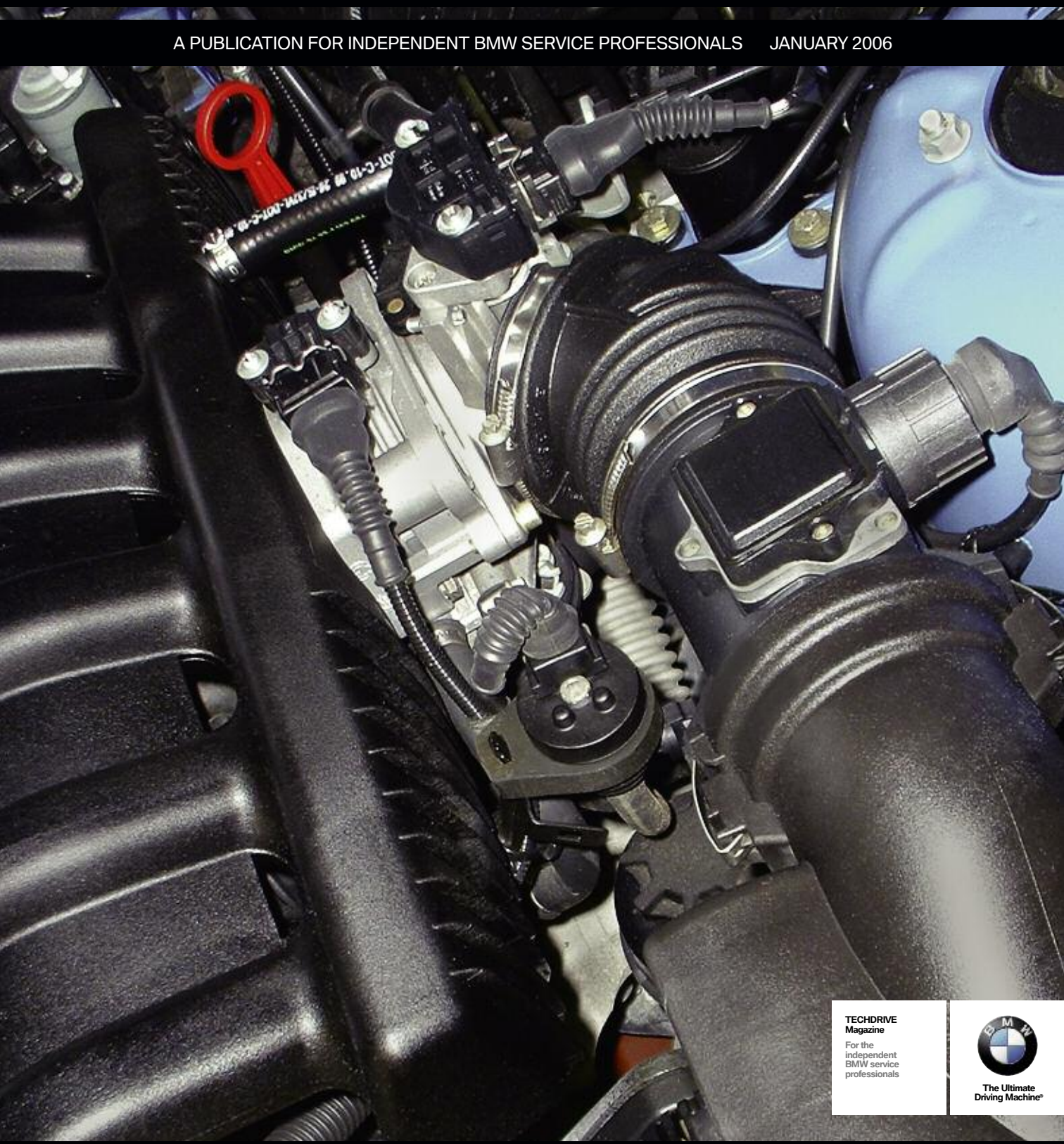
TECHDRIVE

Original BMW Parts

VOLUME 3 NUMBER 1

A PUBLICATION FOR INDEPENDENT BMW SERVICE PROFESSIONALS JANUARY 2006



TECHDRIVE Magazine

For the independent BMW service professionals

The Ultimate Driving Machine®

FUEL SYSTEM • RACK AND PINION EVOLUTION • FILTER TECH

TO OUR READERS

— What could be more useful to independent service technicians who work on BMWs than a publication dedicated specifically to them?

— That's the idea behind the magazine you're holding, TECHDRIVE. BMW of North America both sponsors the publication and provides much of the information that's included. A big part of the rationale behind TECHDRIVE is the belief that if you are able to diagnose, repair and maintain BMW vehicles properly and efficiently, your reputation and ours will be enhanced.

— TECHDRIVE's combination of feature service articles (written from both BMW tech information and interviews with successful independent BMW specialists), new technical developments, systems evolution, as well as the correct BMW replacement part, and service bulletins are intended to help you fix that BMW right the first time, on time. Our list of BMW dealers will assist you in finding Original BMW Parts.

— There's more to this effort, including highly-informative and user-friendly web sites, which we'll explain in future issues.

— We want to make TECHDRIVE the most useful and interesting technical magazine you receive, and you can help us do that. Please email us at editor@techdrivemag.com and let us know what topics you'd like to see covered, and provide any other comments you might have. With your involvement, this publication can evolve into one of your most important tools.

Thanks for your continued interest.

For more information please email us at:
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TECHDRIVE Magazine

For the independent BMW service professionals

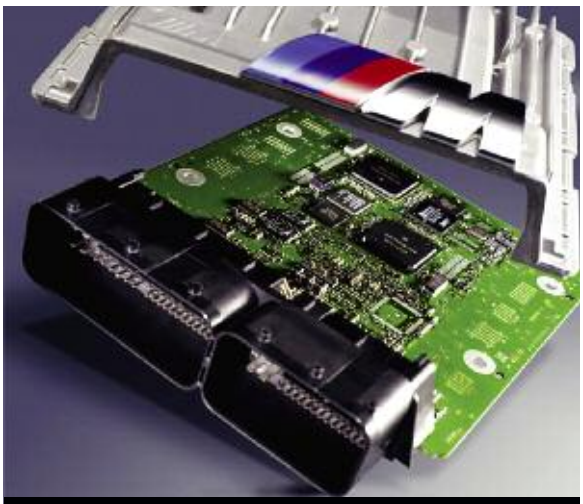
The Ultimate Driving Machine®

Keep the Fuel Flowing

Following the fuel from the gas cap to the injector tip

Getting an engine to run is easy. All you have to do is provide the right amount of fuel, mix it with the right amount of air, compress this mixture to a fraction of its normal volume, fire the spark plug at exactly the right time to ignite the air/fuel mixture, and you have a running engine.

Okay, so it really isn't that easy. Modern BMW engines are carefully designed to provide optimal performance and minimal emissions across their entire operating range. Precise amounts of fuel and air must be present in the combustion chamber when the plug fires to provide the performance BMW owners expect, and to meet the emission levels the government demands. Fuel, air, and spark are equally critical. A problem with any of the three will cut performance and possibly prevent the engine from running at all. This article covers troubleshooting the typical return-type fuel system; future articles will cover returnless EFI, air management and ignition systems.



Of course, nothing would happen if the ECM/PCM didn't complete the circuits to the fuel pump and the injectors by providing ground. Still, look for other problems before condemning this dependable (and expensive) component.

On BMWs, the Engine Control Module or ECM (called by BMW the DME and also known generically as the PCM for Powertrain Control Module) regulates fuel pump operation and the amount of fuel entering the combustion chamber, but it does not monitor actual fuel delivery. In other words, the onboard computer system turns the fuel pump on and off, and precisely controls injector operation, but there is no sensor to actually detect fuel flow.

Be safe

Remember, gasoline likes to burn -- in fact, it really has no other purpose except to catch fire and burn rapidly, almost explosively. It doesn't matter to the gasoline where it burns. Inside an engine's cylinders is no better a place than under the hood, on your clothes, or all over the shop. Always observe all the safety rules whenever you are working on the fuel system:

- **Have a fire extinguisher handy.**
- **Never smoke or have any open flame near gasoline.**
- **Make sure other technicians in the area are not smoking, using a grinding wheel, or creating a spark.**
- **Always store gasoline in an approved safety container.**
- **Make sure your work area is well ventilated.**
- **Use a fluorescent or LED droplight, never the kind with a regular incandescent bulb. It's a fact: More shops burn because of droplights than from any other cause.**

Several special tools are needed to efficiently diagnose BMW fuel delivery problems, including:

• The Modic/DIS/GT1 (BMW offers Online Diagnostics as a low-cost alternative. Go to www.bmwtechinfo.com).

Most auto repair shop fires are started by droplights. So, use the fluorescent or LED type when working on the fuel system (courtesy Ferret Instruments).

- A good digital multimeter (DMM).
- BMW's Universal Adapter (Part Number 88 88 6 614 410), which makes it easy to test connections with out damaging the pins or harness.
- The Fuel Hose Clamp Tool (Part Number 13 3 010).
- The Relay Bypass Switch (Part Number 61 3 050) should be used when fuel vapors are present. The switch eliminates the risk of electrical arcing.
- Check fuel pressure with the handheld fuel pressure gauge (Part Number 13 3 060), or equivalent.
- Special Tool (Part Number 13 5 270) is used on systems with "quick release" couplings between the fuel filter and the pressure supply hose.
- Adapter (Part Number 13 5 220) is used on systems with a treaded fitting on the fuel rail.
- Injector leak down is tested using Special Tool (Part Number 88 88 5 000 362).

Although not as impressive as a lab scope or a scan tool, a good DMM will always tell you the truth -- if you know how to use it.

Fuel system basics

BMW now uses polyethylene fuel tanks to reduce weight and eliminate the possibility of corrosion, which can introduce rust flakes into the system. Early SULEV/PZEV vehicles (M56 engine) used a stainless steel fuel tank. All late models have a "saddle tank" that straddles the drive shaft. This design allows for a lower profile, space saving tank, but it creates two low spots, one

on each side of the drive shaft. Instead of using two fuel pumps, a single electric pump is in the right (passenger) side. Gasoline in the left (driver) side of the tank flows to the right side via a siphon tube.

When the ignition key is turned to “on” the ECM energizes the fuel pump by completing its ground. This primes or pressurizes the fuel system. However, if the ECM does not receive a signal from the Crankshaft Position Sensor that the crank is indeed turning, the ground connection is broken and the pump stops running. Only if the ECM gets a signal that the engine is turning over does the fuel pump remain on. Any physical restriction upstream from the pump will cause the pump’s pressure relief valve to open.

Fuel leaves the tank, passes through the fuel filter, and pressurizes the fuel rail and injectors. A one-way check valve prevents fuel from flowing back toward the fuel pump. The check valve also helps keep the fuel rail and injectors “primed” after the engine is shut off.

In the typical return-type fuel system, the pump provides more volume and pressure than the engine requires. During normal operation, the Fuel Regulator Valve maintains the system at the required pressure and returns excess fuel to the tank. Fuel flow in the return line not only goes back to the tank, but also provides the siphon effect to draw fuel from the left side of the tank.

With the fuel rail and injectors uniformly pressurized, the ECM controls the amount of gasoline injected by varying the length of time it opens the injectors by grounding their solenoid windings. This is called "pulse width," "millisecond value," or "ms value." The amount of fuel that enters each cylinder is, of course, based on the computer's programmed response to input from various engine sensors. Pulse width/ms value is determined by ECM programming and numerous inputs, including those for:

- Battery voltage
- Throttle position
- Air flow in mass
- Crankshaft position and engine rpm
- Cylinder ID
- Engine coolant temp
- Exhaust oxygen content

While cranking, battery voltage goes low, so the ECM increases the ms value to compensate for injector “lag time.” After the engine starts and battery voltage jumps to normal, the ms value is reduced because the injectors respond faster when voltage is higher.

Cold starting requires additional fuel, so the ms value is higher. The ECM adjusts ms value as signals from the Engine Coolant Temperature Sensor change.

For the first few crankshaft revolutions during cranking, additional fuel is provided by all injectors simultaneously (Parallel Operation). Then the ms value is gradually reduced as the engine comes up to speed. When the engine speed approaches idle rpm, the ECM recognizes the Camshaft Position and switches to Semi-Sequential injection.

Here's a typical BMW saddle tank, which straddles the driveshaft and exhaust pipe.

With the exhaust system and the driveshaft dropped, you can see the part of the tank that connects the two sides of the saddle.

During cold start-up, the ECM opens all injectors at the same time (Parallel Operation) for every complete revolution of the crankshaft. However, during warm-up, the ECM takes inputs from the Camshaft Position Sensor and shifts to “Semi-Sequential” operation, which times injector opening closer to intake valve opening.

When the engine is cold, optimum fuel metering is not possible due to poor air/fuel mixing and an enriched mixture is required. The Coolant Temperature input allows the ECM to adjust the injection ms value to compensate during warm up, then minimizes the injected fuel at normal engine operating temperature.

At idle, minimum fuel is needed and the ms value is low. At wide open throttle, maximum fuel is needed and the ms value increases. The exact ms value at any time is changed as inputs to the ECM change.

BMW engines are governed or limited by the ECM, which shuts off the injectors when engine speed reaches 6,500 RPM. Injector operation resumes when engine speed drops below the governed limit. The engine speed governor is independent of vehicle speed. However, this protective feature can be overrun if the engine exceeds redline because the driver missed a downshift with a manual transmission.

If there's a malfunction in the ignition system that would cause excess unburned fuel to enter the exhaust stream, the ECM will shut down the injectors to the affected cylinders to protect the catalytic converter.

Troubleshooting

A fuel delivery problem, causing a no start, hard starting, or poor performance could be caused by a defective sensor. Typically, this would trigger a code. The fuel delivery problem could also be caused by something in the fuel system that doesn’t set a code. If one or more codes are present, follow the recommended diagnostic procedure(s). But if there are no codes present, you will have to troubleshoot the fuel problem the old-fashioned way, step-by-step.

First, make sure there's gas in the tank! Many “won’t start” and “quit running” complaints have been solved by filling up, much to the chagrin of all parties. If the fuel gauge reads empty, believe it.

Next, and especially important, test pressure by using a high-quality gauge and the correct adapter to tap into the fuel system. If fuel pressure is up to specs in all modes, that still doesn't mean there's enough volume. But checking the actual amount of gasoline the pump is capable of supplying is risky business -- don't blow up!

To test fuel pump pressure, install a fuel pressure gauge in the connection between the fuel filter and the fuel pressure regulator. Remove the fuel pump relay from the panel and connect the Rely Bypass Switch across terminals 87b and 30. This will allow activation of the pump without turning on the engine. If the pump doesn’t run, there is a problem in the electrical supply to the pump or the ECM is not completing the ground to the pump.

Very few troubleshooting steps can tell you more than a simple fuel pressure check. Check KOEO, running, and "dead head" (fuel pressure valve or regulator hose clamped).

Pump output should be at least 3 bar (43.5 psi) and the volume should be at least the amount specified for the model car. If pressure or volume is low, the pump may be worn out, its electrical connections may have resistance, or perhaps there's a blockage.

In cases of low psi and/or volume, inspect all the lines for any evidence of crushing or crimping. BMW has issued several service bulletins for various models. Consult these bulletins. Another possibility, of course, is a clogged filter. We've often removed them and found them so blocked that it was impossible to blow through them.

If pressure and volume are both okay, there may be a contamination problem. It doesn't take much water (or whatever) to shut down a fuel-injected car. Draw a sample of gas from the very bottom of the tank, deposit it in a clear glass dish and inspect it. If there's a "blob" at the bottom of the sample, you have a bad water problem. Also, any sign of rust or dirt means serious contamination.

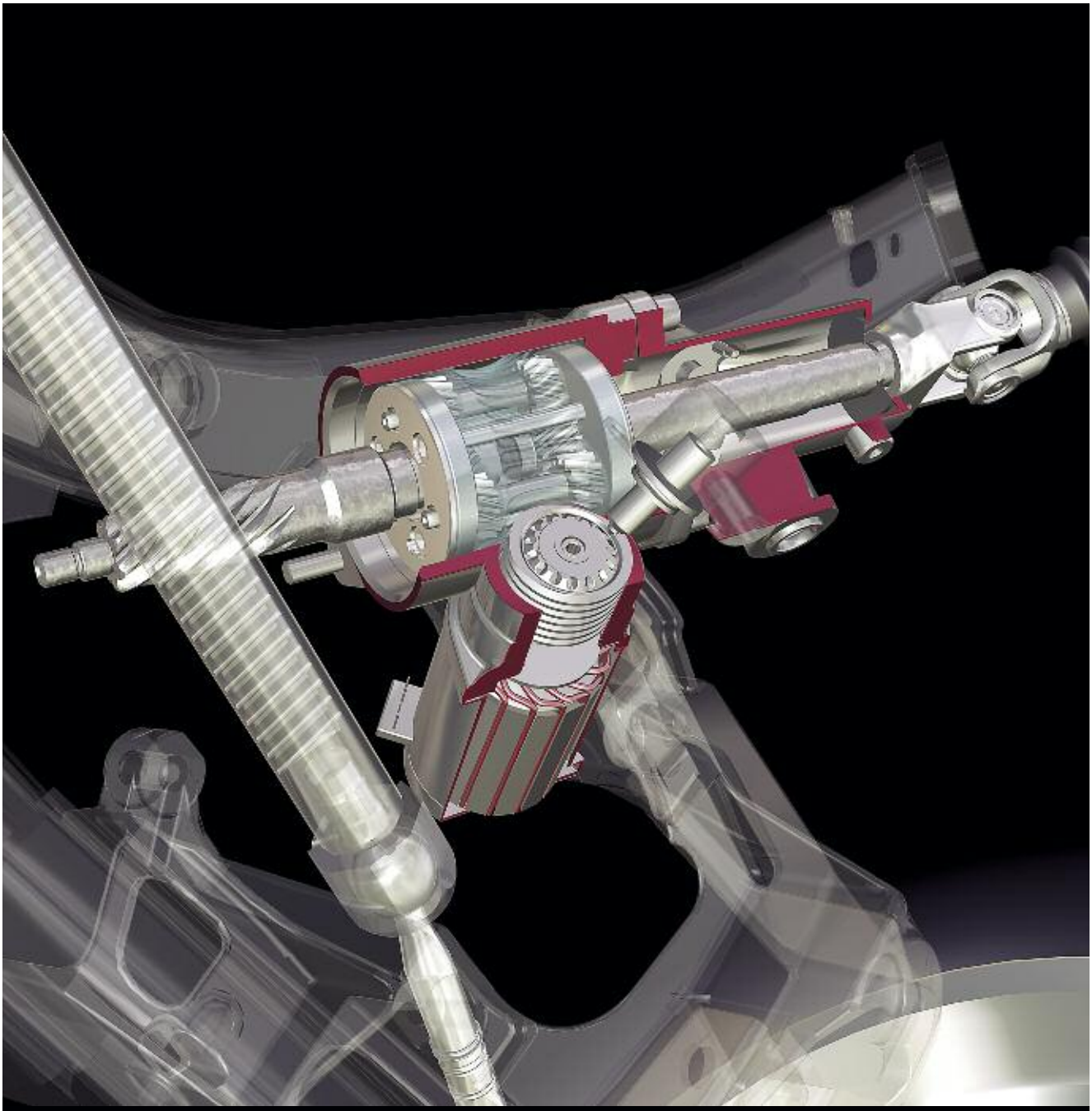
If there's clean gas in the tank and system pressure is normal, either there's trouble with the ECM's network of sensors and wiring (or, very rarely, with the ECM itself), or perhaps the injectors are plugged. While the latter condition isn't as common as it once was, it can still happen.

On most BMWs, access panels to reach the fuel pump and sending units are under the rear seats. Remove the seat cushions to get access to the tank. There are two panels on the "saddle" tanks, the driver side panel is for the siphon tube and one sending unit. The passenger side panel accesses the fuel pump, pump pickup, and pump filter. On SULEV/PZEV vehicles, the fuel pump, carbon canister, and other components are permanently sealed inside the fuel tank. These components cannot be serviced separately.

When the pump is off, pressure should be maintained in the system. If more than .5 bar (7 psi) bleed-off is observed in five minutes, the injectors may be leaking, or the fuel pressure regulator may be sticking open.

The Fuel Pressure Regulator should only open when the pressure in the fuel rail exceeds 3 bar. The regulator should remain closed when the engine is off to keep pressure in the rail. If there is fuel flow back to the tank after the engine is shut off, the regulator is sticking open.

Over the years, various tools have been available for testing injector leakage. In one type, you immerse the injector tip in water, then pressurize the injector with shop air and watch for bubbles.



Rack & Pinion for Performance

The latest steering technology
is under the hood of a BMW

Electrical power steering systems have the potential to eliminate all the negatives associated with hydraulic assist.

From the nimble 3 Series to the luxurious 7 Series, BMWs are bred to perform. Skilled drivers know that when you are behind the wheel of a BMW, you can use all of the car's power to the limits of tire adhesion and your driving ability.

The level of performance that BMW offers requires the careful design and integration of many systems. One of the most important is steering, which is why BMW is a leader in steering technology.

Rack and pinion steering is found on BMWs that get driven the hardest. Compared to the other common steering system, recirculating ball, rack and pinion provides a more sensitive road feel and quicker response to driver inputs. In addition, rack and pinion steering is compact and lightweight, important considerations in any car.

Evolution

Over the years, rack and pinion steering has evolved through several generations of development.

1. The originals were simple, manually-powered units.
2. The first major advancement was hydraulic power assist. A belt-driven pump, powered by the engine, provides hydraulic pressure through a spool valve to the steering assembly, making the steering wheel very easy to turn.
3. The ZF Servotronic assembly represents the third generation of rack and pinion technology. The unit is linked to the onboard computer systems. Vehicle speed inputs to the steering controller govern how much effort the driver must employ. Reduced effort is required during standstill or slow-speed maneuvers, such as pulling into a parking space or making a tight turn at an intersection or driveway. More effort is required as vehicle speed increases for better stability.

BMWs have sophisticated suspensions that keep those fat tires in solid contact with the road surface. But responsive driving characteristics still wouldn't be possible without equally-sophisticated steering systems.

4. The BMW Z4's version of rack and pinion steering is electrically powered and electronically controlled, eliminat ing the need for hydraulic components and their bulk, weight, and leak poten tial. On 3 Series, 5 Series, and 6 Series vehicles, the optional Active Steering system combines Servotronic assist with a planetary gear reduction system to adjust the steering ratio based on vehicle speed.
Active Steering offers the driver a faster effective ratio for low-speed maneuvers, and a slower ratio for high-speed stability.

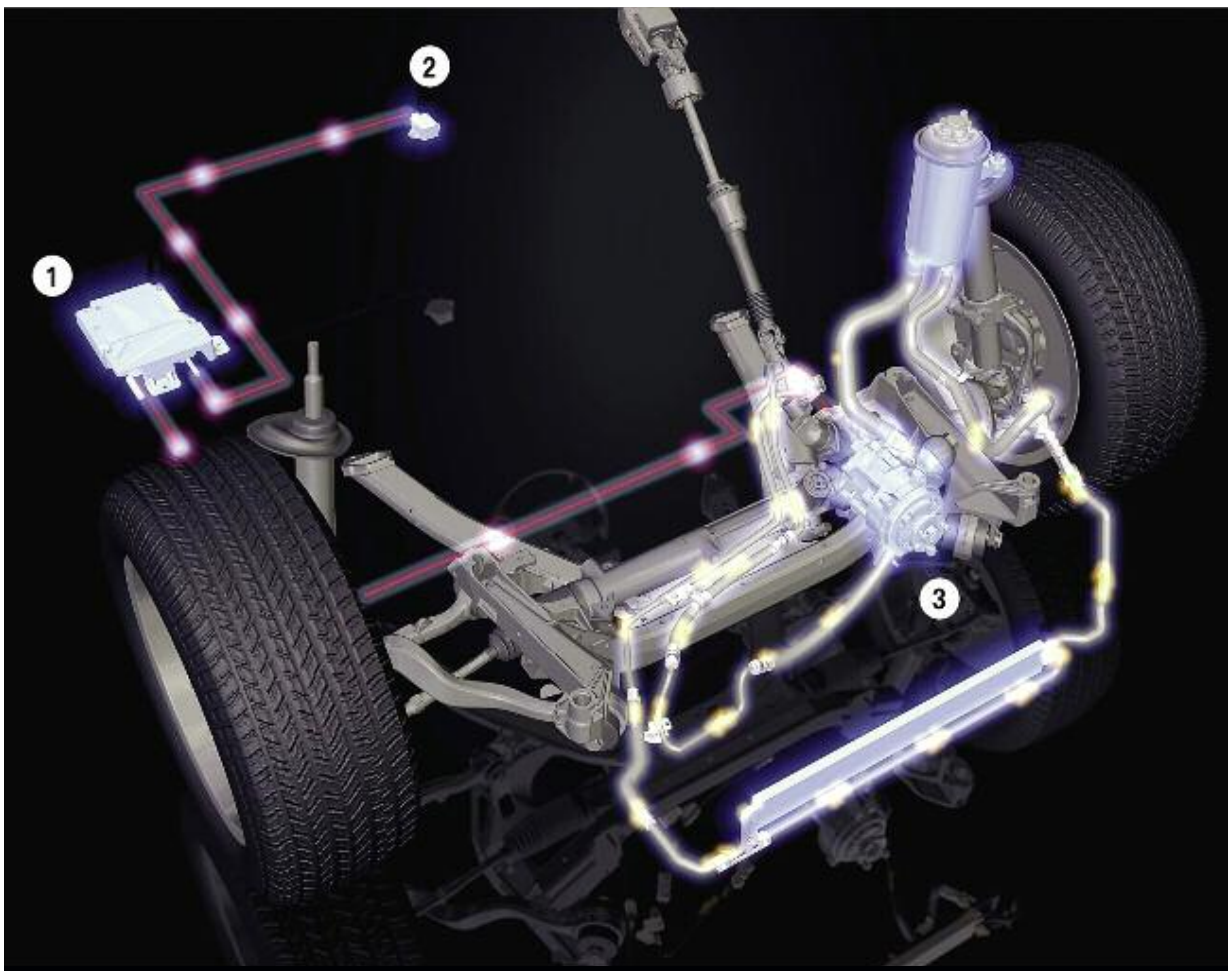
Basic anatomy

Even at its current level of computerized sophistication, the basic rack and pinion steering design has remained the same as it's been for decades. At the end of the steering column, inside the housing, is a pinion gear. The teeth of this gear mesh with the teeth on a straight metal bar, the "rack," that is set at 90 degrees to the steering column.

Attached on the left and right ends of the rack are inner tie rods. The inner tie rods connect to the outer tie rod ends. The outer tie rod ends are attached to the steering arms. The inner tie rod ends and the rack and pinion housing are protected by rubber bellows that seal out road contamination.

To put the action as simply as possible, as the driver turns the steering wheel, the pinion gear teeth turn and engage the rack gear teeth. In response, the rack moves either left or right, which in turn changes the direction of the front wheels.

The advances in BMW steering technology include variable ratio steering, elimination of "bump steer," and the newest, all electronic/electrical system that eliminates hydraulics.



One of the latest innovations combines hydraulic and electric assist. (1) Electronic control unit, (2) Yaw rate sensor, (3) Hydraulically-assisted power steering unit with combined planetary gear and electric control motor.

Variable Ratio

Steering "ratio" is the measurement of how much you must rotate the steering wheel to turn the front wheels a given distance. It is measured in degrees—the number of degrees that the steering wheel must turn in order to pivot the front wheels one degree. The higher the first number, the less effort it takes to turn the steering wheel. The trade off for reduced steering effort is that the steering wheel must be turned farther to change the direction of the front tires.

Early rack and pinion steering had a fixed steering ratio. BMW and other carmakers later added "variable ratio steering." When the front wheels are straight or turned to no more than about 40 degrees, the steering ratio is low for faster response. This offers more control of the car, especially at highway speeds.

As the front wheels are turned more, the steering ratio increases, reducing the effort required to turn the steering wheels. This makes it easier for the driver to make tight maneuvers such as parking or turning a corner at an intersection.

On rack and pinion steering, variable ratio steering is accomplished by changing the cut of the rack teeth. Near the center of the rack, when the front wheels are straight, the teeth are cut at approximately a 20 degree angle. Away from the center and closer to either end of the rack, the gears are cut at 40 degrees.

Several BMWs incorporate engine speed into the steering control, via the onboard computer system. The system takes input from vehicle speed sensors and front wheel angle sensors to adjust the amount of assist applied to the steering system. At higher speeds, less assist is provided for more precise control. At lower speeds, more assist is given for increased driver comfort.

All rack and pinion steering units suffer from "bump steer," which is movement of the steering wheel when the tires hit a bump or dip in the road. Although the tires and suspension are designed to absorb most of this force, many rack and pinion assemblies are so sensitive, there can be noticeable movement in the steering wheel. For drivers, bump steer is at least an annoyance and, in severe situations, a safety risk.

Goodbye Bump Steer

To eliminate bump steer on its power steering units, BMW incorporates a special valve assembly into the power steering system. This rotary valve has a motor, six control grooves, and a sleeve that is connected to the pinion. The valve body has axial grooves that are matched to the control grooves.

A torsion bar connecting the valve motor, the pinion, and the valve sleeve keeps the valve motor centered. Driving down the road, torque can be transmitted to the valve body either from the steering or from the front wheels (bump steer). This torque twists the valve motor relative to the valve sleeve. The twisting motion shifts the position of the motor's control valves relative to the axial grooves in valve body.

When the torque and resultant twist comes from the steering wheel, the grooves direct pressurized power steering flow in the correct path to turn the front wheels in response to inputs from the steering wheel.

But when the force applied to the valve body comes from the opposite direction — up from the front wheels instead of down from the steering wheel — power steering flow is directed to counter the bump steer input. Even if the steering wheel is rigidly held, the valve body rotation corrects for "bump steer" without causing steering wheel movement.

As soon as the bump steer influence is over, the valve assembly re-centers itself to return to the straight-ahead position.

Some late-model BMWs have the power steering pump combined with the water pump, which may come as a surprise.

Electric Steering

Hydraulic assist, better known as power steering, makes it comfortable to drive any vehicle, even the biggest car or SUV, because steering is so easy. Put a person who has only driven vehicles with power steering in a manual steer car and you are guaranteed to hear complaints of "I can't turn the wheel" or "There is something wrong with the steering."

The comfort and convenience of hydraulic assist steering has its price, however. Hydraulic units are large, heavy, and help increase underhood temperatures.

Until recently, a driver's choice was manual steering or hydraulic assist, but the BMW Z4 now offers something completely different: Electric assist power steering from ZF. The ZF Servolectric system is new to BMW. It probably won't show up in your shop for a year or two, but the first time you see the system under the hood, you will appreciate its advantages.

ZF Servolectric uses a controller that monitors steering wheel movement. When driving straight ahead, Servolectric remains in stand-by mode and requires no electrical power. When the steering wheel is moved, sensors measure the steering torque and steering speed. This data becomes input to the engine control module. The ECM then signals the Servolectric unit to provide the correct amount of power assistance. Based on the ECM's signal, the Servolectric motor transmits the required torque to the pinion. All this is done virtually instantly.

The Servolectric system totally eliminates all the components associated with hydraulic power steering. Gone are the belt-driven pump, fluid, hoses, and connections, replaced by a compact electronic controller and a small electric motor provided to BMW as part of the steering column assembly. With the size and weight reduction, and the elimination of a belt-driven pump, Servolectric boosts engine performance and fuel economy.

Unlike hydraulic units, Servolectric is completely independent of engine operation. Full assist is also available at idle speed, making it more convenient when parking or making tight maneuvers in a congested area.

And because it is electronically controlled, Servolectric is easily incorporated into sophisticated dynamic stability control and crash avoidance systems.

With all of its advantages, you can expect electrically-powered electronically-controlled power steering to quickly replace the old-school hydraulic systems on coming models.

Service and Troubleshooting

Despite its relatively small size and weight, BMW's rack and pinion steering unit is very durable and typically lasts the life of the car, even under the aggressive driving conditions that are common for many BMWs.

However, nothing is perfect and steering problems can occur. Common complaints include:

1. The car pulls to one side, or the steering wheel must be held off center to drive straight.
2. The steering is stiff or tight.
3. The steering is loose. The car tends to wander or the driver has to turn the wheel more than normal to get a response.
4. Leaks.

Complaints about pulling to one side, stiffness, or looseness are usually symptoms of suspension, tire wear or underinflation, or alignment problems. Stiffness in a BMW with hydraulic power steering can also be caused by a worn pump, loose belt, low fluid, or leaks. Only after checking the tires, alignment, and the suspension system should you consider the rack and pinion steering assembly as the source of the complaints.

Leaks and torn bellows are the most common problems with rack and pinion steering. External leaks are obvious because you can see the fluid. Internal leaks are detected by pressing on the rubber bellows protecting the inner tie rods. If any fluid is felt inside the bellows, there is a leak.

Servicing the Servolectric units will require following the trouble code and troubleshooting procedure similar to any electronic/electrical device on the car.

Shop level repairs or rebuilding of rack and pinion steering assemblies is not recommended because in-shop service has a very high failure rate. In fact, it is nearly impossible to find repair kits because there is little or no demand for them. It is faster, easier, and you have a much lower risk of a comeback when you replace a bad rack and pinion steering assembly.

Any power steering pump takes up a lot of space in the engine compartment, needs a belt and pulley, and has vulnerable pressure and return hoses.

To provide the best service for your customer, pull the old rack and pinion unit, flush the power steering fluid thoroughly, install a new BMW assembly, fill with the recommended P.S. fluid, replace any worn suspension components, and do a complete wheel alignment. Then you can send your customer back on the road with the taut, precise steering that BMWs are known for.

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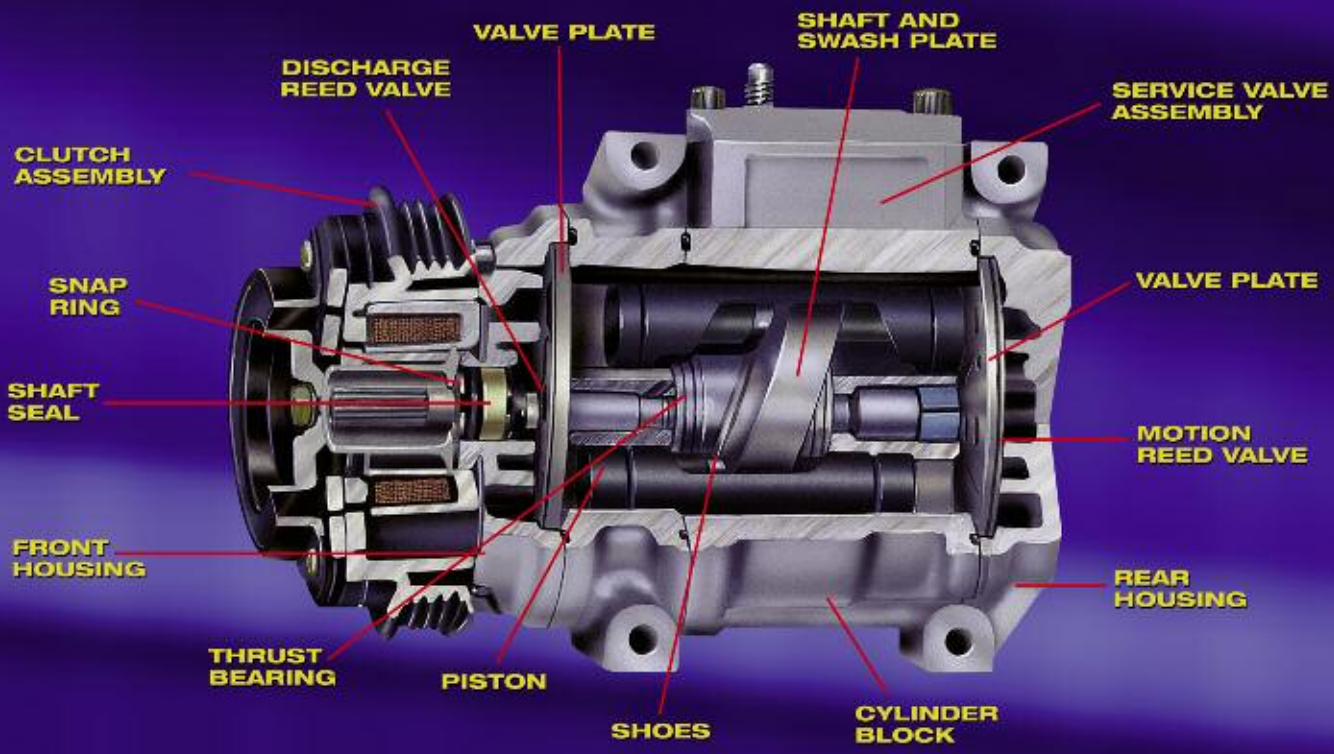

CYLINDER BLOCK & FRONT/REAR HOUSING
Cleaned, inspected and brought to O.E. specifications, or replaced with new components if necessary, to insure proper fit.

DISCHARGE REED VALVE
Inspected, cleaned, and polished, or replaced by new components as necessary, to insure compressor performs as "new."

STEEL GASKET
Replaced 100% with new components to insure compressor performs as "new."

O-RINGS & SEALS
Replaced 100% with O-Rings compatible with both R12 & R134a refrigerant to achieve O.E. performance and maximum service life regardless of which refrigerant is utilized.

OIL
Replaced 100% with R134a compatible oil to insure long service life.

PISTON
Inspected and cleaned, or replaced by new if Teflon surface is damaged, to insure compressor performs as "new."

SHAFT & SWASH PLATE
Cleaned, polished, and inspected, or replaced with new components if necessary, to insure compressor performs as "new."

SHAFT KEYS
Replaced 100% with new components to insure new OEM spec. tolerances.

SHOES
Inspected for deterioration and cleaned to eliminate contaminants, or replaced by new components. Gauged and sized for noise reduction.

SNAP RINGS
Replaced 100% with new components to insure compressor performs as "new."

SUCTION REED VALVE
Inspected, cleaned, and polished, or replaced by new components, to insure compressor performs as "new."

THRUST BEARING
Inspected for deterioration and cleaned to eliminate contaminants, or replaced by new components if necessary.

VALVE PLATES
Inspected, cleaned, and polished, or replaced by new components, to insure compressor performs as "new."

DENSO

Protection at the Micron Level

Filter replacement is low-tech work,
but filter technology is very high-tech

Cabin filters represent a very nice profit opportunity for service shops. Using Original BMW quality replacements, such as this premium charcoal unit, insures perfect fit and performance, and customer satisfaction.

Performing regular fluid and filter maintenance is the single most important thing you can do to ensure that your customers enjoy their BMWs for as long as they like.

Despite its critical importance, most shops consider fluid and filter changes to be "low-tech." However, when you know more about BMW filters, you will understand that the "low-tech" replacement procedure reflects the very high-tech engineering that goes into designing and making modern filters. And, if you take just a few extra seconds to examine the old and new filters and interpret the results, you raise the skill level of filter replacement considerably.

In engineering terminology, filters don't "prevent contamination," they provide "contamination control." A perfect filter would allow all the air or liquid to pass through unrestricted for maximum efficiency, while blocking all contaminants for maximum protection. But no filter can provide 100 percent efficiency and 100 percent protection.

Think about a one-cylinder, fuel-injected engine that has a straight section of pipe for an intake manifold. If the pipe is open, airflow is 100 percent efficient because nothing restricts air movement into the engine. But protection is zero because there is nothing to block any airborne contaminants.

Cover the pipe and protection goes to 100 percent because nothing can get in. But efficiency drops to zero because the engine can't run either—there is no air available.

In addition to efficiency and protection, filters are also rated by capacity, or the volume of contaminants a filter can hold before it becomes overloaded. The greater the capacity, the longer the service interval.

Premium grade filters, like BMW's, incorporate proprietary media, unique flow design, and quality construction for optimal levels of efficiency, protection, and capacity. Discount filters typically cut corners on media, flow design, and construction so they cannot match the service levels of a premium filter.

Before getting into the specific filters, there are some basic procedures you should follow when replacing any filter.

1. Determine how long it has been since the last filter change, according to your shop records, or the owner's maintenance records.
2. Compare the condition of the old filter to the time and mileage indicated on the records. If the car is at its proper scheduled service interval, but the filter is very dirty, your customer's driving is probably in the "severe duty" category. Recommend more frequent service intervals to your customer because of his or her driving pattern.
3. If the filter is very dirty and the car has not been serviced in a long time, advise your customer on the importance of sticking to BMW's recommended service intervals. If your shop has a customer reminder program, verify the customer's current contact information and update your reminder system records.
4. If the filter isn't excessively dirty, but the service internal is overdue accord ing to your records, your customer may be getting service work done else where. If the old filter isn't from BMW, you know for sure the customer is going elsewhere. It's time for some serious customer relations to promote your shop and its ability to provide the best possible service for your customer's BMW.

Whenever you are doing major engine work, such as this intake manifold gasket replacement job, wouldn't it be foolish not to replace that air filter?

Air filter

Air filters work hard. True, air filters are not exposed to the temperatures and/or pressures that fuel filters, oil filters, and transmission filters face. But in terms of volume, air filters work the hardest because burning a gallon of gasoline in an internal combustion engine uses about 10,000 gallons of air! And every gallon of air passes through the air filter before it enters the engine.

Air filters must capture dust, pollen, soot, carbon, sand, and other airborne contaminants. If these contaminants were not captured, they would cause internal engine wear. The standardized SAE test for air filters requires a mixture of contaminants, ranging in size from 0 to 80 microns, to enter the filter. The filter capacity is calculated on the total volume of contaminants the filter holds before becoming too clogged to provide sufficient airflow to the engine.

Premium air filters are designed to be especially effective at capturing 10 to 20 micron size particles because these particles have been shown to cause the fastest, most severe engine wear.

New air filters are "oversized" with excess capacity. A new filter can hold contaminants while still allowing as much airflow as the engine needs. When changed at the recommended service interval, the filter should still be able to meet maximum airflow needs, despite the contaminant load. However, if kept in service too long, or exposed to unusually high levels of contamination, the contaminant load will begin to restrict airflow. The reduced airflow causes a drop in overall performance, especially full-throttle acceleration.

When replacing an air filter element, inspect the old one. If it is excessively dirty, it usually means your customer is not sticking to BMW's recommended service internal. In rare cases, an excessively dirty air filter means the car has been exposed to very high levels of contamination—ask your customer where he or she has been driving.

You promised the car by 5, so he could start his trip

...but that knock off part won't fit and it's 4:30.

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Desert areas during sand storms? Regardless, if this is a chronic condition, recommend more frequent service intervals.

Before installing the new filter, check the air box to make sure there are no dents, cracks or other damage. And look at the filter to make sure it is OK. Never install a filter that has any sign of a defect. Wipe the air box clean, seat the new filter, and secure it. The air box fasteners should be snug, but not difficult to secure.

Oil filters

The BMW onboard engine oil monitoring system that was first introduced on some models in 1999 makes it easy to tell when oil and filter changes are needed. But if your customer's BMW doesn't have the oil monitoring system, and especially if he or she drives in severe conditions (city traffic, trailer towing, etc.), take time to review the situation and recommend an oil service interval that provides adequate protection for that particular car.

According to a survey done by a member company of the Filter Manufacturers Council, only about 20 percent of vehicles are regularly driven under "normal" conditions. The remaining 80 percent—4 out of 5 cars on the road—are driven under "severe" conditions. Even aggressive BMW drivers might think they are "normal" drivers because BMWs are meant to be driven hard.

Your customer is probably in the severe category if he or she:

- Frequently takes trips that are less than four miles, which do't allow the engine adequate time to warm up and reach a desired operating temperature.
- Spends a lot of time idling. And remember that idling doesn't just mean having the car stopped and the engine running. It also includes stop and go driving.
- Does long-distance, high-speed driving when air temperatures are high, typically summertime vacation driving.
- Does a lot of driving on dirt, sand or gravel roads, or in areas when there is a high level of dust.

The media in a BMW oil filter does an excellent job of balancing protection and efficiency. The media will capture 98%+ of all particulate matter, but without causing excessive backpressure. Anytime a fluid must flow through a filter, there is some backpressure -- it cannot be avoided. But BMW filters keep the backpressure so low it doesn't interfere with the lubrication system.

For several good reasons, late-model BMWs use cartridge-type oil filters. In other words, the filter housing is permanent, and only the element is disposable. Typically, the cartridge is located in an easy-to-reach spot, too, so a filter change is easy. Just remember to always replace the O-ring.

Whether it has a metal cap . . .

. . . or the newer plastic type, BMW's cartridge oil filters are especially easy to service. They're always in an accessible location.

Some older BMW models, however, use the spin-on oil filter, which has a lot of technology in a relatively small package. Oil enters the center of the filter, passes through a specially designed filter media, and then reenters the lubrication system. As the oil passes through the filtering media, any particles suspended in the oil are trapped to prevent them from returning to the engine.

As long as the filter is changed regularly, backpressure is normally not an issue. However, if the oil filter is kept in service too long, it becomes loaded with contaminants and backpressure begins to build. Eventually the filter can become so clogged, little or no oil can flow. Operating on the principal that dirty oil is better than no oil, filters have a bypass valve that opens when backpressure becomes too great. This allows unfiltered oil to flow, maintaining adequate oil pressure in the engine.

It is extremely important to note that some BMW oil filters incorporate an anti-drainback valve to keep the filter filled with oil after the engine is shut off. If you were to buy an aftermarket replacement filter without this valve, the bearings would be starved for oil at start-up, resulting in rapid wear and eventually a rod knock. That's yet another reason to buy Original BMW Parts.

Replacing an oil filter is a simple task, but you should include several checks to identify and head off possible problems.

1. Look at the old filter before you remove it. Is it bulging or otherwise deformed? A bulge means there is excessive oil pressure, normally caused by a faulty oil pressure regulating valve in the oil pump. Test the oil pressure and if it is high, the pump must be replaced.

2. Is the old filter dented? A dent means that either a damaged filter was installed the last time—which should never be done—or something struck the filter. Inspect the area around the filter to see if there are any other signs of damage from the car hitting something.

With a fuel filter as sophisticated as this and with such a huge capacity, it would probably be unwise to replace it with anything but the original BMW part.

3.Carefully remove the old filter. Wipe the mounting surface on the engine with a clean rag. Inspect the mount for damage. And make sure the gasket from the old filter hasn't come off and stuck to the engine. Remove it if it is still in place.

4.Look inside the old filter, is the center tube deformed? A bad center tube is not always visible, but if the tube is deformed, there is a chance that filter media or other pieces of the oil filter have entered the engine which can cause big problems. Test the lubrication systems to make sure oil pressure is within normal range and listen for any noises that indicate internal wear problems.

5.Typically, a center tube will be deformed because the filter by-pass valve or the oil pressure regulating valve malfunctioned due to using oil that was too thick in cold weather conditions, excessively contaminated oil, bits of carbon or other "hard" contaminants temporarily jamming a valve, excessive "racing" or hard acceleration with a cold engine.

6.Before installing the new filter, inspect it to make sure there are no dents or other signs of damage and that the gasket is securely attached. Never install a new filter that has any sign of damage.

7.Apply a light coat of engine oil to the gasket and install the filter. When the gasket starts to seat, tighten the filter another quarter turn (90 degrees). Do not over tighten.

8.Drain the old oil filter and dispose of it in compliance with all regulations.

Fuel filters

The job of a fuel filter has gotten much harder than "back in the day" of seven psi mechanical fuel pumps feeding 35-cents-per-gallon gasoline to a carburetor. High-pressure, high-volume fuel injectors require a fuel filter that can handle much higher pressures and capacities, and also do a much better job of removing particulate material. The same piece of dirt or other contaminant that an old carburetor could have "swallowed" without a problem would jam a modern fuel injector.

On late-model BMWs, the fuel filter does double duty. In addition to working as a conventional filter, its large size makes it a

fuel reservoir that dampens fuel pump pulsations. Fuel flow is smoother and steadier as it leaves the filter and travels to the fuel rail and injectors.

Fuel contaminants include dirt, rust, other debris, and water. These contaminants can be external—coming from somewhere in the fuel supply infrastructure. They can also be internal, caused by fuel tank corrosion as a vehicle ages. Since BMW started replacing metal fuel tanks with plastic tanks years ago, internal fuel system contamination has been vastly reduced.

A clogged fuel filter will make itself known by deteriorating engine performance, gradual loss of power, bucking and stalling during acceleration. In the case of a totally clogged filter, there will be no performance at all because not enough gasoline will get through for start-up. Always inspect a clogged filter and try to determine if the contamination is coming from an aging fuel tank or from outside the car. You can use a pipe cutter to open the old filter and inspect the contents.

There is little, if anything, you can do about external contamination, except to suggest that your customer purchase fuel from a different station. If the contamination is coming from the tank, say in an old model BMW, the only solution is to drop it and flush it, or replace it.

Cabin filters

If your customer's BMW is a 1999 or newer model, odds are it has a cabin filter. And if it is a 2003 or newer, then it certainly has a cabin filter. In 1999, BMW had these on 90% of its new cars. Four years later, all BMWs came with cabin filters. This development represents a new and promising profit opportunity for you.

Surprisingly, cabin filters aren't new. The first recognized use of a passenger air filter system was in the 1939 Nash "Weather Eye" system. But the idea didn't really catch on -- Nash still went out of business.

Cabin air filters did not return to the automotive scene until the mid-1980s when deteriorating air quality became a major issue in Europe. BMW realized that its engines were breathing cleaner air than its customers!

Today's cabin filters do an excellent job of removing smoke, dust, bacteria, mold spores, pollens, and some exhaust gas residues like toluene and n-butane. The filters also help protect the blower motor and other components on the BMW heating and air conditioning system.

Surprisingly, despite the near universal use of cabin filters, many BMW owners don't even know they have one. And if they don't know they have a cabin filter, then they certainly don't know that it is probably overdue for a change. The recommended replacement interval is 12,000 to 15,000 miles, or annually, whichever comes first, unless the car is driven in a very dusty or otherwise contaminated areas.

Signs that a cabin air filter is clogged or failing include reduce air flow from the heating/AC system and a musty smell inside the car, especially when the heater or A/C is running. But those are signs of a filter long over due for replacement, like poor performance is a sign that an engine air filter has been in there too long.

Selling replacement cabin filters should be fairly easy when you explain that it protects the customer himself, not his car. It represents a direct, personal benefit. As a powerful visual aid, keep a dirty cabin filter handy so you can show your customers what he or she is protected against. Also, keep the old element to show the customer that his or her money was well spent.

Whenever you promote any filter replacement, don't just treat it as a "low-tech" job, even though filter replacement is easy to do. Instead, sell the job in terms of benefits to your customers and to their BMWs. Regular filter changes will allow them to keep driving their BMWs for many, many miles, which means they will be your customers for a long, long time.

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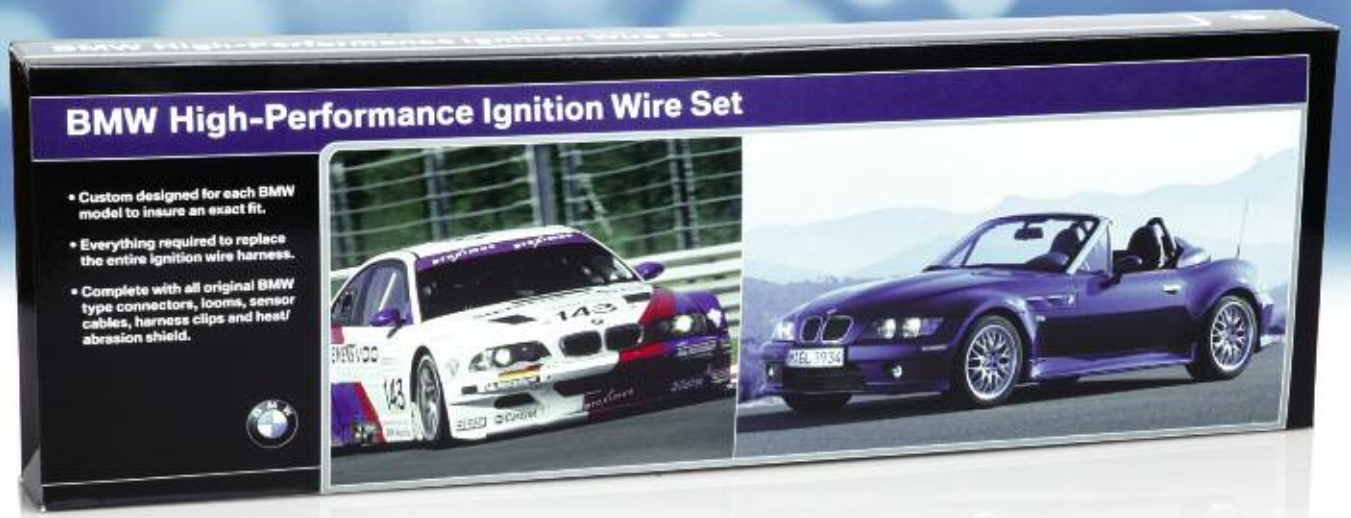

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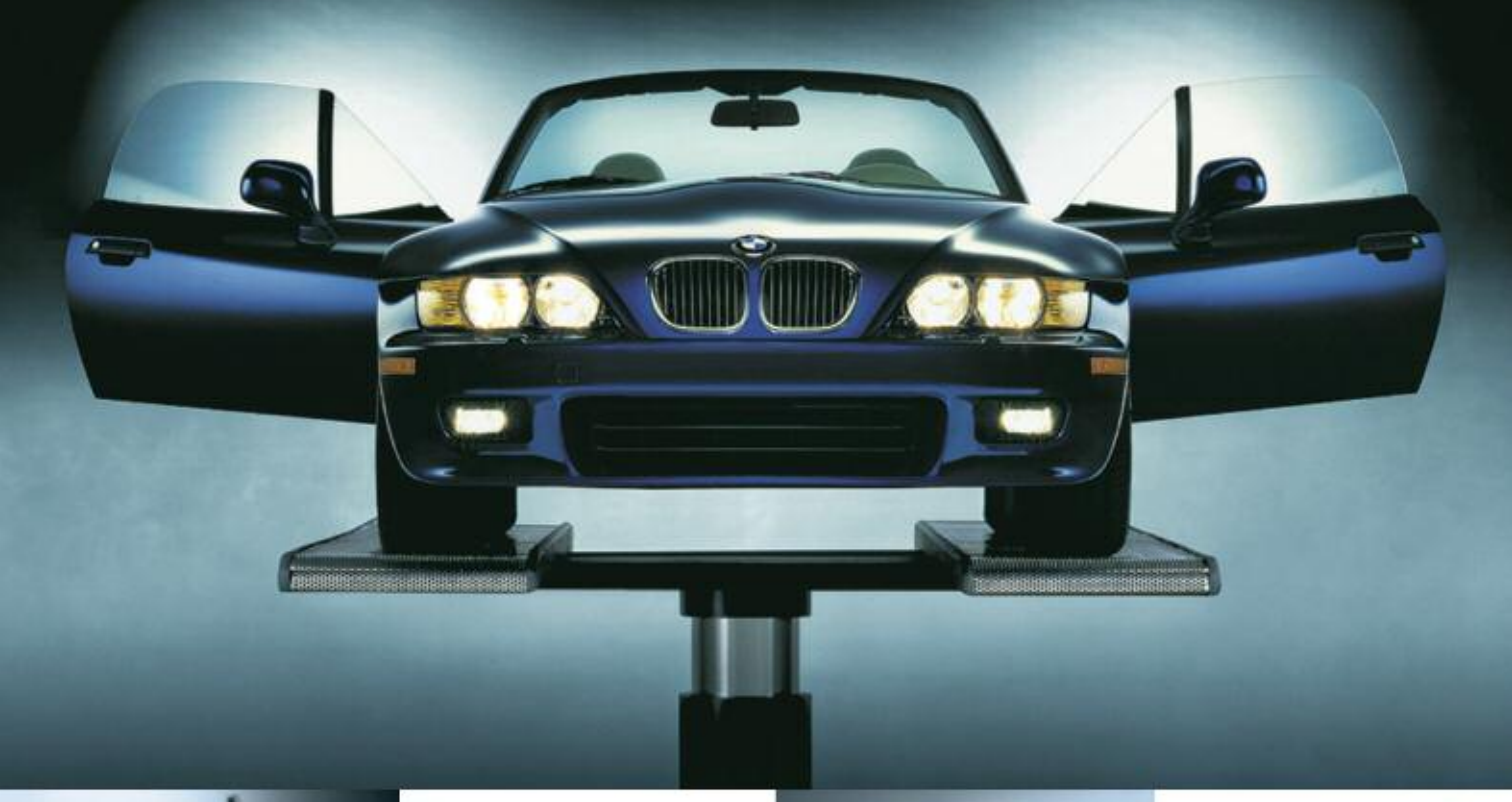

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