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Our position is simple. If you are able to repair and maintain BMW vehicles properly and efficiently, your reputation will be enhanced, as well as the reputation of BMW. To this end, feature articles are intended to provide hands-on diagnostic and repair procedures, service and maintenance techniques, with content sourced from both BMW and successful independent BMW repair specialists.

With a driving combination of the proper repair procedures and the correct Original BMW Replacement Parts, you can expect to fix that BMW right the first time, on time, every time.

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Thanks for your continued interest.

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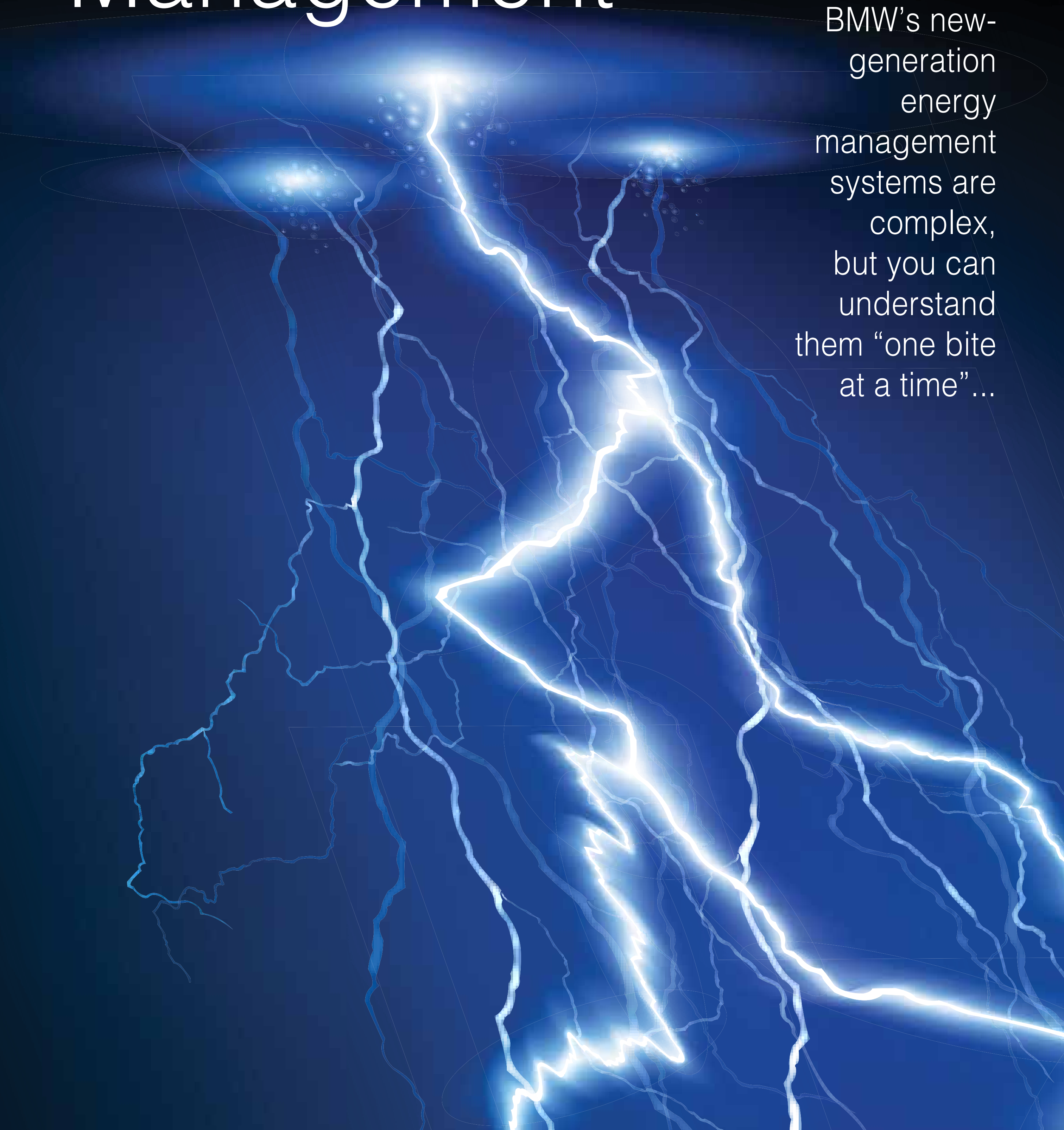
Energy Management

BMW's new-generation energy management systems are complex, but you can understand them "one bite at a time"...



So, here you are reading an article about BMW energy management. You have to admit that this is not a very sexy subject. But the topic is intriguing enough that you are taking the time to find out what this is all about. In this article you'll find a comprehensive overview of BMW energy management strategy, the components involved, how to use that information in service, and some service best practices.

BMW's first bona fide attempt at energy management started with the E65 seven series. How successful that was is debatable but it was a good first start. The E65 seven series, with its increased number of control modules, bus systems and features, launched the era of the modern BMW as we know it now.

BMW added a dedicated power module and software to control the flow of energy in and out of the battery and reduce consumer load when the vehicle was not in use. This increased the likelihood that the battery could restart the vehicle. The original goal was to make sure that the technological wonder known as the BMW E65 would not leave the owner stranded in the country club parking lot and ensure trouble-free operation when driven.

Thankfully for everyone involved, that strategy evolved into the powerful and fantastic system used today. Starting with the launch of the 2004 E6X five series, the energy diagnosis test module added powerful diagnostics for the energy management system. The energy diagnosis test module assists service technicians in determining a cause or causes of a discharged battery.

Those causes may be a bad battery, a closed circuit current draw in excess of 80mA, or excessive vehicle wake ups due to unauthorized bus activity. It could also be a function of control modules that prevent the vehicle from entering sleep mode, i.e. sleep mode preventers, prolonged parking periods, vehicle lighting being left on, ignition being left on or an unfavorable driving profile such as short trips.

With the 09/06 model update of the E6X, the energy diagnosis test module really started delivering detailed diagnostics. As for the E65, the energy diagnosis test module offered very little assistance in determining the root cause of battery discharge. It never reached its full diagnostic potential even after the 05 model update. So our overview of energy management with regard to the energy diagnosis test module will largely exclude this model.

In all Boardnet 2000 vehicles (almost all E series vehicles with a MOST bus), with the exception of the E65 seven series, and all Boardnet 2020 vehicles (F series), the energy management software is located in the DME. That software is responsible for many functions such as: determining the battery condition, determining the required charging voltage, boosting idle speed, requesting power shutdown of terminals and electric loads, and enabling battery discharge.

Let's take a look at the first item — determining the battery condition. The DME is responsible for the majority of the calculations of the battery condition. It gathers the relevant data from a small sensor/control unit called the Intelligent Battery Sensor (IBS). Using the data from the IBS, the DME is able to increase or decrease the output from the alternator, increase the idle speed to assist with alternator output if needed, and request reduction or termination of nonessential loads if the demands on the electrical system are too great.

The IBS is a Mechatronic component attached to the battery negative lead. It is mounted to the battery negative terminal and has power supply from a fused connection to the B+ terminal of the battery. It has the function of measuring battery voltage in, battery voltage out, current in, current out, and battery temperature under all operating conditions.

The IBS performs minor calculations and forwards its data directly to the DME. The IBS determines the state of charge (SOC) of the battery and is a critical component in determining the battery state of health (SOH). SOC is pretty self-explanatory, it's the open circuit voltage value or the amount of energy left in the battery. It has some diagnostic value but doesn't indicate the battery's ability to deliver current. That is where SOH comes in.

SOH measures the battery's ability to deliver a specified amount of current when requested. The DME calculates the battery SOH based on the voltage drop across the battery, measured by the IBS, during engine starting. The IBS delivers the state of charge, the value of the current demand from the starter, and the voltage drop across the battery, to the DME. The software in the DME processes those values to determine the battery's impedance ("effective resistance") and conductance and derives the SOH value. This process should be familiar to anyone who has performed a load test on a battery with a VAT40.

The DME uses the SOH factor to set the start capability limit and after-start recovery charge strategy. There are other factors used to determine the charge strategy like ambient temperature and battery type and size, which can be covered in charging system basics.

For now, let's just focus on energy management as it pertains to the energy diagnosis test plan. The start capability limit is the minimum voltage required to

New generation IBS next to the old generation IBS.

re-start the vehicle based on the state of health of the battery. There are typically two start capability limits, an upper and lower, or start capability limit one and start capability limit two. These limits are transmitted to the IBS from the DME prior to the DME entering sleep mode. The IBS will monitor the battery voltage level and wake the DME if the limit has been reached.

Now that we understand how the start capability limit is calculated, let's look at some of the other terms used in the energy diagnosis test plan.

Before we go much further we must understand the terms used to designate terminal status. By now, you probably have a pretty firm grasp on the basic terminal designations 30, 31, and 15 specified by the standard DIN 72552. Terminal 30 is a line from the battery positive terminal direct. Terminal 31 is a return wire from the battery negative or ground direct. And terminal 15 is switched positive after the battery ignition switch output.

Let's look at some variations used in energy management. Terminal 30g, also known as 30B in F series vehicles, is a time-controlled terminal shutdown. This means that control modules and components that are supplied by terminal 30g receive power when the vehicle is on, and remain powered for a specified amount of time after the vehicle is shut off.

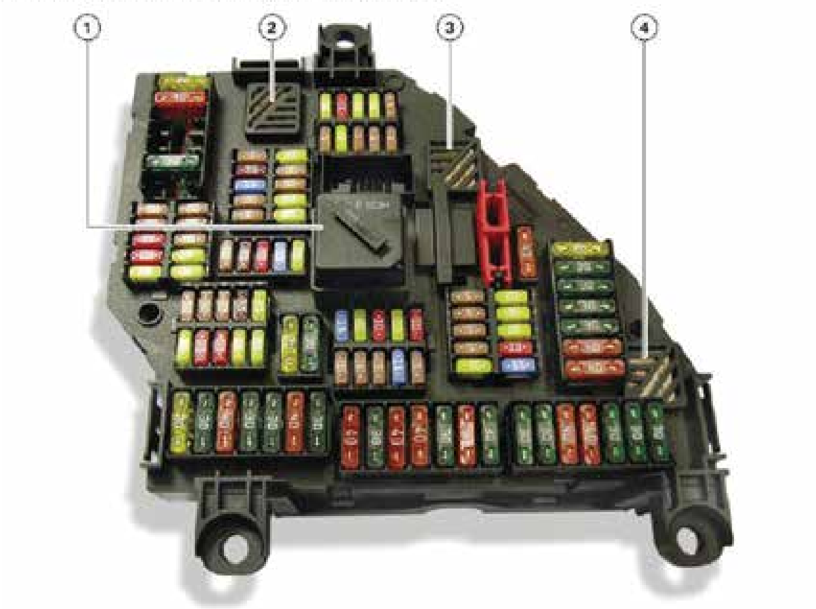
The Car Access System (CAS) is responsible for switching terminal 30g on and off using the 30g relay/30B relays. The CAS will open the 30g/30B relays after a specified period of time, from ignition switch terminal 0. In service the general rule of thumb is the terminal 30g/30B relays will be opened by the CAS one hour after ignition off. This time can be shorter if the vehicle does not have a TCU or combox or if it is an F series that has been double locked.

Rear Fuse Carrier in the Luggage Compartment

Due to the large number of consumers and control units in the F01/F02, an additional fuse carrier has been fitted in the luggage compartment.

As well as the fuses, a few relays are plugged in here or soldered to the circuit board. If one of the soldered relays is faulty, the rear distribution box must be replaced as a whole unit. The connection port of the battery cable is located on the rear of the fuse carrier.

External view of the rear fuse carrier in the F01/F02



Index	Explanation	Index	Explanation
1	Relay terminal 30B (plugged in)	3	Relay terminal 15N (soldered)
2	Relay terminal 30F (soldered)	4	Relay for the heating element in the rear window (soldered)

30g / 30B relay

When the CAS opens the 30g/30B relays, that marks the start of "Sleep Mode" and the IBS starts measuring closed circuit current. This means that any control modules or components connected to these relays are disconnected from power after the vehicle enters sleep mode and cannot cause a closed circuit current draw.

Okay, let's put it all together with an example from an energy diagnosis test plan. Let's say you perform an energy diagnosis test plan and the results indicate that the most likely cause of the battery fault is: 30g/30B relay. What does that mean? Is there a problem with the 30g/30B relays? Not necessarily.

The reference to the 30g/30B relays is more of an information flag indicating that the relays were switched off before the normal sleep mode switch off time. And since closed circuit current monitoring does not occur until the 30g and 30B relays are shut off, there would be no reason to go looking for a draw.

Instead, the focus should be on looking for what would be causing the battery voltage to drop off. In this case the most likely cause of the fault would be a weak/faulty battery. This strategy is refined and included in battery diagnosis in the energy diagnosis test plan starting with the F10 five series. Typically, a faulty battery that generated the results of the the 30g/30B relay would also generate the information flag: 30g_f/30F relay.

Now we will look at the terminal 30g_f relay also known as the 30F relays in F series vehicles. The 30g_f/30F relays are bistable relays, which means that they are relays that only require power to switch positions and the activation coil does not require power to keep them in the activated position.

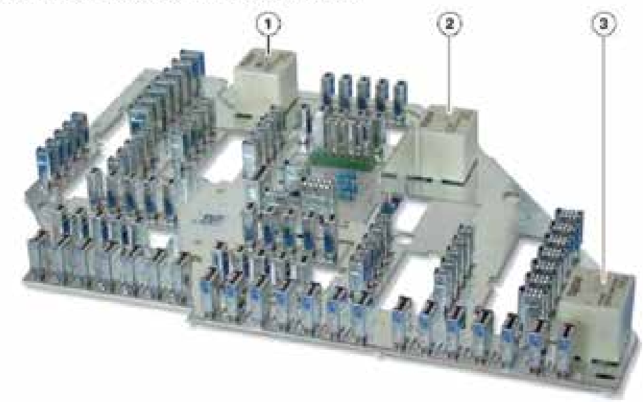
The designation 30 indicates the connection to battery positive and the g specifies that it is switched from a relay, followed by the f which stands for fault. So, the 30g_f/30F relays are shut down in the event of faults. These relays are normally on and are only switched off in the event of a fault such as unauthorized bus wake up, the start capability limit being reached, closed circuit current violation, or if sleep mode preventers are identified by the vehicle gateway (SGM, KGM, JBE, ZGM, FEM or BDC).

The 30g_f/30F relay shutdown process starts with a 10 second reset. After the reset, the IBS and/or vehicle gateway will continue to monitor for continued activity. If the condition that caused the reset continues, the 30g_f/30F relays will be opened until the next authorized vehicle wake up and a fault/ information flag will be stored.

On the subject of vehicle wake ups, there are a couple things that you should know. One is the difference between an authorized and unauthorized wake up. And another is determining which modules are authorized to wake up the vehicle.

All control modules that wake up the vehicle are logged by the vehicle gateway. This function reliably started with the 9/06 model update for E6X, and

Internal view of the rear fuse carrier in the F01/F02



Index	Explanation	Index	Explanation
1	Relay terminal 30F	3	Relay for the heating element in the rear window
2	Relay terminal 15N		

Battery Cables

In the F01/F02, three main power lines on the underbody run from the distribution box at the battery to the engine compartment. One of the main power lines runs via the positive battery terminal to the starter motor and to the alternator.

The second line powers the engine electronics (and electric coolant pump).

The third line runs to the distribution box in the engine compartment. This distribution box supplies the electric fan with power. This line is safeguarded by the high-current fuse (100 A) in the distribution box at the battery.

Cable	Cross section	Material
Cable to the starter motor and alternator	110 mm2	Aluminum
Cable to the front distribution box, behind the glove compartment	25 mm2	Copper
Cable to the rear fuse carrier	10 mm2	Copper
Cable to the power distribution box in the engine compartment	16 mm2	Copper

30F relay.

continued with more fidelity on all models that were capable of an energy diagnosis test module.

With regard to authorized vehicle wake ups, only two modules are authorized to wake up the vehicle, the CAS and the vehicle gateway, whatever that may be (SGM, KGM, JBE, ZGM). For Boardnet 2020 vehicles using FPM or BDC, those would be the only authorized wake up modules. All other modules that wake of the vehicle are considered unauthorized wake ups.

So, when examining a list of control modules that have awakened the vehicle, the CAS and vehicle gateway can be excluded as unauthorized wake ups, unless their wake-up cycle is abnormal, such as every minute or five minutes etc. Just a note, the KOMBI will show up in the wake up list intermittently throughout sleep mode. This is normal activity and can generally be disregarded.

The KOMBI periodically wakes up to check the ambient temperature as a function to optimize cold start emissions and energy management calculations. When analyzing unauthorized wake up, focus on the modules that are waking up at regular intervals. If there are multiple modules waking up the vehicle, try to determine if there is a common denominator — i.e., common power/common ground switch contacting the sensory input etc. If the focus is on a single control module, all of that control module's inputs need to be ruled out as the root cause prior to replacing the control module. These can include power and ground, corrosion-free connections, and wiring harness integrity

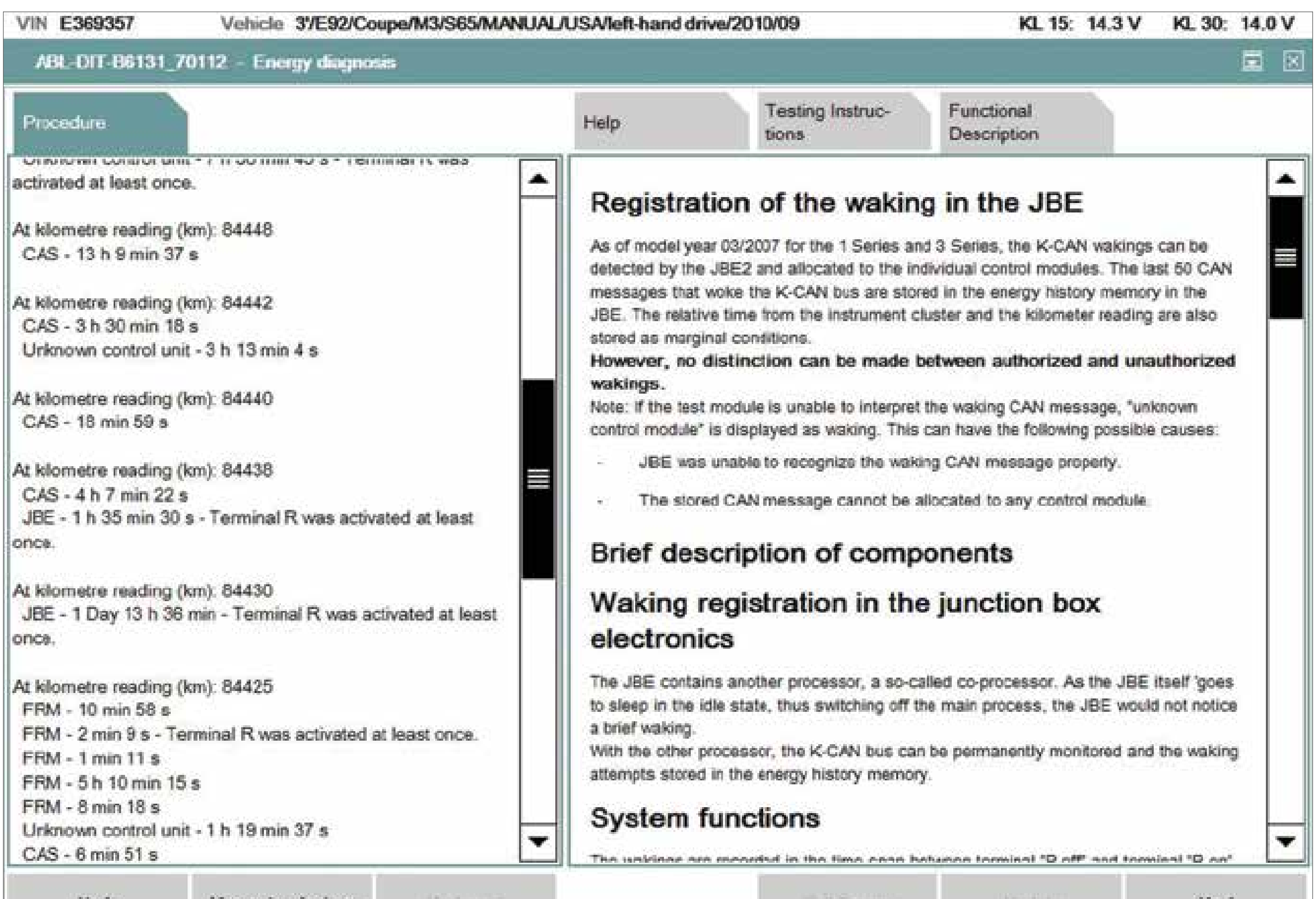
What is a sleep mode preventer? A sleep mode preventer is the control module that fails to enter sleep mode or set the ready to assume sleep mode bit more than one time after the ignition is switched off (terminal 0). After terminal 0, control modules for relevant data are required to restart and log off of their respective bus systems. The vehicle gateway monitors bus activity and logs which control modules have signed off and assume sleep mode.

Any control module that indicates it is ready to assume sleep mode more than one time is automatically classified as a sleep mode preventer. The majority of the control modules in the vehicle should assume sleep mode in the first 16 minutes (8 minutes for Boardnet 2020 vehicles) after terminal 0. This time frame, 16 or 8 minutes, is considered the first phase of sleep mode, and added conclusion nonessential consumer cut out occurs. That means any interior lights, map lights, convenience lighting and convenience features are turned off.

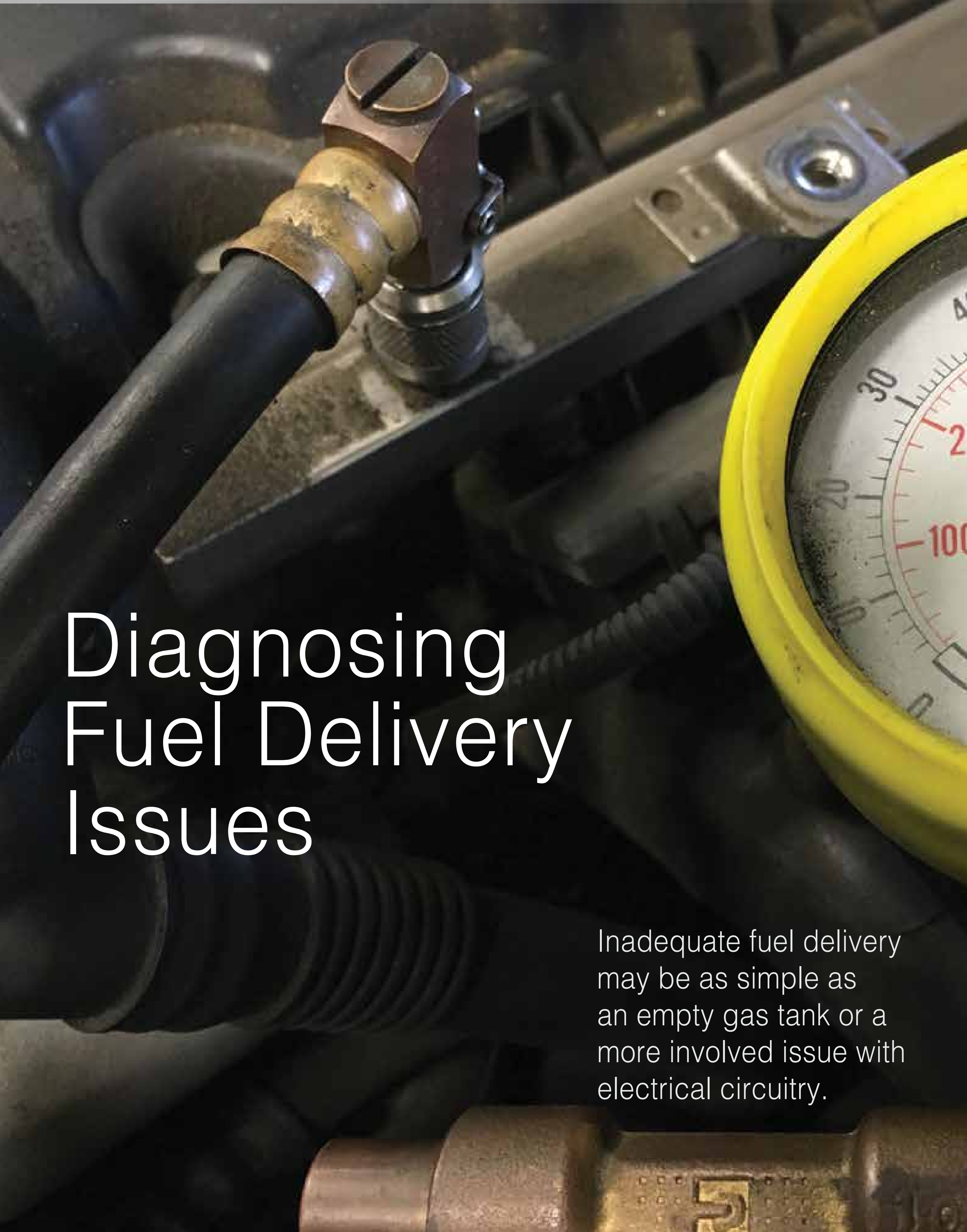
The vehicle gateway compares a registry of control modules that logged on to the bus during the last vehicle wake up to the list of modules that have logged off and entered sleep mode. The vehicle gateway module checks the vehicle bus system for modules that are communicating/still awake at 5, 10, 15 and 20 minutes after terminal 0. Any module that is still logged on at the 20 minute interval is designated a sleep mode preventer since it should have logged off by the 16 minute time frame.

That strategy is shortened up a little bit for the Boardnet 2020 vehicles since it uses an 8 minute first phase of sleep mode. But you get the general strategy, and now have an understanding of what a sleep mode preventer is. When a control module is identified as the sleep mode preventer, the inputs to the control module need to be investigated and ruled out as possible causes that may keep the module awake prior to replacing that control module. These can include power/ground corrosion-free connection switch contacts that may be monitoring the status of subsystems they may control.

Okay, now for everyone's favorite subject, closed circuit current draw/violations. As the sophistication of the energy management system progresses with new models, the subject becomes less and less challenging. With the addition of the 30g/30B relays and 30g_f/30F relays, there are fewer control modules connected directly to terminal 30, which means there are fewer control modules that can be identified as causes for a closed circuit current drain. ●



This example shows unusual wake up activity from the FRM.



Diagnosing Fuel Delivery Issues

Inadequate fuel delivery may be as simple as an empty gas tank or a more involved issue with electrical circuitry.

When a vehicle presents itself with a crank but no start condition, a few items must first be determined, one of which is, "Does it have fuel?" While this might seem like a simple question of whether or not the gas tank is empty, what we really need to know is whether or not there is adequate fuel delivery to the engine. This question can be answered with a standard fuel pressure and volume test. If the answer is no, it's time to figure out why.

Checking the flow

First, let's talk about that initial fuel pressure and volume test. Modern port fuel injected engines have a test port with a Schrader fitting to allow for convenient measurement. On most BMWs this is located on the fuel rail. However, some models have the test port built into the fuel filter and pressure regulator assembly. Pressure specifications vary, so be sure to look them up. For a while all BMWs had a standard spec of 50 psi. Over the last decade that has changed. We now see pressures up to 87 psi, and some vehicles call for a variable pressure. As far as volume goes, a good rule of thumb is to look for fuel delivery of a quart in 30 seconds.

No or low pressure or volume can be caused by an empty tank, bad pump, faulty pump control circuit, or a leak in the system. While no fuel delivery will certainly cause a no start condition, low or inadequate delivery may still allow the engine to run. In this latter scenario, the complaint may be a lack of power or misfires, with or without a check engine light. In all cases a complete vehicle scan should always be performed. Fuel trim faults indicating a lean mixture in both the "Additive" and "Multiplicative" ranges may indicate a failure to deliver enough fuel volume. Newer vehicles may also have a fuel pump plausibility fault.

The logical starting point

Fuel delivery starts at the tank, so let's look there first. BMW uses what is referred to as a "saddle tank." This refers to the shape of the tank. In order to achieve

Left: A fuel pressure gauge can quickly answer the question of whether or not there is adequate fuel supply.

optimal weight distribution, the fuel tank is located beneath the rear seat. To allow room for the exhaust and drivetrain, the tank is shaped like a saddle. This results in two storage areas with a common connection on top. There is only one fuel pump, located on the right side, so fuel must be transferred from the left side of the tank in order to feed the pump. These design elements are where we can encounter the first possible issues when dealing with no fuel delivery.

Is there gas in the tank? Because of the design, there are two fuel level senders, one on each side. Depending on the model you're servicing, these provide direct inputs to the instrument cluster, JBE or FEM. The control module evaluates both signals to determine the total fuel level to display to the operator. Obviously a problem with one or both sensors can result in a false display. Another problem can be the failure to transfer fuel from the left side of tank to the right side. In both of these scenarios, the vehicle will effectively run out of gas even though the gauge does not show empty.

Using an enhanced scan tool, with the ability to communicate with the instrument cluster, you can view live data from both fuel level sensors. You can also go into "Instrument Cluster Test Mode" and call up fuel level data directly out of the vehicle without a scan tool via test number 6. Test 6 may also display the raw data, or actual resistance, of each sender unit. This is displayed in ohms.

The first thing to note is the comparison of the fuel level in both sides of the tank. There should never be more fuel on the left side than the right side. If so, there may be a transfer problem or a failure with a level sensor. Due to the possibility of a sensor problem, actual fuel level should be confirmed visually. Removal of the access covers for both sides of tank is relatively straightforward on most models, with the notable exception of "Z" chassis.

Make sure sensors are telling the truth

If, after visual inspection, it is determined that the level readings are incorrect, continue with electrical diagnosis of the level sensor circuit. Sensors are potentiometers, so a voltage drop test while moving the float arm is the easiest test.

When the replacement of a fuel lever sender is needed, either as a result of failure or as part of a replacement fuel pump assembly, there is an important step that is often overlooked. Because this is an analog signal being generated by a mechanical component, wear results in signal degradation. This problem is addressed using adaption values stored in the instrument cluster or appropriate processing control module.

Now if the sensor was bad, the software has been applying a lot of inaccurate adaptations to that signal. As a result, when the sensor is replaced, the signal will be modified to a point that it too is inaccurate. This can, and often times does, lead to the same symptom the vehicle first presented itself with until adaptations shift back to zero, which can take several full tank refills.

Using test 6 within the instrument cluster is an easy way to check the status of fuel level sensors. Some vehicles even allow the resistance values to be displayed.

To avoid this problem and a dissatisfied customer, these adaptation values must be reset. This resetting is accomplished via test number 21 in the instrument cluster test mode. Remember, the cluster must first be unlocked. When asked to enter the unlock code, simply add the last five digits of the VIN together. For more information on cluster test mode, visit the BMWTIS website (https:/www.bmwtis.com) and read the "Driver Information and Displays" section of the body electric training manuals.

If visual inspection reveals that the left side level is in fact higher than the right side, there is a problem with the siphon jet pump circuit inside the fuel tank. This system relies on return flow and pressure after the fuel pressure regulator. A restriction in the system, like a clogged filter, could result in low flow. A bad fuel pump can also result in insufficient flow.

Because the fuel level sender is often incorporated into the pump assembly, remember to clear the adaptation values for the sensor circuit in the instrument cluster when replacing.

Another possibility is an internal leak. A hose in this siphon jet circuit can break or come loose at a service connection fitting. While the access covers are still off, activate the in-tank pump. In the case of a broken or disconnected line, there will be fuel spraying out from this leak. A disconnection due to improper installation may be repairable. However, a broken line will likely require the replacement of the entire tank. Some technicians are finding that the plastic corrugated lines used inside of BMW fuel tanks are starting to fail. This is probably a result of the ethanol content in today's gasoline.

Time to check the circuitry

If initial testing did not reveal any problems with fuel levels, it's time to check the fuel pump circuit. On early vehicles the pump control circuit is pretty straightforward, consisting of little more than a fuse-protected relay. Now, however, all new BMWs utilize a control module to operate the in-tank pump. At this point we will be doing some electrical circuit diagnosis.

Before starting, be sure the vehicle battery and charging system are in good order. If the vehicle doesn't start, obviously the charging system can't be tested. However, the battery may be low on

When this hose was crimped onto its fitting, it was not completely inserted. The result was an internal leak.

charge due to the several unsuccessful attempts to get it started. Electrical system test results are only accurate with appropriate system voltage. Connecting an auxiliary power supply will assure consistent system voltage throughout the diagnostic process.

To test the fuel pump circuit, you will first need to activate it. Depending on the model and year, this can be done in one of two ways. On earlier BMWs the pump circuit is controlled using a conventional relay. This relay may be located in many different locations, from the engine compartment to the trunk. Once the relay is located, simply jump it via a purpose built tool or a small fused wire with spade connectors on each end. You will need to connect terminal 30 to terminal 87 at the relay socket.

Starting in the early 2000's BMW started varying the fuel pump speed to match load conditions. This first appeared on the E39 and E46 Motorsport vehicles and was later introduced on all chassis. The reason for this was to deliver only the fuel volume needed to meet current load demands plus a little extra to ensure the return system could still transfer fuel via the siphon pump system in the tank. This concept saves energy, reduces wear on the fuel pump, reduces the overall temperature of the electric motor, and therefore helps to prevent unnecessary fuel vaporization in the tank.

All in all this is a great feature. In order to do this, the conventional relay is replaced by an ECU. On those early "M" cars, this ECU was little more than a smart relay. The engine control module, or DME, out puts a pulse width modulated (PWM) square wave pattern to indicate the desired delivery. On these models you can jump the circuit the same way as you would on earlier relay-controlled circuits.

Now all BMWs have a fuel pump control module that is on a bus network. These ECUs are called EKP modules. The first chassis to use this was the E65/66 although on this vehicle it is a unique setup. Instead of a dedicated ECU for fuel pump regulation, the electronics were incorporated into a pre-existing control unit. The module chosen for this task was one of the safety system satellites, specifically, the right side B pillar satellite, or SBSR.

The SBSR is on the Byteflight network. This means that the command path for fuel pump control goes from the DME over PT-CAN to the central gateway module, or ZGM. From there the activation signal is sent over Byteflight to the SIM and passed on to the SBSR. Suddenly the importance of a complete vehicle scan becomes clear. On all other BMWs with a dedicated EKP module, the module is on the PT-CAN. So the signal path is much less complicated. As a side note, the EKP module contains one of the two terminating resistors for PT-CAN.

Because the EKP modules are on a vehicle network, they can be accessed via a scan tool. Using your scan tool, live data like pump speed and current draw can be viewed, fault codes can be stored, and the pump can be commanded to run. The speed

On the E65/E66 chassis, an airbag system control module, the SBSR, is used for EKP regulation. Because the SBSR incorporates accelerometers used for crash detection, do not manipulate it while the key is on. This is a common cause of fuel pump circuit failure.

is controlled via fixed frequency variable duty cycle, also known as PWM.

Your scope is your friend

To ensure accurate circuit analysis, you will have to test using a lab scope. If using a DVOM, the low sample rate will only display an average. For example, 12 volts at a 50% duty cycle will be displayed as 6 volts. If you were unaware of this, you would find yourself chasing a power supply problem that doesn't exist. To avoid this issue, either use a high sample rate digital oscilloscope, or when commanding the pump to run with scanner, select the option of running the pump at 100%.

A DVOM and a solid understanding of voltage drop theory is all you need to fully analyze the fuel pump circuit.

Now that the circuit is complete, or commanded on via scan tool, perform a voltage drop test across the fuel pump connector under the rear seat. You should be measuring within half a volt of system voltage (some will be lost through various connections). If measurement is within spec, and you cannot hear the pump running, clearly the problem is in the tank. Remove the electrical connecter and visually confirm that the contacts are not burnt before proceeding with a pump replacement.

However, if the measured voltage is more than half a volt lower than system voltage, there is a problem with the circuit. First determine if the problem is on the power or ground side. This is done by doing a voltage drop test of the complete circuits on either side of pump to the battery. Connect the ground lead of your DVOM to the negative post of the battery, and connect the positive lead to the ground pin on the pump connector. This is a complete ground circuit voltage drop test. A reading of anything over half a volt is a problem.

To check the supply side of the circuit, place the positive lead on the positive post of battery and the negative lead to the power pin of the pump connector. This is a voltage drop test of the entire positive circuit. This test can determine if there are any bad connections or open circuits. Don't forget, a blown fuse is an open circuit.

Once you have determined which side of the pump control circuit is faulty, it is time to further isolate the issue. Using a wiring diagram, locate all the connections in the circuit. Continue to perform the described drop test at additional locations to divide the circuit. Potential issues can be anything from a burnt connector, loose ground, worn relay contacts, or even cold solder joint failures on the circuit board of the EKP control module. Note that the SBSR is a common failure point with solder joint failures.

Everything discussed here can also be applied to the low pressure side of the fuel supply system in vehicles equipped with direct injection engines. The primary difference is that, in these vehicles, fuel pressure is controlled by EKP regulation using feedback from a fuel pressure sensor located in the fuel line. This is opposed to a mechanical fuel pressure regulator. These systems do not have a pressure test port. Measurements are done via live data stream with your scan tool, or by using an adapter to the "T" into the fuel line.

When replacing a faulty fuel pump, you should always replace the fuel filter too. If the repair requires replacement of the EKP module, it will likely need coding or programming. If you are replacing the SBSR, after coding and programming don't forget to restart the system time for the passive safety system. ●

Always replace the fuel filter when replacing a faulty pump. This in-tank filter has become heavily contaminated after less than 120,000 miles of use.


FlexiTherm
1
2
3


FlexiTherm


PYLE
-0.1
mbar
UNITS
HOLD
DIF
PDMM01
Manometer
Auto-Off
CE

Trouble-shooting Mixture Codes on the N54 Engine

The BMW N54 engine which first appeared in the E92 335 coupe is a twin turbo direct injected engine. The HPI system can produce fuel pressures up to 2900 psi (200 BAR).

The engine uses two small low-pressure turbochargers to minimize turbo lag at low elevations. For this reason, the turbo pressure is only 8.8 psi since the engineering goal was to offer the same driving feel as with naturally aspirated engines. BMW's brand for turbocharging is "TwinPower Turbo."

The three diagnostic trouble codes (DTCs) we encounter most often for fuel mixture issues are: 2e91 Mixture Control 2; 29e0 Mixture Control 1; and 3100 Boost Deactivation. For this 3100 code we should reference BMW TSB 12 28 07. This indicates that the code should be ignored if set with other codes. So now we are set to pursue the two mixture codes.

One of the first things we generally check on BMW motors is crankcase pressure.

We have to understand that, unlike other BMW engines, the n54 does not use a diaphragm for the crankcase ventilation system. Instead it uses four small cyclonic separators. While this arrangement can cause some air restriction and oil consumption when it malfunctions, rarely does it seem to cause fuel trim issues. The spec for the system is 17MB.

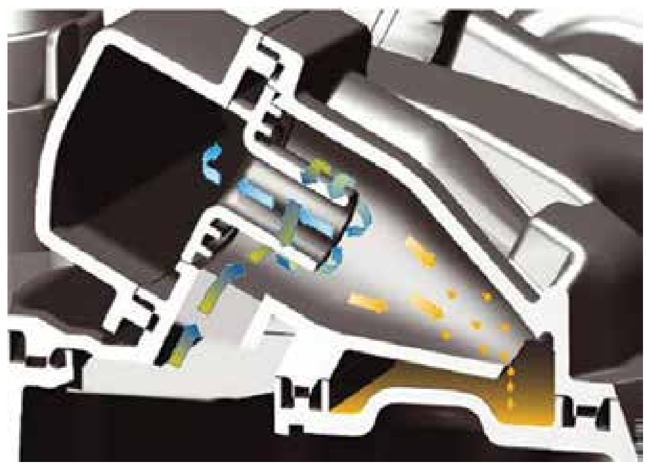
Next we should check for vacuum leaks using a smoke machine, typically in two areas — one via the oil cap, and the second by tee-ing into the vacuum ports on the vacuum canisters near the exhaust. The smaller vacuum leaks generally result in trims in the 8-15% range.

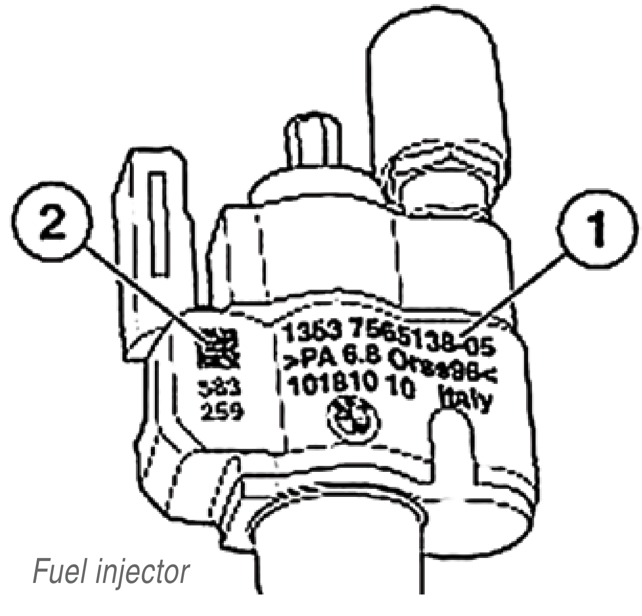
Most of the time the fuel delivery system will have set codes. However it's always wise to check the low side pressure on the n54 engine. 5 bar is the spec. Low pressure or delivery can affect fuel trims so make sure to check both pressure and delivery on the low side.

At this point we have checked all the above items and you may still be getting trim codes, often with no running issues detected. This is where fuel trims come into play. When we see trims over 22% or so (some as high as 33%) the last thing left is fuel injectors. There are also some ISTA test plans that will help identify faulty injectors. However experience suggests that trims that are excessively high will indicate an injector problem as long as none of the previous items mentioned are causing the issues. One should note that if the Injector index is below index 11, all injectors in that bank must be replaced. See picture to the right; the index number is labeled #1.

There are several things to note when replacing fuel injectors. Injectors must be coded to the specific vehicle being serviced. See #2 on this picture. If you are re-using injectors, make sure to replace the seals using the appropriate BMW special tools. Do not use a puller than can shock the injectors, since the crystals can be damaged when doing so. There are three TSBs for warranty extensions and recalls, so make sure you check these before selling you customer new injectors. TSB 01-02-15, TSB 01-17-15, and recall 13-14-10 deal with fuel injector issues. A quick VIN check in Ista Air or Ista will show if the injector recall is still open for the vehicle you're servicing. The other two TSBs are warranty extensions and will not show up.

Finally, be sure to test drive the vehicle after service and make sure the values drop. ●





Fuel injector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BMW N52 engines oil leaks from behind oil filter housing

The new N52 series includes the N52B25. Also included is the N52B30 engine which has 6 cylinders and is totally different from previous versions of the M54B30. It is equipped with popular Double-VANOS camshaft and light-weight aluminum-magnesium engine block along with lighter connecting rods and pistons.

A new cylinder head design is used in this engine. It incorporates variable valve timing on both the intake and exhaust valves. The Valvetronic II improved system of valve lifting is used in order to increase the engine's efficiency.

The N52 engine uses three aluminum bolts securing the cylinder head to the timing cover. This is where our problem starts for this oil leak. These aluminum bolts tend to break; the one you can see with a quick glance is the bolt located behind the oil filter housing.

This bolt is relatively easy to replace. The procedure involves removing the intake manifold and cutting a small slot in the bolt; it will then back out rather easily. This however is not where you should stop. If you find this bolt broken there is a strong possibility that there are other bolts broken under the valve cover as well.

The next step involves removal of the valve cover to inspect the remaining timing cover bolts.

Once the valve cover is off there are a few things you should inspect, one being the Valvetronic eccentric shaft sensor. Here we are looking for any signs of oil in the electrical connector. This would indicate a problem in the sensor which should be replaced at this time. A faulty sensor allows oil to leech into the sensor and can cause issues down the road. Some of the codes this sensor will set are

- 2A31 Valvetronic eccentric shaft sensor, guide sensor
- 2A32 Valvetronic reference
- 2A47 Valvetronic eccentric shaft sensor plausibility

It's best to change this sensor when the valve cover is off.

There are two more bolts located under the timing gears. These are also aluminum and should be checked. If either of these is found to be broken or loose, you will have to pull the front timing gears off to change the bolts. BMW instructions can be found in 1131505.

Special tools required:

11 0 300	11 4 280
11 4 360	11 4 362
11 5 200	11 9 280

If you find the broken bolt head, pull it out. However if you have gotten unlucky and the bolt head cannot be found the fun is only beginning. At this point you should remove the oil pan to retrieve it. The bolt head can easily jam in the timing chain and cause jumped timing or worse. Once the pan is pulled down and you have retrieved the bolt, it's time for reassembly. ●

Tech Writers Wanted!

We are looking to expand our team of contributors for *the bimmer pub*. We are interested in technicians who are knowledgeable in BMW and are interested in and able to provide technical information on how to diagnose a specific problem and provide the procedural repair information to fix the vehicle system. You provide the knowledge - our editors do the rest.

If you you or anyone you know works on BMW and might be interested in writing, please let us know. (Writing under a pseudonym is also an option.) We would be happy to speak with you or a colleague directly about the opportunity.

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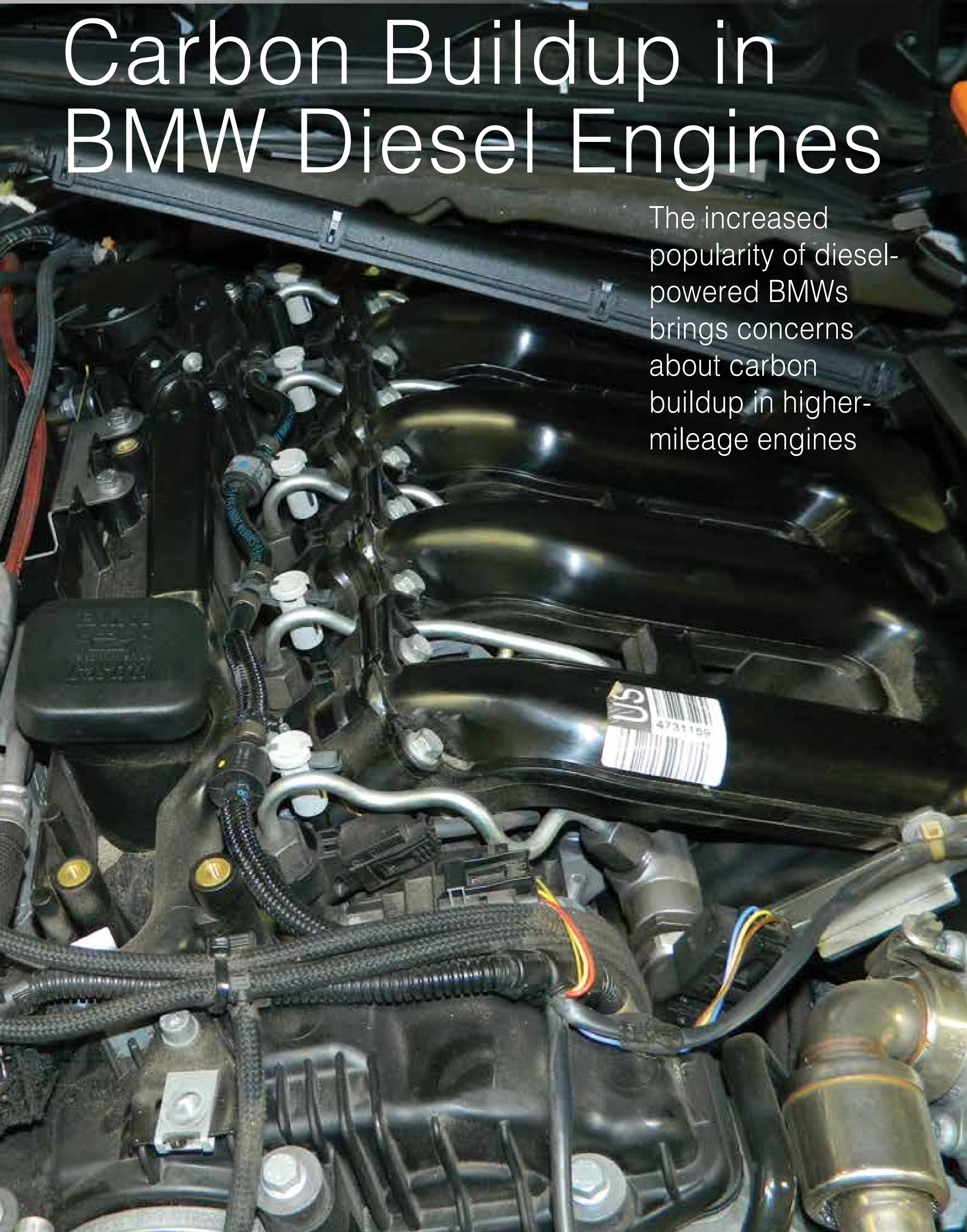
Carbon Buildup in BMW Diesel Engines

The increased popularity of diesel-powered BMWs brings concerns about carbon buildup in higher-mileage engines



For the 2009 model year, for the first time in over two decades, BMW began selling vehicles equipped with diesel engines. The E90 and E70 both were available with the M57D30T2 (US) engine. This is a turbocharged common rail injection 3.0-liter diesel that meets the EPA tier 2 Bin 5 requirements. In order to meet these new "Clean Diesel" standards, some new technologies are fitted to these vehicles. This emissions reducing equipment is placed both before and after the combustion chamber. In this article, we will be looking at the technology before the combustion chamber in the air management system, and the problems it is creating.

Exhaust Gas Recirculation (EGR)

The recycling of exhaust gases is one of the methods used to reduce NO_X in a diesel engine. By introducing exhaust gas into the intake stream, the amount of oxygen in the combustion chamber is reduced, which results in lower combustion chamber temperatures.

BMW gasoline engines currently do not use a more conventional "external" EGR system. EGR on BMW gasoline engines is considered an "internal" system which is carried out via the variable camshaft control system (VANOS). The VANOS system modifies the camshaft timing to achieve a precise amount of valve overlap. The valve overlap allows a certain amount of EGR to occur, thus lowering NO_X significantly. Mostly, gasoline engines respond to an EGR flow rate of about 5 to 15%.

Here you can see how much carbon can develop on the EGR valve mechanism.

BMW gasoline engines are able to benefit from the "internal" method of EGR due to engine design and engine management strategies. In the case of diesel engines, which run in a constantly lean mode, the NO_X content in the exhaust gas is much higher. Therefore, the "internal EGR" method is not able to sufficiently lower NO_X to acceptable levels.

So, BMW diesel engines employ an external EGR system to meet these needs. Diesel engines benefit from EGR rates as high as 50% under certain operating conditions. Unlike gasoline engines, diesels can introduce EGR at idle. This is due to the fact that the diesel has a mostly open throttle at idle. This helps reduce NO_X at idle which is when a diesel is most lean. The recirculated exhaust gas, which is mixed with the fresh air and acts as an inert gas, serves to achieve the following:

- A lower oxygen and nitrogen concentration in the cylinder,
- A reduction in the maximum combustion temperature of up to 500°C. This effect is increased still further if the recirculated exhaust gases are cooled.

The EGR valve is located in the throttle housing. Exhaust gas is ducted from the exhaust manifold to the throttle housing. There is a connection at the forward end of the manifold for this purpose. Connected here is the EGR valve, which controls the volume of recirculated exhaust gas. The EGR systems differ between the E70 and the E90. Both vehicles use the "high-pressure EGR," but the E70 uses an additional "low-pressure EGR" system. The low pressure EGR system is required in the E70 due to its additional weight and higher operational loads (i.e. towing etc.).

Swirl Flaps

The M57 engine uses a four valve combustion chamber design much like its gasoline counterpart.

However, the arrangements of the intake ports in the cylinder head are radically different. Each of the two intake valves has a separate port. One is called the tangential port and is located in the same conventional position as other intakes, on the side of the head. The other port is called the swirl port. The swirl port comes straight down through the valve cover. As a result of these two ports and their locations, the intake manifold has a very unique design.

The purpose of this air management configuration is to allow control over how air is delivered to the combustion chamber during the intake stroke. If incoming air is directed to only one valve within a four valve configuration, swirl is generated. This swirl increases the turbulent kinetic energy of the air present in the cylinder during both the intake stroke and the compression stroke. This method of air control works in conjunction with the piston geometry to ensure a more complete mixture formation.

By controlling “swirl” within the combustion chamber, significant reductions in NO_X and particulate emissions are possible. This design is not exclusive to the M57 diesel engine. In fact, this takes place on every engine BMW currently manufactures for use in the automobile. With the gasoline engines, turbulent kinetic energy is increased by use of Valvetronic. This feature is known as “phasing.”

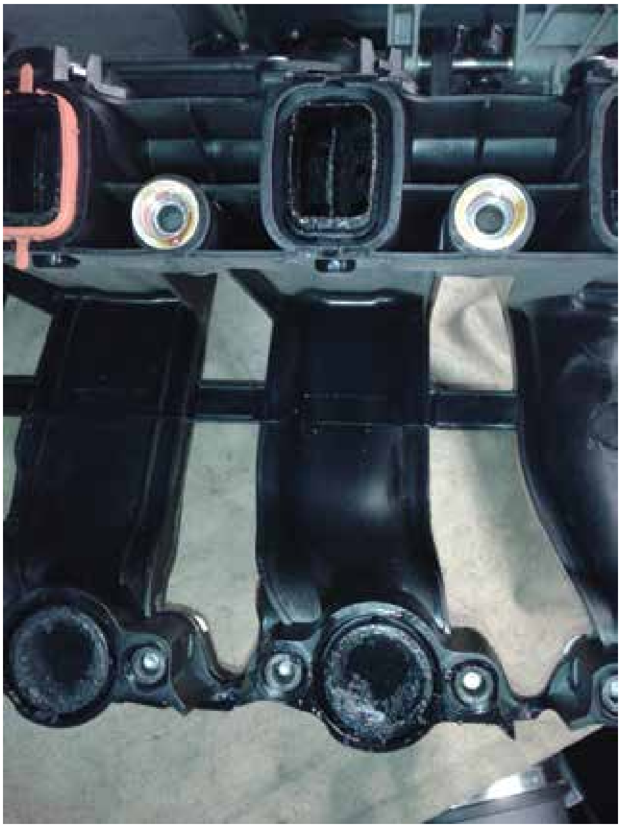
In order to control the delivery of air to only one port on the M57, the tangential port has what is called a “swirl flap” installed in the runner of the intake manifold. The swirl flaps are controlled electrically. This method of actuation provides a means of position feedback with the DDE system to comply with OBD requirements. An additional benefit of this method of control is a more precise positioning of the swirl flaps as needed. The flaps are map controlled using engine speed, engine load, and coolant temperature inputs.

Swirl flaps ensure better swirl of the incoming air during the intake and compression cycles. The adjustable swirl flaps, located in the tangential channels of the intake system, are opened and closed according to the operating status of the engine.
On the M57TU engine, the swirl flaps are closed at low RPM and load conditions. To increase the swirl effect, swirl flaps are designed to close tightly on the M57TU engines. With increasing engine speed, the DDE opens the flaps to facilitate charging through the tangential ports. The position is based on the driver’s load choice, engine speed, and the coolant temperature. The swirl flaps are varied by a linkage that is operated by a DC motor.

Effects of Swirl Flap Malfunctions

If the swirl flaps stick in the open position, deterioration in exhaust gas characteristics in lower

M 57 engine with intake manifold and valve cover removed speed ranges will develop. Otherwise there is no effect. If the swirl flaps stick in the closed position power loss of approximately 10% can develop at higher engine speeds.



Massive amounts of carbon can build up in intake manifold runners, compromising performance and economy.

Carbon Buildup

If you thought carbon buildup in the intake was bad on gasoline direct injected engines, imagine what happens when soot from the EGR system mixes with the oil from crankcase ventilation on a diesel. This is becoming a major problem. This issue takes place over a period of time ranging typically between 40,000 and 80,000 miles depending on vehicle operation and maintenance habits. The resulting reduction in performance is gradual, so not usually noticed by the driver. However, the disruption in air delivery will eventually be recognized by the engine management software in the DDE. This will result in the illumination of the "Malfunction Indicator Lamp" or "Check Engine Light."

The buildup of carbon creates a restriction in the air management system. If the resulting restriction is uneven across cylinders, this will cause uneven cylinder filling and power balance problems. Detection of this is similar to the crankshaft acceleration rate misfire detection on a gasoline engine. This will set cylinder-specific "roughness

Carbon can also build up at the throttle body connection, further impeding the flow of incoming air.

Carbon can build up in cylinder head swirl ports in addition to other places within the induction system.

controller" faults (459C, 4593, 4596, 4592, 459B, 4595). In addition to these faults, the overall reduction in airflow will set plausibility faults for the air mass sensor (3FF1). It is not uncommon to also see plausibility faults for the throttle body and EGR valve.

The fix is the same as on a gasoline engine, clean it. However due to the design of the intake on the diesel engine, this is significantly more labor intensive. You will need to not only remove the intake manifold, but also the valve cover.

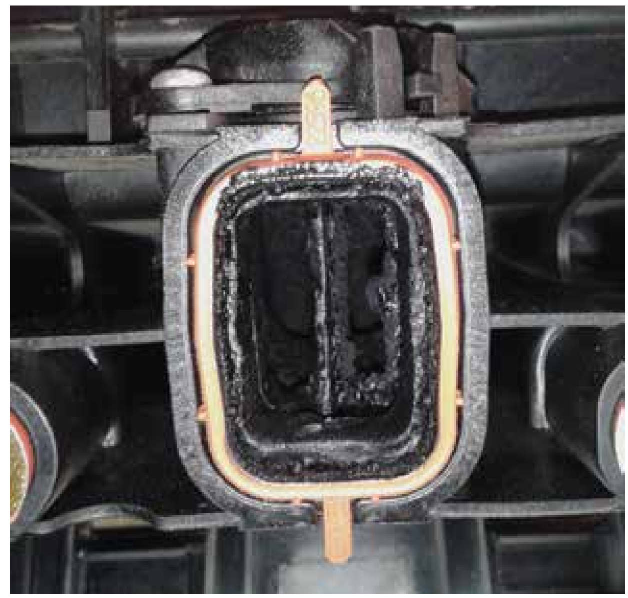
When it comes to cleaning carbon from the intake, you typically have three options. Option one is chemicals. This process is still in its infancy within the industry. The problem here is that the carbon is a product of blow-by gasses and oil from the crankcase ventilation system mixed with soot via the EGR. It is then formed via heat and pressure.

Not all engines run at the same temperatures and pressures, as this will vary depending on loads. So every engine has a unique molecular make-up to the carbon build within. Don't forget, with enough heat and pressure, carbon forms a diamond! So, because of so many variations, it is difficult to create a chemical that breaks down a such a wide variety of all the different potential chemical make-ups that can reside in the intake. And there can be significant variations from one manufacturer to another.

Option two is to clean manually using a combination of picks and scrapers. This method works OK but is incredibly time consuming. You will also not achieve the type of results that make before and after pictures look great. What you will achieve is a massive reduction of the restriction in the air management system. This will correct the drivability symptoms.

The last option is to use a blasting media in conjunction with a delivery method to clean the system. The media of choice is walnut shells, and the BMW factory tool (part number 81 29 2 208 034) for performing this walnut shell basting procedure is the best way to do it. This tool offers some additional features over generic gravity fed systems. The BMW blaster uses a pressure fed hopper to force the media solution into the distribution nozzle. It also uses a dual stage trigger, allowing the user to switch back and forth between walnut shells and just air.

In addition to the blaster, you will need specific adapters for the M57 engine (part numbers 2 356 966 and 2 356 967) and blasting wands (part numbers



Other places where carbon can build up include the tangential ports on the intake manifold and the tangential ports on the cylinder head.

Here is an example of how thoroughly you should seal off ports and passages prior to carbon blasting.

Using carbon blaster on swirl port.

This is a tangential port on an intake manifold with swirl pot closed after soda blasting.

2 356 968, 2 356 969, and 2 356 970). It is best to obtain an extra set of wands as you will find that making some modifications to them will give you more freedom to clean difficult-to-reach areas of the intake ports. For more information about the BMW carbon blaster and how to use it check out service information bulletin 11 03 14.

Before starting the cleaning process, take some time to cover and protect all open passages in order to prevent blasting media from going into locations that would be undesirable. Remember to only clean ports that have closed intake valves. You will need to turn the engine over by hand to complete the job and clean all ports. A special socket (part number 01 6 480) will be necessary for turning the crankshaft hub. The whole cleaning process will take some time, and you will use between 30 and 60 pounds of walnut shells depending on the severity of the buildup.

The intake manifold is also going to need to be cleaned Many service centers are simply replacing the intake manifold with a new one. However, the intake manifold can be successfully cleaned using a soda blaster. This is a blasting cabinet that uses baking soda as the abrasive media. Soda is soft enough to not cause any damage to the plastic or even the impregnated rubber seals on the swirl ports.

If you choose to use this method, completely disassemble the intake removing all the swirl pots, sensors, hardware, actuators, and replaceable gaskets before cleaning. You will need to clean the throttle body and EGR valve before reassembly. You can also use the soda blaster for this or use a good throttle body cleaning chemical. Be sure to keep any chemicals from flowing along the actuation shafts and entering the electronics.

When everything is clean and the parts have been reinstalled, there are a few things that need to be done before starting the engine. First, you will need to bleed the fuel circuit. Because diesel injectors open hydraulically, if the system is not bled the engine cannot start. There is also the potential for damage caused by running the high pressure pump dry.

Using your scan tool, there is a service function for fuel circuit bleeding. This function runs the in-tank pump while also opening the return valve at the rear of the high pressure fuel rail. The bleeding function is designed to clear out any air after replacement of the fuel filter. It will not clear out air trapped in the individual lines running from the rail to each injector.

To clear out this trapped air, crack open each line at the injector while the in-tank pump is running. You will see air bubbles exiting. Wait until you have a steady stream of diesel fuel and then retighten the line fitting. Perform this step on each injector. Obviously this will make a mess, so have some rags stuffed around the area and then clean everything up before starting the engine. Run the engine and check for any air, fuel, and oil leaks before installing the sound dampening cover.

Lastly, the "zero-mass adaptations" need to be cleared from the DDE. Failure to do this can potentially result in false cylinder specific faults. Prior to ISTA 3.47.10, this required an IRAP session to be performed at a dealership. The test plan has now been incorporated into ISTA. However, the vehicle must be programmed with ISTA/P 3.54.3 resulting in a target I-level of E89X-14-11-501 or E070-14-11-501 depending on chassis. ●

The swirl ports on the cylinder head can look like this after cleaning.

Here is a complete M57intake manifold reassembled after soda blasting.

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