StarTuned®

Information for the Independent Mercedes-Benz Service Professional

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Inside:

Individual Component Testing
Idle Quality
Alignment 2017
Fuel Tank

Mercedes-Benz

Who's Your *Part*ner in Success? Mercedes-Benz's PartsPro

You've chosen your career as an ISP (Independent Service Provider) because you enjoy maintaining, diagnosing, and repairing motor vehicles. One of the most challenging pieces of your business is parts procurement.

Finding the right parts at the right price and being certain they will arrive when promised can be a challenge.

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PartsPro is a rigorous program intended to train Mercedes-Benz dealership parts department personnel on how to better take care of you and ultimately your customers. PartsPro certified dealers have elevated their commitment to supporting the independent repair channel, and will provide you with the highest level of customer service. They focus on the things that matter most to you!

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On occasion we all need a helping hand. Your PartsPro dealer is there to assist. Whether it means providing diagnostic assistance, information on supplies or special tools, or anything else you may need, your PartsPro dealer is there to assist you in repairing your customers' Mercedes-Benz vehicles and getting them back on the road as fast as possible.

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Of course, you'll continue to have the peace of mind that installing only Genuine Mercedes-Benz parts can provide.

StarTuned®

September 2017

Welcome to *StarTuned®*, the magazine for independent service technicians working on Mercedes-Benz vehicles. Your Mercedes-Benz dealer sponsors *StarTuned®* and provides the information coming your way in each issue.

Mercedes-Benz wants to present the information you need to know to diagnose and repair Mercedes-Benz vehicles accurately, quickly and the first time; text, graphics, on-line and other technical sources combine to make this possible.

Feature articles, derived from approved company sources, focus on being useful and interesting.

Our digest of technical information can help you solve unanticipated problems quickly and expertly.

We want *StarTuned®* to be both helpful and informative, so please let us know just what kinds of features and other diagnostic services you'd like to see in it. We'll continue to bring you selected service bulletins from Mercedes-Benz and articles covering the different systems on these vehicles.

Send your suggestions, questions or comments to us at:

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In This Issue

Visit us at our web site MBWholesaleParts.com to view past issues of *StarTuned®*, along with a wealth of information on Genuine Mercedes-Benz Parts.

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Mercedes-Benz
The best or nothing.

Individual Component Testing in Engine Management Diagnosis

No interpretation from scan tools or OBD II, just data from "the horse's mouth" on relays, switches, sensors, circuit voltage drops, etc. We've always recommended this before condemning an expensive part.

This DMM can take up to 20A read directly.

Sometimes you have data from a scan tool, but you need to further test and evaluate a part or system that may be causing trouble. Here are some tried-and-true tips for testing individual components.

Before scan tools

Many technicians working today have only heard about the days before scan tools, and there are some of us who watched the technology boom during our careers. We can remember as young technicians in training being told about the future – for example, some day there would be no more points and condensers for ignition, and, get this, no distributor, either! Some of the older "mechanics" in our classes had a good laugh over that. Back then, electronic ignition was a distinct possibility, but the concept of sorting spark without a distributor seemed like science fiction. The point being that almost everything we tested back then was done individually, and you had to develop the skills to do that. That's still needed today.

Scan tools notwithstanding, a professional-grade DMM is still as essential as a soldier's battle rifle.

Tools of the trade

Of course, if you have a superior scan tool such as the XENTRY and have put in the time to learn how to use it to best advantage, in most diagnostic situations it makes sense to see what it can tell you as a first step. Sometimes if you've already got a good idea about what's causing the symptoms, however, you can save time by going directly to the likely component or circuit. Also, it's good practice to verify the scan tool results before you replace an expensive part.

One of our go-to devices for component testing is a classic digital multimeter (DMM). Any high-quality DMM should have measurement functions, troubleshooting features, and dependable accuracy for solving various problems on both conventional and hybrid vehicles. In addition to having all standard multimeter features such as the capability of measuring voltage, current, continuity, and resistance, it should also be able to perform diode tests and pulse width measurements in milliseconds for fuel injectors, etc., both of which come in handy. Other common functions include rpm with a suitable pick-up, and temperature with an optional probe.

A professional-grade DMM can take current measurements up to 20A for 30 seconds and 10A continuously. A magnetic hanger will let you attach the meter to most steel surfaces for easy set-up and viewing. Some are also designed to be used in high-energy environments as found in hybrids.

Other equipment that's useful for individual component testing includes:

- Just as in the old days, nothing's handier or faster than a 12V test light. Remember, you MUST use only the LED type on modern vehicles as the obsolete incandescent bulb variety can draw enough current to damage sensitive electronics.
- Connected to the vehicle's battery, a power probe can easily activate electrical components, detect circuit polarity and continuity, and test wires for bad ground connections and resistive power feeds.
- Automotive lab scopes are available in a wide range of prices from very expensive to quite affordable. These are

really helpful when confirming patterns of crankshaft and camshaft position sensors, fuel injector waveforms, and ignition coil patterns. Having a low-amp probe to go with it is very helpful in checking current ramping.

You've verified the concern, now test the part!

We'll start with solenoids. Some of the most common ones you'll find in your troubleshooting career is a purge canister or vapor canister solenoid, sometimes called a vent valve. Any solenoid is basically an electromagnet that operates a switch, valve, lock, etc. when its circuit is completed. It consists of a coil of wire and a movable iron core called the armature. When current flows through a wire, a magnetic field is set up around the wire. If we make a coil of many turns of wire, this magnetic field becomes many times stronger. When the coil is energized, the core moves to increase the flux linkage by closing the air gap between the cores. The movable core is usually spring-loaded to retract it when the current is switched off.

In the case of a solenoid valve, there are two types you may encounter: those that are normally closed and those that are normally open (not to be confused with the duty-cycle type). One method of testing is to use the scan tool if possible and energize the circuit. This will allow you to check the circuit to the solenoid for faults. With your voltmeter attached, you should see battery voltage when the energization occurs. You should also be able to hear a click, although that's not always reliable.

A good way to check an evap solenoid valve is by injecting 12V to see if it works.

If you want to check fuses or any feed of battery voltage with a test light...

...always use the LED type as the old-fashioned incandescent-bulb variety can draw enough current to damage electronics.

Although we've seen service manuals refer to testing by using your DMM's ohms function, and give specifications for resistance, it has been our experience that this method is somewhat unreliable. We prefer to actually apply battery voltage and ground using a power probe or other method and watch/listen for the solenoid to operate. By applying vacuum with a manual pump, you can see if the valve is operating as designed. In a pulse width modulation (PWM) solenoid, a DC supply voltage is switched on and off at a given frequency for a modulated period of time (duty cycle). The duty cycle is the "on" time of the voltage and is expressed as a percentage of the time period. At 50% duty cycle, the voltage is "on" for 50% of the time, and "off" for the remaining 50%. Therefore, the time-averaged voltage is only 50% of the maximum supply voltage, and the current to the solenoid is only 50% of maximum current as well. It is this time averaging that allows PWM signals to be used for proportionally controlling solenoids.

A lab scope can be helpful here. You should have a known-good pattern to go by — usually available in the repair procedure in XENTRY.

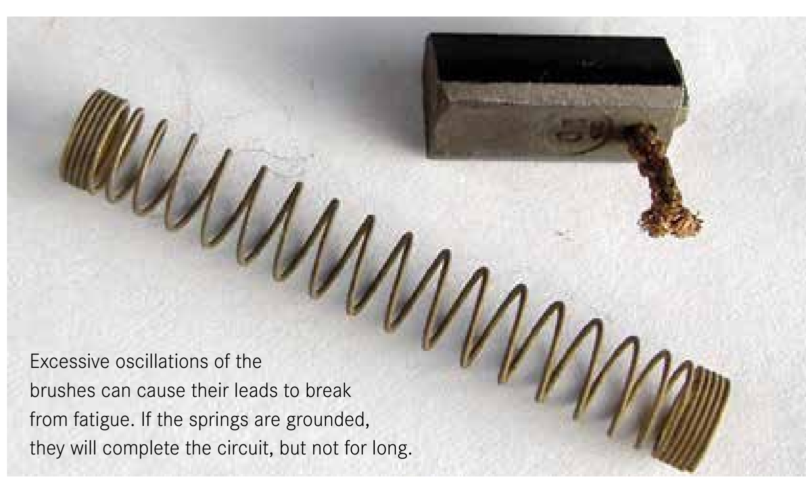
Pushing gasoline

So, you suspect a worn out fuel pump. Your pressure and flow tests have revealed a problem with the internals of the pump and now you need to confirm your suspicions. Being able to energize the circuit with the scan tool is helpful, but you can use other methods. If the pump runs, but you are concerned about poor performance in the form of low psi or flow, then you need to do some testing. Check for available voltage at the fuel pump as close as possible to the pump itself. Really important here is to check for voltage drop. Wires carrying current always have inherent resistance to current flow. Voltage drop is defined as the amount of voltage loss that occurs through all or part of a circuit due to resistance. To check for voltage drop in a circuit, connect your voltmeter's test leads in this manner: positive lead to the battery positive post and negative lead to the current supply lug of the device being tested — in this case, the fuel pump. Then the circuit must be energized (pump turned on) to get a reading. The traditional rule of thumb was 0.2V drop per connection as allowable, but with today's sensitive systems anything more than 0.1V is cause for concern. Realistically, however, you should never see more than .5V drop or the pump will be starving for voltage.

Check all the connections until you've found the culprit. Be sure to test the ground side of the circuit as well. Simply connect the ground lead of the DMM to the negative post of the battery and the positive lead to the ground circuit, again as close to the pump as possible. Another great test of the pump is to use your lab scope and a low-amp probe to check the current ramp pattern.

What is current ramping? Basically, fuel pumps are electric motors, and electric motors work by flowing an electric current to the coil windings through a set of carbon contacts (brushes). The windings have a set of contact points called commutators.

A low-amp inductive probe that works with your DMM or lab scope allows you to read small currents without breaking connections.

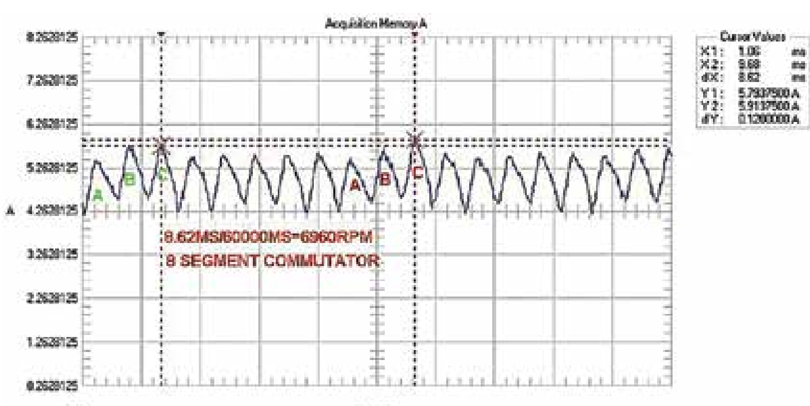


Excessive oscillations of the brushes can cause their leads to break from fatigue. If the springs are grounded, they will complete the circuit, but not for long.

As the coil windings rotate, the carbon contacts make a different set of connections, which show up on the current waveform. By analyzing this waveform, you can deduce a couple of details about a fuel pump motor. First, a determination has to be made as to the number of commutators involved. This is easier said than done, but for now it is important to know that most pumps have eight commutators. Given this information, it is possible to determine the speed of the motor, and, by doing so, the condition of the fuel pump. By simply freezing the waveform and measuring the time it takes to make eight current "humps" (eight commutators), all we have to do is divide 60, 000 by such figure – it takes 60 seconds to a minute and 1,000 milliseconds to a second, so 60 sec. x 1,000 ms = 60,000 ms. This can actually be applied to any electric motor. By knowing the rotational speed and current draw of a fuel pump motor, we can determine its condition.

A faster-than-normal fuel pump, with low current draw, points to a lack of resistance in the fuel flow. A defective fuel pressure regulator letting too much fuel return back to the tank, a worn-out impeller, a clogged suction filter sock, etc. can all lead to a fast-spinning pump. The same even applies to a returnless fuel system as it still has an internal fuel pressure regulator. On the other hand, a slow pump with high current draw points to a restriction in the fuel lines. A clogged fuel filter, restricted fuel pressure regulator, etc. will slow the rpm of the armature since it has to push the fuel harder. Your lab scope will also give you average current draw in amps as well to help in your troubleshooting.

This is the kind of reading you should like to see when checking voltage drop in the pump's ground.



Note that in this fuel pump test the rpm is fast and the amperage draw is low.

Relays

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. This consists of an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it), sometime called a field coil. You can think of a relay as a kind of electric lever: switch it on with a tiny current and it switches on ("leverages") another device using a much bigger current. Why is that useful? As their name suggests, many sensors are incredibly sensitive pieces of electronic equipment and produce or modify only small electric currents. But often we need them to drive larger components (pumps, motors, etc.) that use bigger currents. Relays bridge the gap, making it possible for small currents to activate larger ones. That means relays can work either as switches (turning things on and off), or as amplifiers (converting small currents into larger ones).

For illustration purposes, we'll look at the common Bosch four- or five-pin relay used on many

Since Mercedes-Benz vehicles last longer than other makes, you might still be seeing the KLIMA relay in your shop. While it's more complex than a basic relay, it can still be tested directly.

Mercedes-Benz automobiles. The pins will be labeled 85, 86, 87, 87a, and 30. Most relays will have similar configurations. Pin 30 is connected to a fused 12V feed. Pin 87 is "load," the device to be operated. Number 85 is negative for the coil, and 86 is positive for the coil. Relays can either be positive-side-controlled or negative-side-controlled. When voltage is applied to pin 86 and pin 85 is grounded, the field coil is energized and the switch is pulled in, sending the line voltage from pin 30 to the load-side pin 87 (normally open or off). Pin 87a is used where you want to have a normally-on circuit. Your power probe is a great tool for applying voltage or ground to the field coils. Then you can check for current flow through the relay with your voltmeter.

Position sensors

Checking the signal on a typical camshaft or crankshaft position sensor is relatively simple. If your diagnostics lead you to suspect a fault here, it's time to get out the lab scope. After consulting the manual for a known-good waveform, attach your scope's test lead across the signal wire of the sensor and a good ground.

There are two types of revolution or position sensors you will encounter in your testing:

- Variable Reluctance Sensor.

This consists of a pickup coil, a magnetic core, and a permanent magnet, and is mounted next to a gear wheel or reluctor. As the teeth of the gear wheel pass by the face of the magnet, the amount of magnetic flux passing through the magnet, and consequently the coil, varies. When the gear tooth is close to the sensor, the flux is at a maximum. When the tooth is farther away, the flux drops off. The moving target results in a time-varying flux that induces a proportional voltage in the coil, which varies as a function of the speed rotation and the distance to the gap in both frequency and amplitude. The typical waveform of this type can be seen in Figure A. Look for dropouts and glitches for intermittent problems.

- Hall Effect.

This consists of a semiconductor sensor combined with an electronic circuit that protects the sensor from possible voltage peaks, and a permanent magnet. The operating principle is based on the Hall Effect, a phenomenon in which voltage is generated by the action of a magnetic field acting at a right angle on a thin conducting material. The waveform we get from the sensor is a "U" wave as opposed to the sine wave in variable reluctance sensors. A typical waveform can be seen in Figure B.

A typical variable reluctance sensor.

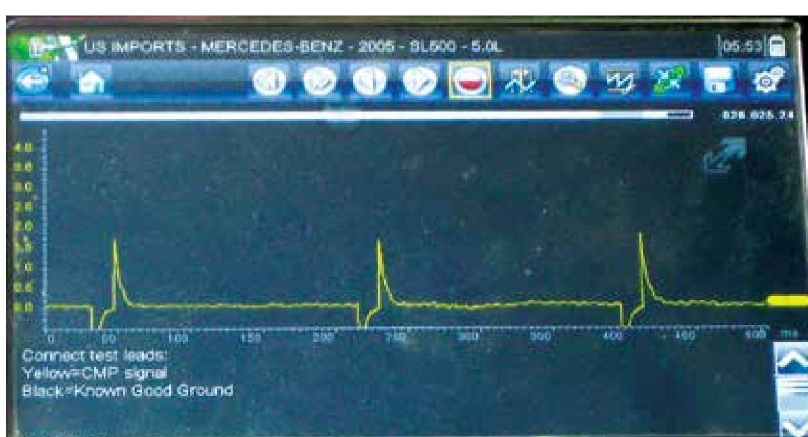


Figure A. A known-good camshaft position sensor's waveform.

Fuel injectors and oxygen sensors

Fuel injectors can be electrically tested using your multimeter's voltage function combined with the ms function (CAUTION: Late-model piezo fuel injectors must not be tested with a voltmeter as they are very sensitive to electrical connections).

With a traditional heated oxygen sensors (as opposed to an AFR, or Air/Fuel Ratio sensor), most of the time you will be able to see the waveform through your scan tool, but a common failure code will be for the sensor heater circuit. In this case, you will want to use your ohmmeter function to test this circuit. Look up the resistance specification, and connect the meter to the leads according to the diagram. Most of the time, a faulty heater will be open.

Being thorough pays off

In most cases your diagnosis of a faulty part will begin with a scan of all vehicle systems. But when your diagnostic platform directs you to a possible faulty part it will pay off very well indeed to do your homework and be thorough in individual component testing. It will give you peace of mind knowing you've done due diligence, as well as pay you back for your equipment investment.

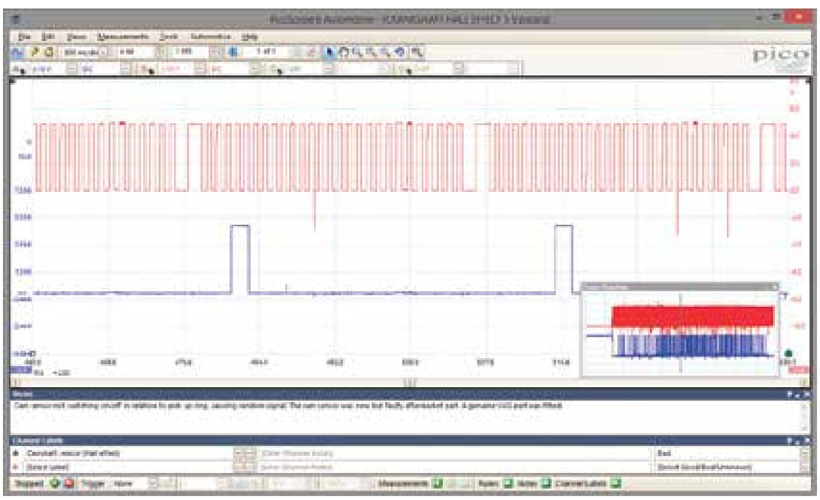


Figure B. A Hall Effect waveform.

There are better ways to test a traditional heated oxygen sensor, but the heater itself will reveal its condition through the use of a DMM.

Nobody Likes Poor Idle Quality

The causes range from internal engine problems and vacuum leaks to improper spark plug gaps. How to proceed logically.

Note that the mount on the left is shorter than the new mount on the right indicating that it has collapsed.

So, you have a vehicle in one of your service bays and the work order says, “Customer states poor idle quality.” This is where good service writers earns their keep. Perhaps this is you — many independents have to wear a lot of different hats. We must try to find out as much as information from our customer as possible. Does it occur all the time? Is it intermittent? In gear, or only in park or neutral? Does the vehicle drive normally otherwise? If we have determined that indeed the problem only occurs when the vehicle is at idle, then the next question to ask ourselves is, “What is different about the vehicle when at idle as opposed to when it’s driving down the road?” Air flow is one part of the answer. The vehicle rpm is substantially lower, so it fits that the air flow into the engine is much lower as well. Keep this in mind as we work through some logical steps to address the problem.

If a quick visual inspection doesn’t reveal anything obvious, it makes sense to enlist the power of XENTRY, or whatever scan tool you have available. Even OBD II Mode 6 can help you zero in on problem cylinders.

On solid ground

Your customer or service adviser has informed you that the concern of poor idle quality only takes place when the vehicle is in gear. Verify the complaint and road test. Faulty or leaking motor mounts can be felt as excessive vibration in the cab or steering wheel. This can mask itself as an engine idle problem when indeed the customer is feeling the normal vibrations of the engine without the proper dampening. After confirming the customer’s concern, check for weak or broken motor mounts. Most Mercedes-Benz motor mounts are hydraulic, meaning oil-filled. Such mounts give you a smoother ride and feel compared to the solid rubber type. A visual inspection may reveal a leaking mount, which would indicate a need for replacement. Have an assistant power brake the engine while in gear and watch for excessive movement. Be sure to check in both forward and reverse. Lifting each side of the engine with a hydraulic jack (use wooden blocks to prevent damage) can also reveal a broken or weak mount. Always replace the mounts in pairs, and don’t forget to check the transmission mount.

Cylinder contribution

Before modern technology took over, when addressing idle-quality concerns one of the most important tests was of cylinder power balance. We could hook up an analyzer to the ignition system and, using the technology we had then, have the analyzer either manually or automatically cancel one cylinder at a time to try to determine if one or two are weak. Today it is known as a cylinder contribution test, or smooth running values. Using your scan tool, take a look at the smooth engine running PID and see if you have a cylinder with weak contribution compared to the other cylinders.

We should mention that the OBD II Mode 6 is also useful here as it provides misfire counts for each individual cylinder.

Once you have identified the cylinder or cylinders, you can logically proceed with solving the problem.

This 1957 300C wagon had a rock-solid idle. Why should your customers’ late-model cars be any different?

Spark, fuel, and compression

As much as automobile technology has advanced in the last few decades, any gasoline-burning internal combustion engine still needs three essentials in order to run: FFC — fire (spark), fuel, and compression. Of course, all of these ingredients must be present at the right time. Let's take a look at the spark part of the equation.

What comes to mind when you think of a tune-up? In older model vehicles, a tune-up could have referred to replacing spark plugs, spark plug wires, the distributor cap and rotor, and adjusting the timing and carburetor. With modern vehicles, fuel delivery and timing are controlled electronically via the vehicle's Engine Control Unit (ECU), or, according to SAE, the Powertrain Control Module (PCM). This brings one question to mind: What does a proper tune-up consist of on today's vehicles? Basically, a tune-up now consists of nothing more than replacing spark plugs and checking the condition of other critical ignition and emissions-control components. Older vehicles used conventional, non-precious-metal spark plugs that required replacement at least every 30,000 miles. Now, all manufacturers have switched to long-life precious-metal platinum and iridium plugs. Not only do they provide longer service life, they also provide additional benefits, such as improved fuel economy and reduced emissions. The advancements in air/fuel ratio technology (and, of course, the big shift to unleaded gasoline, which occurred in 1975 — 42 years ago!) have also improved spark plug life. Ignition systems have undergone advancements since the days of the distributor cap, rotor, and high-tension cables. All late-model Mercedes-Benz ignition systems have eliminated plug wires and the distributor cap and rotor with COP (Coil On Plug, or Coil Over Plug, depending on the source) technology. COP ignition coils are typically non-wearing items, which are replaced only if one has failed. Using four, six, or eight coils instead of one means each of the individual coils has more time to energize between firings. This improved coil saturation time increases the available voltage, which helps mostly at higher rpm where misfires are more likely to occur.

COP delivers about 30% more spark energy than the old distributor, single coil, and spark plug wire system, but a weak, corroded, open-circuited, or otherwise defective individual coil will cause a misfire. Be sure to check the connecter for looseness, broken lock tabs, or oxidation. The PCM will send the signal for the coil to energize and discharge, expecting the spark to occur and ignite the air/fuel mixture in the cylinder. But the plug does not fire.

A misfire causes unburned gasoline to enter the exhaust system. This increases the temperature of the catalytic converter, which could damage it. To prevent this, the PCM generally shuts off the fuel injector on a cylinder that misfires more than a certain number of times and under certain conditions. COP boots on the ignition coil fit tightly around the spark plug insulator, and these boots can become brittle and lose their moisture-tight seal when exposed to years of heat and chemical action. Cracked or damaged boots should be replaced whenever new spark plugs are installed if available separately from the coil. Remember the silicone ignition grease.

Incorrect heat range choice and electrode gap setting can have an effect on how efficient combustion is. What makes the heat range of the spark plug important is the reliability and longevity of the spark plug. A too-hot plug can fracture due to excessive heat, and, more critically, can become a hot spot in the

Note the white discoloration on the end of this COP boot. This could indicate spark leakage along the spark plug insulator to ground.

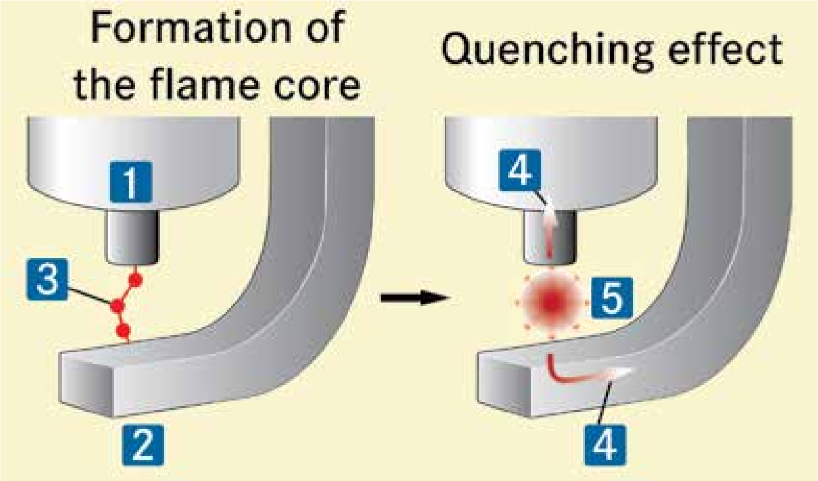
A premium plug with iridium electrodes. Heat range and gap still have to be right.

combustion chamber that will cause pre-ignition and detonation, both destructive conditions. However, a certain amount of heat is required to prevent the spark plug from fouling even with today's gasoline. A cold spark plug will be prone to carbon deposits and fouling. Once the electrode nose is fouled, it will become less effective and its spark quality will fall off as voltage bleeds away via "shunts." Never vary from the recommended spark plug part number – even if you think you know better than the engineers.

An Incorrect spark plug gap can create its own set of problems. Even though the manufacturers pre-gap plugs from the factory, it's important to check them as they might not be gapped to Mercedes-Benz's specifications, or may have been altered in shipping. If the gap is wide enough, the flame core and the quenching effect will be right, so reliable ignition can be expected. But if the gap is too wide, a large discharge voltage becomes necessary, and the limits of coil performance are exceeded, and discharge becomes impossible, or the coil will kill itself trying to do its job.

Pull the spark plug from the offending cylinder and check it for fouling, proper gap, and heat range. Be sure that it is Mercedes-Benz's recommended spark plug for the application. Many technicians have been tempted to use plugs from an interchange and end up having issues with engine-running values. (NOTE: Certain engines, such as M276 and M278, use indexed spark plugs, so the gap must face in a particular direction when installed or running problems may result.) Stick with the genuine article.

Now swap it with another spark plug (on cars with waste-spark ignition, don't swap with the companion cylinder as sometimes the misfire counter will not "see" it) and return to your scan tool to check the smooth engine running values again. Has the misfire moved? If so, then you have found the problem. If not, you still need to eliminate spark from the equation. Is it COP, or does it have wires? Swap the coils or wires in the same manner and recheck until you have eliminated spark as the problem. Now to move on to other possible causes of poor idle.



Note the quenching effect as the flame is dissipated to the ground electrode.

The squeeze

At this stage you've already been dealing with spark plugs, so now is a good time to check on the compression of the cylinder, paying special attention to any that you suspect of being weak (cylinders). This used to be the first part of a normal tune up, but considering the advancements in engine technology we are seeing far fewer issues with compression today than in the past, unless, of course, maintenance has been neglected, or the number of miles on the odometer is in the hundreds of thousands. Check compression in all the cylinders so that you have a good base line to compare against. Consult the Workshop Information System (WIS) for the proper specifications, but what's really important in idle concerns is the relativity to the other cylinders. A mechanically sound engine should have no more than a 15% variation among cylinders. In the case of a cylinder that's weaker than it should be, further testing is called for.

Now it is important to get as much data as possible to understand the cause of a weak cylinder. A wet compression test can be helpful in determining if the compression is escaping through the rings or a valve (no improvement in the latter case). Another valuable test to run here is dynamic compression, also known as a running compression test. When you do a normal compression test, you are checking cylinder sealing, not cylinder breathing. This test looks at the breathing of an individual cylinder. Put all spark plugs but one back in. Ground that plug wire or unplug the coil to prevent module damage. Disconnect that injector on a port fuel system or deactivate the fuel pump if you haven't already done so. Put your compression tester into the empty hole. The test can be done without a Schrader valve, but most people recommended leaving the valve in the gauge and releasing the pressure on the gauge every five or six "puffs." Start the engine and take a reading. Write it down. Give the throttle a "snap" acceleration. The reading should rise. Write it down. What you are trying to do is open, then close the throttle as fast as possible without actually increasing rpm. This forces the engine to take a "gulp" of air. Now write down your readings for at least the bad cylinder (if there is a single bad cylinder) and maybe for two or three good ones. Running compression at idle should be 50-75 psi (about half cranking compression). Snap throttle compression should be about 80% of cranking compression.

Here are two possible scenarios:

- Example 1, restricted intake: Static - 150 psi. Running – 75 psi. Snap – 80 psi. If the snap reading is low (much less than 80% cranking compression), look for restricted intake air due to a severely carboned intake valve, a worn cam lobe, a rocker problem, and possibly stuck shutters in variable intake systems.
- Example 2 restricted exhaust: Static – 150 psi. Running – 75 psi. Snap – 180 psi. If snap measurements are significantly higher than 80% of cranking measurements, look for restricted exhaust on that cylinder, which may be caused by a worn exhaust cam lobe, or a collapsed lifter. Or, if they are all high, look for a clogged catalytic converter.

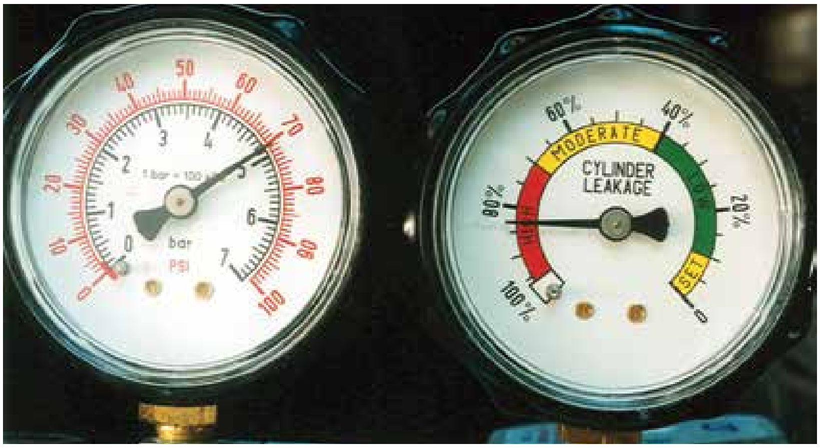
A cylinder leak-down test will round out the evaluation if you indeed have a low cylinder. This simple test will allow you to "hear" where the leakage may be occurring (intake, exhaust, or crankcase) along with the percentage of leakage occurring. Cylinder leakage of 8% or less is considered acceptable, the lower the better. Check for bubbles in the cooling system as well – you may be dealing with a blown head gasket.

Fuel and air flow concerns

Assuming you've eliminated spark and compression faults as possibilities, fuel and air flow volume need to be checked. Concerning fuel, connect your pressure gauge and look for proper specifications. Although a lower-than-spec reading would most likely affect all cylinders, it is important to confirm this basic requirement. Once you've established good fuel pressure and volume, check the injector of the weak cylinder. Use your lab scope and look at the waveform to be sure it is getting the proper signal. Bad injector commands can be caused by many things from faulty drivers in the PCM to a cracked reluctor for a cam or crank sensor, which we won't go into in this article.

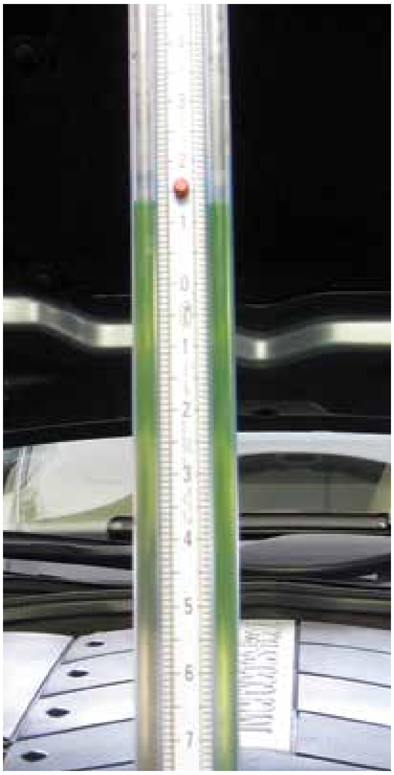
Nothing's more direct than a dry/wet compression test, but the procedure outlined in this article will tell you even more than the traditional way.

A worn-down cam lobe can prevent sufficient filling or exhausting of a cylinder. You can check for proper lift with a dial indicator on a suitable fixture if you suspect such a condition. Also, look for a collapsed lifter.



A leak-down test will help you evaluate a cylinder's integrity. Traditional and still useful.

A smoke machine is great for finding intake leaks, and we've even identified a burned-through piston with one.



You can check crankcase ventilation pressure with a manometer.

Current ramping is a useful test for a faulty injector. A good signal is an indication that you may have a faulty injector. Pull the connector while running to confirm you have no change in rpm in that cylinder. An ohm check with your multimeter can be used for finding excessing resistance. Use the reading from one of the known-good injectors as your base line. An open or shorted injector will need to be replaced, of course. Sometimes the injector can check out electrically, but still be faulty for mechanical reasons — it could be plugged or stuck. With your pressure gauge attached, use a scan tool to energize the suspect injector and watch for a pressure drop, then compare that to the other cylinders. If you have little or no pressure drop, you've found the problem. Swapping injectors is also a good way to check for mechanical problems, although it's more labor intensive.

How about air flow? Remember, we talked about there being less air flow at idle than at cruise, hence just a small amount of dilution or diminished air flow can cause poor idle. Smoke test the intake system and check for intake leaks. Any unmetered air will cause idle problems and will usually be accompanied by high fuel trims.

Don't forget to check the crankcase ventilation system for internal leaks. PCV problems usually show up as internal leaks and won't be revealed by a smoke test.

Using a slack tube manometer is handy for checking this. Manometers operate on the hydrostatic balance principle: A liquid column of known height will exert a known pressure when the weight per unit of volume of the liquid is known. This test is most easily done at the dipstick tube or the oil filler cap.

Check your scan tool data PIDS and watch the air flow through the MAF sensor against specifications.

Overlooked?

By now, we hope you've learned to look for a perforated or otherwise leaking duct downstream of the MAF, which admits what's called "false air" that causes such a lean mixture that massive misfiring can occur, especially at idle.

There's another possibility that's often overlooked: A vacuum leak in the intake manifold runner that leads to the misfiring cylinder that leans it out to the point of idle misfire. Remember, an O2 or A/F ratio sensor is an averaging device, so it won't cause the PCM to richen the mixture enough to that cylinder to produce a burnable blend. We remember numerous examples of this, mostly in the form of a gasket leak at the intake manifold-to-cylinder head interface, but sometimes just a cracked hose that's connected to a tap in that runner. A propane wand is one way to find the gap.

An EGR valve that's stuck open, or causing a vacuum leak, is not unusual. Smoking the intake may reveal this, or you can open and close the valve's pintle with long-nose pliers.

These are all logical steps to take when addressing idle quality problems. Remember to start simple, and stick with the basics. Use a logical approach to addressing the customers concerns and try to keep a mental flow chart in your head as you move about your diagnosis.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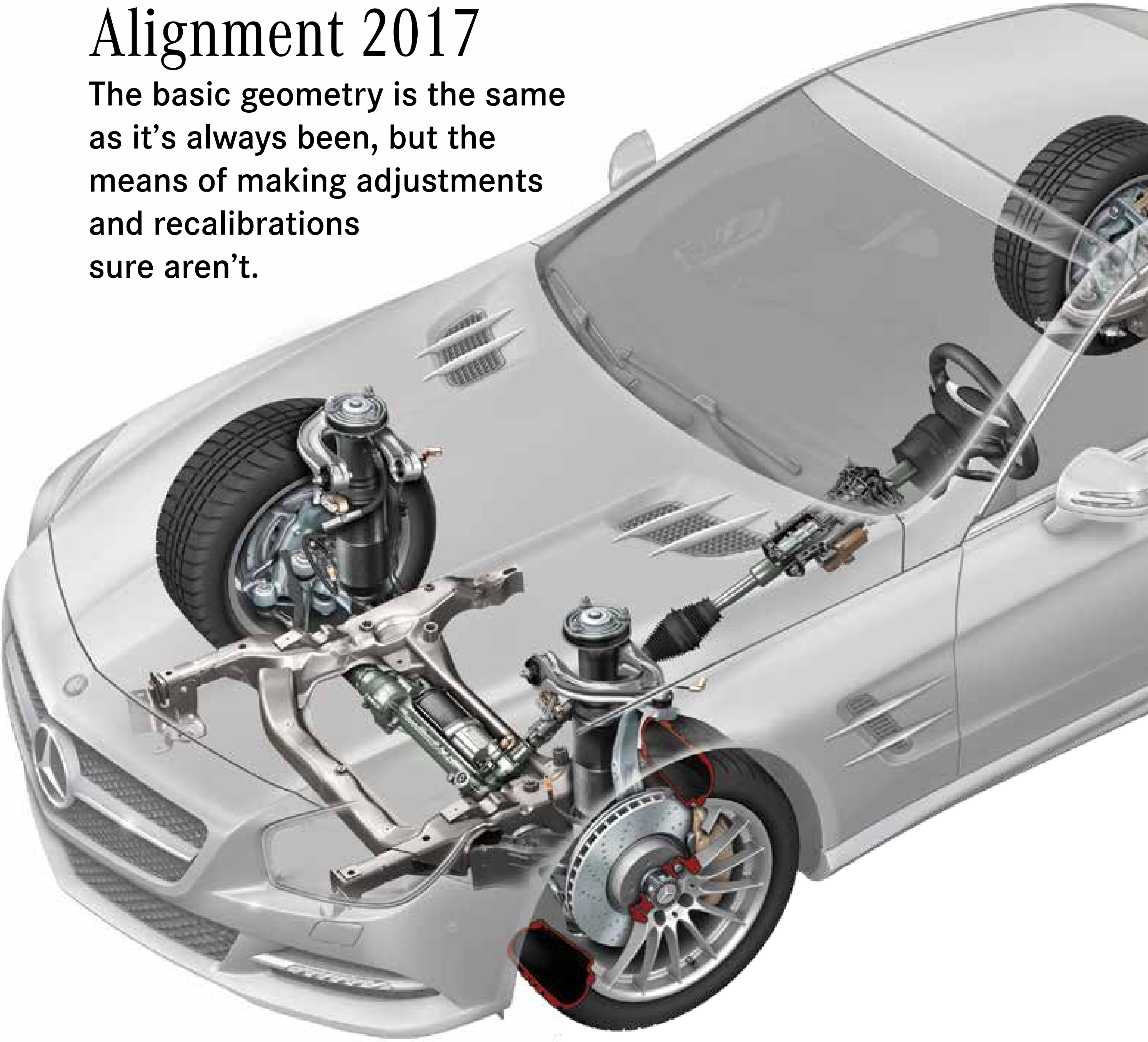
Alignment 2017

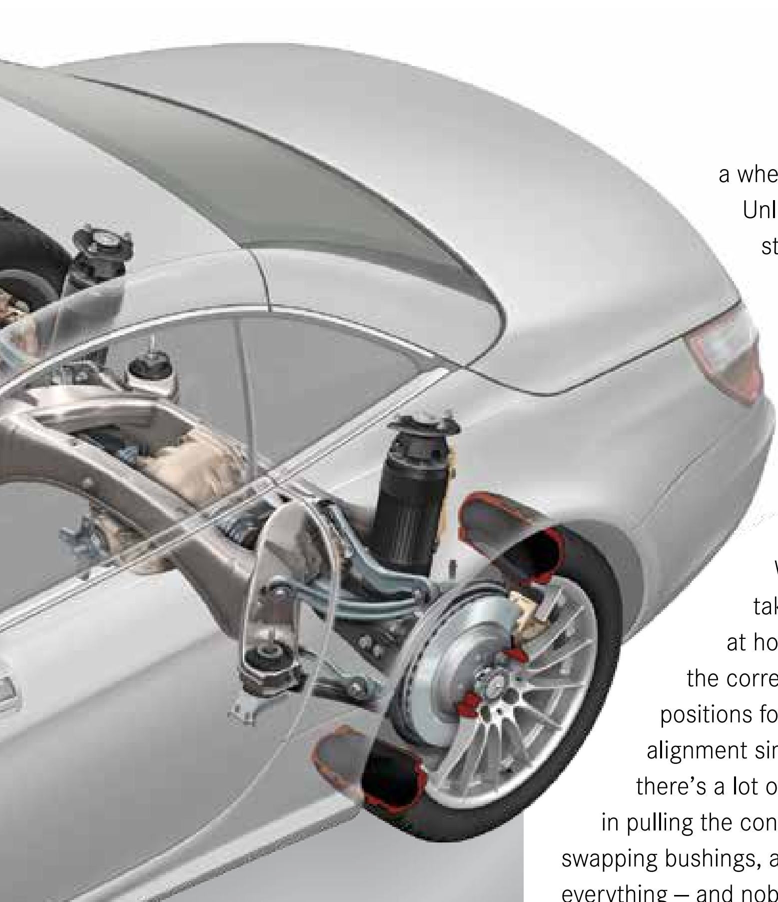
The basic geometry is the same as it's always been, but the means of making adjustments and recalibrations sure aren't.



Wheel alignments are nothing new, but how you go about them has evolved over the years. Long ago, Mercedes-Benz used eccentric washers for camber, and the company still uses them in some models for rear toe. Later models used bolt kits, where you got to pick one of three possible settings.

Modern Mercedes-Benz cars use eccentric control arm bushings, again with a choice of three settings. While not a lot different from those bolt kits, now we have to be darn sure of the position for those bushings since the effort to make a change is far higher than with bolts.

This article is written for technicians who already know how to perform



a wheel alignment.

Unlike past models, starting with the SL-Class (R231), newer Mercedes-Benz models now use eccentric bushings to adjust camber. We're going to take a careful look at how to calculate the correct bushing positions for a wheel alignment simply because there's a lot of work involved in pulling the control arm, swapping bushings, and reinstalling everything — and nobody wants to do that more than once unnecessarily.

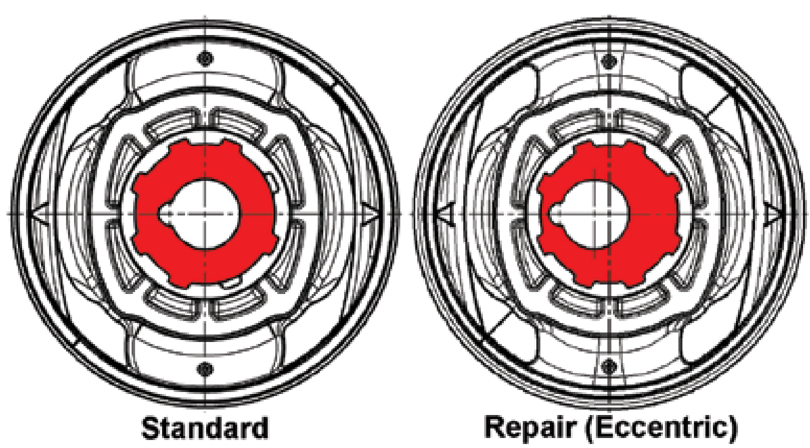
Even when we get fabulous electrics such as the Vision Mercedes-Maybach 6 Cabriolet (see cover), the essentials of wheel alignment — toe, caster, and camber — will still be with us.

Before we start, a brief review of the three main alignment settings is in order:

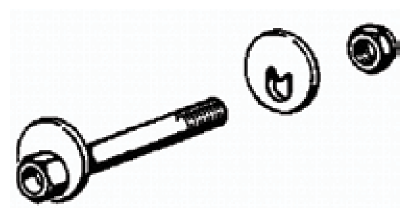
Toe is the inwards or outwards splay of the wheels. Stand up and look at your feet: In most people, their toes are farther apart than their heels, which is negative toe, although some of us have their toes closer than their heels (pigeon toed?), which is positive toe. In rear-wheel-drive cars, a small amount of negative toe is a typical setting, enhancing straight-line stability.

In Mercedes-Benz vehicles, front toe is adjusted by changing the effective length of the tie rods by turning the threaded ends. Rear toe often uses eccentric washers at the rear control arm mountings. Toe has the greatest effect on tire wear, and therefore needs to be set quite precisely. Since the adjustment process is simple and inexpensive for the manufacturer on the assembly line, it is unlikely to change.

Caster is the forward or rearward tilt of the wheel axis relative to vertical. Think of the casters on a typical desk chair: The axis is tilted very far backwards so the wheels pivot and drag behind the direction of motion, which is positive caster. Because of the beneficial self-centering effect



The newest models from Mercedes-Benz now use eccentric bushings for setting caster and camber. Unlike eccentric washers and bolt kits, pressing in a new bushing is supposed to be a one-time event, so getting the right position the first time is essential.



In the old days, eccentric washers were used for adjustments, allowing for perfect stepless setting. Most Mercedes-Benz cars still use these for the rear toe adjustment.

of positive caster, the typical car has a setting of several degrees of positive caster. Caster adjustment is relatively uncommon — if it is out of tolerance, it often points to bent or damaged components, which need to be replaced. Caster is adjusted by moving the top of the strut mounting forwards or rearwards, and is greatly affected by rear ride height.

Camber is the inwards or outwards tilt of the wheels when viewed from the front. If you stand with your feet spread far apart so that your legs tilt inward, that is negative camber (typically employed in race cars for enhanced cornering). Camber has some influence on tire wear, but more influence on handling, with a small negative setting being typical, which helps tire grip when in a curve. Front camber is adjusted by moving the mounting points of the lower control arm or spring arm inward or outward.

If you have been performing wheel alignments for a while, you know all this, but the important part of the discussion above is whether an angle is positive or negative. Toe and camber are generally negative, while caster is positive. As for toe, nothing is really new, so we won't discuss it any further. The settings you really need to pay attention to now are caster and camber.

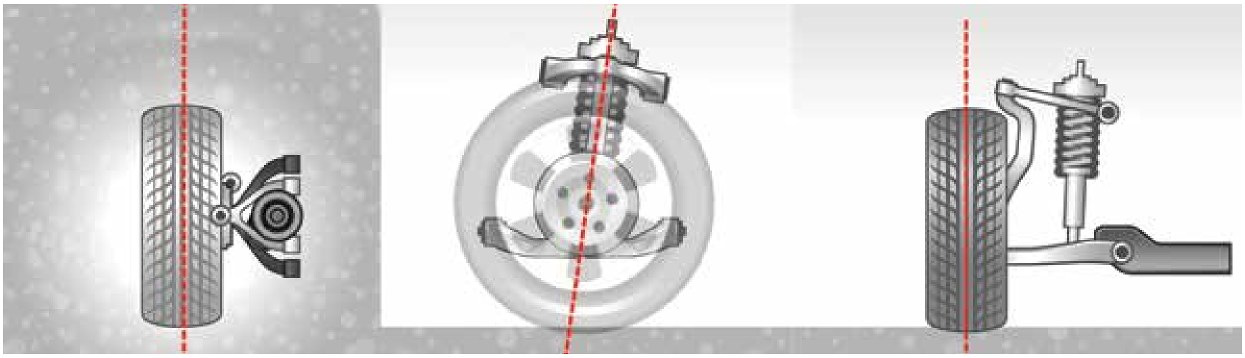
Due to the geometry of the front suspension, caster and camber have an effect upon each other: If you move the front of a lower control arm outwards to increase negative camber, the wheel is also being moved towards the rear of the vehicle slightly, which causes a positive increase in caster. Changing the camber has an effect upon caster, and vice-versa, so this effect must be considered when calculating the adjustment you want to perform. Unlike eccentric washers, or even bolt kits, now when you decide to make a camber adjustment you need to swap out one or both bushings, which isn't a trivial amount of work. Worse still, if you guess wrong, you're going to have to do it over.

That's what the rest of this article will help you do: eliminate all the guesswork so you can do the work with the least effort and best effect.

In the best-case scenario, your wheel alignments are being done on a Mercedes-Benz-approved MKS rack, following the work procedures detailed in the Workshop Information System (WIS). The MKS rack – unrelated to the actual alignment machine that happens to be mounted to it – provides a precision surface on which to perform a wheel alignment. If just a few millimeters (!) out of level, you're going to get wrong data and possibly mis-align the wheels. So if you want your customers happy, use the right equipment. Mercedes-Benz dealers are required to check their MKS rack's calibration often, and have it recalibrated every 6 to 12 months at a minimum.

Our local ISP shop can't afford an MKS rack and alignment machine (the volume just doesn't support one), so our friendly Mercedes-Benz dealer does the work when we need it. It keeps one technician busy all day doing nothing but alignments, and it has a second machine that's used almost all day as well, so not only do they have the right equipment, they have a tremendous amount of experience in the Mercedes-Benz procedures.

We're going to assume you know how to prepare for and perform a proper wheel alignment, so we won't cover the steps here. If you don't know, you need to learn how: Just following the alignment machine's prompts without, say, checking tire pressure and condition, suspension and vehicle condition, vehicle loading, properly settling the suspension, or even the all-important before-and-after road tests, will surely lead to poor results and likely a customer complaint. Nobody wants that.



Just as it's been since the beginning of the automotive era, toe, caster, and camber are the three main alignment settings. Knowing which direction is positive and which is negative is now more important than ever before.

For this example, we'll be using a Model 205 C-Class, but the concepts are the same for all models. After some suspension work, we set the car on the rack and found the right front camber to be at 0° 22'. We can look up the camber specification using WIS in Group 40, but the alignment machine gives us the specification as 0° 3' with a maximum permissible deviation left/right of 0° 11', so we are definitely out of specification here.

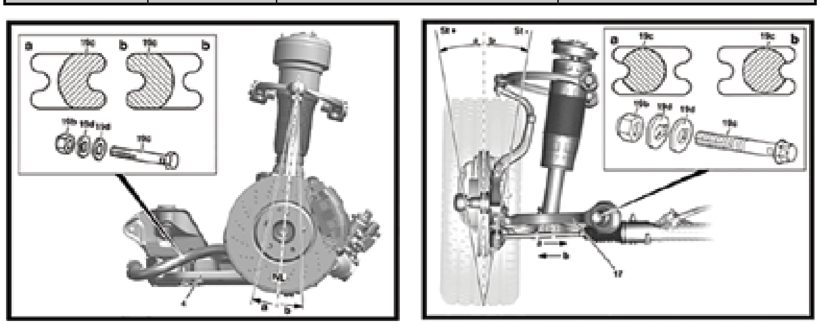
We need to bring the right front camber in by ideally 0° 19', but anything from 0° 14' to 0° -8' is close enough. For the purposes of this example, we're not considering the total camber tolerance of +0° 15' to -0° 27', we're focused on cross-camber relative to the left front.

Our dealer's parts team told us we can buy either standard (as part of the arm assembly) or eccentric bushings (individually) for both the strut rod and the spring control arm. It is clear that we need something to change the camber, but buying two eccentric bushings would be a waste of money.

Looking at WIS document AR40.20-P-0263LW "Adjust camber and caster at the front axle," we see that changing the strut rod bushing lets us adjust caster, while changing the spring control arm bushing lets us adjust camber, so that's the part we need to order. If you're still not sure, take a moment to think about which direction you need to move the wheel – in or out, forwards or backwards – and then figure out what that movement will do to camber and caster. Will it increase or decrease, and is that what you want? It might be a little confusing to think in three dimensions like that, but taking the time for the mental exercise could save you some grief later.

Bolt Kit Effect Example (221)

Spring control arm direction	Torque strut direction	Camber (negative)	Caster affect
Bolt kit in spring control arm			
Inwards = a	No change	Camber decrease approx. +18'	Caster decrease approx. -27'
Outwards = b	No change	Camber increase approx. -18'	Caster increase approx. +27'
Bolt kit in torque strut			
No change	Fore = a	Camber decrease approx. +4'	Caster increase approx. +30'
No change	Aft = b	Camber increase approx. -4'	Caster decrease approx. -30'
Bolt kit in both spring control arm and torque strut			
Inwards = a	Aft = b	Camber decrease approx. +12'	Caster decrease approx. -60'
Outwards = b	Bore = a	Camber increase approx. -12'	Caster increase approx. +60'
Inwards = a	Fore = a	Camber decrease approx. +22'	Caster increase approx. +3'
Outwards = b	Aft = b	Camber increase approx. -22'	Caster decrease approx. -3'



This shows the inter-dependence of the wheel adjustments in an older Model 221 S-Class, which uses a bolt kit. Even though the torque strut is used to adjust caster, it still has an effect upon camber. These effects need to be considered using a thought experiment to be sure you position the adjustment bushing in newer models correctly.

We remove the spring control arm from the car and bring it to our hydraulic press. Using WIS document AR33.15-P-01700-2LW "Insertion/extraction of the rubber bushing on the track control arm" (linked from the previous document) and its recommended Mercedes-Benz special tools W220 589 06 43 00, W211 589 00 43 00 and W221 589 00 43 00, we find the perfect combinations of sleeves, punches and counter-holders to make extraction and insertion of the bushings actually enjoyable in its ease and simplicity.

But, as we get ready to press in the new eccentric bushing, we pause: Which way should it face? Looking at the first document again, we see the spring control arm can be positioned for two camber adjustment possibilities, of +0° 16' or -0° 16'. Since we need to reduce camber – make it less negative – we check the document again and see that the eccentric bushing needs to be pressed into place with the eccentric hole farther from the ball joint, as shown at "D" in the WIS spring control arm image. We do that, put the car back together, recheck and find the right front camber to be 0° 6', almost dead on the mark.

Before we celebrate our success, we really should think about ride height. If we consider the condition where the rear ride height is just an inch low, we can see how that would push our measured caster nearly a full degree towards zero. The point is that failing to consider ride height can lead to dramatically wrong alignment settings.

Before even thinking about ride height, make sure to adjust the vehicle loading to “ready-to-drive” condition. This means emptying the vehicle of all cargo, making sure the spare tire is present and in place, and the fuel tank is filled about halfway, again as explained in WIS. As you might imagine, an extra hundred pounds in the trunk could really throw things off.

Ride height is a critical aspect of any alignment. In most models, measuring the ride height is mandatory to calculate the correct alignment settings, particularly caster. In some models – those with active suspensions – you need to calibrate the ride height sensors to ensure the suspension is at the right place for an alignment. Let’s take a look at the four major suspension types you’ll encounter and what you need to know about them.

Steel Suspension

A “steel” suspension is characterized by steel springs or torsion bars at the front and/or rear, coupled with traditional shock absorbers or dampers. A leaf-spring rear is also considered a steel suspension. Only the spring carries the weight of the vehicle. The ride height of a steel suspension is adjusted using rubber shims of various thicknesses inserted between the spring and the spring seat.

Self-leveling suspension

Certain models are equipped with a self-leveling suspension at the rear, for example, in a station wagon. Depending on the specific system, hydraulically- or pneumatically-actuated rear struts automatically adjust vehicle ride height to compensate for vehicle load, using a suspension-mounted ride height sensor.

The ride height in vehicles with these systems is adjusted using rubber shims as with a steel suspension, followed by adjustment of the level control system as detailed in WIS. The basic ride height must NOT be set by adjusting the sensor control point, as this produces an incorrect system calibration.

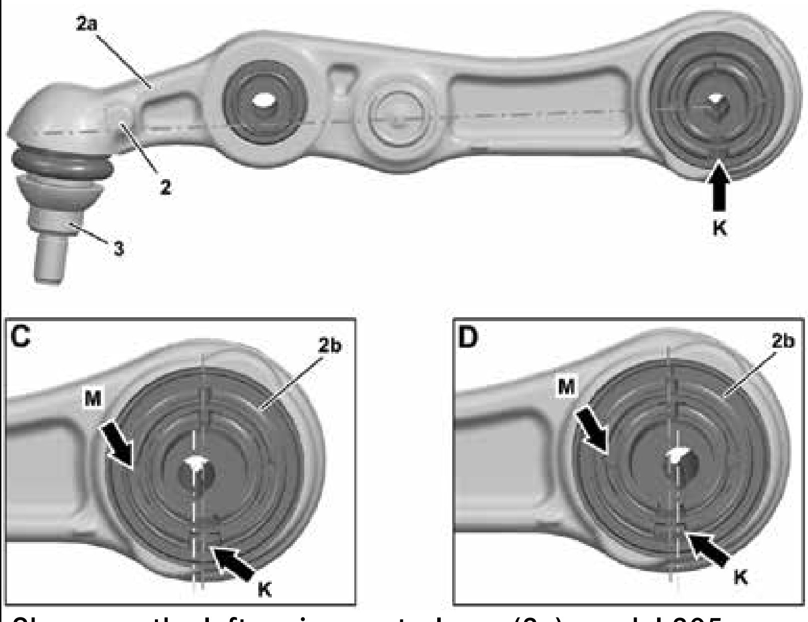
MacPherson Strut Suspension

A MacPherson strut suspension is characterized by the use of an integrated load-bearing coil spring surrounding a damper, which is a structural member of the strut assembly. The strut is part of the wheel-locating structure.

The ride height of a MacPherson strut suspension is generally not adjusted. If the ride height is not within the published tolerances, the spring and/or spring mountings must be replaced, or there could be body damage. However, in some cases a small amount of adjustment can be found by loosening and retightening the strut mounting bolts.

Airmatic & ABC suspension

Vehicles with AIRMATIC suspension have semi-active pneumatically-adjusted load-bearing suspension struts (say that three times fast!) that have adjustable damping. The vehicle ride height and suspension



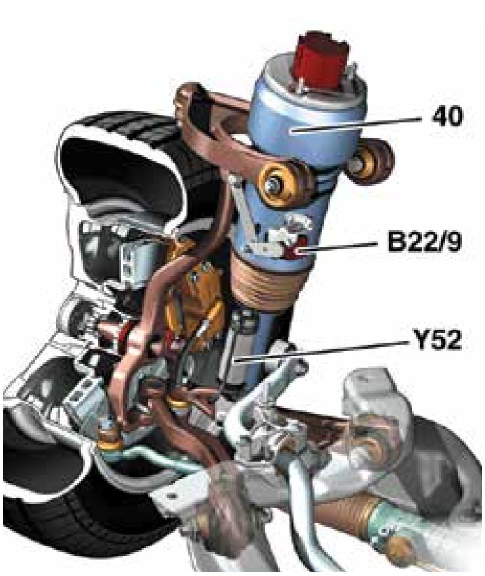
Shown on the left spring control arm (2a), model 205
Bild C Positive camber change: +3mm = +16’
Bild D Negative camber change: -3mm = -16’

A portion of WIS document AR40.20-P-0263LW “Adjust camber and caster at the front axle”. Cutout “D” shows the hole in the eccentric bushing positioned further from the ball joint, and the text tells us this will change camber by 16’ towards negative (-16’).

characteristics vary according to vehicle operating parameters, such as vehicle speed and driver selection.

Vehicles with Active Body Control (ABC) have active load-bearing suspension struts that act very quickly to adjust the vehicle ride height and suspension characteristics, again according to vehicle operating parameters such as cornering, braking, acceleration, and road surface characteristics, as well as driver settings.

Measuring ride height is critically important since ride height determines the specific alignment settings. Mercedes-Benz dealers use this ROMESS gauge along with their precision MKS alignment rack to ensure the highest levels of accuracy.



An AIRMATIC suspension strut (40), the suspension level sensor (B22/9), and the control valve (Y52). Before performing a wheel alignment on a vehicle equipped with AIRMATIC, you need to raise and lower the suspension once. In some cases, you may also need to recalibrate the level sensors.

Steel and Macpherson suspensions need to be settled before starting a wheel alignment. We do this by jouncing the car – pressing down forcefully and allowing an untouched rebound – at each of the four corners of the vehicle. This also applies to the self-leveling rear suspension, but there we need to first verify the suspension basic level is set correctly by measuring as explained in WIS.

In AIRMATIC and ABC vehicles, the suspension must be raised and lowered using the suspension system before performing a wheel alignment. Note that in USA-produced SUVs (e.g., W166), the system requires wheel speed to be non-zero for the suspension to lower. Drive the vehicle slowly (approx. 10 mph) over a short distance.

It is not always required to actually calibrate the AIRMATIC and ABC suspension for a routine alignment, but if the height readings seem out-of-line, or you've replaced a major component (control unit, level sensor, spring link, or upper link arm), then a ride height sensor level calibration should be performed. Note that it is not necessary to recalibrate ride height when only a strut is replaced.

A level calibration in an AIRMATIC or ABC vehicle allows the control unit to match the level sensor readings to the actual ride height. An uncalibrated sensor still provides level readings, but the control unit does not know how to relate that to the actual vehicle ride height.

Ride height calibration is performed using XENTRY, a level MKS rack, and the ROMESS inclinometer. Although the exact details may vary by model, the general procedure is:

- Place vehicle on a level MKS rack.
- Raise and lower suspension completely.
- Enter the Level Calibration routine in XENTRY and follow the steps.
- Set the ride height to the nominal values (within the green zone) as shown on the screen.
- Measure the ride height angles using the ROMESS gauge and enter these into XENTRY.
- The ride height should be calibrated. It is possible that the calibration is unsuccessful. In these cases, perform the calibration again.

As we said in the first paragraph, wheel alignments are about the same basic things as ever, but advances in suspension technology and adjustment methods have certainly changed the game enough to take notice. If you take anything from this article, let it be that just a little bit of careful thought about how you are moving the wheel around while doing an alignment will let you hit the numbers every time, to your and your customer's benefit.

Mercedes-Benz Classic Center

A World-Class Preservation Facility for a World-Class Marque

The heart of any automobile brand is its reputation, a reputation built on quality, durability, safety, success in motorsports and, of course, styling. But reputation is also built on heritage, which incorporates all of the above features.

And so, of course, the world-class reputation and respect for Mercedes-Benz vehicles is well-deserved, and built on all of the above attributes.

But while car companies have come and gone over the last century, Mercedes-Benz has remained at the pinnacle of automotive technology and reliability for more than 130 years. And there is no greater evidence of this than the Mercedes-Benz Classic Center in Irvine, California.

Opened in June of 2006, the Mercedes-Benz Classic Center is dedicated to the preservation of classic Mercedes-Benz vehicles. The Center considers a Mercedes-Benz to be a “classic” when a particular chassis has been out of production for fifteen years or more.

The scope of their products and services is far-reaching and staggering:

- Complete restoration services for every classic Mercedes-Benz vehicle – from mechanical maintenance and repair to complete mechanical overhaul to frame-up nut-and-bolt restorations.
- Full structural and cosmetic repair, including fabrication of NLA components.
- Total upholstery refurbishing, including duplication of OE fabric patterns and materials.

The Mercedes-Benz Classic Center spans more than 28,000 square feet, all dedicated to the preservation, repair, restoration, and maintenance of classic Mercedes-Benz vehicles. It incorporates separate work stations for various services – metalworking, paint prep, spray booth, mechanical service bays, alignment, and final assembly.

There are also an extensive parts department, a storage area, a machine shop, and even a showroom where selected customer cars are exhibited, along with the occasional classic Mercedes-Benz available for sale.

The facility features a team of some twenty two specialists, including craftsmen, parts specialists, and management. Each craftsman has a specialty talent perfectly suited to the tasks at hand. Some are auto body craftsmen, some are specialists in engine systems like early fuel injection, some are painters, some are upholsterers. Most are multi-

talented craftsmen with certain individual specialty talents, and all are artisans in their own right.

The facility accepts assignments spanning the full scope of maintenance and repair. They can service, calibrate, and tune the mechanical fuel injection used in the legendary gull-wing 300SL, or perform a complete frame-up restoration on a pre-war model.

Every restoration project, large or small, is subject to the same meticulous four-step process:

1. Arrival and initial inspection. Every car brought in for any kind of service receives the same detailed inspection and evaluation. Dialogue with the owner or consigner begins the process, with discussion of services desired. The vehicle is examined in detail, assessing visually apparent mechanical and cosmet-ic needs, along with documenta-tion of any existing flaws or damage. An initial outline plan is developed based on these discussions and observations.

2. Disassembly and documentation. Those areas to be serviced are carefully disassembled, and the conditions of various components are recorded in written form as well as photographically. All disassembled components are carefully packaged, labeled, and inventoried to assure authentic reassembly, down to nuts, bolts, and washers. This, along with the vast data base available at the Center, assures complete authenticity of the finished product.

   Once disassembly and documentation are complete, consultants from the Center engage in extensive dialogue with the car owner, discussing recommended repairs and other services, along with expected costs and an estimated timetable for completion.

   In the case of a total restoration of a pre-war car, for instance, the process may span as much as two to three years. This time frame is representative of the attention to detail required to restore one of these priceless cars to as-new condition.

3. Repair and refinish. This is where the craftsmanship at the Center becomes most apparent. The Center has a vast library of documentation on almost every classic and vintage Mercedes-Benz vehicle. And they also are in direct communication with their counterparts in Germany, who can provide detailed specifications, drawings, and technical and refinishing information on nearly any Mercedes-Benz vehicle ever built. Such data can include frame alignment specifications, internal engine clearances and other assembly specifications, and even such information as to original fabric patterns and materials when restoration involves re-upholstering interior components.

4. Reassembly and final inspection. Meticulous attention is paid to

detail during the reassembly process, and each component is individually inspected and tested in the process. In addition, once a restoration is complete, every system in the vehicle, including mechanical systems and cosmetic accoutrements are afforded a white glove inspection and evaluation to assure that every aspect of the restoration meets the extraordinarily high standards of this operation. Upon completion and careful evaluation, items such as suspension parts receive the same color painted inspection markings as they would have received during original production.

Any anomalies are noted and corrected, and a detailed written report is provided to the owner.

It is not uncommon for the Center to have as many as thirty cars at a time in various stages of repair and restoration. This allows for the most efficient use of the craftsmen's time when parts need to be sourced or fabricated.

As you would expect, the Center has a vast parts department of the most commonly-needed parts, including those that may be correct for various models or model years. And they also have direct access to parts specifications, blueprints, and parts inventories at Mercedes-Benz headquarters in Germany. While work is never rushed at the Center, when necessary, needed parts can be air-freighted to the Center, and most common parts can arrive in just one or two business days.

Happily, the parts inventories at the Center, and from Germany, are available to independent repair and restoration shops that may be servicing classic Mercedes-Benz vehicles. While the Center does not offer technical repair assistance to shops or vehicle owners, parts professionals at the Center are intimately familiar with Mercedes-Benz vehicles of all vintages, and work with technicians and restorers to meet their parts needs.

While tours of the facility are not offered to the public, the resources of the Center are a great asset to owners seeking the ultimate in restoration services, and to those in independent repair and restoration shops in need of authentic parts for vintage Mercedes-Benz vehicles.

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Product Name	Part Number	Quantity	Product Description	Recommended Consumer App.
Mercedes-Benz SPEC.				
Mobil 1 Formula M 5W-40	BQ 1 09 0197	Bulk - No Equipment	Fully synthetic formulas designed specifically for gasoline passenger cars	Low SPAsh. Available at most M-B dealers
	BQ 1 09 0195	6/1 Quart Cases		
	BQ 1 09 0196	55 Gallon Drum		
Genuine Mercedes-Benz Oil MB 229.5 Specification SAE 5W-40	A0009898301USB6	6x1 Quart Cases	Fully Synthetic formula specifically designed for Mercedes-Benz engines that require the 229.5 Specification	Mercedes-Benz Engines that require 229.5 Specification Oil
	A0009898301USB8	55 Gallon Drum		
	A0009898301USB9	Bulk - No Equipment		
Mobil 1 0W-40	BQ 1 09 0010	Bulk - No Equipment	Fully synthetic formulation designed to meet the requirements of many European vehicles	Porsche A40. Many European vehicles. HT/TS applications.
	BQ 1 09 0015	6/1 Quart Cases		
	BQ 1 09 0016	55 Gallon Drum		
Mobil 1 ESP X1 0W-30	BQ 1 09 0184	Bulk - No Equipment	Advanced full synthetic formulas designed specifically for diesel passenger cars that have particulate filters	Low SPAsh. Available at most MB dealers
	BQ 1 09 0182	6/1 Quart Cases		
	BQ 1 09 0183	55 Gallon Drum		
Genuine Mercedes-Benz Oil MB 229.52Specification SAE 5W-30	A0019893701USA9	Bulk - No Equipment	Fully Synthetic formula specifically designed for Mercedes-Benz engines that require the 229.51 and 229.52 Specification requirements	Mercedes-Benz Engines that require 229.51 Specification Oil
	A0019893701USA6	6x1 Quart Cases		
	A0019893701USA8	55 Gallon Drum		
Mobil 1 5W-50	BQ 1 09 0133	16 Gallon Keg	Higher viscosity, advanced full synthetic formula designed for performance vehicles	Porsche A40. HT/HS applications.
	BQ 1 09 0194	6/1 Quart Cases		
Mobil ATF 134	BQ 1 09 0166	55 Gallon Drum	Extra high performance automatic transmission fluid formulated with selected HVI base oils	Recommended for use in Mercedes-Benz automatic gearboxes
M-B Genuine ATF 134FE	A0019897703USA8	55 Gallon Drum		
Mobil 1 ESP Formula MB 5W-30	BQ 1 09 0165	12x1 Liter Cases	Advanced full synthetic formulas designed specifically for passenger car diesels that have particulate filters	Low SPAsh. Available at most MB dealers.
AdBlue® ½ Gal.	A 000 583 0107	1/2 Gallon Bottle	Non-toxic solution that transforms harmful Nitrogen Oxide (NOx) emissions from diesel-powered vehicles into harmless water vapor and nitrogen	Recommended for use in Mercedes-Benz, Volkswagen + BMW AdBlue® (DEF) applications
Diesel Exhaust Fluid 55 Gal	BQ 1 47 0002	55 Gallon Drum		
Mobil 1 5W-30	BQ 1 09 0017	6/1 Quart Cases	Advanced full synthetic formulation designed to meet the requirements of many domestic, including GM, and imported vehicles	Vehicles that require 5W-30. Corvette approved.
	BQ 1 09 0018	55 Gallon Drum		
Mobil 1 10W-30	BQ 1 09 0019	6/1 Quart Cases	Advanced full synthetic formula designed for domestics and imports	Vehicles that require 5W-30 or 10W-30
	BQ 1 09 0020	16 Gallon Keg		
	BQ 1 09 0021	55 Gallon Drum		
Mobil 1 5W-20	BQ 1 09 0083	6/1 Quart Cases	Advanced full synthetic formulation designed to meet the requirements of many newer vehicles including Hondas, Fords, Chryslers, and newer Toyotas	Vehicles that require 5W-20
	BQ 1 09 0084	55 Gallon Drum		
Mobil 1 0W-20 AFE	BQ 1 09 0169	6/1 Quart Cases	Advanced full synthetic formulation designed for enhanced fuel economy and cold weather performance	Most vehicles that specify 0W-20 (newer Toyotas and Hondas), 5W-20 and certain hybrids
	BQ 1 09 0168	55 Gallon Drum		
Mobil 1 0W-30 AFE	BQ 1 09 0174	6/1 Quart Cases	Advanced full synthetic formulation designed for enhanced fuel economy and cold weather performance	Most vehicles that specify 5W-30 or 10W-30
Mobil 1 Synthetic ATF	BQ 1 09 0164	6/1 Quart Cases	Multi-vehicle, fully synthetic fluid designed to meet the demanding requirements of modern passenger vehicles	Vehicles that require Dexron III, Ford Mercon and Mercon V performance levels
	BQ 1 09 0163	55 Gallon Drum		
Mobil 1 15W-50	BQ 1 09 0023	55 Gallon Drum	Boosted, higher viscosity, advanced full synthetic formula designed for performance vehicles	HT/HS applications. Racing and Flat tappet applications
	BQ 1 09 0022	6/1 Quart Cases		
Mobil 1 Gear Oil (Mobil 1 Gear Lube 75W-90)	BQ 1 09 0085	12/1 Quart Cases	Exceeds the most severe service requirements in both conventional and limited slip applications	SUITABLE for use in modern high performance automobiles like SUV's, Vans and Light duty trucks requiring API GL-5 level performance

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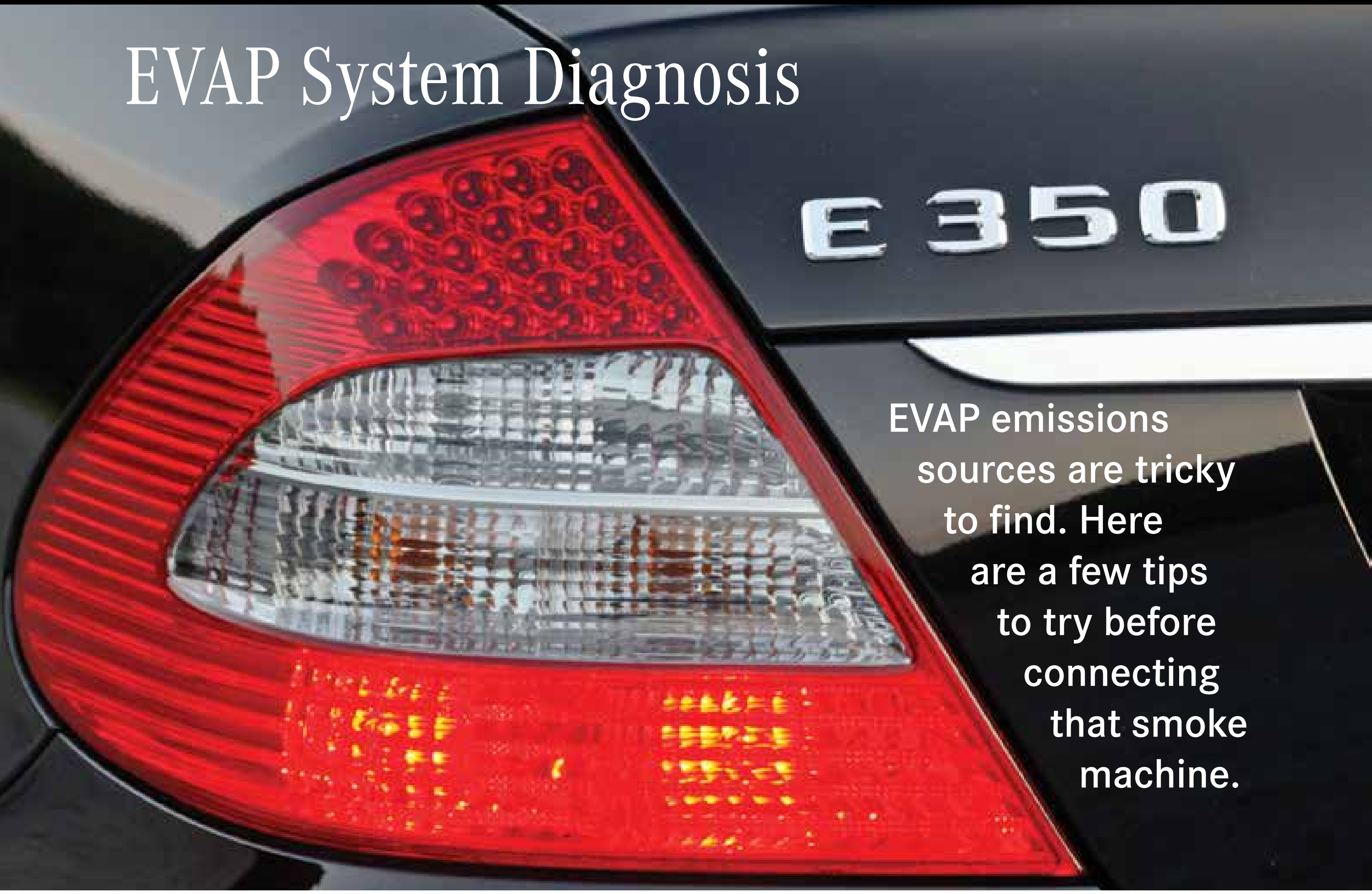
Product Name	Part Number	Quantity	Product Description	Recommended Consumer App.
Mercedes-Benz SPEC.				
Mobil Special 5W-30	BQ 1 09 002464	Bulk - No Equipment	Formulated from quality base stocks combined with modern performance additives to give the engine the expected protection and performance under a wide variety of operating conditions	Recommended for gasoline fueled automobiles and light duty trucks requiring an API SN/SM/SL/SJ
	BQ 1 09 0171	12/1 Quart Cases		
	BQ 1 09 003064	55 Gallon Drum		
Mobil Special 10W-30	BQ 1 09 003164	Bulk - No Equipment	Formulated from quality base stocks combined with modern performance additives to give the engine the expected protection and performance under a wide variety of operating conditions	Recommended for gasoline fueled automobiles and light duty trucks requiring an API SN/SM/SL/SJ
	BQ 1 09 0172	12/1 Quart Cases		
	BQ 1 09 003764	55 Gallon Drum		
Mobil Special 10W-40	BQ 1 09 003864	Bulk - No Equipment	Formulated from quality base stocks combined with modern performance additives to give the engine the expected protection and performance under a wide variety of operating conditions	Recommended for gasoline fueled automobiles and light duty trucks where a higher viscosity API SN/SMSL/SJ oil is preferred or recommended
	BQ 1 09 0173	12/1 Quart Cases		
	BQ 1 09 004464	55 Gallon Drum		
Mobil Special 5W-20	BQ 1 09 012464	Bulk - No Equipment	Formulated from quality base stocks combined with modern performance additives to give the engine the expected protection and performance under a wide variety of operating conditions	Recommended for gasoline fueled automobiles and light duty trucks requiring an API SN/SM/SL/SJ
	BQ 1 09 0170	12/1 Quart Cases		
	BQ 1 09 013264	55 Gallon Drum		
Mobil Special 20W-50	BQ 1 09 004664	55 Gallon Drum	Formulated from quality base stocks combined with modern performance additives to give the engine the expected protection and performance under a wide variety of operating conditions	Recommended for gasoline fueled automobiles and light duty trucks where a higher viscosity API SN/SMSL/SJ oil is preferred or recommended
Mobil Delvac 1300 Super 15W40	BQ 1 09 0053	Bulk - No Equipment	Extra high performance diesel engine oils that help extend engine life in the most severe on and off-highway applications while delivering outstanding performance in modern, high-output, low-emission engines including those with Exhaust Gas Recirculation (EGR) and After-treatment Systems with Diesel Particulate Filters (DPFs) and Diesel Oxidation Catalysts (DOCs)	Specifically recommended for the latest low-emissions, high performance diesel applications equipped with aftertreatment systems using Diesel Particulate Filter (DPF) and Diesel Oxidation Catalyst (DOC) technologies
	BQ 1 09 0058	12/1 Quart Cases		
	BQ 1 09 0059	4/1 Gallon Cases		
	BQ 1 09 0060	55 Gallon Drum		
	BQ 1 09 0179	6/1 Quart Cases		
Mobil Delvac 1300 Super 10W30	BQ 1 09 0086	Bulk - No Equipment		
Mobil Delvac 1 5W40	BQ 1 09 0051	4/1 Gallon Cases	Fully synthetic supreme performance heavy duty diesel engine oil that helps extend engine life while providing long drain capability and fuel economy for modern diesel engines operating in severe applications	Recommended for use in all super high performance diesel applications, including modern low emission engine designs with Exhaust Gas Recirculation (EGR)
	BQ 1 09 0052	55 Gallon Drum		
Mobil Grease XHP 222	BQ 1 09 0078	60/14 oz Cartridge	Formulated to provide excellent high temperature performance with superb adhesion, structural stability and resistance to water contamination	Recommended for industrial and marine applications, chassis components and farm equipment
	BQ 1 09 0079	120 lb Keg		
	BQ 1 09 0080	400 lb Drum		
	BQ 1 09 0098	40/14 oz Cartridge		
Mobil Lube HD Plus 80W90	BQ 1 09 0096	120 lb Keg	Extra high performance, automotive lubricant formulated from select base oils and an advanced additive system specifically for limited-slip differentials	Recommended for use in limited-slip differentials, axles, and final drives requiring API GL-5 level performance
	BQ 1 09 0097	400 lb Drum		

EVAP System Diagnosis



EVAP emissions sources are tricky to find. Here are a few tips to try before connecting that smoke machine.

Vehicle-related environmental regulations focus on reducing three types of harmful emissions: unburned hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NO2, or NOx). Mercedes-Benz engineers have brought powerful new technologies to the fight, including more efficient combustion chambers, low-friction engine components, higher-precision ignition timing, direct fuel injection systems, variable valve timing, and closer engine tolerances.

In addition to those new technologies that make engines more efficient, key systems directly reduce the targeted harmful emission categories. CO emissions are limited by the positive crankcase ventilation (PCV) system, the secondary air injection (SAI) system, and the catalytic converter. NOx emissions are reduced by the exhaust gas recirculation (EGR) system and the catalytic converter. For HC emissions, the first line of defense is the evaporative emissions system, with additional help from the PCV, secondary air, and catalytic converter (aftertreatment) systems.

Leaks are by far the leading cause of EVAP system trouble codes being set. However, seeing a leak-related trouble code and solving an EVAP system problem can be two very different things. Diagnosis can be complicated by the fact that some leak trouble codes can be caused by problems other than a cracked hose or leaking fitting. In a system with only one psi of pressure, finding the typical small leak can be time-consuming at best. Key system components may be hidden from easy visual inspection. Even when you can see the relevant valves, lines and fittings, the leak opening is often too small for the unaided eye to see. An EVAP smoke machine is essential.

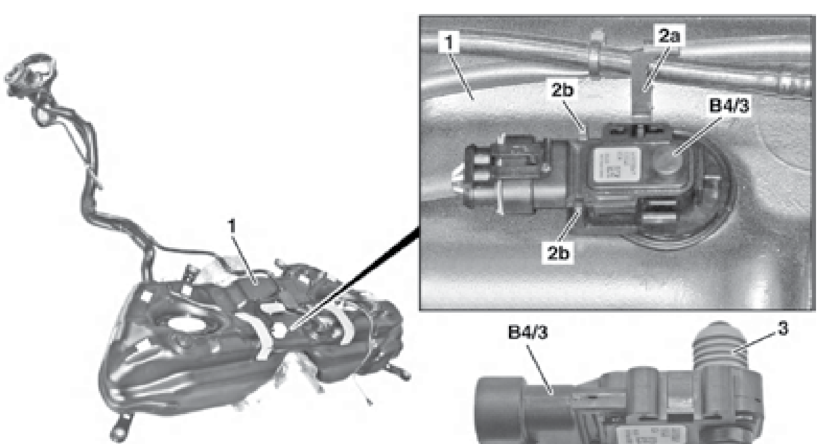
What appears to be a leak may actually be a stuck valve not allowing vacuum to flow where and when it should, or an electrical problem preventing a component from responding appropriately to actuation commands from the PCM (Powertrain Control Module, SAE's term, but you may be used to ME for Motor Electronics). A small leak will eventually become a large leak that can come back to bite you, so despite the diagnostic headaches, you have to find and repair it.

Reach first for your scan tool

Even with a Mercedes-Benz-approved EVAP smoke machine, the process of moving things around may alter the conditions that caused a trouble code to set, making it difficult to verify and repair the original problem. For example, it could shake loose the piece of debris that was causing a valve to stick open, push a vacuum hose back on its fitting, and, in essence, temporarily eliminate the problem that caused the customer's complaint.

Before setting up the smoke machine or checking to make sure the gas cap is tightly closed, conduct an EVAP leak test using the Mercedes-Benz XENTRY or previous Star Diagnosis tool. Because you connect under the dash, you won't likely have altered one or more of the conditions that could be a primary leak source. Also, if the vehicle fails the leak test, you'll have verified that the fault code is not due to an intermittent problem or ME control unit issue.

Mercedes-Benz structures its test to look for three leak levels: gross leak (equal to or greater than 3 mm in diameter), fine (equal to or greater than 1 mm), and very fine leak (equal to or greater than 0.5 mm diameter). It tests first for the largest leak first, and works its way down.



The fuel tank pressure sensor seal (3) could be deteriorated, or the sensor (B4/3) may have become stuck, and is sending a false positive signal to the ME control unit. Take care to not turn or tilt it when removing the faulty FTP sensor, as this may damage the locking tab (2b), which is needed to secure the replacement sensor.

Using your Mercedes-Benz scan tool or an aftermarket substitute hooked up to the diagnostic connector under the dash, close the vent solenoid and open the purge valve. Vacuum should reach approximately -6 mbar within 12 seconds in the fuel tank on a typical E350. See your Mercedes-Benz service information for fuel tank test and adjustment values for the vehicle you are working on. If no vacuum builds up in the fuel tank, there is a major leak. A trouble code will set, the warning light will flash in the instrument cluster, and the message "Check Filler Cap" will appear in the multifunction display.

No matter what the reason you are performing the purge cycle test, if there's a leak of more than 3 mm, you will likely hear a loud hiss. If you can hear it, but the ME control unit does not see the leak and set a trouble code, replace the fuel tank pressure (FTP) sensor. The FTP sensor is likely stuck in a manner that sends a good (plausible) signal despite the leak.

If there is no large leak, proceed to check for a fine (1 mm) leak. Close the vent solenoid and open the purge valve long enough to build up approximately -6 mbar of vacuum in the fuel tank, then seal the purge solenoid. With the EVAP system sealed, measure the vacuum level for 30 seconds. If vacuum falls more than 0.3 to 0.5 mbar per second over a 30-second period, there is a fine leak, and the ME control unit will set a code. Note that this specification is dependent upon the fuel level in the tank, and will be taken into account by the ME control unit pass/fail algorithm as necessary.

If no fine leak is found, purging restarts until a vacuum of -6 mbar is built up again. Close the purge solenoid (the vent solenoid also remains closed), and watch for vacuum decay. If vacuum drops faster than 0.10 to 0.15 mbar per second (again, depending on fuel level), there is a very fine (micro) leak. Note that the ME control unit measures fuel outgassing shortly before checking the FTP sensor, and takes any outgassing into account for fault determination.

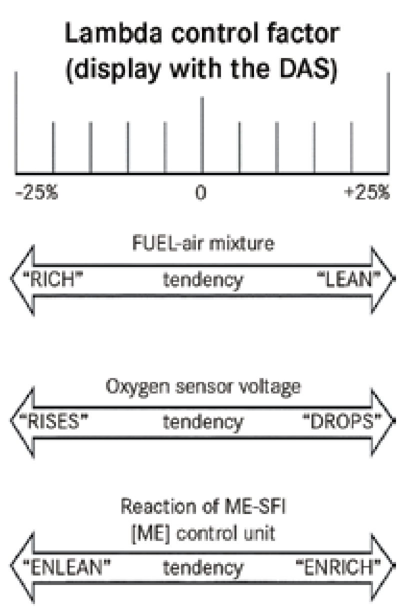
The Purge Solenoid

When the vehicle is being driven and certain conditions (speed, engine temperature, and others) are met, the ME control unit opens the purge valve to apply vacuum and pull measured amounts of fuel vapor from the EVAP canister into the engine to be burned.

If the purge solenoid is stuck open, it is applying vacuum to the EVAP system whenever the engine is running, regardless of conditions. If the EVAP canister was saturated with gasoline vapor, the fuel trim adjustment has to play catch-up with the rich condition caused by those extra fuel vapors being dumped into the engine. Once all of the fuel vapors have been drawn out of the EVAP canister, we are then drawing fresh air through the open vent solenoid and into the engine, causing an undesired lean condition. Either way, a stuck open purge solenoid is considered by the ME control unit to be a gross leak, and sets a code.

Under normal conditions during the canister purge cycle, the FTP sensor should see vacuum in the line in order for fuel vapors to be drawn from the EVAP canister into the engine. If the sensor registers no or inadequate vacuum in the purge line after the purge solenoid is commanded open by the PCM, a fault code is set.

The lack of vacuum could have a long list of potential causes. These include an inoperative or clogged purge or vent solenoid, clogged or disconnected purge line, cracked or damaged EVAP canister, misrouted vacuum hose, rusted filler neck, open or short in the purge valve wiring, faulty purge valve, or a failing fuel tank pressure sensor.



A faulty FTP sensor or defective purge valve can cause the air/fuel mixture to become too rich or lean, depending on fuel level and engine speed, and require excess adjustment from the ME control unit in order to keep the engine running efficiently.

On many Mercedes-Benz models featuring the 272.9 series engine (and others), the purge solenoid is normally closed, and is actuated by the ME control unit. Using a pulse-width-modulated (PWM) signal, the ME control unit provides precise purge volume by varying the frequency and duration of purge solenoid open times. If vacuum is found when there is no command from the ME control unit to open the purge solenoid, the valve may be stuck open. Rust, particles from deteriorated seals, or other debris can enter the purge solenoid valve and prevent it from closing completely.

The EVAP Vent Solenoid

A P0449 code means that the ME control unit has detected a fault with the circuit that controls the EVAP system vent solenoid. The cause could be a short to power, short to ground, an open, a failure of communication between the

With XENTRY you can read current configurations of various systems on Mercedes-Benz vehicles, access and troubleshoot any system or control module, stream real-time sensor data, conduct sensor actuation and testing, read and clear fault codes, and perform online or offline initialization and coding of sensors and modules.

ME control unit and the solenoid, blockage of the valve or line to it, or less likely with a P0449 code, a faulty valve.

Two wires service the vent solenoid. One supplies voltage from the fuse or junction box, and the other carries the ground commands from the ME control unit to activate or deactivate the vent solenoid (by controlling when the circuit is grounded). Do a voltage drop test between the fuse and the wiring connector at the valve to make sure that the solenoid is receiving enough current (12V) to actuate opening and closing.

To check if the EVAP vent valve is receiving open and close commands from the ME control unit, actuate the solenoid using your scan tool. Close the vent. If the solenoid is working and receiving commands from the ME control unit, you should hear a “click” when it closes. If the vent valve does not open or close when commanded, check for power and ground in the wiring connector at the solenoid.

With the vent solenoid closed, open the purge valve and let vacuum build in the tank for 6-8 seconds, then watch for vacuum decay. If the tank holds vacuum for at least 30 seconds, open the vent solenoid and close the purge valve. Fuel tank pressure should rise and stabilize at a level pre-set by the ME control unit.

Check potential fuel cap issues

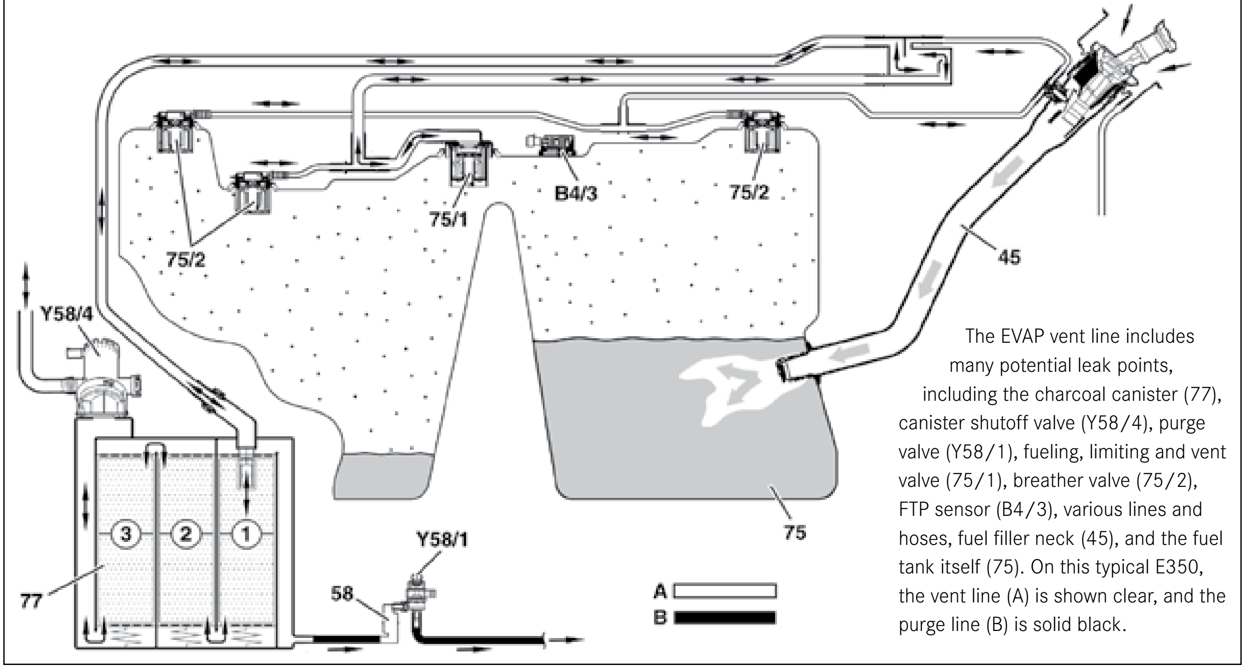
A gross leak code such as P0455 may not automatically be a sign that there is a problem with the fuel cap. If vacuum does not build up in the fuel tank when the purge valve opens, the computer simply sees a lack of vacuum and sets a leak code. It does not always set a more specific code that tells you whether other conditions, such as a stuck purge solenoid, are causing the lack of vacuum. You can do the detective work by using your enhanced scan tool to actuate various EVAP system components and watch the responses from the fuel tank pressure (FTP) sensor.

Of course, check that the fuel cap is tightly screwed into the filler neck. If not, tighten cap, delete the code and re-check for EVAP system leak tightness.

Inspect the fuel filler neck. Is there excessive rust allowing leaks through the neck, or preventing a good seal with the cap?

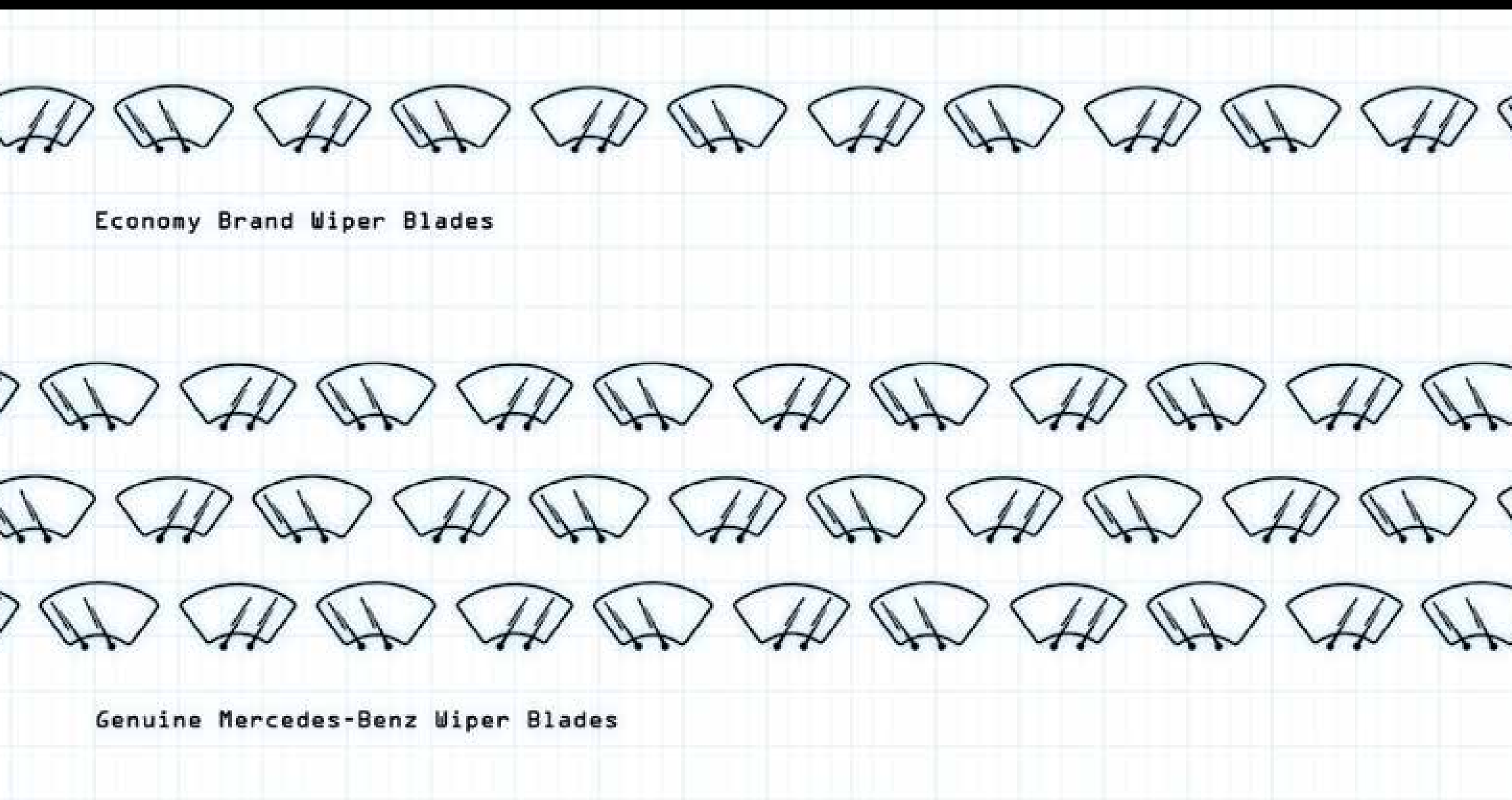
Is a leak actually occurring?

As already mentioned, it pays to check first using the best scan tool you have available, preferably. Once you verify there is a leak, you can switch to the Mercedes-Benz-approved EVAP smoke machine to quickly find it. The approved smoke machine features low-pressure test procedures, so it does not alter or harm components in the vehicle EVAP system. That combined with the procedures outlined above will guarantee the accuracy of your diagnosis.



The EVAP vent line includes many potential leak points, including the charcoal canister (77), canister shutoff valve (Y58/4), purge valve (Y58/1), fueling, limiting and vent valve (75/1), breather valve (75/2), FTP sensor (B4/3), various lines and hoses, fuel filler neck (45), and the fuel tank itself (75). On this typical E350, the vent line (A) is shown clear, and the purge line (B) is solid black.

PartsPro



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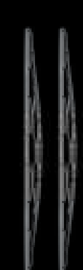

*As compared to economy wiper blades using durability test #PN 103713, which tests wiper durability through 1.5 million wiping cycles.

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