inside the car.

    IDB will allow simple plug-and-play use of any consumer electronics, regardless of the manufacturer. In addition, a firewall contained in the IDB will allow all electronics in the car to operate independently of each other, eliminating signal interference.

17. **How will IDB specifically impact telematics?**

    Many companies are expected to integrate IDB into their telematics components and other electronics systems. Motorola, for example, plans to integrate IDBs into our telematics Communications Units, enabling the system to act as the central hub for all electronics interacting within the car. This will allow consumers to simply plug and play various electronics via their TCU, and take advantage of additional telematics services, without requiring multiple wires and cables overlapping in different areas of their vehicle. Not only will IDB allow easier installations, but it enable drivers to add new services without being concerned about propriety systems and wiring. With IDB, consumers will have greater choice, resulting in greater market growth.

Automatic airbag deployment notification, information services and other telamatics services must be supported by your carrier's network, depend on service availability and coverage, and require a subscription. These services are not available in all areas. Check with your service provider for availability. All location based services are subject to the availability of GPS signal or alternative location tracking means. GPS coverage is not

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available in all areas.

The use of wireless devices and their accessories may be prohibited or restricted in certain areas. Always obey the laws and regulations on the use of these products. All navigation systems select routes based on several criteria: geographic distance, type of route, and in some cases dynamic traffic information. While these systems usually opt for the shortest travel time to your destination, it is important that you take into account factors including road and driving conditions, terrain and local environments, some of which may contain hazards to you or your vehicle. Always use your best judgment when deciding on a route. As the driver of your vehicle, you are always the final decision-maker, and despite the many advantages of using any Telematics system, you are ultimately responsible for ensuring your safety.

GLOSSARY

AMPS Advanced Mobile Phone System

The first-generation analog cellular phone system that originated in the United States.

APCO

Association of Public Communications Officials

CDMA Code Division Multiple Access

An advanced digital cellular and PCS platform that converts audio signals into a stream of digital information (made up of 1s and 0s). This "digital speech packet" is transmitted via a wide-band channel consisting of several radio frequencies. CDMA differs from the other popular digital cellular platform, TDMA, in that it uses several frequencies instead of just one. These digital platforms ensure greater call clarity and security, prevent cloning fraud and allow a greater number of calls to be handled by a tower or response center at one time.

CDPD Cellular Digital Packet Data

Using the existing AMPS system to carry digital data, by transmitting dense packets of information across vacant analog channels.

CTIA

Cellular Telephone Industry Association

Data Bus

The central collection of wires that carry instructions to electronic components throughout the vehicle.

DCS-1800

The low-power variant of GSM (the European digital standard). Uses a 1.8 GHz carrier. Example: Mercury One-2-One.

DCS-1900

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The proposed use of GSM (the European digital standard) with a 1.9 GHz carrier for PCS applications.

DCTU Digital Cordless Telephone U.S.

A standard based on a micro-cellular radio system that provides low-power cordless access between a subscriber and a base station up to a few hundred meters away. DCTU is a version of its European counterpart, DECT.

DECT Digital European Cordless Telephone

A standard based on a micro-cellular radio system that provides low-power cordless access between a subscriber and a base station up to a few hundred meters away.

ETACS Enhanced TACS (Total Access Communication System)

European analog cellular.

ETSI European Telecommunications Standards Institute

The standards body responsible for GSM.

FDMA Frequency Division Multiple Access

Used for AMPS and TACS, the two key analog systems and their variants, this system gives each conversation its own unique radio channel.

FLEX® Protocol

Created by Motorola, FLEX is the global de facto standard for high-speed, one-way alphanumeric paging. With its ability to handle more robust code transport messages effectively, Motorola's FLEX protocol is laying the foundation for graceful growth from 1600 to 6400 bits per second (bps) transmission rates.

Gateway

A device that allows consumer products to interface with the communication system in vehicles, while protecting the vehicle's system from defective devices or inappropriate messages.

GPS Global Positioning System

Also refers to Global Positioning Satellite. A system using satellites, receivers and software to allow users to determine their exact geographic position.

GSM Global System for Mobiles

A European digital standard.

Half-Rate

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A variant of GSM, Half-Rate doubles system capacity by more efficient speech coding.

IDB ITS Data Bus

A medium-speed multiplexed bus intended for command and control of devices in vehicles. It has been proposed by Motorola and the Society of Automotive Engineers (SAE) as an industry standard. Should this happen, IDB will allow device manufacturers to create products that will be compatible with all vehicles - versus today's data bus systems which differ by automobile manufacturer. The IDB would interface with an existing vehicle bus through a gateway.

iDEN® Integrated Digital Enhanced Network

A new generation of digital wireless technology developed by Motorola to enable multiple services to be delivered from a single, integrated wireless communications system. iDEN is the backbone of the Nextel all-digital cellular service.

InFLEXion®

A Motorola protocol which enables transmission and storage of voice messages and offers enhanced privacy, channel efficiency and ease of use. What's more, InFLEXion allows greater detail and expression to come through.

IS-41

The protocol for "roaming" within the U.S., describing how services should "hand over" between operators.

IS-54

The TDMA standard for U.S. digital cellular.

IS-95

The CDMA standard for U.S. digital cellular.

ISO 9000

The International Organization for Standardization (ISO) published the ISO 9000 series of quality management and quality assurance standards in 1987 as a means to rationalize the many various national approaches to the subject of product quality. The ISO 9000 series has been widely recognized as an aid in developing manufacturing and service organizations' quality management as an additional assurance to product purchasers that the products and services they buy will consistently meet quality objectives.

ISO 9001

This standard is used when conformance with specific requirements is to be assured by the supplier during several product stages including design and development, production, testing, inspection and servicing.

ITS IntelligentTransportation Systems

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A broad range of diverse technologies, including information processing, communications, control and electronics, which, when applied to our transportation system, can save time, money and lives.

ITS America IntelligentTransportation Systems of America

An organization mandated by the U.S. Congress in 1991 to foster public and private partnerships to increase the safety and efficiency of surface transportation through the application of advanced ITS technologies.

JDC Japanese Digital Cellular

Now renamed PDC.

JTAC Japanese Total Access Communication

Like the European TACS, JTAC is the Japanese analog cellular system.

LMR Land Mobile Radio

Wireless communication for specialized applications, such as taxis and emergency services.

MMI Man/Machine Interface

Also known as User Interface. The means by which the user interacts with a machine or device. In the past, knobs, dials and displays manipulated by a user's hand were common interfaces on technical devices. Today, MMI includes more advanced functions such as Voice Dialing, speech synthesis and touch screens.

NAMPS

Narrowband AMPS.

PCS Personal Communications Service

Service that bundles voice communications, numeric and text messaging, voice mail and other features into one device, service or bill.

PCS-1900

Like DCS-1900, this refers to the proposed use of a 1.9 GHz carrier for PCS applications.

PDC Personal Digital Cellular

The Japanese cellular standard.

PHS Personal Handy System

The Japanese cordless phone standard.

Protocol

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A standard set of rules that governs how computers or other electronics communicate with one another. Protocols define a message's format as well as how they are exchanged. Agreeing to a standard protocol allows different types of computer systems to communicate with one another in spite of their differences.

PSAP Public Safety Answering Point

PSTN Public Switched Telephone Network

QS 9000

The quality system standard established by Chrysler, Ford, General Motors, truck manufacturers and other subscribing companies. This standard includes the ISO 9000 requirements, plus additional requirements for all aspects of the business. QS 9000 includes a detailed Advanced Product Quality Planning, Control Plan, Continuous Improvement, Production Part Approval Process, Manufacturing Capabilities methodologies and more.

ReFLEX®

The world's first two-way alphanumeric paging protocol, created by Motorola. ReFLEX enables pagers to confirm receipt, respond to and initiate messages.

SAE Society of Automotive Engineers

A one-stop resource for technical information and expertise used in designing, building, maintaining and operating self-propelled vehicles for use on land or sea, in air or space.

SIM Subscriber Identification Module

A card used in GSM to personalize a handset.

TACS Total Access Communication System

European analog cellular.

TCU Telematics Control Unit

The embedded vehicle control unit that communicates with the automobile controls, GPS satellite and customer service center to provide Telematics features to a driver.

TDMA Time Division Multiple Access

An advanced digital cellular platform that converts audio signals into a stream of digital information (made up of 1s and 0s) and divides it into "digital speech packets" according to time. The packets are then transmitted one a single radio frequency. TDMA differs from the other popular digital cellular platform, CDMA, in that it uses one channel instead of many. These digital platforms ensure greater call clarity and security, prevent cloning fraud and allow a greater number of calls to be handled by a tower or response center at one time.

TETRA TErrestrial Trunked RAdio

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European digital cellular land mobile radio system.

TIA Telecommunications Industry Association

The United States' telecommunications standards making body.

User Interface

Also known as Man/Machine Interface (MMI). The means by which the user interacts with a machine or device. In the past, knobs, dials and displays manipulated by a user's hand were common interfaces on technical devices. Today, User Interfaces include more advanced functions such as Voice Dialing, speech synthesis and touch screens.

VR Virtual Reality

Used in a variety of Motorola products and services, it is a type of computer-generated environment in which the user interacts with the environment in three dimensions that provide sensory information to make an individual feel that they are in a different place.

WAP Wireless Application Protocol

A standard that aims to align industry efforts to bring advanced applications and Internet content to digital cellular phones.

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GENERAL INFORMATION

The Battery - Overview - All Models

THE BATTERY

Model: All

Production Date: All

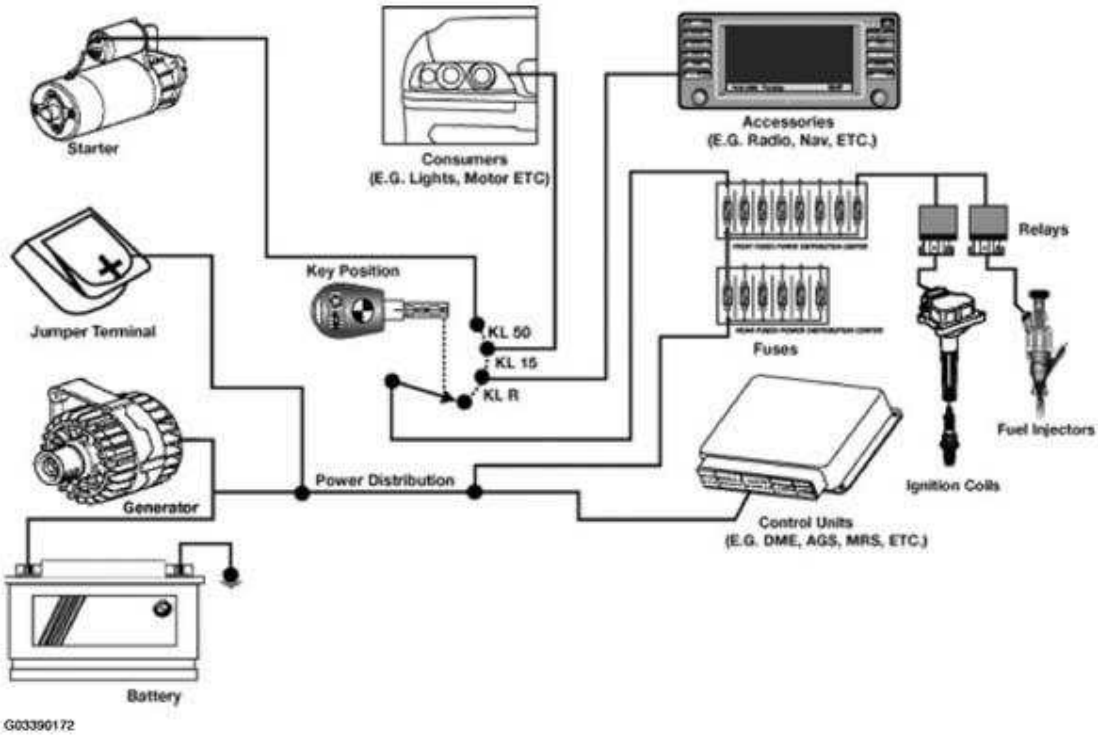


Fig. 1: View Of Electrical Components Connected To Battery
Courtesy of BMW OF NORTH AMERICA, INC.

Purpose of the Automotive Battery:

The battery is the primary EMF source in the automobile. In addition the battery performs the following functions:

- Provides voltage and current for the starter motor.
- Provides voltage and current for the ignition during cranking.
- Supplies all electrical power when the charging system is not operating.
- Supplies the extra power necessary when the vehicle's electrical load exceeds the supply from the charging system.
- Acts as a voltage stabilizer in the electrical system. The battery evens out voltage spikes and prevents

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them from damaging other components in the electrical system.

- Provides power to KL30, KL15 and KLR.

The battery does not store electrical energy. It stores chemical energy that is converted to electrical energy as it discharges.

BATTERY CONSTRUCTION

Modern automotive batteries are made of cases (usually plastic) containing alternating plates of Lead and Lead Dioxide (or Lead Oxide) separated by insulators. These alternating plates are connected in series to produce a voltage of 12.6 volts, or about 2.1 volts for each set of Lead and Lead Dioxide plates. The negative terminal is connected to a Lead Dioxide plate and the positive terminal to a Lead plate.

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Fig. 2: Identifying Battery Plates
Courtesy of BMW OF NORTH AMERICA, INC.

The plates are covered with electrolyte which is a solution of 35% Sulfuric acid and 65% Water.

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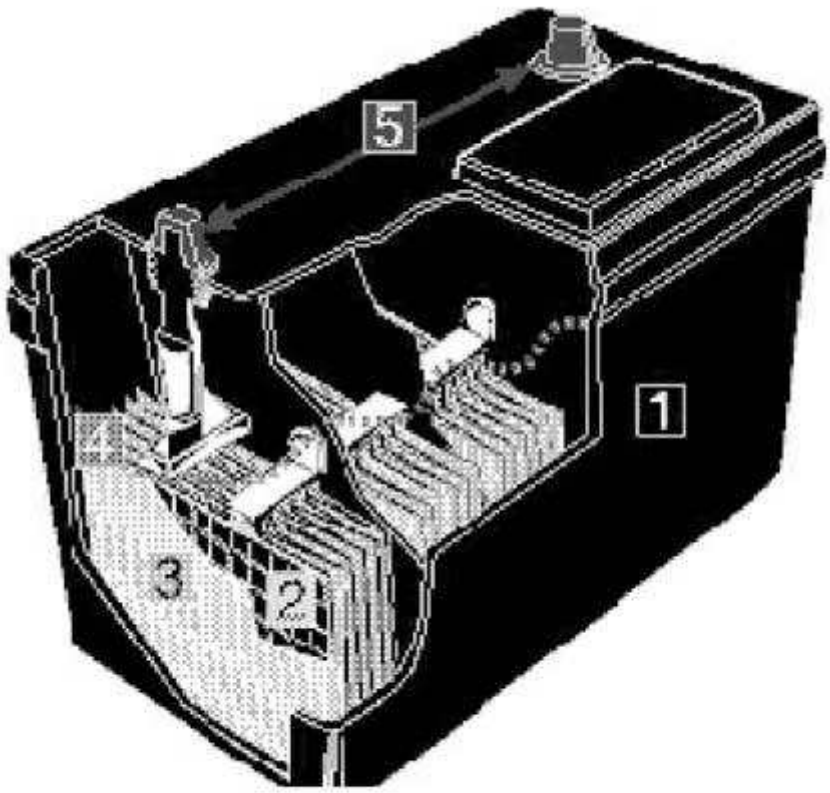


Fig. 3: Cross Sectional View Of Battery
Courtesy of BMW OF NORTH AMERICA, INC.

1. Plastic container.
2. Positive and negative internal plates made of lead.
3. Plate separators made of porous synthetic material.
4. Electrolyte which is a dilute solution of Sulfuric acid and water better known as Battery Acid.
5. Lead terminals which are the connection point between the battery and whatever it powers.

Battery Case

Most battery cases and their covers are made of polypropylene. The case is divided into six sections or cells, shaped similar to an ice-cube tray.

The case is designed to:

- Withstand hot and cold temperature extremes.
- Resist damage caused by mechanical shock in automotive applications.

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- Resist acid absorption and chemical damage.

The Grids

The grids are the supporting framework for the active material of the plates. They also conduct current to and from the active material plates.

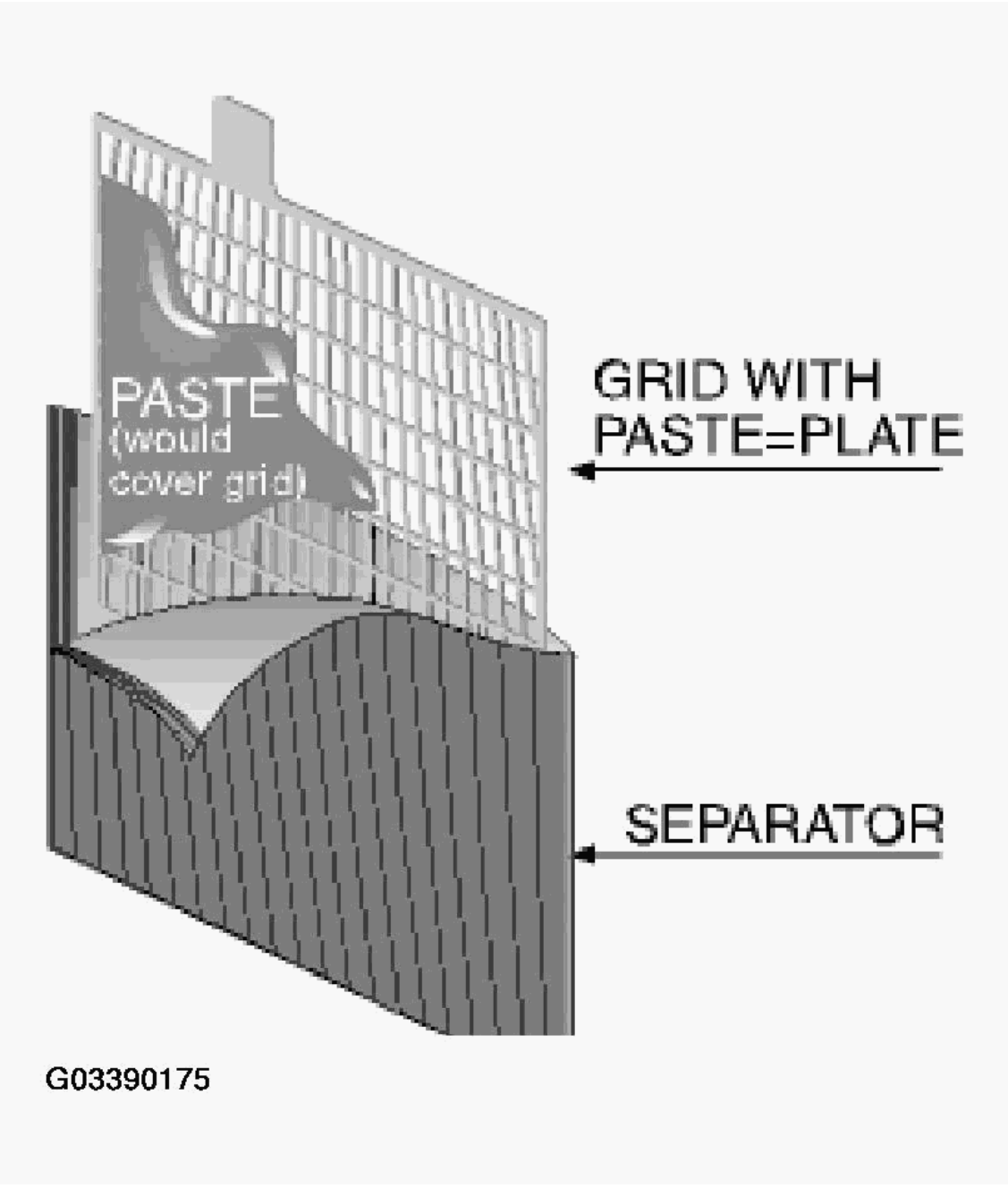


Fig. 4: Identifying Battery Grids
Courtesy of BMW OF NORTH AMERICA, INC.

The Plates

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Plates are grids covered with a paste mixture of Lead Oxide and Sulfuric Acid and water. An expander material made of powdered sulfates is added to the paste to produce negative plates.

A forming charge is applied to the positive plates converting the Lead Oxide to Lead Dioxide, a highly porous material which allows the electrolyte to freely penetrate the plate.

A forming charge is also applied to the negative plates converting the Lead Oxide to Sponge Lead. The Sponge Lead allows the electrolyte to penetrate freely allowing the material beneath the plate surface to take part in the chemical reaction.

The Separators

Separators are thin sheets of electrically insulating porous material used as spacers between the plates to prevent short circuits within the cells.

Fine pores in the separators allow ionic current flow in the electrolyte between the positive and negative plates.

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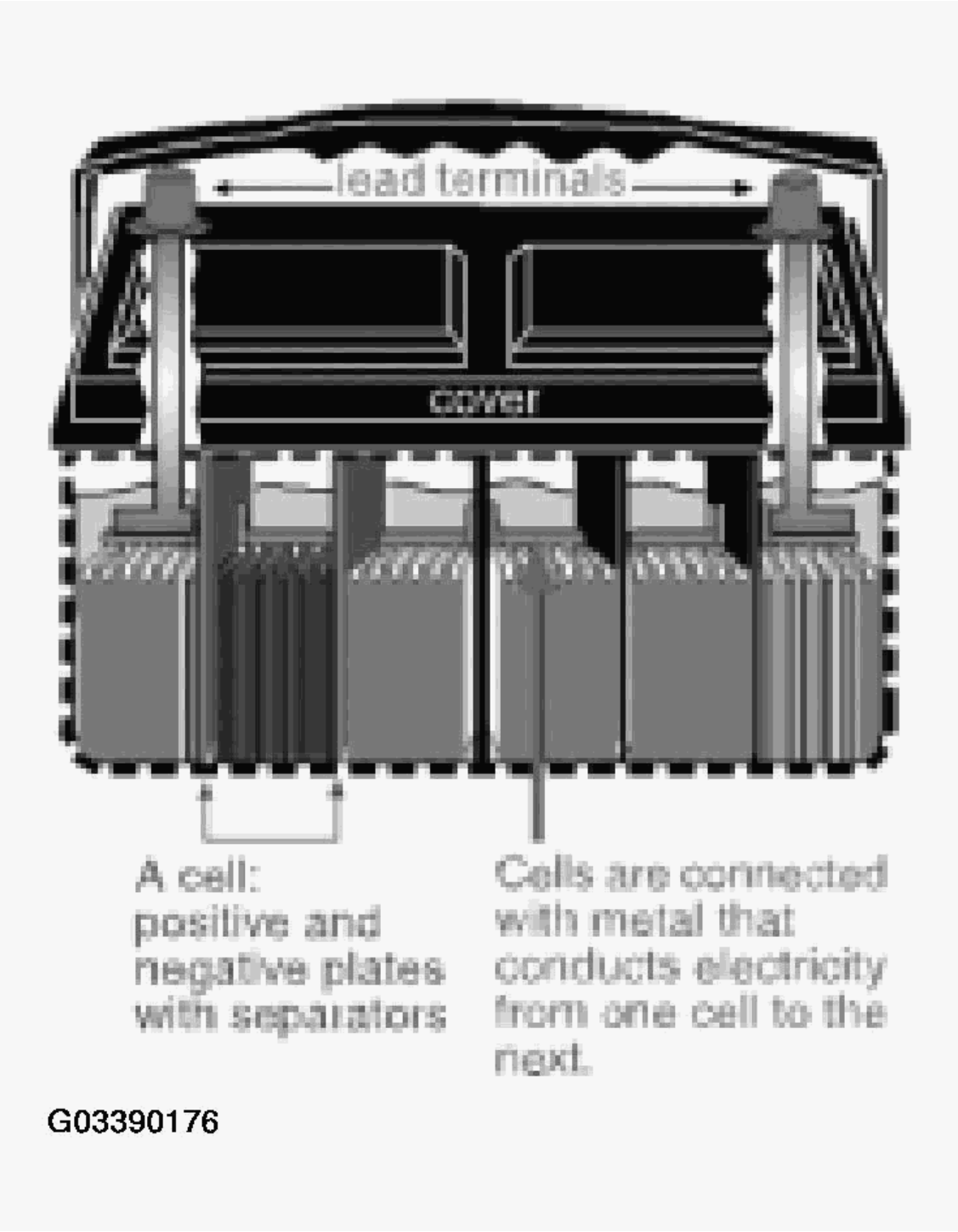


Fig. 5: Identifying Battery Separators
Courtesy of BMW OF NORTH AMERICA, INC.

Elements

In the most common method of construction, a stack of alternate positive and negative plates are formed with separators between each positive and negative plate. The lugs of the negative plates are welded together as are

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those of the positive plates. The plate strap of each group of plates is used to connect them in series with the plate group of the next cell, or with a battery terminal.

The assembly resulting from placing one positive plate group and one negative plate group together, with separators is known as an element. There is one element per battery cell. More or larger plates per cell will increase plate surface area and increase capacity of the battery but will not affect the voltage output.

Electrolyte

The electrolyte is a mixture of Sulfuric Acid and Water. Electrolyte consists of 35% sulfuric acid and 65% water.

The electrolyte is the carrier for the electric current to move between the positive and negative plates through the separators.

The Lead Terminals

BMW's use a tapered top terminal. This design uses tapered terminal posts built to industry standards so that all cable clamps will fit any battery with these posts.

The positive terminal is slightly larger than the negative to minimize the danger of installing the battery in reverse. The positive terminal is 17.5mm in diameter at the top. The negative terminal is 15.9mm at the top.

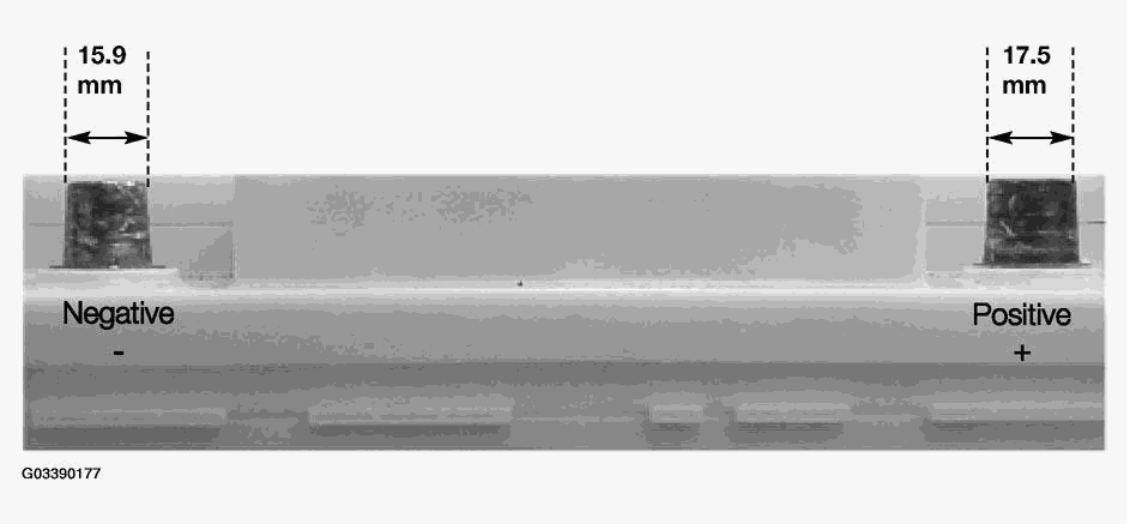


Fig. 6: Identifying Battery Terminals
Courtesy of BMW OF NORTH AMERICA, INC.

BATTERY TYPES

There are at least three types of the Lead-acid batteries that are currently used in the Automotive Industry.

Lead-Acid Battery

The three major contributors to battery chemistry are lead, lead dioxide and sulfuric acid. Pure lead is too soft to

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withstand the physical abuse of mobile applications, so a strengthener is needed. About 6% antimony, a semi metallic element produced as a by-product to copper and lead ore refining, is added to strengthen the lead.

The antimony added to the grids acts as a catalyst and makes the loss of hydrogen and oxygen through outgassing worse. These batteries require frequent water replenishing.

Lead/Calcium Battery

Introduced in the 1970's Lead/Calcium batteries have Calcium added to the positive and negative grids to reduce the outgassing. These batteries were first referred to as "maintenance free". The Lead/Calcium batteries are not resistant to deep-cycling which occurs when a battery is drained to a very low voltage before being recharged. Frequent deep-cycling renders these batteries unable to sustain a charge. Lead/Calcium batteries need to be charged at higher voltage settings or they will not be recharged to full capacity.

Hybrid Battery

Hybrid batteries use a positive grid strengthened with antimony and a negative grid with calcium. The hybrid battery is more resistant to deep cycling than the lead/calcium, but still not as good as the original Lead-acid battery. Water usage is greatly reduced in the hybrid battery, although regular checking is advisable. Most cars supplied with hybrid batteries have their voltage regulators set to 14.3 volts.

Hybrid batteries were first installed in the E30 convertible during the 1991 Model Year.

HOW THE BATTERY WORKS

Discharging

Batteries don't store electrical energy, they store chemical energy and convert it to electrical energy during the discharging process.

Each cell of a battery contains positive and negative plates (grids). The positive plate is made of lead dioxide, the negative plate of a spongy lead. The negative plate combines with the sulfuric acid to create lead sulfate and one extra electron. The positive plate produces hydrogen ions and sulfuric acid ions (positive ions, atoms missing one electron).

The extra electrons from the negative plate are passed from the negative battery terminal and through the electrical consumer, back to the positive battery terminal. Once back at the battery, the free electrons combine with the positive ions at the positive battery terminal producing lead sulfate and water.

It is important to remember that the system is closed. For every electron generated at the negative terminal, there is an electron consumed at the positive terminal.

As the process continues, the active materials (lead and lead dioxide plates and the electrolyte) become depleted and the reactions slow down until the battery is no longer capable of supplying electrons. At this point the battery is discharged.

The discharge process changes the ratio of sulfuric acid to water in the electrolyte, as more water is produced in the discharge process. By measuring the volume of acid in the water, the state of charge of the battery is

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discovered.

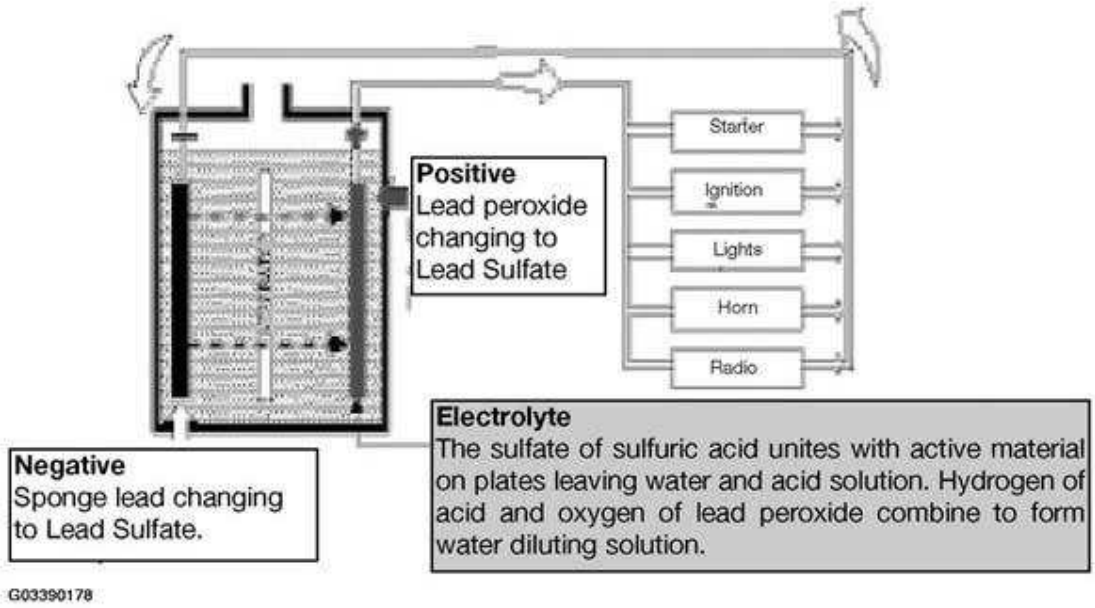


Fig. 7: Identifying Discharge Process
Courtesy of BMW OF NORTH AMERICA, INC.

Charging

Applying voltage to the battery from an external source such as the generator or battery charger reverses the chemical action in the battery.

Reversing the chemical action in the battery, forces the free electrons at the negative terminal of the battery back into the electrolyte raising the sulfuric acid percentage. This chemical action removes the Lead sulfate that had formed on the negative plates leaving pure active material.

The electrons that were forced into the electrolyte are able to react with the lead sulfate on the positive terminal again raising the Sulfuric acid content and leaving pure active material on the positive plates.

This process enables the battery to be used over and over again.

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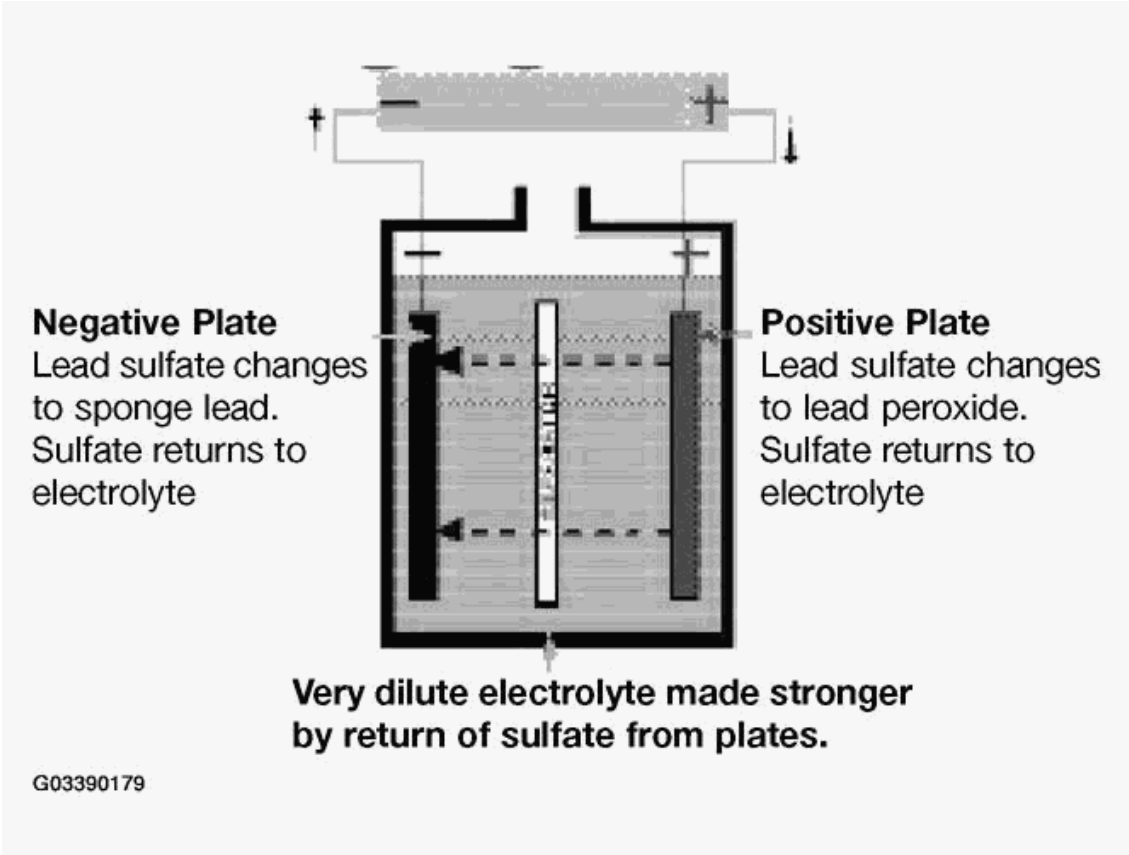


Fig. 8: Identifying Charging Process
Courtesy of BMW OF NORTH AMERICA, INC.

COMMON BATTERY TERMS

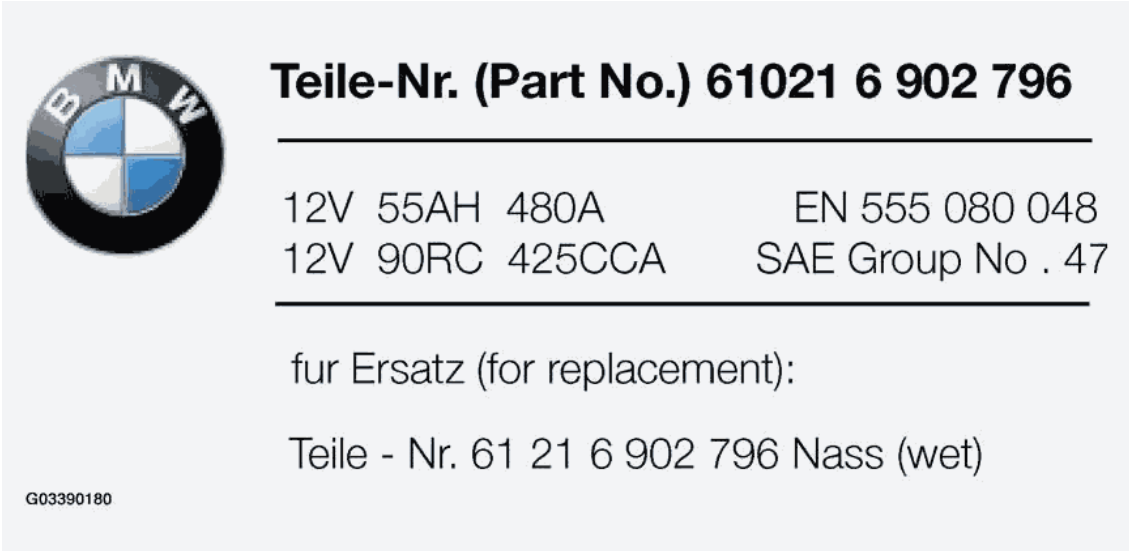


Fig. 9: View Of Battery Label
Courtesy of BMW OF NORTH AMERICA, INC.

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- **Ah - Amp Hour Capacity**

  This rating is derived from discharging a fully charged battery at a constant amp draw for 20 hours @ 80° F, without the voltage of the battery falling below 10.5 volts. The constant amp draw is multiplied by the 20 hours to come up with the Amp Hour Rating.

- **CCA - Cold Cranking Performance**

  Represents the amperage capacity a fully charged battery can deliver @ 0°F for 30 seconds before the voltage of the battery falls below 7.2 volts.

- **RC - Reserve Capacity**

  Reserve capacity is expressed in minutes and relates to the amount of time a fully charged battery can maintain a constant draw of 25 amps @ 80°F before the voltage falls below 10.2 volts.

- **W - Watts**

  The measurement of electrical power that the battery can deliver for a cold start. It is calculated by multiplying the starter amperage draw @ 0°F times 10 volts.

- **V - Volt**

  Unit of measure of potential difference (Electrical pressure).

- **A - Amp**

  The current flow in a circuit. Value is proportional to the number of electrons flowing past a point in one second.

- **ohms - Ohm**

  The measurement of the resistance of a component or circuit to current flow.

- **Electrolyte**

  The mixture of sulfuric acid and water. 35% sulfuric acid, 65% water.

- **Specific Gravity**

  The measurement (by weight) of the volume of sulfuric acid in the electrolyte. A specific gravity of 1.275 (the specific gravity of a fully charged battery) means that the electrolyte is 1.275 times heavier than water. The specific gravity of water is 1.000.

- **Sulfate**

  Deposits formed on the plates of the battery as the electrolyte gives up its sulfuric acid. Excessive deep

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cycling of a battery can cause a hardening of this deposit and make it impossible to return sulfate to the electrolyte. A sulfated battery is one which has these hardened deposits on the plates and cannot be recharged to full capacity.

- **OCV Open Circuit Voltage**

  The measurement of the voltage of a battery across the terminals.

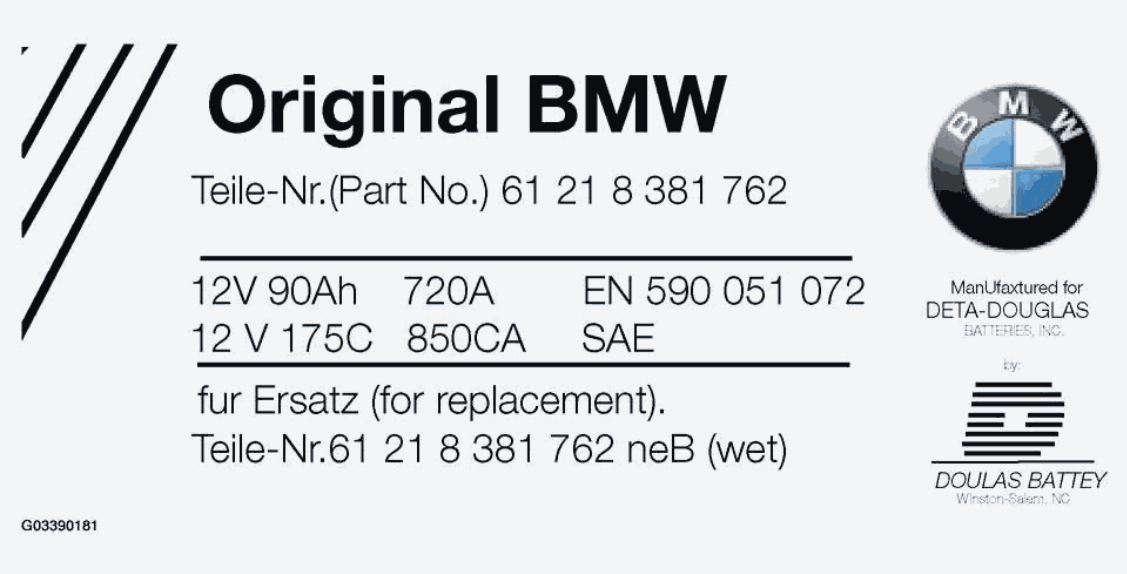


Fig. 10: View Of Battery Information Label
Courtesy of BMW OF NORTH AMERICA, INC.

BATTERY TESTING

There are four steps to follow in testing an automotive battery:

- Inspection.
- Removal of Surface Charge.
- State-of-Charge Test.
- Load Test.

Tools Needed

To test a battery following tools are needed:

- DVOM Digital Volt Ohm Meter.
- Battery Load Tester (i.e. Snap On VAT 60).
- DISplus or MoDic.
- Battery Draw Test Special Tool PN 61 2 300.
- Closed Circuit Measurement Adapter PN 90 88 6 612 310.

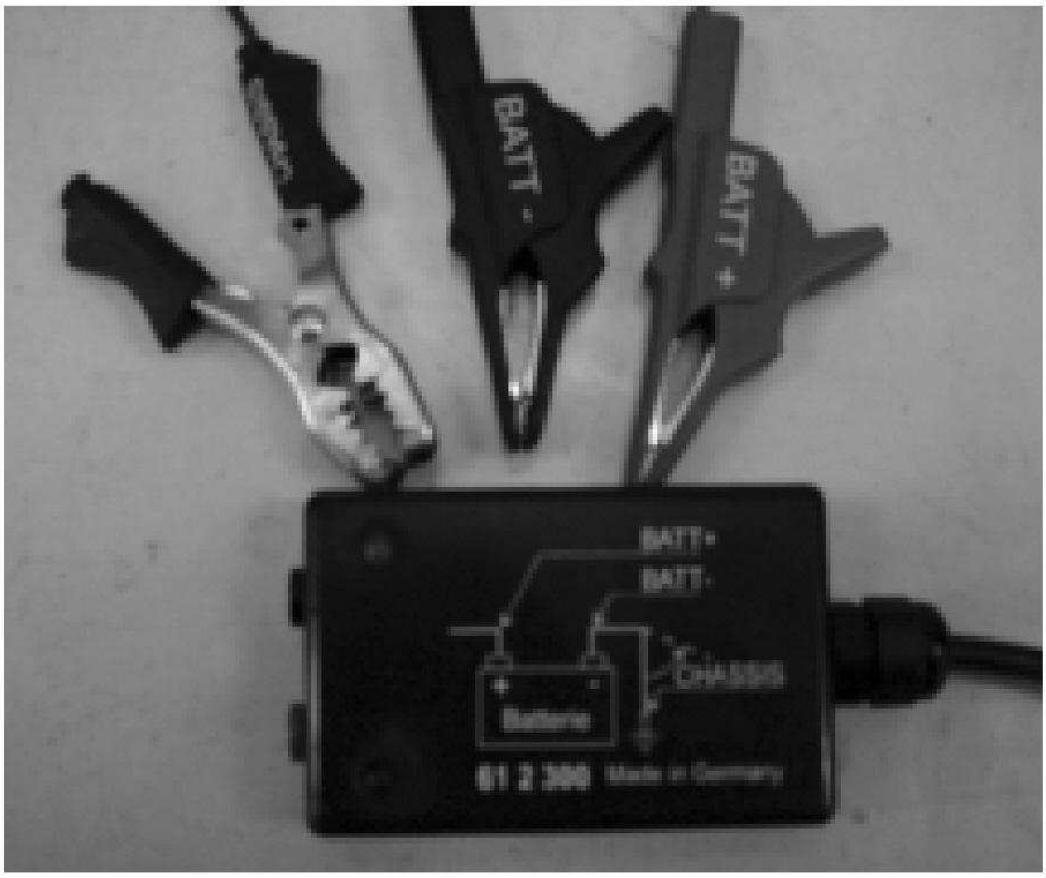
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- Temperature Compensating Hydrometer.



Fig. 11: Identifying Battery Load Tester
Courtesy of BMW OF NORTH AMERICA, INC.

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Fig. 12: View Of Draw Test Tool
Courtesy of BMW OF NORTH AMERICA, INC.

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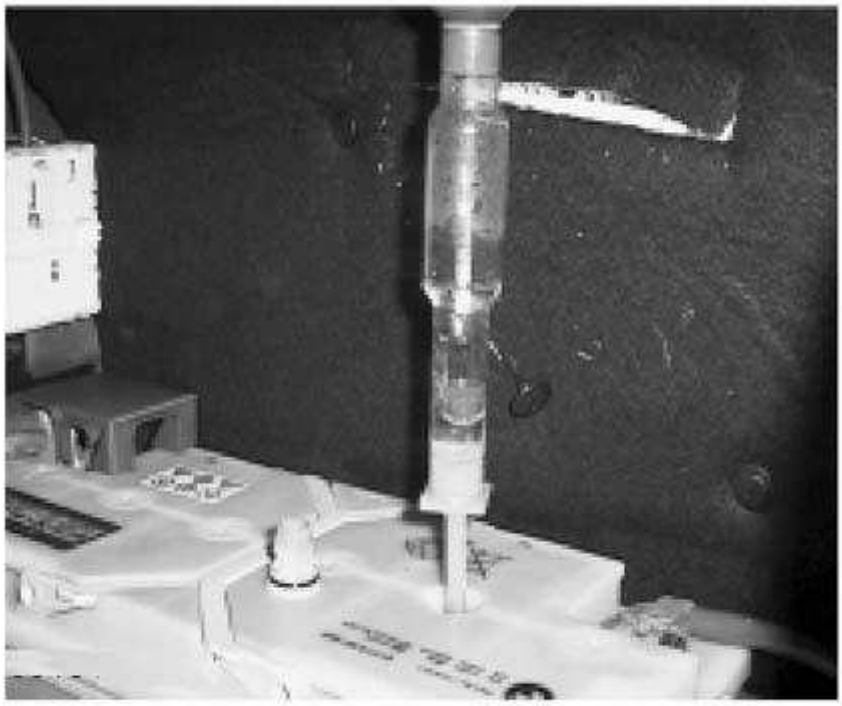
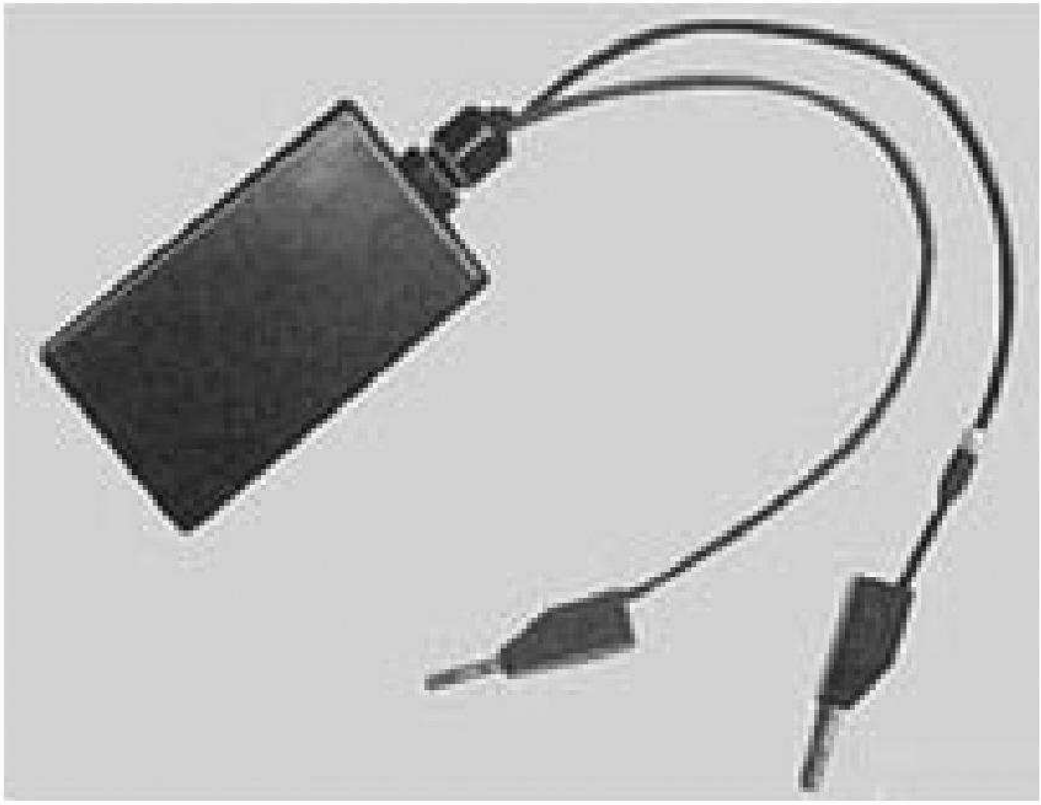


Fig. 13: Identifying Temperature Compensating Hydrometer
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Fig. 14: View Of Closed Circuit Measurement Adapter
Courtesy of BMW OF NORTH AMERICA, INC.

Inspection

Visual inspection is important for the detection of obvious problems:

- Loose Generator Belt.
- Low Electrolyte Level.
- Corroded Cable or Terminal Clamps.
- Loose Hold-Down Camps or Cable Terminals.
- Damaged Battery Case.

NOTE: The proper electrolyte level is just covering the plates, not all the way to the top of the battery inspection holes.

Removal of Surface Charge

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If the battery has just been recharged, or the car has been driven, eliminate any surface charge by one of the following methods:

- Allow the battery to sit for 2-3 hours.
- Turn the headlights on high beam for 5 minutes and wait 5 minutes after turning off.
- With battery load tester, apply a load of 1/2 the battery's CCA for 15 seconds, then wait 5 minutes.

State-of-Charge Test

OPEN CIRCUIT BATTERY VOLTAGE SPECIFICATIONS

Open Circuit Battery Voltage	Approximate State Of Charge	Average Cell SG
12.65 +	100%	1.265 +
12.45	75%	1.225
12.24	50%	1.190
12.06	25%	1.155
11.89	0%	1.120

Use the table to determine the battery's State-of-Charge.

Pay special attention if the DVOM measurement of OCV is equal to:

- 0 volts - Indicate an open cell.
- 10.45-10.65 volts - Indicates a shorted cell.

For non-sealed batteries, check both specific gravity (SG) in each cell with a temperature compensated hydrometer and battery OCV, without the engine running.

For sealed batteries, measuring the battery's OCV (without the engine running) with an accurate DVOM is the only way to determine the state-of-charge.

Batteries with a built-in hydrometer measure the state-of-charge in one cell only. If the indicator is clear or light yellow, the battery has a low electrolyte level and should be refilled before proceeding or replaced.

A state-of-charge reading **BELOW** 75% using SG, voltage measurement or dark indicator in batteries with built-in hydrometers, indicates the battery must be recharged before proceeding.

Replace the battery if one or more the following conditions are met:

- More than 0.050 difference in the specific gravity readings between the highest and lowest cell (There is a weak or dead cell).
- The battery will not recharge to 75% or greater state-of-charge or the built in hydrometer does not indicate good (green indicates 65% or better).
- DVOM reading indicates 0 volts (Open cell).
- DVOM reading indicates 10.45-10.65 volts (Shorted cell).

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Load Test

A battery which has a state-of-charge of 75% or greater or has a "good" built-in hydrometer indication may be load tested.

With a battery load tester properly installed, load the battery for 15 seconds to one of the following:

- One-half (1/2) the CCA (Cold Cranking Amps).
- Three (3) times the AH Rating (Amp Hour Rating).

The voltage on a good battery will **NOT** drop below 9.7 volts during the battery load test. After the load is removed, wait 5 minutes, the battery should bounce back to 50% or greater state-of-charge. If a battery drops below 9.7 volts during the load test, does not bounce back or fails to start the engine, the battery should be replaced. Batteries which pass this test should be recharged to restore peak performance.

Load Test Conditions

Tests assume electrolyte temperature of 80° F, 26.7° C.

If the electrolyte temperature is above 80° F add .1 volt for every 10 degrees up to 100°.

If the temperature is below 80° F subtract .1 volt for every 10 degrees to 40°.

BATTERY MAINTENANCE

Electrolyte Level

If battery electrolyte level is allowed to drop substantially, the gas volume inside the battery grows proportionately resulting in an increased amount of flammable gas mixture. Any external or internal spark may result in an oxyhydrogen explosion. Additionally the plates are no longer covered by the electrolyte and may corrode.

The battery electrolyte level should be checked on every Inspection I and Inspection II.

Use only distilled water to top up the battery!

Tap water and electrolyte must never be used to refill or top off an automotive battery.

Workshop Hint:

Electrolyte levels may drop at a higher rate in the winter months, due to higher loads and increased utilization of electrical systems.

Battery Cable Connections

The top of the battery should be clean. Check for and correct corrosion on the top of the battery and the cable connections.

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Workshop Hint

Many battery problems are caused by loose or corroded connections. Insure that cables are free from corrosion and tight before continuing diagnosis.

Battery Charging

The purpose of charging a battery is to put back the energy that has been removed. A battery that is not properly charged will deliver sub-standard performance and display a shorter life span.

A battery should be charged only after performing a visual inspection on the battery case and the electrolyte levels. Never attempt to charge a battery with a damaged case or low electrolyte levels.

A state-of-charge test should be performed before attempting to charge a battery.

Always connect the positive lead of the battery charger to the positive terminal of the battery and the negative lead of the battery charger to the negative terminal of the battery.

Unplug the charger or turn it off **BEFORE** disconnecting the leads at the battery.

Batteries that are fully discharged should be charged according to the following table.

BATTERIES SPECIFICATIONS

Reserve Capacity Rating (RC)	Slow Charge	Fast Charge
80 minutes or less	15 hours @ 3 amps	2.5 hours @ 20 amps
80 to 125 minutes	21 hours @ 4 amps	3.75 hours @ 20 amps
125 to 170 minutes	22 hours @ amps	5 hour @ 20 amps
170 to 250 minutes	23.hours @ 6 amps	7.5 hours @ 10 amps
Above 250 minutes	24 hours @ 10 amps	6 hours @ 40 amps

The best charging method is to **SLOWLY** recharge the battery using the BMW approved battery charger.

A slow charging rate allows more time for the electrolyte to penetrate the plates.

Sulfated Batteries

Continuous discharging of the battery or low electrolyte levels cause crystals to form on the plates. These crystals of lead sulphate occur when a battery is discharged. The deeper the discharge the more serious the sulphation. The sulphur molecules that form the sulphate are then absent from the electrolyte, causing the electrolyte to become inefficient.

A battery relies on clean plates and strong electrolyte to both receive charging current and offer strong current discharge. A sulphated battery can do neither. Proper recharging of the battery will remove some but not all of the sulphate. Eventually the battery plates are coated with enough sulphate that it is impossible to achieve an efficient recharge.

Testing A Battery for Sulphation

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A battery which fails the load test should be tested for sulphation. To test a battery for sulphation, place it on a battery charger for three minutes with the charger set on 40 amps. After three minutes check the OCV, if the reading is greater than 15.0 volts the battery is sulphated. Batteries which indicate a sulphated condition should be recharged slowly and retested before being discarded.

Battery Freezing

A fully charged battery can be stored at sub-freezing temperatures with no damage. The battery is protected from freezing to a temperature of -75° F. A fully discharged battery however will freeze at +27° F.

Avoid freezing by keeping the battery fully charged.

Carefully inspect a battery which has frozen for a cracked case.

Battery Maintenance (Center Vehicles)

The battery charge is monitored while the vehicle is at the VPC and before it leaves on the transport. When the vehicle is having the QC I performed at the center the check list requires that the battery voltage be checked and maintained to 12.65V minimum.

In order to facilitate tracking vehicles in inventory, BMW has in place a Battery Maintenance Program. The program uses:

- Battery Log Forms.
- Battery Log Binder.
- Colored windshield stickers (red, green, yellow and white).

The Battery Maintenance Program has three possibilities:

- Vehicle in storage, battery disconnect switch removed.
- Vehicle in showroom or display.
- Vehicle in storage, Battery disconnect switch left in the vehicle.

Vehicle In Storage, Battery Disconnect Switch Removed

A four week charging cycle has been established for these cases. All vehicles arrive with a color coded sticker on the windshield. The color corresponds to the week that the battery must be charged. Also the vehicle will be provided with a Battery Log Form.

The "A" portion (Vehicle Receipt) of the Log Form must be completed during the QC I Display check and then has to be filed in the Battery Charge Log Book under the applicable color coded section. All the vehicles in that color section will have to be charged that week.

Vehicle In Showroom or Display

Because of the high consumer demand on vehicles that are being displayed and not driven, a four week charging cycle is not enough. For vehicles in the showroom the battery has to be charged as frequently as

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necessary to ensure that the battery never drops below 12.5V. Use the "C" portion of the log form (Display Vehicle - Monitored Daily) to keep track of the charging and checking of the battery.

Vehicle In Storage, Battery Disconnect Switch Left In The Vehicle.

Since the battery disconnect switch is left installed and in the "OFF" position the 3 month charge cycle can be used. Use the "D" section of the Battery Log Form to document when the battery is charged.

Upon the sale of the vehicle, the Battery Log Form should be removed from the binder and placed in the vehicle file for future reference.

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VPC USE: VIN: _____
Voltage: _____
Date: ____ /____ /____
Inspector: _____

2000
Battery Log Form

Stock # _____

This form should be filled out when the vehicle is received and updated according to the proper procedure (display vs. storage vehicle). It should be placed in the vehicle history file when sold.

Note: Failure to maintain batteries as recommended and documented with this form will be considered sufficient cause to reject warranty claims.

Ⓐ Vehicle Receipt	Model	VIN
Center #	Voltage as received	Inspected by	Date received

Ⓑ Vehicle In Storage - Charged Every 4 Weeks — Color indicates battery is to be charged during the week of . . .

Week Of	Voltage Before Charge	Charged By	Week Of	Voltage Before Charge	Charged By	Week Of	Voltage Before Charge	Charged By	Week Of	Voltage Before Charge	Charged By
Jan. 3			Jan. 10			Jan. 17			Jan. 24		
Jan. 31			Feb. 7			Feb. 14			Feb. 21		
Feb. 28			Mar. 6			Mar. 13			Mar. 20		
Mar. 27			April 3			April 10			April 17		
April 24			May 1			May 8			May 15		
May 22			May 29			June 5			June 12		
June 19			June 26			July 3			July 10		
July 17			July 24			July 31			Aug. 7		
Aug. 14			Aug. 21			Aug. 28			Sept. 4		
Sept. 11			Sept. 18			Sept. 25			Oct. 2		
Oct. 9			Oct. 16			Oct. 23			Oct. 30		
Nov. 6			Nov. 13			Nov. 20			Nov. 27		
Dec. 4			Dec. 11			Dec. 18			Dec. 25		

Ⓒ Display Vehicle - Monitored Daily

Date										
Voltage before charge										
Charged by										

Date										
Voltage before charge										
Charged by										

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Fig. 15: Battery Log Form (B Section)
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Battery Log Form Stock # _____

This form should be filled out when the vehicle is received and updated according to the proper procedure (display vs. storage vehicle). It should be placed in the vehicle history file when sold.

Note: Failure to maintain batteries as recommended and documented with this form will be considered sufficient cause to reject warranty claims.

Ⓐ Vehicle Receipt	Model	VIN	
Center #	Voltage as received	Inspected by	Date received

Ⓓ Vehicle In Storage - Charged Every 3 Months

January	Date	February	Date	March	Date
Voltage Before Charge	Charged By	Voltage Before Charge	Charged By	Voltage Before Charge	Charged By
April	Date	May	Date	June	Date
Voltage Before Charge	Charged By	Voltage Before Charge	Charged By	Voltage Before Charge	Charged By
July	Date	August	Date	September	Date
Voltage Before Charge	Charged By	Voltage Before Charge	Charged By	Voltage Before Charge	Charged By
October	Date	November	Date	December	Date
Voltage Before Charge	Charged By	Voltage Before Charge	Charged By	Voltage Before Charge	Charged By

Ⓒ Display Vehicle - Monitored Daily

Date										
Voltage before charge										
Charged by										

Date										
Voltage before charge										
Charged by										

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Fig. 16: Battery Log Form (D Section)
Courtesy of BMW OF NORTH AMERICA, INC.

NOTE: If the battery voltage drops below 11.6v for three days or more the battery must be replaced before delivery to the customer

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Battery Maintenance Flowchart

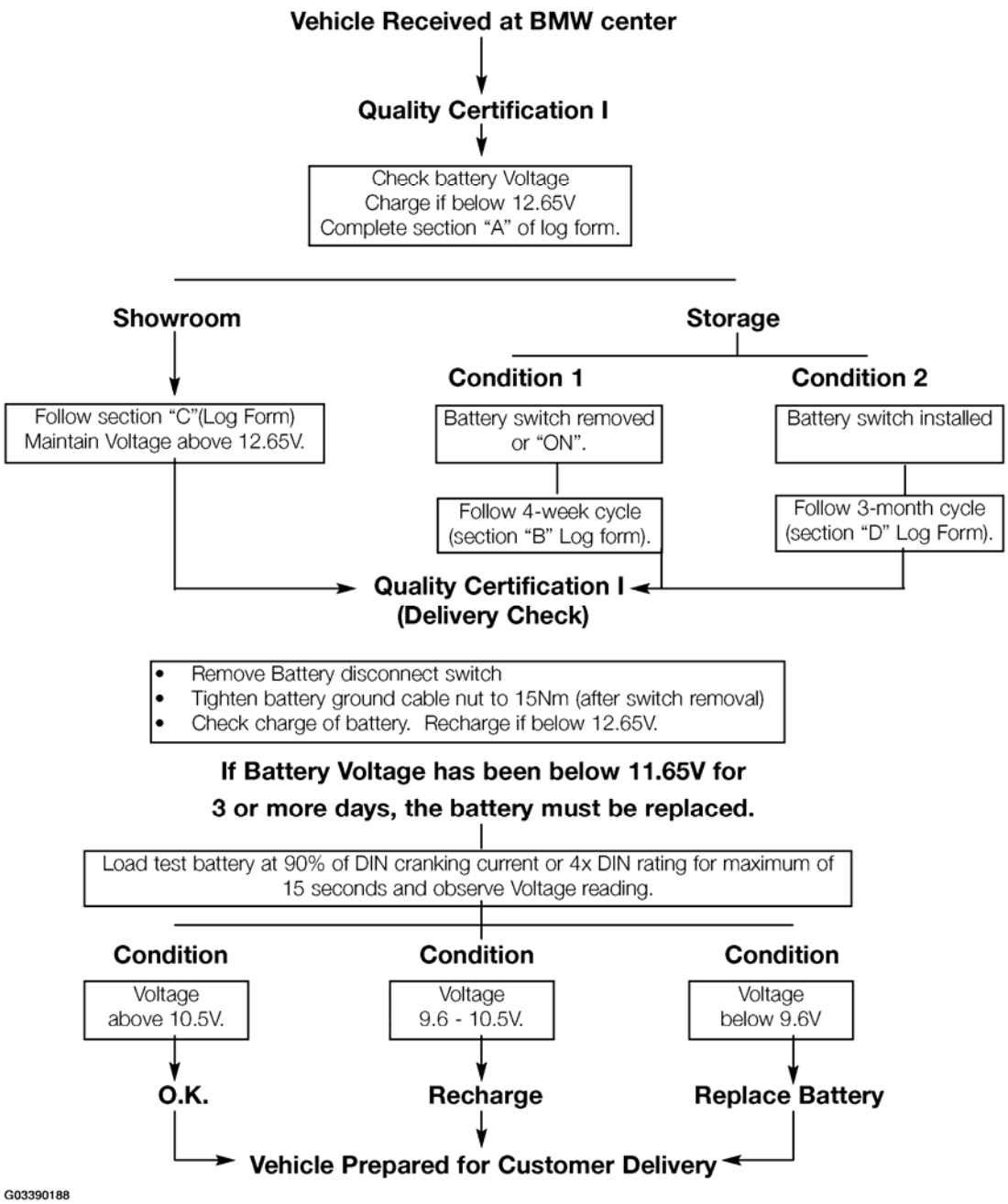


Fig. 17: Battery Maintenance Flow Chart
Courtesy of BMW OF NORTH AMERICA, INC.

BATTERY REPLACEMENT

Batteries determined to be defective through testing procedures should be replaced using the following guidelines.

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- Reconfirm battery is actually defective and it does not need charging.
- Insure that ignition switch is in "Off" position and engine is not running.
- Disconnect negative battery terminal first.
- Place negative battery cable in a position so that it can not come in contact with battery during removal process.
- Reinstall battery hold down clamp.
- Install positive cable first.
- Recheck output of vehicle generator and balance of electrical system for other problems.
- Provide clear and concise description of the defect including cell readings, load test results and any other pertinent information which led to the battery replacement.
- Tag battery with VIN and repair order number.

Battery Failures

An analysis of batteries replaced under warranty shows that many claims could have been avoided had the batteries been maintained in a full state of charge.

Batteries must be maintained at all times when vehicles are at a retailer whether they are new cars, used cars, in storage (back lot), on display, or customer cars in for maintenance or repairs.

Batteries replaced due to lack of maintenance will not be covered by warranty.

Most Common Causes of Premature Battery Failures

- Failure to maintain proper state of charge.
- Loss of electrolyte due to overcharging or excessive heat.
- Deep discharging (Leaving lights on or other parasitic draws).
- Undercharging of battery.
- Vibration (Loose battery hold down clamp).
- Using tap water (instead of distilled water).
- Corrosion.
- Freezing.

Workshop Hints

Safety Tips

- Proper Clothing:
  - Always wear a face shield or safety goggles.
  - Plastic gloves can prevent acid burns to hands.
- Neutralizing Electrolyte:

Any leakage or spillage of battery electrolyte should be neutralized as soon as possible to prevent damage to

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paint, body or trunk linings. Depending on the amount of spillage dilute some baking soda in water and apply to areas of the car that have been exposed to the battery electrolyte. The neutralizing action will create some foaming in the area where the chemical action takes place. Flush with ample amounts of water once the chemical reaction has subsided.

General Battery Hints

- Add only distilled water NEVER TOP OFF WITH ACID.
- Keep electrolyte level above plate separators.
- Keep battery top clean and dry.
- Keep open flame and metal objects away from battery top and terminals.
- Keep vent caps tightly in place (if applicable).
- Use proper charging equipment.

SPECIAL BATTERY SYSTEMS

Special battery systems are broken into two groups:

- Vibration Compensating Battery Systems.
- Dual Battery Systems.

Vibration Compensating Battery Systems

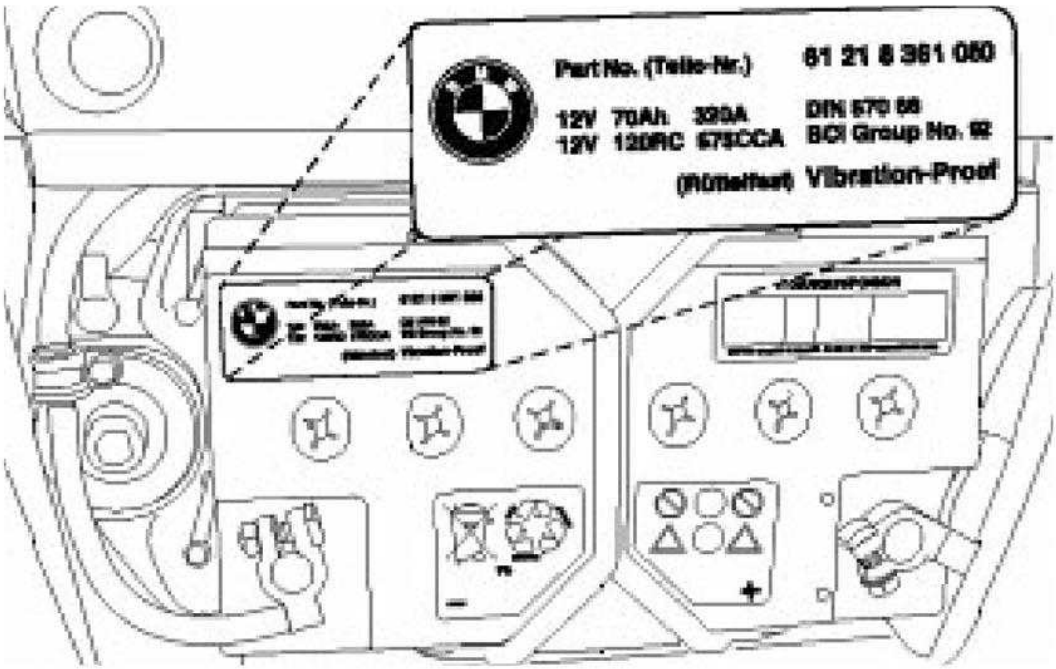
Vibration Compensating Battery Systems act as vibration absorbers, smoothing out road vibrations in the E36 and E46 convertibles.

E36:

The E36 convertible is not only an energy source. The battery is designed as a vibration dampener. Due to this additional function the battery also has a special tray with an integrated vibration absorber.

NOTE: E36 convertible batteries are labeled "Vibration Proof". Replacement batteries must be of the same type.

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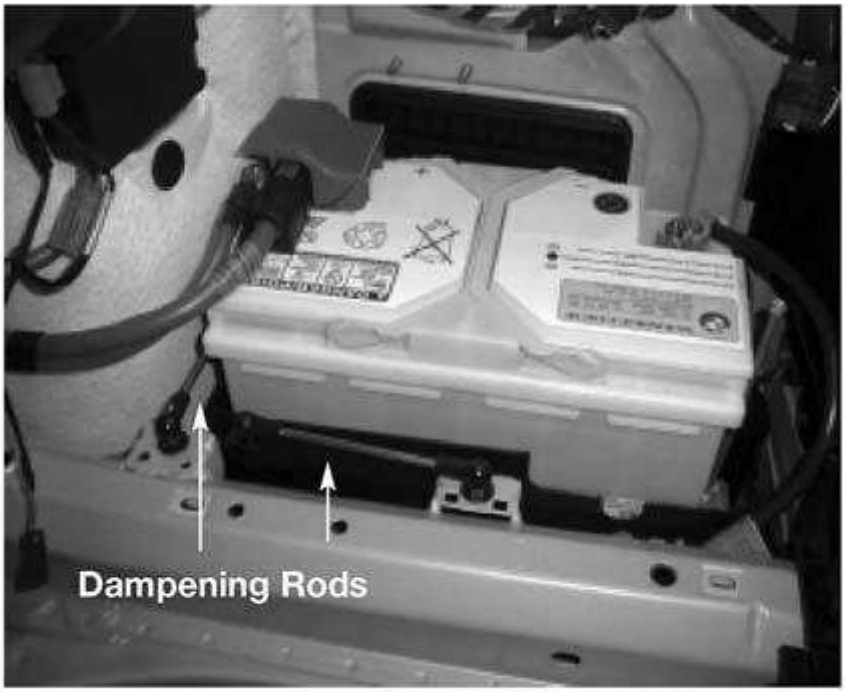
Fig. 18: View Of Battery Identification Label
Courtesy of BMW OF NORTH AMERICA, INC.

E46:

The E46 convertible uses the same battery as the E46 sedan, coupe and touring. The battery box is specially designed to float on the vertical axis through three articulated rods.

This allows the battery to act as an inertia mass and dampen various vibrations while the vehicle is driven.

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Fig. 19: Identifying Dampening Rods
Courtesy of BMW OF NORTH AMERICA, INC.

Dual Battery Systems

E31 (850i):

The dual battery system on the 850i was introduced to handle the higher level of electronic technology with increased functions and safety features that were added to the vehicle, as well as the added diagnostic information.

Design considerations were made to minimize electrical loads during Key Off and periods of driving with low engine speeds while certain timed operations (e.g. Glove compartment light, courtesy lights and seat heating) were active.

Special testing and charging procedures exist for the dual battery system on the 850i, refer to appropriate article for specific information.

E38 750iL:

The dual battery system on the 750iL is necessary due to the addition of the E-CATs. If a single battery system was used, the E-CATs would be provided power from the single battery just after cold engine start-up when the battery is at its lowest capacity. This would increase engine loads due to charging of the single battery and cause an increase in injector "On" time during the cold engine warm-up period, which result in unnecessary tail pipe

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emissions.

Providing separate battery systems for the starting circuit and the vehicle circuits also minimizes the possibility of a discharged starter battery ensuring reliable engine starting.

Components of E38 Dual Battery System

- Starter Battery: Located in the right rear trunk wheel, the starter battery is connected to the starter motor and to the heating coils of the E-CATs (via the E-CAT module).
- Vehicle Circuit Battery: Located above the starter battery on a swing out mount, the vehicle circuit battery provides operating power for the balance of the vehicles electrical requirements and is directly connected to the vehicle generator.
- Battery Isolation Switch: Located on the swing out mount of the vehicle circuit battery the battery isolation switch opens and closes the circuit between both batteries based on monitored conditions.

NOTE: The battery isolation switch is NOT used to boost a discharged starter battery with the voltage of the vehicle circuit battery to start the engine. The battery isolation switch can only withstand a maximum current flow of 60 amps.

Battery Isolation Switch

The Battery Isolation Switch provides the vehicle with separate battery systems for the vehicle circuits and the starting circuit.

When the isolation switch is open, the vehicle circuit battery is the only power source connected to the power distribution center.

When the isolation switch is closed the starter battery is charged and the vehicle circuit battery is boosted by the starter battery.

Modes of the isolation switch:

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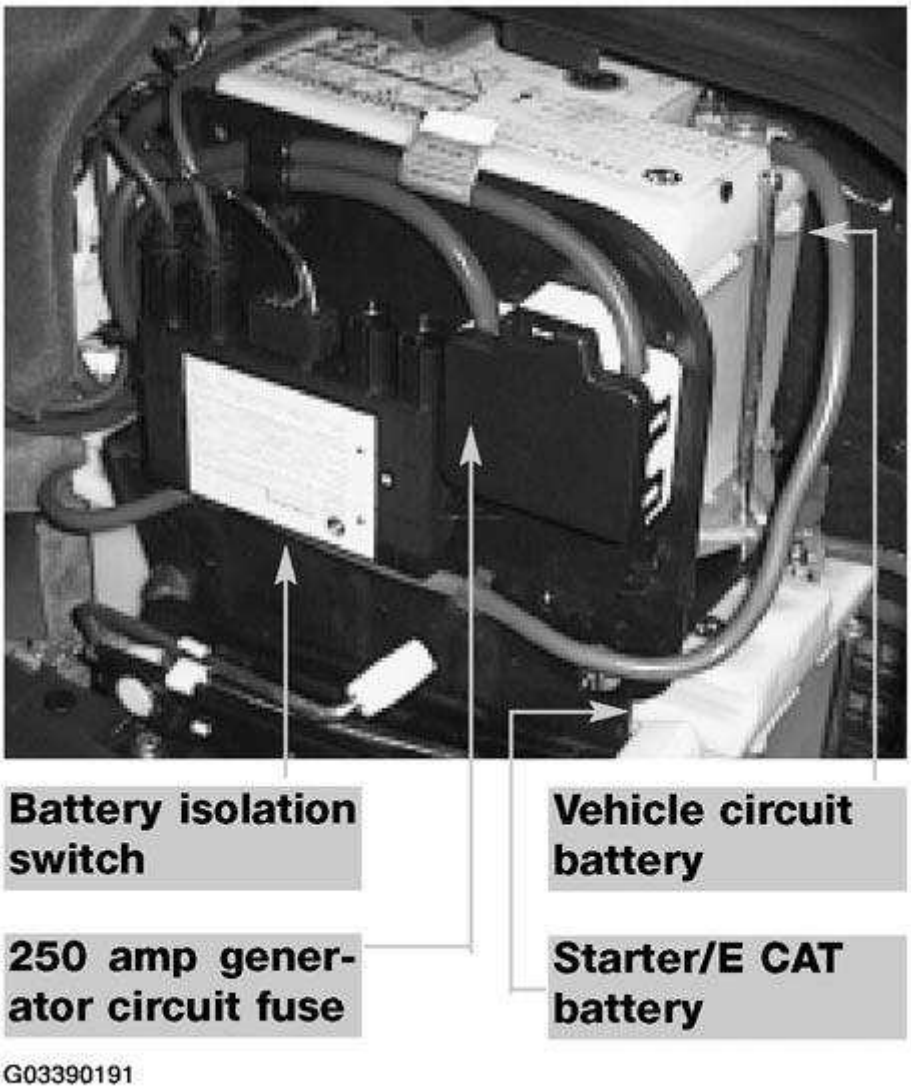


Fig. 20: Identifying Battery Isolation Switch
Courtesy of BMW OF NORTH AMERICA, INC.

- Starting Mode:
  - Normal Starting.
  - Safety Starting.
- Driving Mode.
- Charging Mode.
- Sleep Mode.

Starting Mode

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When the isolation switch recognizes KL15 via the K Bus, it determines the voltage of the vehicle circuit battery.

- If the vehicle circuit battery **IS** sufficiently charged, it proceeds with **Normal Starting.**
- If the vehicle circuit battery IS NOT sufficiently charged, it proceeds with **Safety Starting.**

Normal Starting

- The isolation switch is open.
- Within 0.5 seconds of engine start-up the E-CAT module energizes the E-CAT heating coils (program dependent) and simultaneously signals the isolation switch that the ECATs are "On" via signal "KATON" (low signal).
- Upon completion of the heating period, the E-CAT module signals the isolation switch that the E-CATs are off (High Signal).
- Under normal conditions, the isolation switch is not closed before the heating procedure is finished.

Safety Starting:

- In response to a discharged condition of the vehicle circuit battery, the isolation switch closes to momentarily boost the vehicle circuit battery and supply all systems with starter battery voltage via the power distribution center.

  This operation lasts for a maximum of 30 seconds or until confirmation of engine start up is received. (TD signal on the K Bus)

- Receiving the TD signals causes the isolation switch to immediately open for the duration of the E-CAT heating cycle.
- If the engine is not started within the 30 seconds, the isolation switch opens and remains open until KL 15 is recognized on the next start-up cycle.

Driving Mode

The vehicle circuit battery is permanently connected in parallel to the generator and is charged when the engine is running. When the isolation switch is closed, the generator simultaneously charges the starter battery.

As the vehicle is driven the isolation switch cycles between open and closed based on:

- Voltage values of both batteries.
- Current transfer between both batteries as monitored by the isolation switch.
- Internal temperature of isolation switch.

Conditions Causing Switch To Open While Driving:

- Sufficiently charged starter battery.
- Current flow through switch exceeding 0.5 amps.

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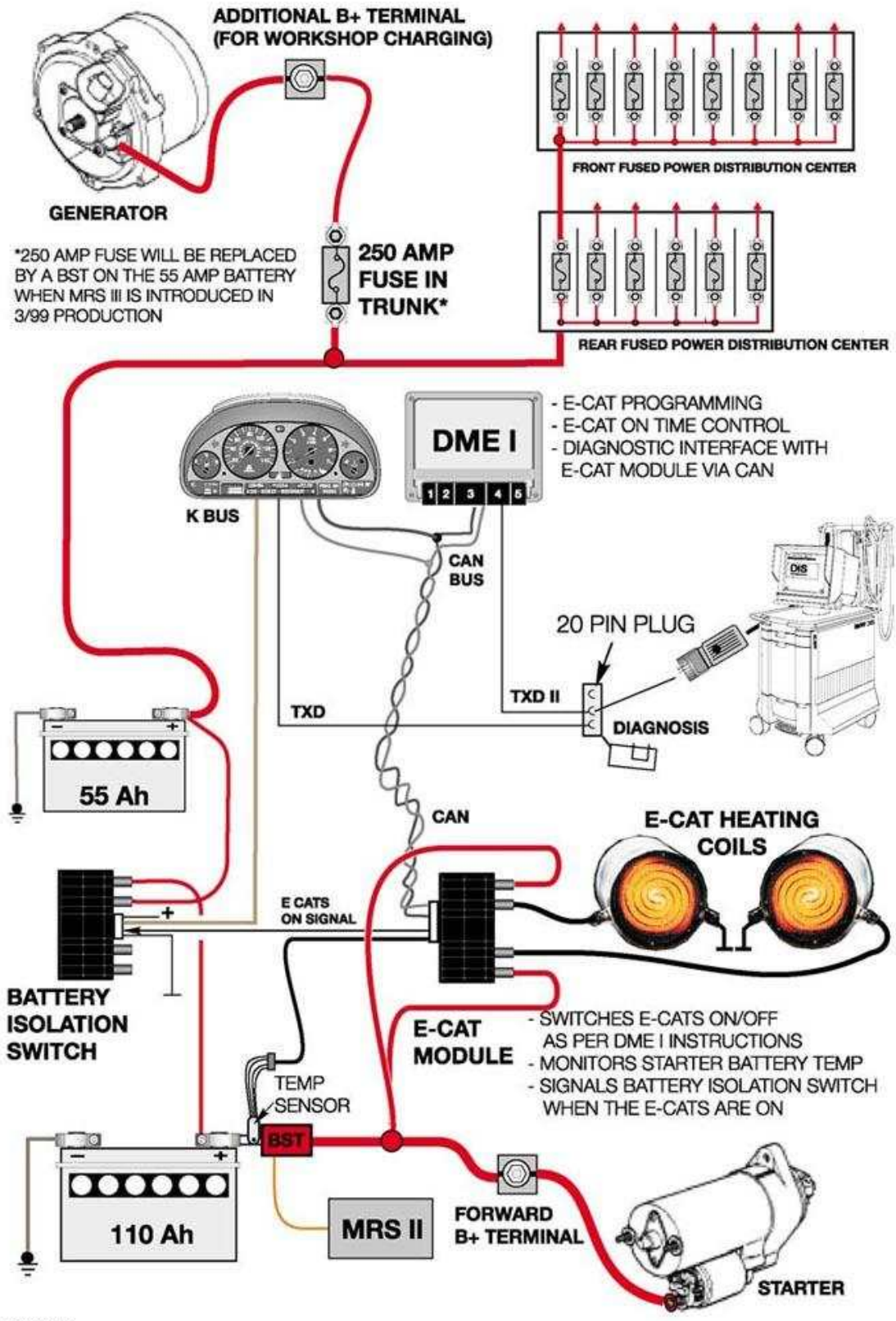
The starter battery will supplement vehicle electrical needs during periods of high demand (e.g continuous wiper operation combined with lights and blower).

- The internal temperature of the isolation switch exceeds programmed maximum value.

Conditions Causing Switch To Close While Driving:

- Monitored voltage of vehicle circuit battery exceeds that of starter battery by 0.7 volts.
- The voltage of the vehicle circuit battery drops below 9 volts three times within one minute.

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Fig. 21: Identifying Battery Charging System
Courtesy of BMW OF NORTH AMERICA, INC.

Charging Mode (in the workshop)

The isolation switch monitors starter battery voltage during key off conditions and continues monitoring after the vehicle and the isolation switch have entered sleep mode.

- If starter battery voltage exceeds 13.8 volts during charging in the workshop, the isolation switch comes out of sleep mode and closes.

  This causes the starter battery voltage to bleed off to the vehicle circuit battery, charging the circuit battery and protecting the starter battery from overcharging.

The isolation switch remains closed until the next key on cycle.

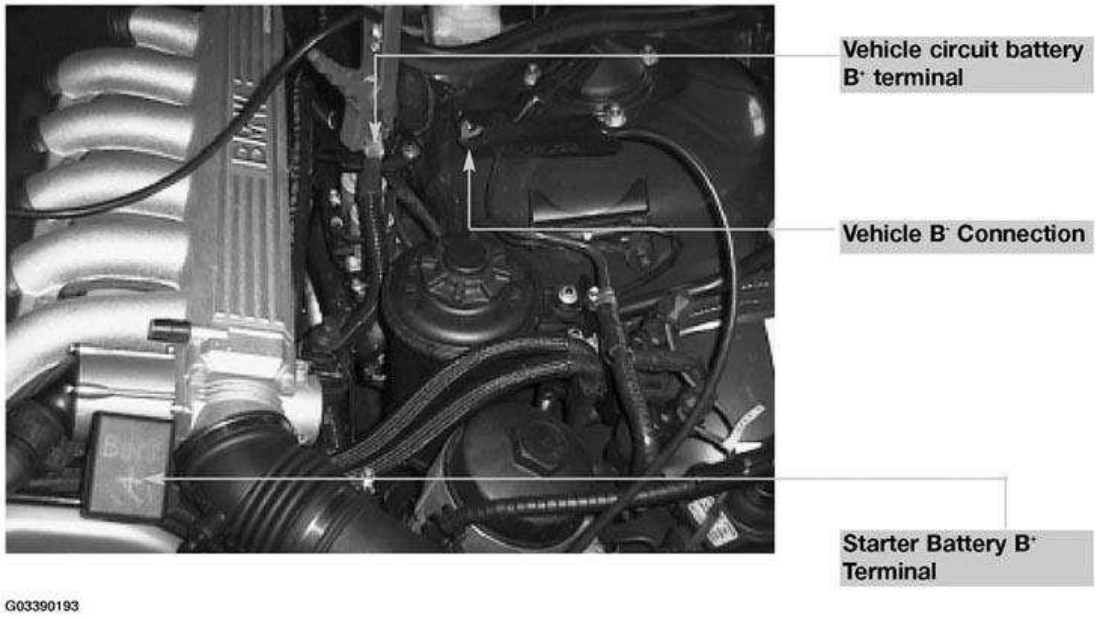


Fig. 22: Identifying Charging Mode (In Workshop)
Courtesy of BMW OF NORTH AMERICA, INC.

Sleep Mode

The isolation switch goes into sleep mode as soon as the engine is switched off. The current draw of the isolation switch drops below 1 mA. The isolation switch comes out of sleep mode if:

- KL15 is recognized.
- Starter battery voltage exceeds 13.8 volts (charging mode)

Failure of KATON signal:

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If the **KATON** signal is not received due to:

- Open or short to B+ - isolation switch closes for 4 seconds after start-up, TD received.
- Short to B- - isolation switch opens 60 seconds after receiving TD.

CLOSED CIRCUIT CURRENT DRAW TESTING

Increased closed-circuit currents may occur permanently or intermittently and cause the battery to discharge prematurely. The increase in closed circuit current may be caused by a faulty control unit or by the installation of a non-approved accessory.

In a situation where a vehicle has broken down due to a discharged battery, for diagnostic purposes it is important not to disconnect the battery. The control unit may reset if the battery is disconnected. Following a reset, a faulty control unit may start functioning correctly again, making accurate diagnosis impossible.

Tools Needed:

- Closed Circuit Current Measurement Adapter.
- MoDic Adapter.
- DISplus, MoDic or DVOM.

To correctly measure closed-circuit current, measurement adapter **61 2 300** (P/N 90 88 6 612 300) should be used. This tool provides a bridge to ground, before the negative battery terminal is disconnected, and this prevents the control units from being reset.

The additional use of MoDiC adapter **61 2 310** (P/N 90 88 6 612 310) provides a method for current measurements over an extended period of time.

The measuring device needed depends on the situation.

The DISplus may be used in situations of suspected high current draw.

The 1000 amp probe measures AC and DC current from 0 to 1000 amps. It is a self calibrating inductive pick-up. (Use this pick-up with current draws over 10 amps) The DISplus, through MFK 1 is capable of measuring up to 2 amps.

The MoDic is particularly suitable for extended measurements and provides a graphical readout of recorded measurements over time. It is recommended for the situations where the use of a multimeter provided insufficient information for problem diagnosis.

The DVOM may be used for measurements up to 10 amps either with the measurement adapter or alone.

NOTE: It is extremely important that the battery is NOT disconnected during the installation of test equipment. Disconnection of battery may cause faulty component to function normal.

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Performing Closed Current Draw Test

- Select proper measuring device (DISplus, MoDic or DVOM)
  - Remember amperage draw in excess of 10A will damage DVOM.
  - Use inductive amp probe of DISplus when amperage draw is high.
    - When using DISplus inductive probe, clamp on negative battery cable with:
    - Arrow pointing away from battery. Switch off all consumers.
    - (It is not necessary to disconnect B- from body when using inductive probe).
- Connect (-) test lead to negative battery terminal and (+) test lead to a known good ground.
- Ensure all systems are **OFF !**
- **Be sure DVOM is on and set in proper mode.**
- Disconnect battery ground lead from body.
- Observe meter reading, wait for vehicle to enter sleep mode.
- Identify faulty circuit by disconnecting fuses, relays, control modules or connectors, observing meter readings.
- Defective circuit is found when current is below maximum closed current for vehicle being tested.

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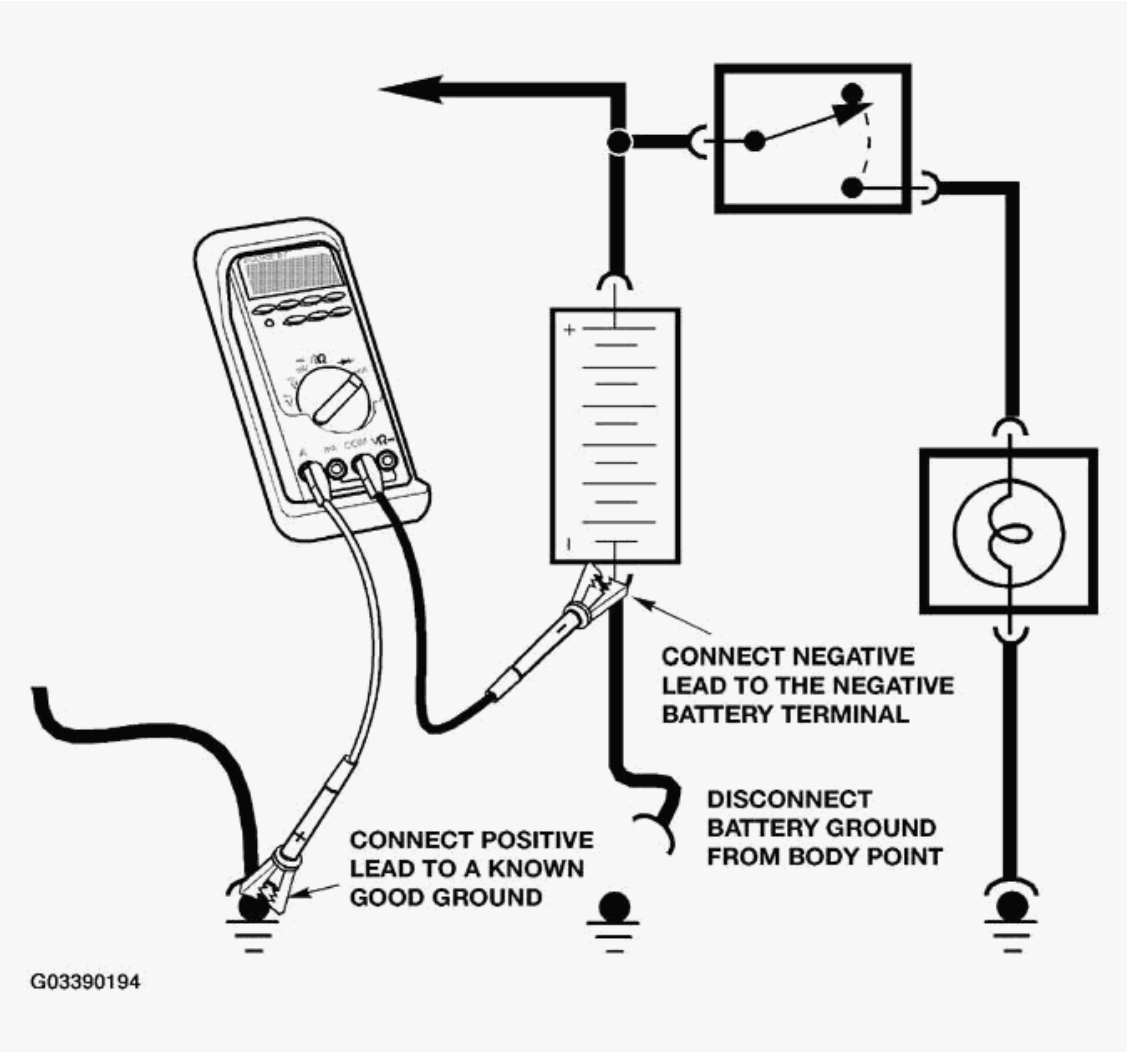


Fig. 23: Identifying Performing Closed Current Draw Test
Courtesy of BMW OF NORTH AMERICA, INC.

MAXIMUM CLOSED CURRENT BY VEHICLE

E31	50mA
E32	50mA
E34	40mA
E36	30mA
E38	50mA
E39	40mA
E46	40mA
E52	50mA
E53	40mA
Z3	30mA

NOTE: Refer to appropriate article for complete instructions to perform closed circuit

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current measurement using measurement adapter and MoDIc adapter.

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GENERAL INFORMATION

Understanding Diagnostics - Overview - All Models

UNDERSTANDING DIAGNOSTICS

Model: All

Production Date: All

Trial and error creates inconvenience for the Customer and the Service Department when mis-diagnosis or longer waits occur as the technician tries different repair attempts. This is against BMW's promise to the customer to **"Fix it right the first time, on time, every time".**

If the vehicle is not repaired efficiently the productivity of the technician suffers. Taking some time at the beginning to plan a diagnostic course of action can help give structure to what may appear in the beginning to be a chaotic situation.

As future systems increase in complexity so does their dependency on the Diagnosis Program as the principle tool for troubleshooting. However, the importance of understanding the calculated steps of a basic troubleshooting plan is just as important as before.

There will always be instances where the Test Modules provided by the DISplus need to be supplemented by a thoughtful diagnostic plan that is created by the skilled Technician. A parallel diagnostic plan that includes proper recording of test data along with the Diagnosis Program is a good habit to follow every time that troubleshooting is required.

A successful diagnostic plan will:

- Save repair time.
- Satisfy the customer by reducing vehicle down time.
- Increase Center profitability.
- Increase technician pride and earnings.

DIAGNOSTIC PLAN

The Diagnostic Plan consists of 5 steps:

- Verify the Customer Complaint - "Experience the Symptom!"
- Analyze the Problem.
- Isolate the Problem.
- Repair the Problem.
- Verify the Repair.

VERIFY THE COMPLAINT

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Most troubleshooting starts the moment you receive a written description of the customer complaint. The complaint is the customer's description of a symptom that they are experiencing with the vehicle.

Symptom

A symptom is any circumstance, event or condition that accompanies something and indicates its existence or occurrence.

There may be multiple symptoms that are created with one problem.

An example is a defective thermostat: If the thermostat is stuck open the heater output will be insufficient, also, if the engine can never reach operating temperature then fuel mileage and performance will suffer. Which one of these complaints (symptoms) would lead you to the problem faster?

What is important to remember is that the customer may only complain about one symptom. It is the job of the technician to be a detective and carefully observe. There may be another symptom not complained of that directly points to the root cause of the problem.

Steps to Verify The Complaint

- Before getting in the vehicle, review the R.O., confirm this is the correct vehicle.
- Is any additional information needed about the complaint? Certain questions to the customer can help narrow this step.
- Is the problem intermittent? What are the conditions (roads, temp., speed, etc.)? What is the frequency of the occurrence?
- Test drive if driveability related or the conditions require, duplicate conditions as stated by customer.
- Was the complaint reproduced?
- Is knowledge of system or vehicle sufficient?
- Review Reference Training material and owner's handbook for a description of feature operation.
- Research complaint in SIB's.
- Research past repair history on vehicle.

ANALYZE THE PROBLEM

After verification of the complaint, analyze the problem. Use all resource available to aid in system diagnostics:

- Vehicle Fault Memory.
- ETM, RM, SIB.
- Vehicle Repair History.
- Training Handouts.
- Round Table Information.
- Hotline.
- Known Good Vehicle.

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Analyzing the problem allows for the development of a repair plan.

Steps in Analyzing The Problem

- Perform a Short Test.
- Does an SIB pertain to this vehicle?
- Refer to the Function Description for additional system information.
- Is a test plan available for this system?
- Use fault symptom selection.
- Perform Diagnosis Request.

ISOLATE THE PROBLEM

To isolate the problem is " to place apart from others".

The object here is to zoom in on the problem area. It is easy to be overwhelmed by a problem, just reaching for an ETM can add to the confusion. The DISplus provides automatic tests in test modules to aid in the determination of the exact area or cause of the problem.

The elimination of components from the diagnostic trail, shortens the path. The first question asked should be:

- Is the problem Hydraulic, Mechanical or Electrical?

Save time by **NOT** testing components that could not create the problem.

Steps in Isolating The Problem

- Use Test Modules.
- Perform electrical tests with the DISplus Measurement System or a DVOM.
- Consult fault charts in Repair or Diagnostic Procedures Articles.
- Control Module Self Diagnosis.
- Use appropriate special tools (e.g. battery draw tester, tank leakage adapters, breakout boxes, etc.).
- Substitute a known good part.

Workshop Hints:

If a **TEST PLAN** is not available for a particular situation do the following:

- Think about the system in its entirety.
- Be sure the normal operation is understood.
- Develop a **PLAN.**
- Use all available resources.
- Don't try to diagnose the entire system at once, break it into manageable chunks.
- Check the easy things first. It would waste time to install the Breakout Boxes to find a bad bulb.

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When following a TEST PLAN:

- **DON'T** Skip steps.
- **NEVER** assume results without doing a step.
- Recheck your work.

REPAIR THE PROBLEM

Repair the problem using approved repair techniques and parts. Having verified, isolated and analyzed the problem the last step is to repair or replace the component. Before installing that shiny new part, take one last step back from the vehicle to ask a final set of questions.

- Could another component have caused this part to fail?
- Were all the instructions in the Test Plan or Diagnostic Procedures followed?
- Is there ***anything*** that might have been overlooked?

Confident that the proper diagnosis has been made, complete the repairs.

Steps to Repairing The Problem:

- Follow the instructions in the repair article.
- Follow specific guidelines for wire harness repair or replacement.
- Make proper adjustments after installing the part.
- Perform Coding or Programming if required.
- Make sure another problem is not created in performing this repair.

VERIFY THE REPAIR

Always recheck for the complaint under the same conditions used to verify. The object is to prove the problem does not resurface.

- Clear the fault codes.
- Test drive the car.
- Check for re-occurring fault codes.
- Clear adaptations if necessary.
- Recheck the part installation for missing bolts or tie wraps.

Workshop Hints:

- Follow repair or replacement procedures as detailed in appropriate article.
- Use only genuine BMW parts.

THE I.P.O. PRINCIPLE

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Control Modules receive information from sensors advising them of certain operating conditions. This information is identified as Input to the control modules. The Input continually informs the control modules of conditions that may be changing.

The control module then process the Input information comparing it to programmed responses or commands based on every possible operating condition. The control module decides based on the programming and the Input conditions which Output signal to operate.

The control module, based on the processing that has occurred, then sends a signal to a component changing the status of that component. The components respond to the Output signal of the control module.

This is known as the I.P.O. Principle.

I.P.O.

- Status of switch is changed.
- Changing switch status is sent to processor.
- Processor looks at conditions which must be met.
- If the processor deems the conditions for switch status change are met, a relay is signaled via a ground signal.
- The relay is energized, the points are closed and the light bulb glows.

NOTE: The processor looked at other inputs before making the decision to activate the relay.

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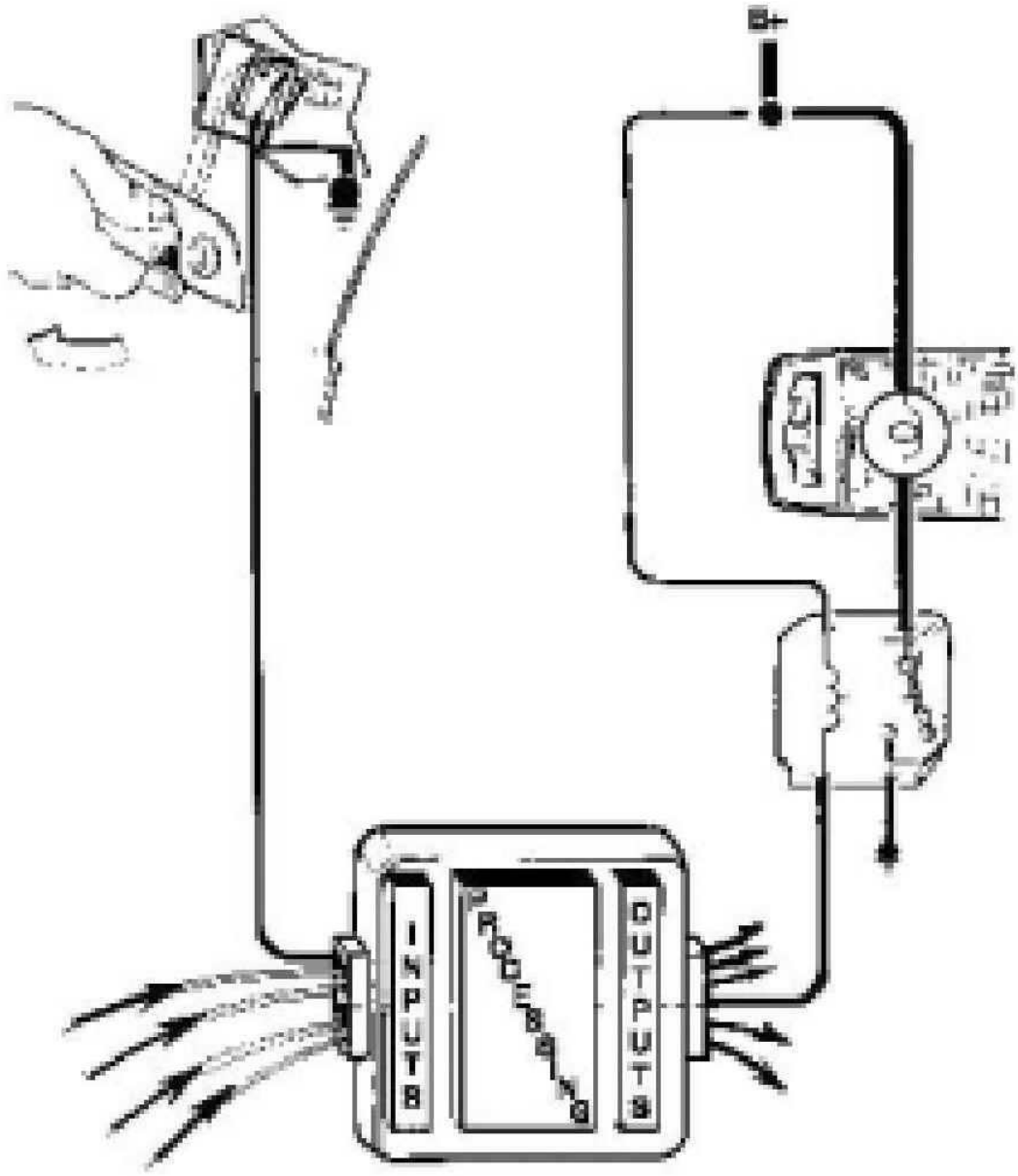


Fig. 1: Identifying I.P.O. Principle
Courtesy of BMW OF NORTH AMERICA, INC.

Any device controlled by a processor requires input to the alert the operating program of a condition. The program processes the input information and logically activates an output of a component.

All BMW control systems are explained by the IPO principle. It is the key to understanding all BMW control

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system technologies.

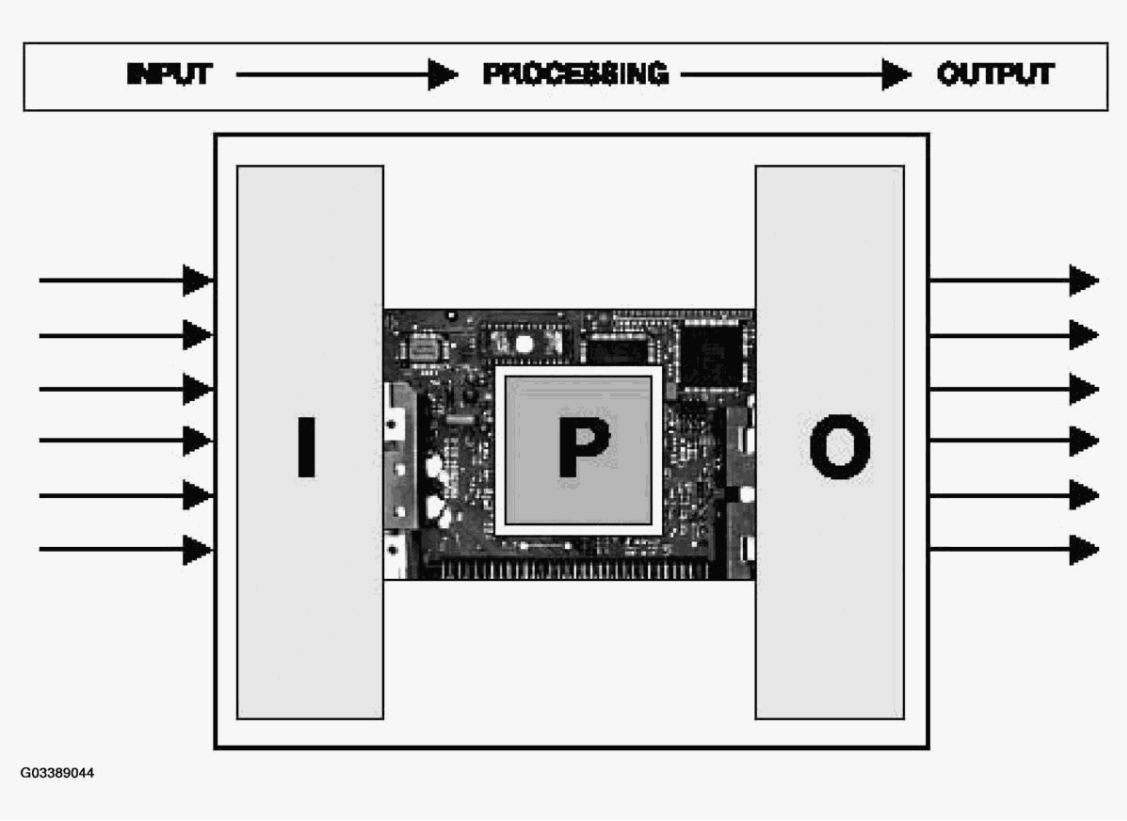


Fig. 2: I.P.O. Principle Display
Courtesy of BMW OF NORTH AMERICA, INC.

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GENERAL INFORMATION

xDrive/DSC - Overview - X3

XDRIVE/DSC

PURPOSE OF THE SYSTEM

xDrive

The innovative xDrive four-wheel drive is a system that controls and regulates the distribution of driving torque to the front and rear axles. The measured variables of DSC are used by xDrive but are also influenced by modified handling performance.

The multi-disc clutch is the heart of the xDrive. By using the controlled multi-disc clutch, it is possible to resolve the conflict between traction and handling performance.

This is achieved through the fact that torque distribution is not determined by a fixed gear ratio in the xDrive as was the case in the previous systems. Instead, the distribution of driving torque is dependent on the locking torque of the controlled multi-disc clutch in the transfer case and on the transferable torque to the front and rear axles.

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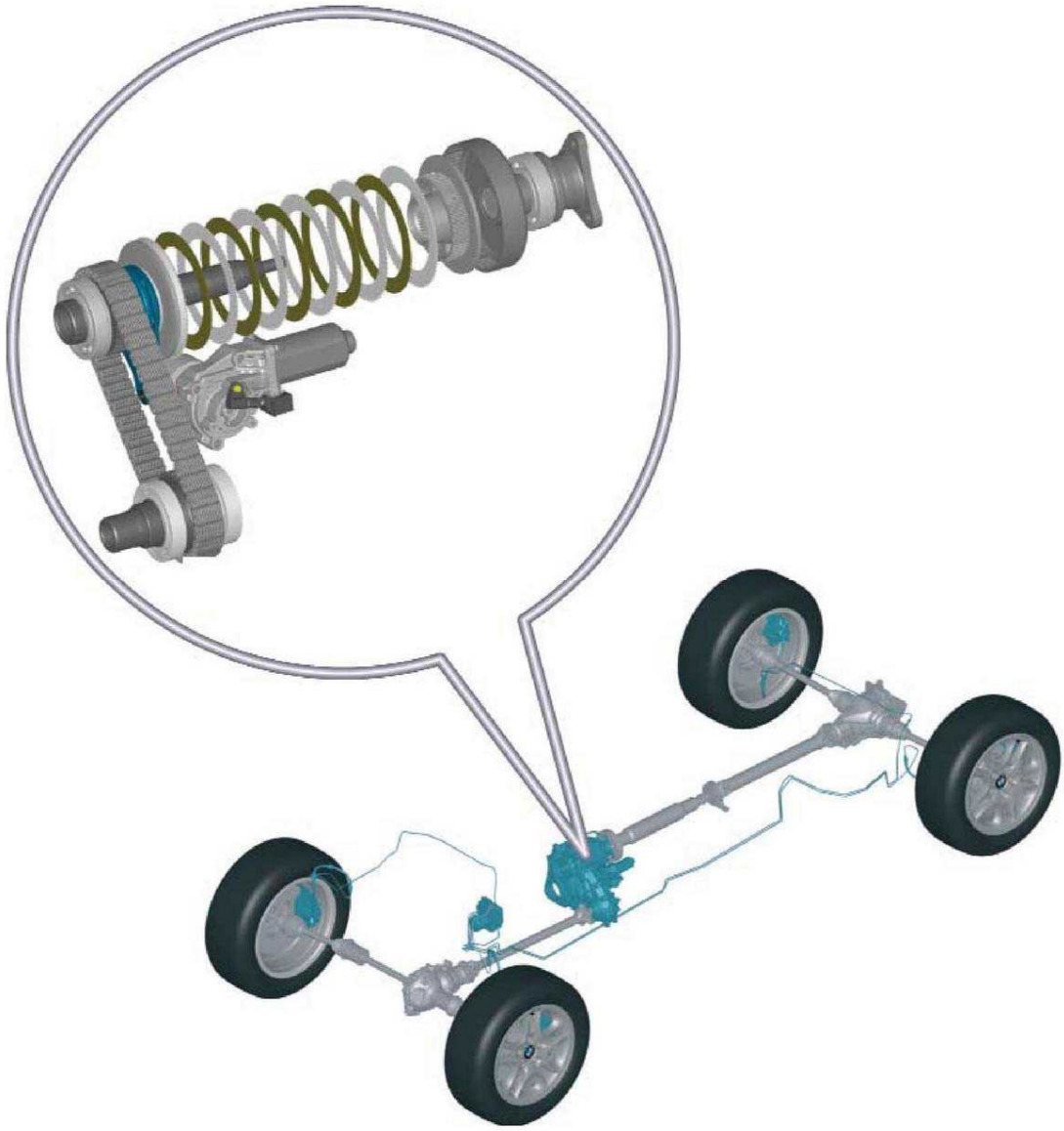


Fig. 1: Identifying xDrive
Courtesy of BMW OF NORTH AMERICA, INC.

XDRIVE - SYSTEM COMPONENTS

ATC 400 / ATC 500 Transfer Case

The ATC 400 is installed in the E83 and the ATC 500 in the E53 MU. They differ in that the ATC 500 is splined to the front propeller shaft and the ATC 400 uses a four bolt flange. In addition, there is one more disc in the multi-disc clutch of the ATC 500 and the distance between the input shaft and the output shaft to the front axle is 19 mm greater than in the ATC 400.

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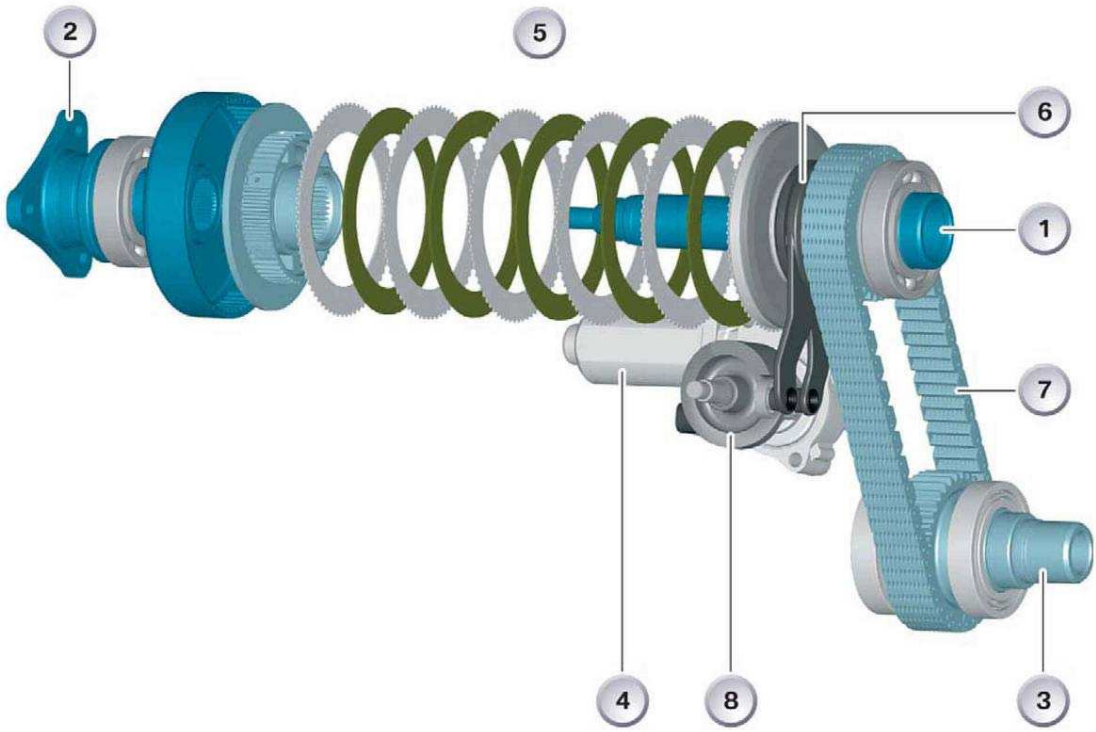


Fig. 2: Identifying ATC 400 / ATC 500 Transfer Case Components
Courtesy of BMW OF NORTH AMERICA, INC.

The flange illustration of the ATC transfer case is the same for automatic and manual transmissions.

Power Flow

When the multi-disc clutch in the transfer case is disengaged, no driving torque is transmitted to the front axle. All of the driving torque is then distributed to the rear axle. This is because the input shaft (1) is splined providing a permanent connection to the rear axle propeller shaft output flange (2). The multi-disc clutch couples the rear axle propeller shaft output flange to the front propeller shaft output (3).

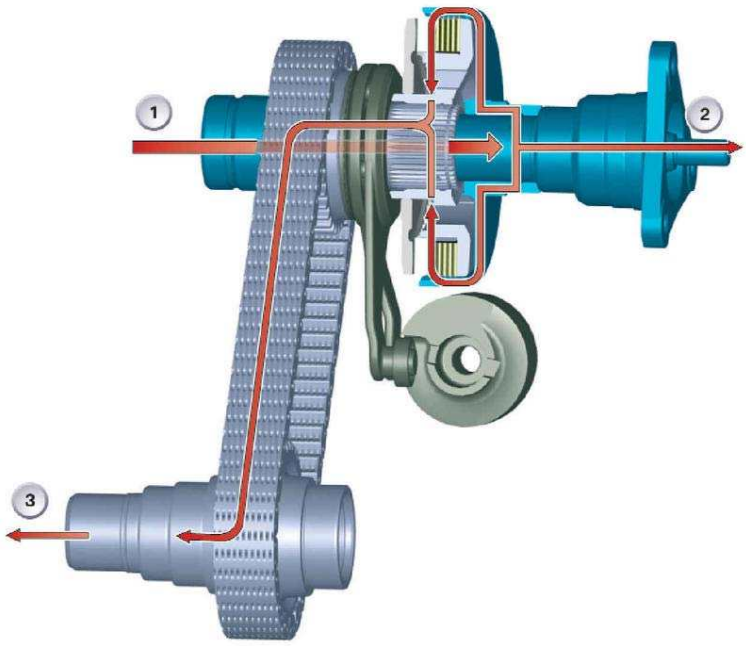
The driving torque on the front axle is increased or decreased by regulating the locking pressure of the multi-disc clutch, providing a stepless coupling of the front axle to the drivetrain. This depends on driving situations and road conditions. When the multi-disc clutch is fully engaged, the front and rear axles turn at the same speed.

Driving torque distribution (front/rear) is based on available traction at each axle. For example, when traction is identical on the front and rear axles and a driver accelerates from a stop in first gear at full throttle, the rear axle is capable of sustaining greater driving torque as the vehicle weight shifts from the front to the rear.

Another example is when the front axle is on a high traction surface and the rear axle is on ice. In this case,

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virtually 100% of the available driving torque is transmitted to the front axle. Based on available traction, virtually no driving torque can be supported by the rear axle. Obviously, when more driving torque is transmitted to the front axle, driving torque on the rear axle is proportionally reduced due to lack of traction.



1. Input from transmission 2. Rear propeller shaft output 3. Front propeller shaft output

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Fig. 3: Identifying Power Flow
Courtesy of BMW OF NORTH AMERICA, INC.

1. Input from transmission 2. Rear propeller shaft output 3. Front propeller shaft output

NOTE: On a vehicle equipped with an automatic transmission, when driving onto brake analyzers, move the selector lever to the "N" position. On a vehicle equipped with a manual transmission, do not press the accelerator pedal once on the brake analyzer. This keeps the transfer case clutch open and the vehicle cannot be pulled off the analyzer.

Adjusting Levers

When the disc cam is rotated, it forces the adjusting levers apart.

The ball ramps create a precision axial movement which compresses and increases pressure on the multi-disc clutch.

This is completely variable up to a full lock.

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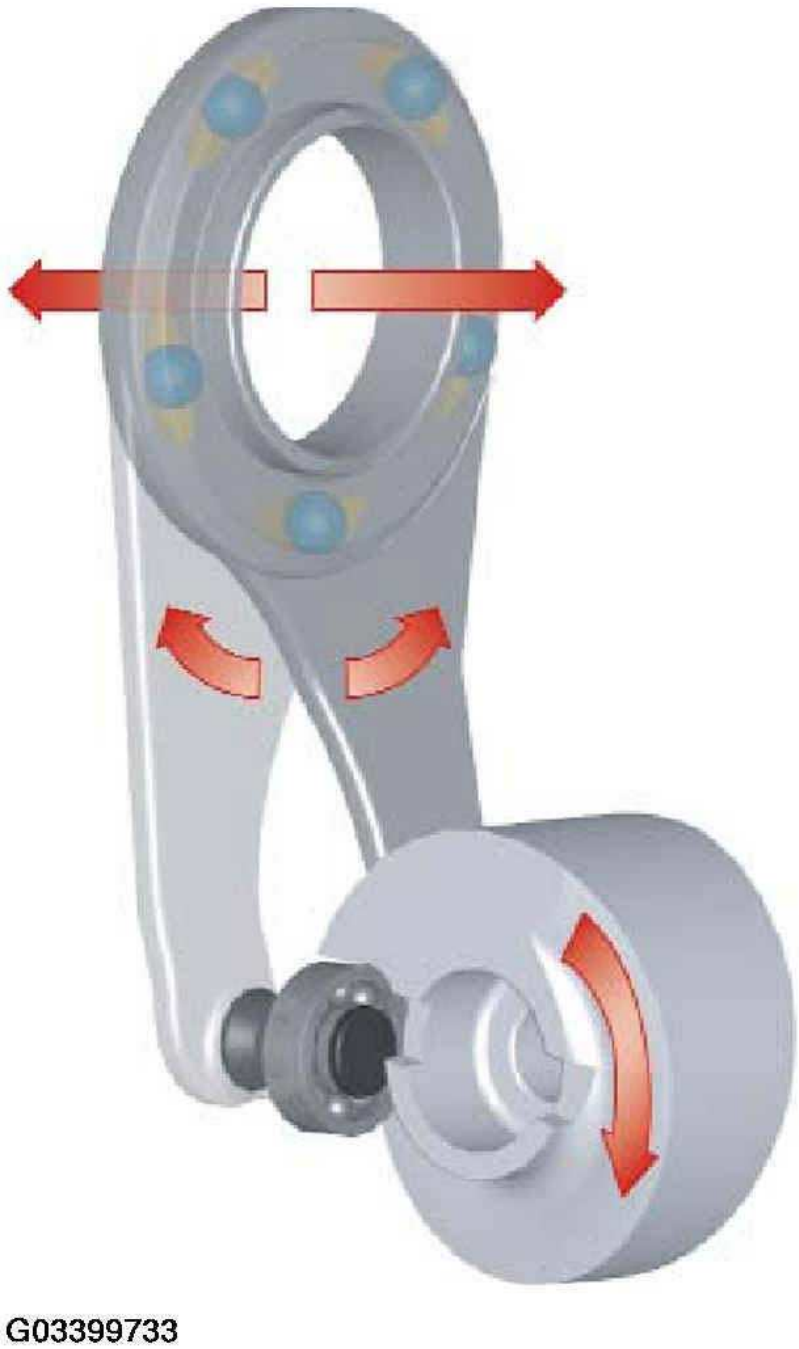


Fig. 4: Identifying Adjusting Levers
Courtesy of BMW OF NORTH AMERICA, INC.

Servomotor With Motor Position Sensor

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The servomotor with worm gear are powered to rotate the disc cam.

The servomotor is a permanent magnet (1) DC motor which contains a Hall sensor (2) to detect the position and the adjusting speed of the motor shaft.

This is proportional to the degree of multi-disc clutch engagement.

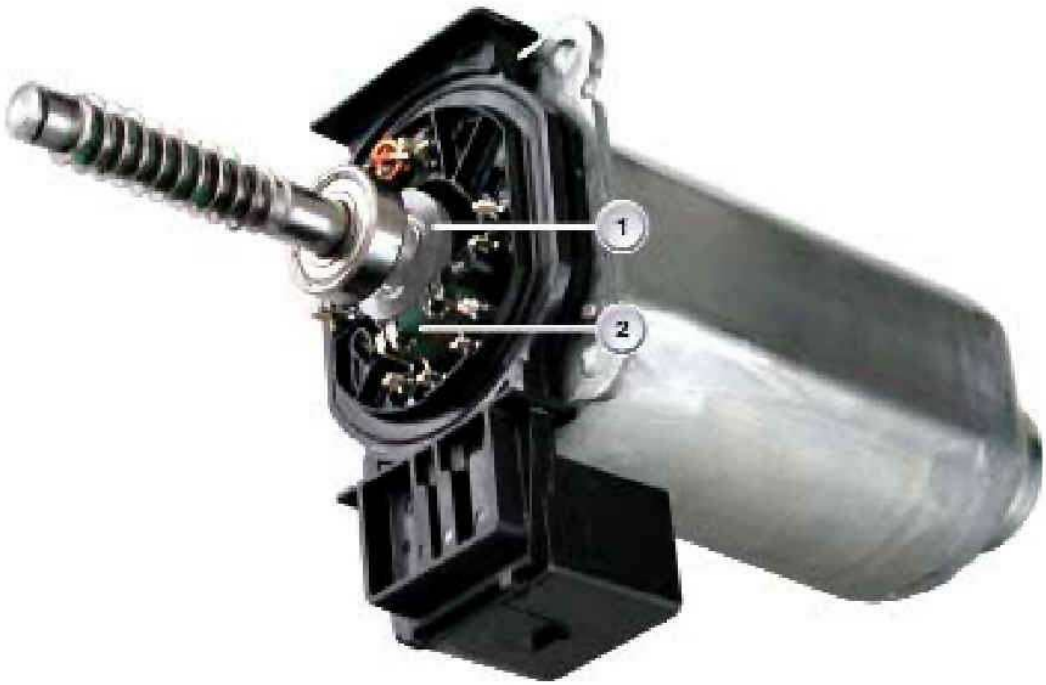


Fig. 5: Identifying Servomotor With Motor Position Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

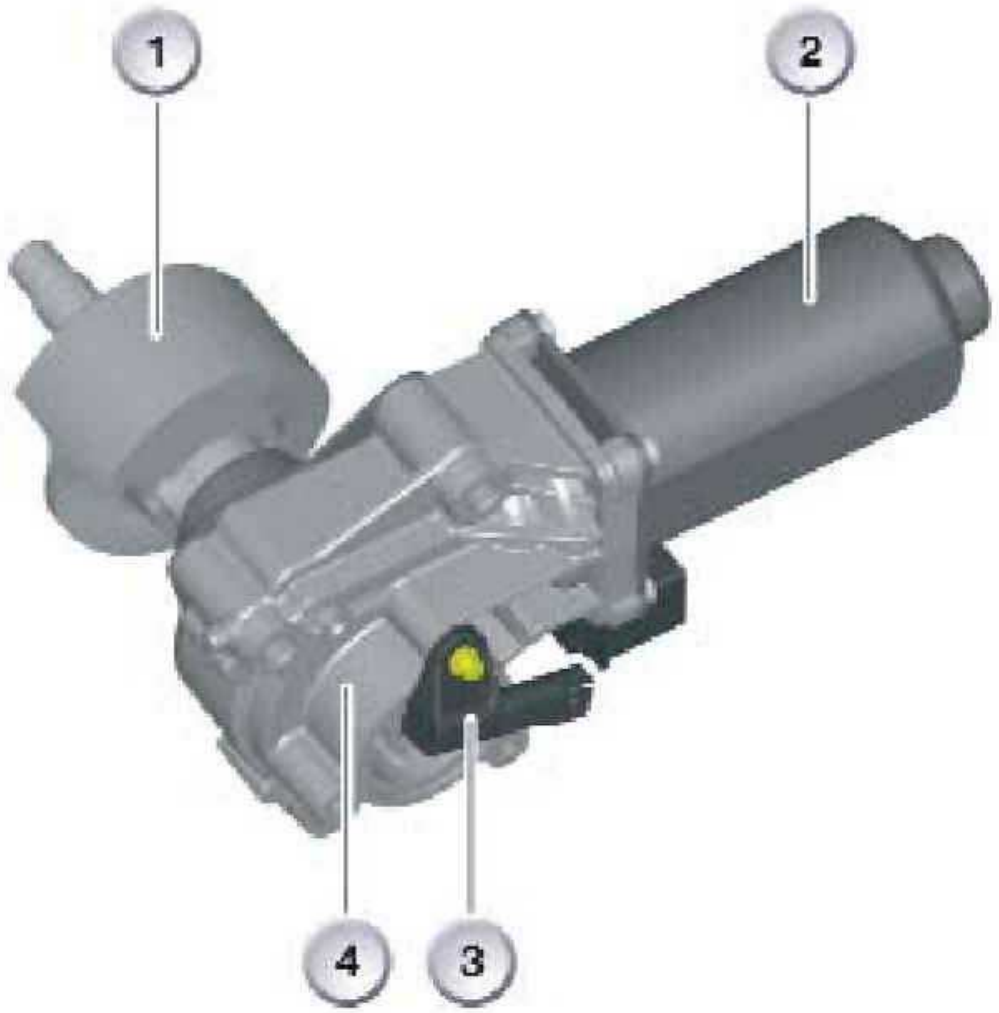
Coding Resistor

Because of mechanical tolerances in production, the characteristic curve of the multi-disc clutch locking torque varies slightly.

Once the actual locking torque has been measured on the clutch test bench, a resistor is attached to the servomotor; the resistor's value is a reference to the locking torque characteristic.

Each time the engine is started, the transfer case control unit measures the resistance value once and the optimum program map for the transfer case fitted is selected.

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1. Disc cam
2. Electric motor
3. Coding resistor
4. Worm gear

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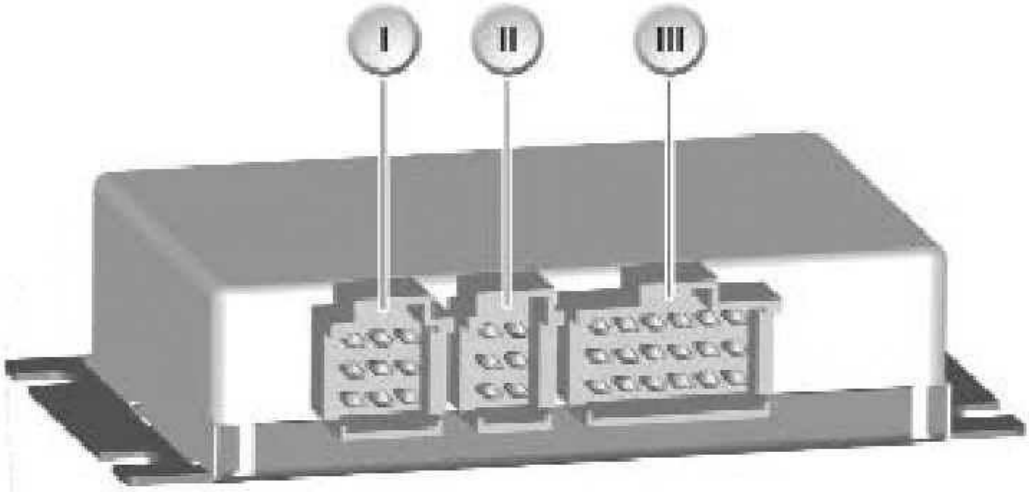
Fig. 6: Identifying Coding Resistor
Courtesy of BMW OF NORTH AMERICA, INC.

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Transfer Case Electronic Control Unit

The transfer case control unit (VGSG) is installed in the E83 on the rear floor panel under the luggage compartment trim.

In E53 MU, it is located underneath the rear bench seat on the left.



I. 9-pin ELO connector (not used)
II. 6-pin ELO connector
III. 18-pin ELO connector

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Fig. 7: Identifying Transfer Case Electronic Control Unit
Courtesy of BMW OF NORTH AMERICA, INC.

Bus Overview

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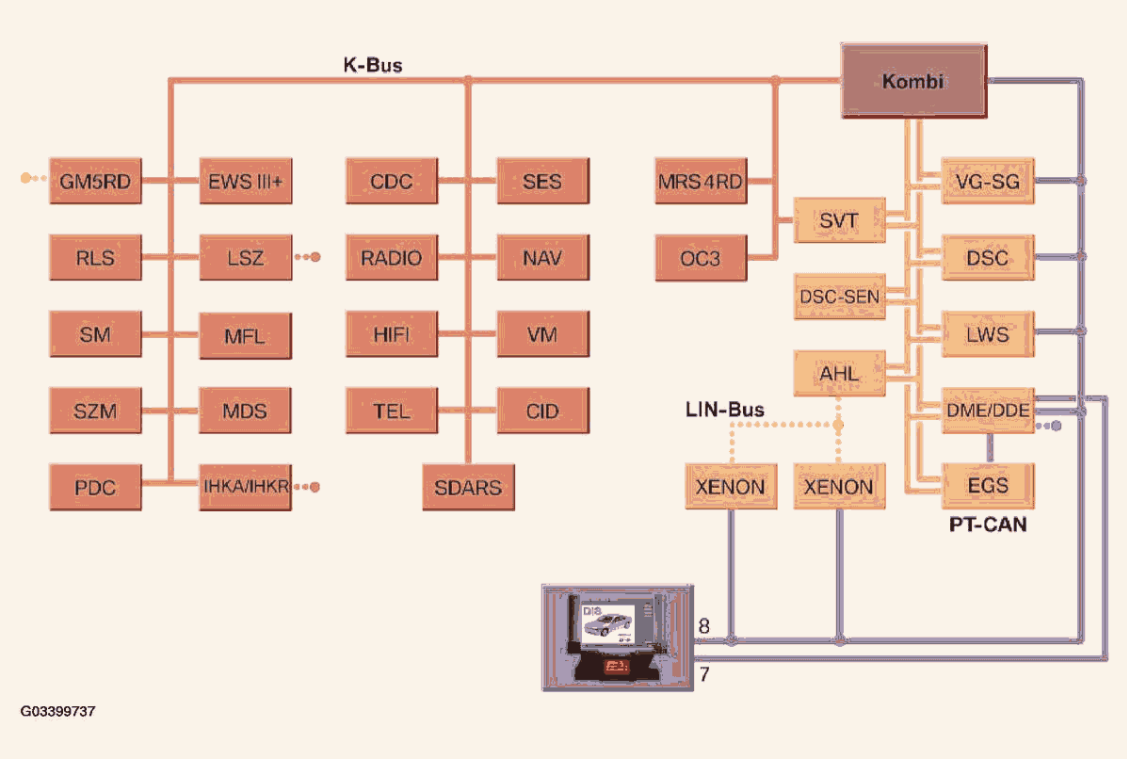
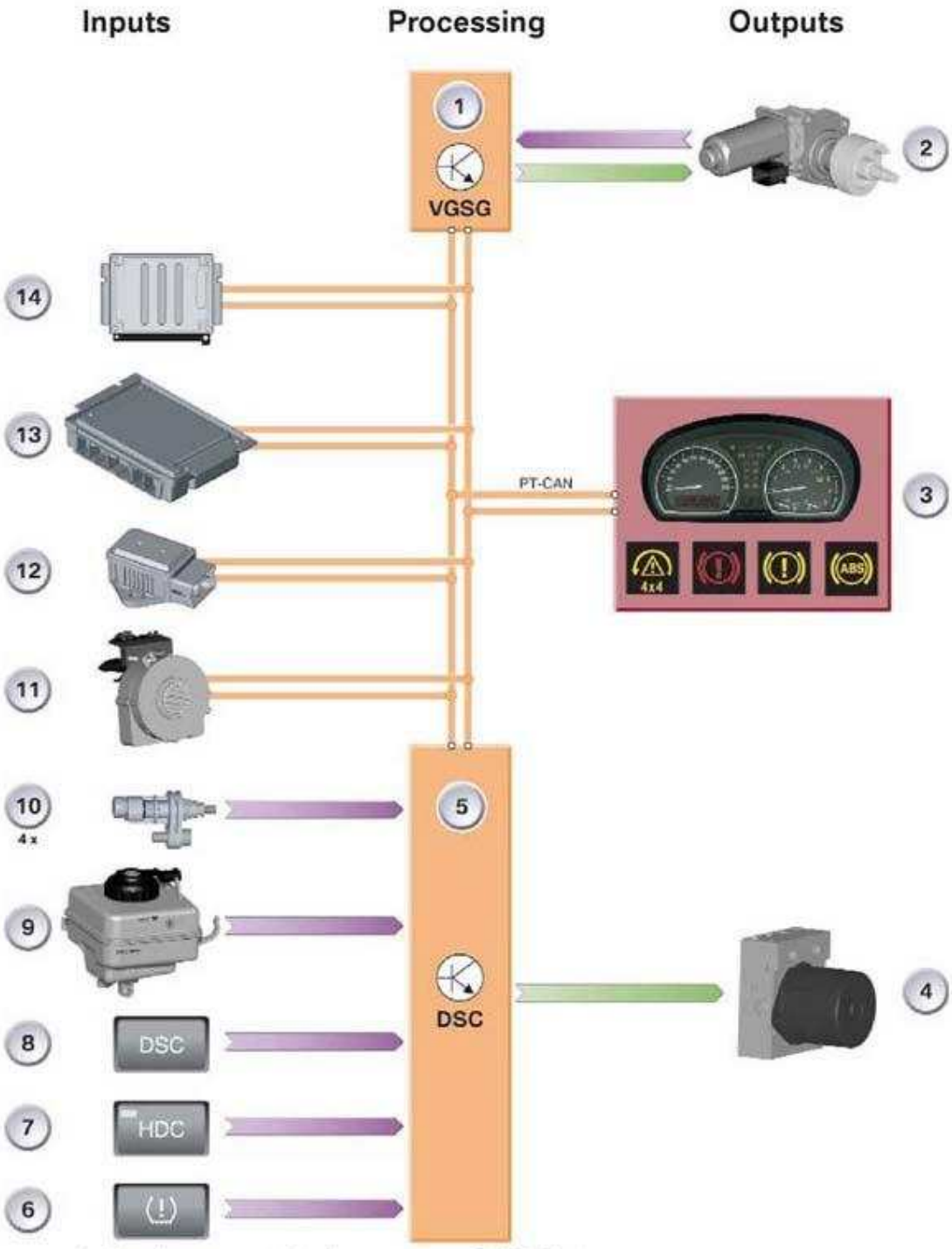


Fig. 8: Bus Overview
Courtesy of BMW OF NORTH AMERICA, INC.

The transfer case control unit (VGSG) is on the PT-CAN Bus. VGSG shares information with DSC for overall xDrive control and has diagnostic communication via the OBD connector.

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1. Transfer case control unit
2. Transfer case clutch servomotor
3. Instrument cluster
4. DSC hydraulic modulator
5. DSC control unit
6. RDW button
7. HDC button
8. DSC button
9. Brake fluid level
10. Wheel speed sensor
11. Steering angle sensor
12. Yaw/transverse acceleration sensors
13. EGS
14. ECM (DME)

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Fig. 9: Identifying Inputs, Processing And Outputs
Courtesy of BMW OF NORTH AMERICA, INC.

XDRIVE - PRINCIPLE OF OPERATION

xDrive

The transfer case control unit (VGSG) regulates the locking pressure of the multi-disc clutch in the transfer case. The transfer case control unit receives information on the required clutch locking pressure from the DSC control unit. The processing, control and electronics required for this are integrated in the transfer case control unit. This information is converted and output as a corresponding rotary motion of the servomotor.

In order to position the servomotor and compensate for wear, a reference run is carried out each time the ignition is switched off. The servomotor position is determined by a Hall sensor integrated in the servomotor. During the reference run, the clutch is engaged and disengaged completely (once). While the clutch is actuated, the current consumption is measured for the servomotor position. This allows the VGSG to determine the beginning and end of the clutch actuating procedure.

A clutch and oil wear calculation is also processed and stored in the VGSG. It increases the locking pressure as necessary in order to reduce friction.

In the event of DSC failure, the VGSG incorporates a fallback level (strategy) for activating the transfer case clutch in order to maintain the four-wheel drive function.

TCC

Regulation of the transfer case clutch (TCC) locking pressure allows stepless coupling of the front axle to the drivetrain. The driving torque on the front axle can be increased or decreased depending on the driving situation and road conditions. Obviously, when more driving torque is transmitted to the front axle, driving torque on the rear axle is proportionally reduced due to lack of traction.

The advantages of variable distribution of driving torque to the front and rear axles are:

- Optimum utilization of the cornering and longitudinal wheel forces on the front and rear axles.
- DSC brake interventions only become necessary at a significantly later stage, an increase in comfort refinement.
- Compared with an "open" differential transfer case and DSC, xDrive significantly improves driving torque distribution when traction on the front and rear axles is notably different.

The DSC control unit influences control of the transfer case clutch. Even when DSC is deactivated, TCC remains active for the purpose of maximum traction and driving dynamics.

Permanent four-wheel drive is only completely deactivated in three control situations:

- During very tight cornering with low engine torque to allow speed compensation between the front and rear axles (e.g. parking)
- At speeds > 180 km/h

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- When the vehicle dramatically understeers

The transfer case clutch control logic is described in three main modules:

- Pre-control
- Traction control / driving dynamics control
- Tire tolerance logic

Pre-Control

The pre-control logic (shared from DSC) reflects the driver's command and is calculated based on:

- Accelerator pedal value
- Engine torque
- Engine RPM
- Vehicle speed
- Gear
- Steering angle

In normal driving, the clutch is operated with minimum slip so that permanent four-wheel drive with a driving torque distribution of 40% on the front axle and 60% on the rear axle is available.

Even when the traction for the front and rear axles is dramatically different, the pre-control ensures that the system responds very quickly, as can be seen in graphic on the following page.

Notes:

"Open" Transfer Case VS xDrive

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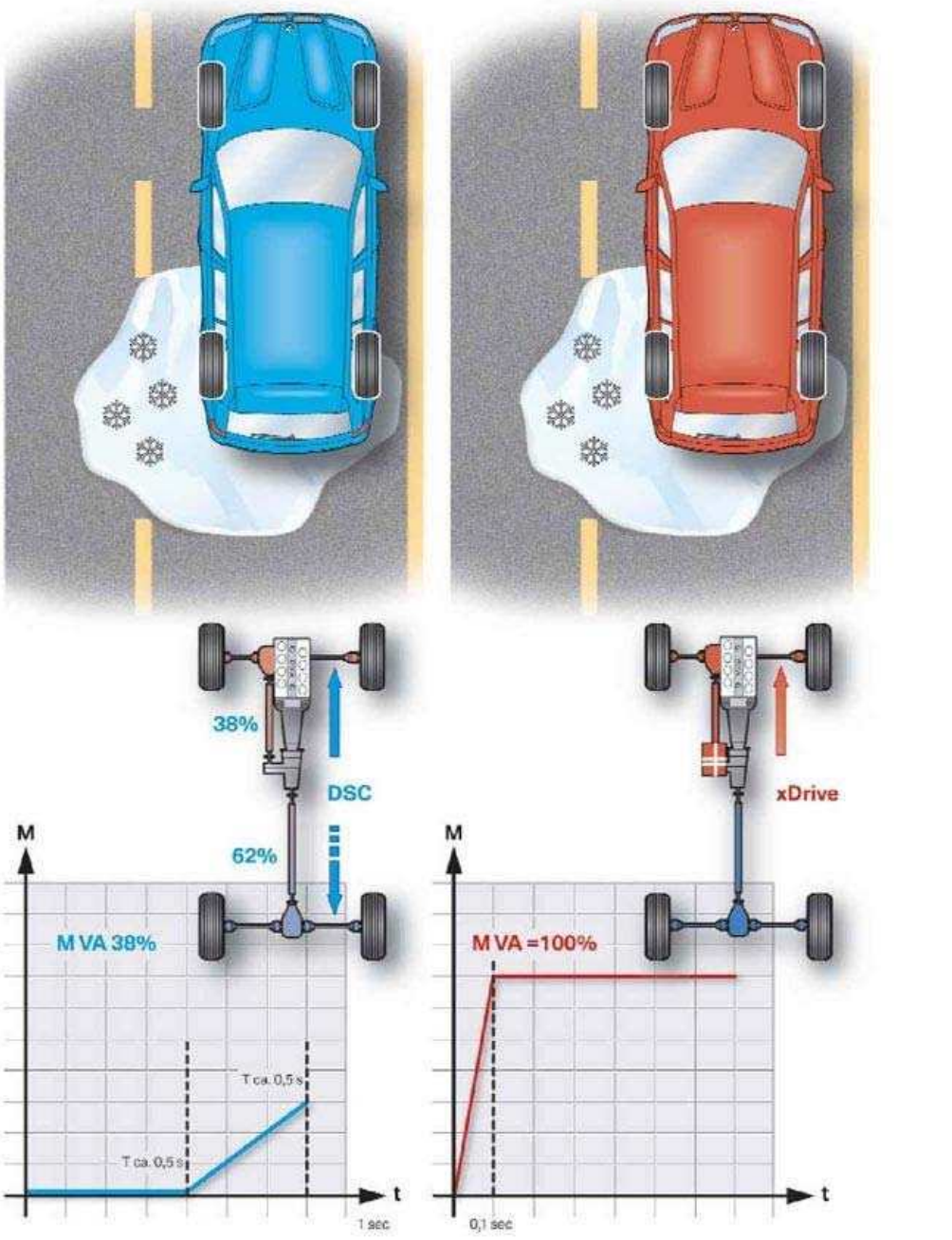


Fig. 10: Open Transfer Case Vs xDrive
Courtesy of BMW OF NORTH AMERICA, INC.

In the case of the open transfer case, the brake is applied after slip is detected on the rear axle. This takes

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approximately one half of a second in reaction time. 62% of the driving torque is supported on the two rear brake discs and only 38% of the driving torque can be transferred to the front axle. In other words, wheel slip must be sensed first before driving torque is transferred through the transfer case by applying the rear wheel brakes.

In contrast to an "open" transfer case (differential), the xDrive does not require brake intervention on the rear axle because no slip can occur (permanent through connection). The transfer case clutch is engaging the front axle as the vehicle is accelerating. This takes significantly less time (approx. one/tenth of a second).

Traction Control / Driving Dynamics Control

Traction control monitors the slip conditions on the front and rear axles. The wheel speeds, yaw rate and transversal acceleration serve as the input signals.

The function of traction control/driving dynamics control is to achieve optimum traction and to keep the vehicle stable.

As seen in the following graphic, in the event of an oversteer tendency, the transfer case clutch is completely engaged and the maximum supportable driving torque on the front axle is transmitted. This helps to "pull' the front of the vehicle until stability is achieved.

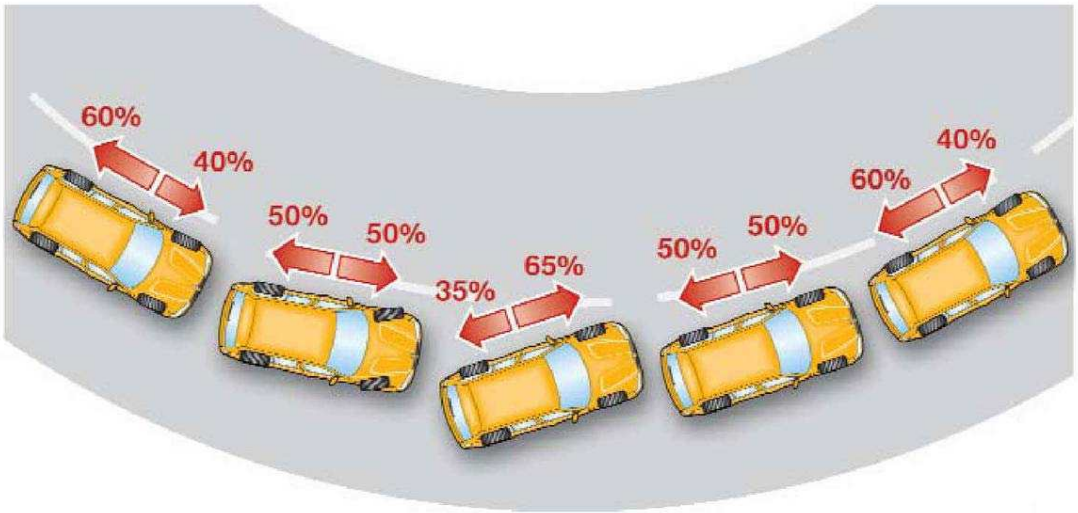


Fig. 11: Identifying Traction Control / Driving Dynamics Control (Oversteer Tendency)
Courtesy of BMW OF NORTH AMERICA, INC.

In the event of an understeer tendency, the clutch can be fully disengaged if necessary. In this example, the front axle is separated from the drivetrain and the driving torque can only be transmitted to the rear axle. This helps to "push" the rear of the vehicle until stability is achieved.

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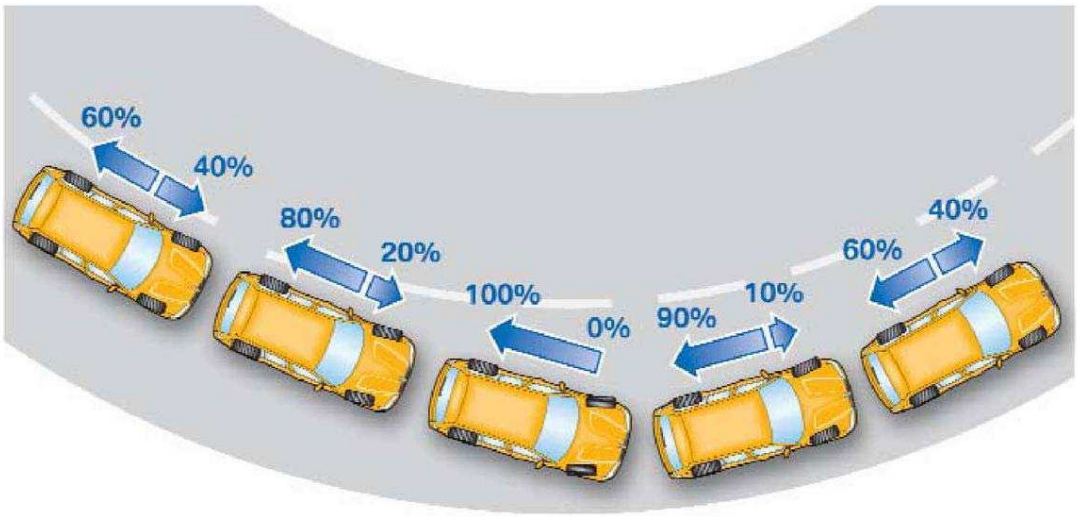


Fig. 12: Identifying Traction Control / Driving Dynamics Control (Understeer Tendency)
Courtesy of BMW OF NORTH AMERICA, INC.

Tire Tolerance Logic

The tire tolerance logic detects different tread circumferences on the front and rear axles. This occurs when:

- Mixed tires are used
- Space saving spare tire is installed
- Tires are used that have been worn down to different levels

Normally, tire circumference deviations result in drivetrain torque bias (unwanted variations).

The tire circumference can fluctuate up to 1% or more as a result of mixed tires or wear.

The tire tolerance logic decides depending on the driver's command and driving situation whether the slip is to occur in the transfer case clutch or at the contact area between tire and road.

If the slip is permitted in the transfer case clutch, the locking pressure set by the pre-control is reduced in order to keep the work loss low. In the driving dynamic control situation, the clutch is locked slightly more than normal, the four wheel drive is always guaranteed when required.

For maximum xDrive performance, tires (and wheels) of the same diameter should be installed on the vehicle.

Notes:

XDRIVE / DSC - SYSTEM COMPONENTS

The xDrive / DSC system consists essentially of those components from the familiar DSC8. The controllable

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multi-disc clutch in the transfer case is a new feature.

- DSC8 module
- Transfer case electronic control unit (VGSG)
- Yaw and transversal acceleration sensors
- Wheel speed sensors
- Pressure sensor
- Steering angle sensor
- Brake fluid warning switch
- Brake light switch
- DSC button
- Transfer case motor position sensor
- Coding resistor
- Transfer case servomotor

Hydraulic Schematic

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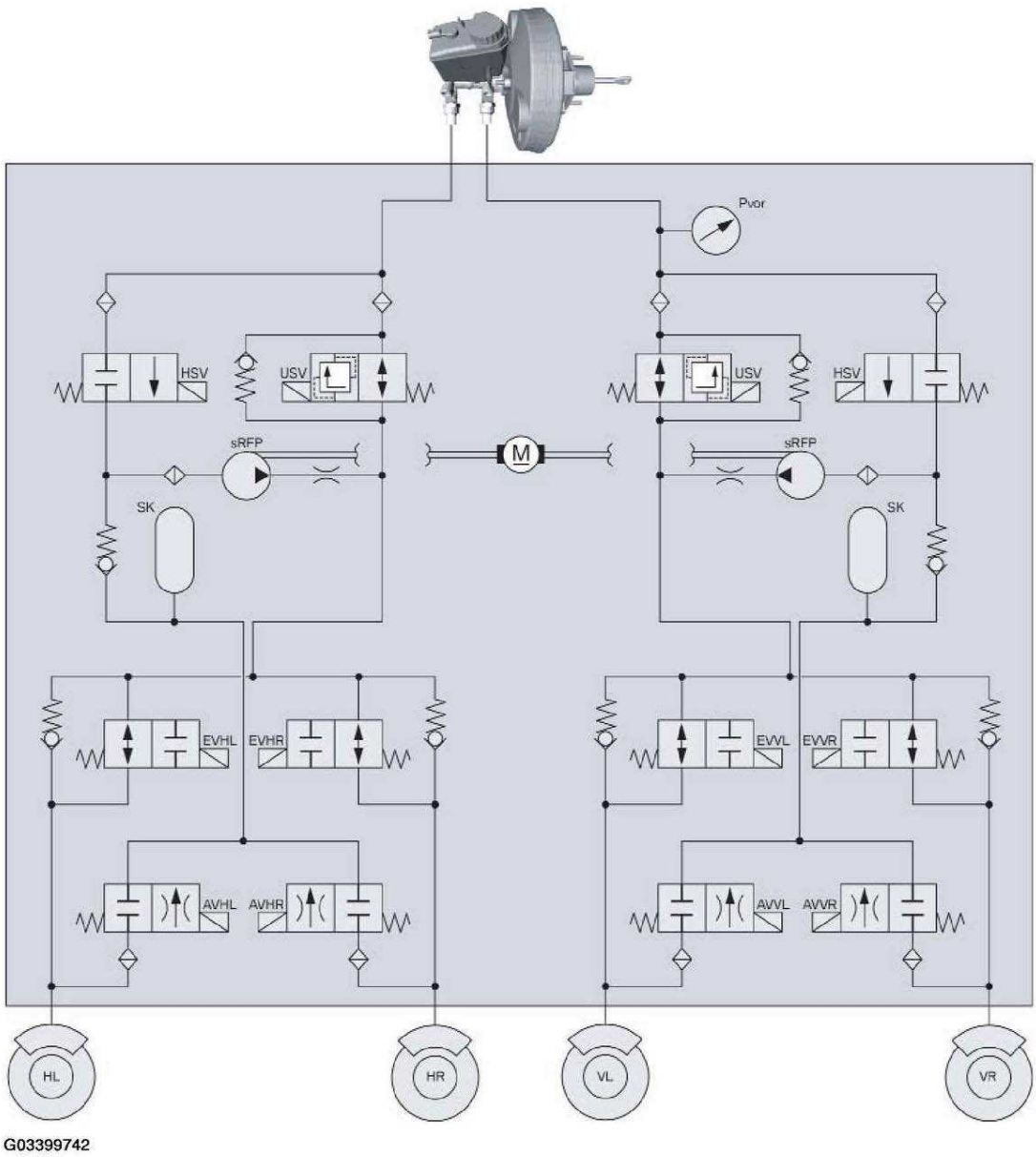


Fig. 13: Hydraulic Schematic
Courtesy of BMW OF NORTH AMERICA, INC.

DSC Module

The DSC module located in the engine compartment consists primarily of the following three components:

- Surface mounted control unit
- Valve block with integrated pressure sensor
- Pump motor

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It is the same design as the DSC8 module which was introduced at BMW with the E60.



Fig. 14: Identifying DSC Module
Courtesy of BMW OF NORTH AMERICA, INC.

Yaw And Transversal Acceleration Sensors

The sensor (assembly) in the E83 and the E53 MU is located on the transmission tunnel at the rear.

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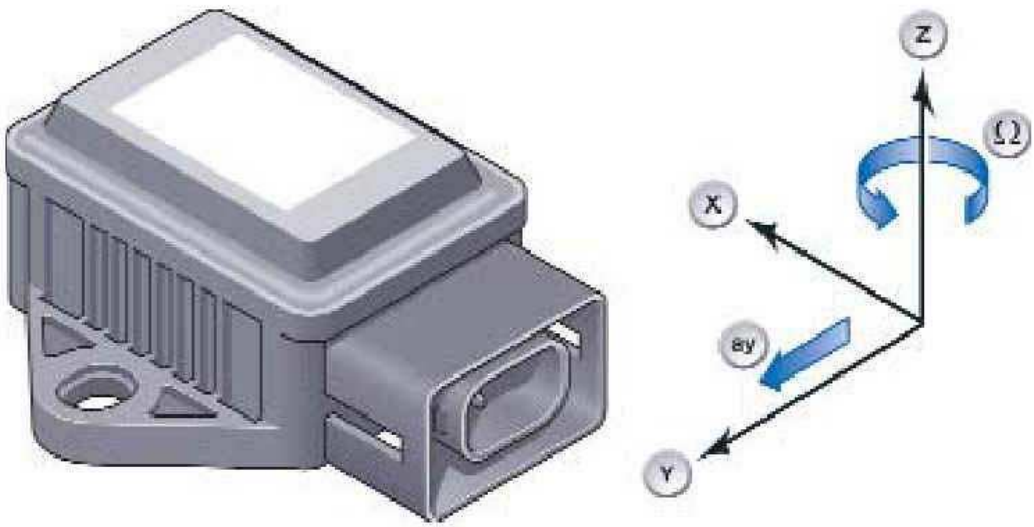


Fig. 15: Identifying Yaw And Transversal Acceleration Sensors
Courtesy of BMW OF NORTH AMERICA, INC.

Wheel Speed Sensors

The active wheel speed sensors require a supply voltage for operation and output a signal of non speed dependent constant amplitude.

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Fig. 16: Identifying Wheel Speed Sensors
Courtesy of BMW OF NORTH AMERICA, INC.

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The xDrive uses wheel speed sensors with an integrated evaluation circuit. The output signal is transmitted with the pulse width modulation (PWM).

The rising signal edge is used to determine road speed; the pulse width contains additional information on the direction of rotation, standstill detection, installation position detection and air gap reserve to the sensor ring. Direction of rotation detection is by the internal Hall sensor signals (like E65).

XDRIVE / DSC SYSTEM - PRINCIPLE OF OPERATION

As featured in earlier DSC modules, the DSC8 mounted control unit also features two microprocessors. The surface mounted control unit also incorporates two semiconductor relays:

- One for the pump motor
- One for the solenoid valves

When a speed of 6 km/h (4 mph) is exceeded, an electronic self-test is started which the pump motor and all the solenoid valves are briefly activated. When the brake light switch is activated simultaneously at that speed (for example: two footed drivers), the self-test is carried out at 15 km/h. Checking of the wheel speed signals is started at 2.75 km/h.

In the xDrive, the DSC also assumes the function of calculating the locking pressure for the multi-disc clutch in the transfer case. The locking pressure is set based on the driver's command and regulated as required depending on the driving situation.

The locking pressure produces the distribution of driving torque to the front and rear axles. The DSC sends the required locking pressure request to the VGSG via the PTCAN Bus.

In turn, the VGSG signals the locking pressure actually set depending on:

- Transfer case fluid temperature (calculation based on locking pressures)
- Electric motor loads
- Multi-disc clutch loads

System Functions

The xDrive / DSC system comprises the following functions (same as E60 or E53 except for *):

DSC:

- ABS Antilock Braking System
- ASC-X Automatic Stability Control X *
- DSC Dynamic Stability Control
- EBV Electronic brake-force distribution
- DBC Dynamic Brake Control
- CBC Cornering Brake Control

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- MSR Engine drag-torque control
- HDC Hill Descent Control
- ADB-X Automatic Differential Brake *

xDrive:

- TCC Transfer Case Control (previously covered)

ASC-X / ADB-X

Unlike regular road vehicles, SAVs are also meant to demonstrate satisfactory handling characteristics and appropriate traction on unconventional roads. In order to provide optimum propulsion with sufficient cornering stability on both normal roads and other road surfaces, Automatic Stability Control X (ASC-X) contains a detection function to distinguish between them.

When off-road terrain is detected, wheel slip threshold is increased to provide sufficient traction force with the increased levels of traction loss.

ASC-X is supplemented by the Automatic Differential Brake (ADB-X) function, which applies the brakes to the wheels per axle, for side to side torque transfer. For example, when a wheel is spinning on one side (up to the slip setpoint), the brakes are applied to that wheel and the driving torque is transferred through the axle differential to the wheel with the higher traction. This provides superb capabilities when there are diagonal traction losses (ie. left front/right rear).

ADB-X remains active when DSC is deactivated. Furthermore, ADB-X can develop full capability because the engine power is not reduced, even during extreme four wheel drive operation. Only that wheel which has a low traction receives the brake application.

The brake disc can overheat with excessive ADB-X intervention with DSC deactivated. In this situation, the operation is discontinued at a disc temperature of approx. 700 °C and is resumed when this temperature drops below approx. 400 °C. This is a calculation performed by the DSC control unit based on brake application time, pressure, wheel speed, etc.

Limp Home Operation

In order to maintain the four wheel drive function for as long as possible even in the event of important sensor signal failures or failure of the DSC control unit, a limp home control is integrated in the transfer case control unit. This control operates in redundancy to the transfer case clutch control in the DSC control unit. The limp home control contains only two control functions, precontrol and traction-slip control.

The wheel speed signals are very important to traction/slip control. Engine signals, steering angle and yaw are used predominantly for precontrol. If individual sensor signals fail, substitute values are calculated and the relevant functions operated with extended control thresholds.

This strategy is continued until useful four wheel drive control is no longer possible. In this event, the driver is alerted by the DSC/xDrive lamp coming on in the instrument cluster and also by an acoustic warning signal (gong).

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Faulted wheel speed signals on the rear axle are calculated by driving or engine speed (remember, the rear wheels are always driven). If the front wheel speed signals fail, the values of the rear axle are adopted. Wheel speeds also substitute for a faulty steering angle signal.

Warning Indicator Lamps

The warning indicator lamps for the xDrive / DSC are found in the instrument cluster as shown on the right.

The warning indicator lamps and acoustic signals (gong) are assigned to the xDrive / DSC system states of malfunction described below.



Fig. 17: Identifying Warning Indicator Lamps For xDrive / DSC
Courtesy of BMW OF NORTH AMERICA, INC.

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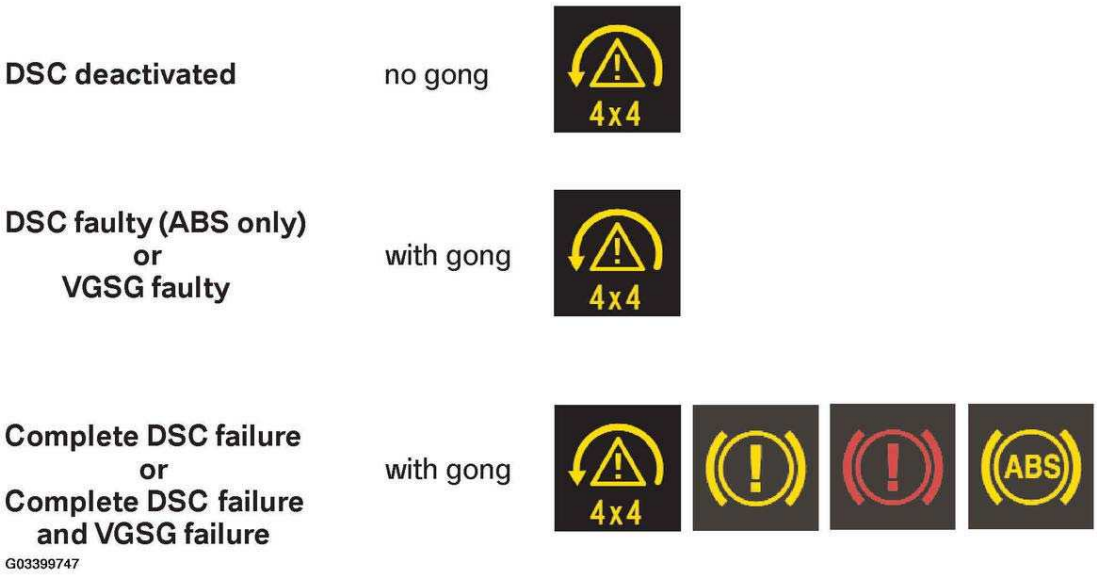


Fig. 18: Identifying Warning Indicator Lamps And Acoustic Signals (Gong)
Courtesy of BMW OF NORTH AMERICA, INC.

WORKSHOP HINTS

CAUTION: On a vehicle equipped with an automatic transmission, when driving onto brake analyzers, move the selector lever to the "N" position. On a vehicle equipped with a manual transmission, do not press the accelerator pedal once on the brake analyzer. This keeps the transfer case clutch open and the vehicle cannot be pulled off the analyzer.

Towing: Use only a flatbed carrier!

Transfer Case Oil And Monitoring

Please refer to Operating Fluids for the required transfer case oil and specifications for the correct amount.

Oil Monitoring is performed by the VTG control module to determine when a service (change) is due. The VTG calculates transfer case and clutch wear based on the amount of slip, engagement pressure (torque), speed and mileage.

This calculation accounts for normal "dry" road driving, "adverse" road driving and "other" road extreme driving. Depending on individual vehicle use - driving styles and driving conditions, the transfer case oil service interval will vary.

When a service is due, this will be indicated by a Fault Code and additional details are available using the DISplus/ GT1. Service functions provide directions on changing the transfer case oil and updating the VTG control module with the necessary reset and adaption procedure. This is extremely important for CBS.

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Diagnosis

Diagnosis is available for fault repairs and service procedures using the DSIplus/GT1. When the tire tolerance logic is active, it can be read out in the fault memory.

Programming (Flashing)

Both the transfer case control unit (VTG) and the DSC control unit are programmable and the new control unit (s) must be programmed when replaced. The wear values stored in the VTG control module (to be replaced) must be transferred to the replacement VTG.

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