STARTUNED®

Information for the Independent Mercedes-Benz Service Professional

September 2016
U.S. $6.00 | €5.36
Volume 16 | Number 3

INSIDE:

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.

Wouldn't it be nice if there were a way to get the parts you need without the hassle and uncertainty, so you can get back to the important business of actually fixing cars and taking care of your customers?

With the Mercedes-Benz PartsPro wholesale certification program, now there is!

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!

Convenience...Accuracy... Profitability...Delivery

A PartsPro dealer has the tools in place to better meet the needs of their esteemed wholesale customers.

For a dealership to achieve PartsPro Certification, parts department personnel must first undergo intensive "customer-centric" training which teaches personnel how to better help YOU.

There's far more to PartsPro than just customer-service training. The dealership must make specific commitments to provide "Best in Class" service in areas such as logistics, which includes ISP-focused parts availability, regular delivery service, outside sales people to provide you personalized service, as well as a dedicated phone line and "will call" pick up area.

Then there's technical help

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.

Only those dealerships that meet the stringent certification requirements earn the right to display the "PartsPro" logo. Additionally, they receive ongoing consultation and training to ensure that they are consistently providing the very best support to you, the ISP customer.

We hope you are already receiving industry leading service from your Mercedes-Benz dealer; however, once your dealer is PartsPro Certified, we believe you'll be thrilled with the new "Best in Class" parts-procurement experience!

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

StarTuned®

September 2016

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

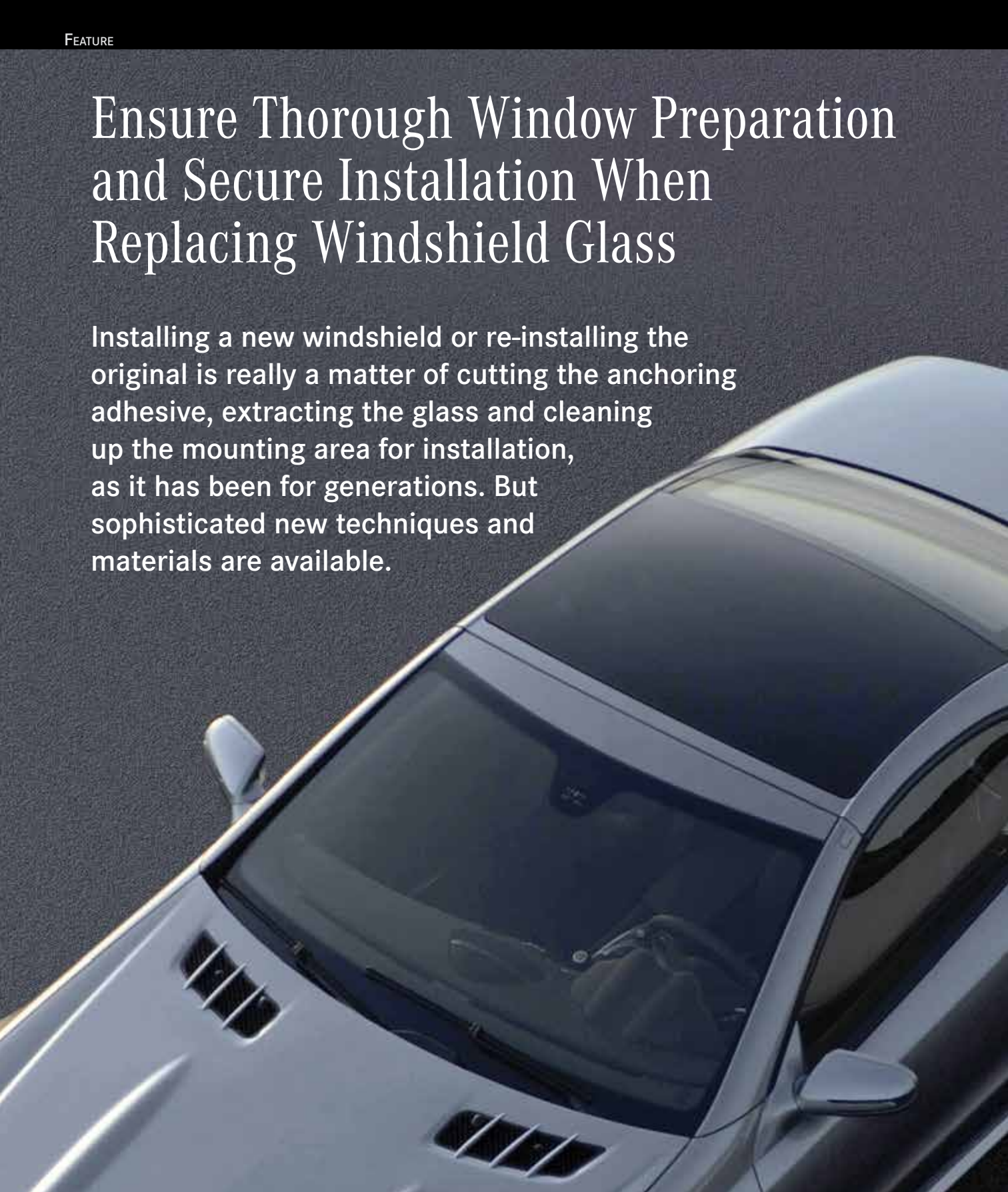
Visit mbusa.com to locate a Mercedes-Benz dealer near you.

In This Issue

Mercedes-Benz
The best or nothing.

Ensure Thorough Window Preparation and Secure Installation When Replacing Windshield Glass

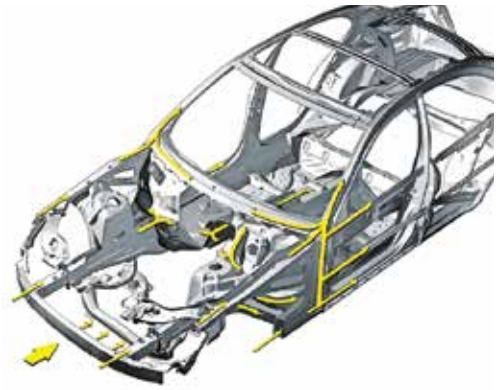
Installing a new windshield or re-installing the original is really a matter of cutting the anchoring adhesive, extracting the glass and cleaning up the mounting area for installation, as it has been for generations. But sophisticated new techniques and materials are available.



Preparing to replace windshields in late-model Mercedes-Benz vehicles? Be aware that these are more challenging undertakings than they once were – the windshields in today's highly-developed Mercedes-Benz road warriors do more than simply provide good vision and keep the driver dry and un-windswept.

Glass – primarily the windshield – also adds strength to the vehicle's safety cage structure, helps retain the occupants within the vehicle in case of collision, supports the front passenger airbag when deployed, and manages energy dissipation in a collision.

Vehicle glass also serves as a platform for various antennas, the wiper park heater, defogger, rain/light sensor, night view assist, multifunction cameras, rearview mirror mount, and in some cases the infrared (IR) reflective film protection (SUNGATE).



Once anchored securely in place, the windshield becomes an integral element in vehicle structural strength.

Complete glass installation kit offers the shop the tools to precisely cut out old glass and install a new windshield. Approved windshield adhesives are included.

Following the roadmap for installation, keep these points in mind:

- The windshield glass being replaced was fastened into the vehicle with very strong adhesive.
- Cut out the glass from the adhesive and remove all but 2 mm of old adhesive before installing or reinstalling glass. Special windlass tools increase the efficiency of the removal process.
- Installed glass becomes an important part of the vehicle's structure and strength, and ***only Mercedes-Benz-approved adhesive applied correctly MUST be used to install and anchor glass in place.***
- Once installed, calibrate or recalibrate all sensors and other devices mounted on or within the glass to ensure each performs as it should.

NHTSA tests check windshield strength

These installation mandates are absolutes, and MUST be followed according to Federal law to ensure vehicle structural rigidity.

The National Highway Traffic Safety Administration (NHTSA) test MVSS 212 measures an installed windshield's ability to keep an occupant who is not belted within the vehicle during a collision, and requires that 75% of the perimeter of the windshield must stay in the body opening after crashing the vehicle into a fixed barrier at 30 mph.

NHTSA Test MVSS 216 measures a vehicle roof's resistance to crushing during a rollover and works by securing the vehicle to a horizontal plane, then applying a downward force to the top of the A-pillar equal to 1.5 times the vehicle's weight. The downward force test device must not move more than five inches.

Applying proper adhesive correctly is critical, and Mercedes-Benz OEM materials are designed to guarantee the required performance. Glass adhesive used to install the windshield must accomplish the following:

- Keep out moisture and wind
- Allow glass to add strength to the vehicle's structure

- Allow the body to flex slightly while not cracking the glass
- Insulate antennas integrated within the glass from grounding to the vehicle's body

For these reasons, only use Mercedes-Benz approved adhesive. To increase vehicle structural rigidity, since January 2004 higher shear-strength adhesive has been used at all Mercedes-Benz production plants for bonding glass. This necessitated a new glass adhesive and glass installation kit for repair work, also used for installing panoramic roofs. The glass installation kit (introduced on 06/29/2016) is called "RS Windshield" (Repair Set) in the EPCnet parts catalog, and replaces the previous two-component adhesive kit, which utilized the Betagun for application. The current kit includes:

- Adhesive cartridge
- Cartridge adhesive applicator nozzle
- Glass cleaner
- Lint-free towel
- Primer and instructions
  (more on the use of the installation kit later)

Protect exposed interior with strong covering material

Of course, before you can use the installation kit, you must first cover the vehicle seats and other exposed interior items with strong material to protect from damage when extracting the old windshield or parts of one and cleaning up residue from the previous installation. Also place protective tape at delicate spots surrounding the windshield that might sustain damage.

Depending on the vehicle year and model, the area at the base of the windshield at the rear of the hood housing the windshield wipers may need to be removed and set aside if it blocks access to the windshield glass. If necessary, this is a simple and quick matter. Check in WIS for any other disassembly details that may apply to the specific vehicle. These actions ensure clear access to the windshield and working room for removing the old windshield and installing a new one or re-installing the previous one.

Carefully remove locating clips and fasteners

Remove locating clips and anchoring fasteners, and put them aside for reinstallation. These clips are essential for keeping the windshield in the correct position and holding it in place in highway use, especially if the going gets rough and the vehicle is subjected to structure-threatening activity.

The next step is to cut the adhesive bead holding the old glass in place. On today's vehicles, the Mercedes-Benz Roll Out 2004 Cutting Tool is recommended to precisely cut the adhesive bead. This tool offers several advantages over previous methods:

- Highly efficient process
- Minimized possibility of paint damage
- No need to remove A-Pillar trim or headliner
- Reduced chance of breaking the windshield

Also, the process can be done by one technician, whereas other types of adhesive removal may require two people.

Remove the clips and retainers around the windshield and place aside for re-installation.

Tape delicate areas that might suffer damage when cutting out the old windshield.

THE REFLECTION OF PERFECTION

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A brand of BASF
We create chemistry

The current Roll Out 2004 Automotive Glass Replacement kit includes:

- Windlass and cutting wire
- Parabolic chisel and awl
- Reversible ratchet
- Mounting wedge
- Guide needle and bent needle
- Extension pieces: 150 mm and 75 mm
- Safety goggles and protective gloves

NOTE: Always wear safety glasses when cutting out glass!

Using the Roll Out 2004 Cutting Tool

The cutting tool kit is based on the use of windlasses that pull the adhesive cutting wire placed around the windshield to smoothly cut the adhesive. The wire provides a precision cut, and can be performed by one technician without assistance.

Although the kit comes with detailed instructions, here we will acquaint you with the procedure so you can see its advantages over old-fashioned methods. To set up the tool, cut a length of wire from the spool in the kit about four times the diagonal dimension of the windshield. Then:

- From inside the vehicle, push the awl from the kit through the adhesive near the bottom center of the windshield to avoid damage to VIN tag.
- Mask painted areas if necessary to prevent paint damage.
- Bring both ends of the wire through the hole in the awl, bending the wire over the awl to secure it.
- Pull the awl back through the adhesive into vehicle interior, with bent wire tips facing upward so they glide against glass when pulling wire through.
- Feed the wire around the perimeter of the windshield up against the adhesive, removing rubber spacers if possible.
- Pull the wire into the vehicle's interior, ensuring that it is located below the glass at all four corners.
- Remove the wire from the awl and clip off the bent ends.
- Attach the first windlass to the right side of the glass, mounting the windlass as close to the glass edge as possible to reduce stress on the glass and prevent cracking.
- Insert the wire into the winding coil and wind the wire into the windlass, then continue to wind using the ratchet.
- Use the chisel to guide the wire along the perimeter of the glass, protecting the interior from wire damage where necessary by using plastic guards – the chisel helps the wire cut more smoothly.
- Continue to draw the wire along the body flange and into the windlass until it cannot be drawn in further, and hold winding coil to prevent it from springing back. ***Release the windlass lock by pulling it outward, and reposition the windlass to prevent the winding coil from becoming immobilized, which might require starting over.***
- Attach the second windlass to the left side of the windshield and draw the wire in. Using plastic guards to protect the interior, reposition the second windlass to continue cutting the adhesive bead – avoid damaging wiring from the overhead control panel.
- Reposition one windlass so it overlaps the other to cut the remaining adhesive while continuing to use the chisel to guide the wire.
- When the wire is pulled through, clip the wire and remove each windlass.

The roll out cutting tool is basically a set of two windlasses used to draw fine wire around the perimeter of the windshield and precisely cut the adhesive holding the old windshield in place, freeing the windshield for removal.

Carefully pull the wire with the windlass around the perimeter of the windshield.

- Whether the wire is round or square, pull the wire the rest of the way through by hand, then clip it and remove each windlass.

CAUTION: The glass can crack where it is attached if excessive pressure is put on the windlass — this could happen when cutting through spacers.

Prepare glass for installation

Locate the replacement glass part number by VIN to ensure you get the correct glass based on the vehicle's equipment level. Some windshields include the last four digits of the part number under the Bar Code in the glass identification information at the lower left corner. This can be used as reference when looking up the correct windshield via EPCnet.

If replacing with new glass:

- Wear clean gloves to prevent fingerprints.
- Clean the entire windshield with standard glass cleaner.
- Attach any antennas.
- Secure any electrical connectors assembled on the glass with tape to keep them out of the way during installation.
- Clean the adhesive area with the cleaner in the kit and apply the primer to the adhesive area.
- Make sure to avoid putting the primer on electrical plug contacts area on the back of the windshield.

If glass is being reinstalled:

- Remove the old adhesive with no more than 2 mm left behind.
- Clean the exposed primer area with the cleaner in the kit if the primer was removed during the adhesive removal process — check the primer coat and repair it with new primer if necessary.
- Secure any electrical connectors on the glass with tape to keep them out of the way.

If any corrosion is detected, repair it before installing the new windshield, and if the body flange is distorted in any way, repair it also.

- If there is paint damage in the adhesive area, apply primer to any scratches, or, in the painted area, perform touch up, preferably using a two-part catalyzed sealer.
- If the adhesive flange has been exposed for more than 24 hours, apply primer to it.
- Install new rubber spacers, ordered with the windshield and glass installation kits.
- Run the defroster to make sure that any glass chips are blown out, then vacuum the work area to remove any loose debris.

Align the glass before installation

Before the adhesive is applied:

- Align (dry-fit) the glass, with the distance between the glass and roof specified in WIS. Use a feeler gauge to check specified distances and gaps.

Very carefully align the windshield glass in preparation for installing it.

- Make sure the VIN plate aligns with the glass opening.
- Use tape to provide reference points.
- When removing the windshield after positioning, recheck the installation position of the rubber spacers – spacers can become dislodged during the alignment process.

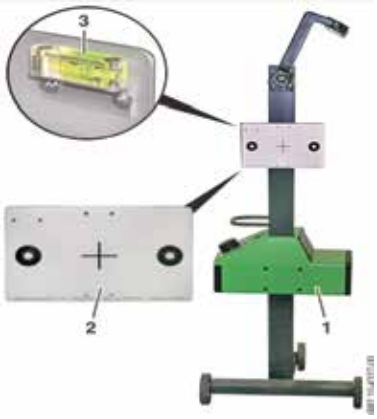
For the actual installation, apply the adhesive to either the body flange or the glass. The height of the adhesive bead should be approximately 13 mm or .5 in., unless otherwise stated in WIS.

- Keep the nozzle perpendicular to the application surface.
- ***Make sure applied adhesive bead height is approximately13 mm and that it is smooth and straight. Adhesive application is incorrect if there is too much adhesive in one area, application is uneven, or air bubbles are present, which could cause a leak.***
- When using a battery-operated caulking gun, employ the intermediate piece special tool.
- ***Install the glass within 10 minutes of applying the adhesive as it will start to cure after that interval, thus, providing decreased adhesion.***

Putting it in place, actually

Open the door windows before installing the windshield – slamming a door with all windows closed may cause fast cabin pressure build-up and unseat the new windshield before the adhesive has cured.

Install the windshield by aligning the glass to the reference points made previously and set the glass down in the vehicle opening (the adhesive has already been applied either to the outer perimeter of the glass, or to the vehicle windshield frame).



Required tools for multifunctioncamera calibrations include the XENTRY/DAS, headlamp aimer, and ROMESS calibration target.

- Press down firmly on the entire outer perimeter of the glass directly over the adhesive.
- Place two pieces of tape from the glass to the roof, and two pieces to the pillars.

The windshield is installed!

- Perform a water leak test once the adhesive cures, replace all removed clips and parts, and reconnect the battery.
- After cleaning both sides of the window, align the wiper blades to clear marks present in the blackened area of the lower portion of the windshield, or align according to WIS instructions.

Calibrate all systems affected

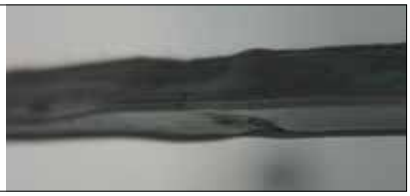
To complete the installation and ensure that the vehicle performs safely day and night, calibrate or recalibrate all systems affected by the installation of a new windshield, or re-installation of previous one, including function checks as needed. Systems needing calibration include:

- Rain/light sensor – if not calibrated, the rain sensor may cause erratic function of the windshield wipers
- Night vision and multifunction cameras
- Infrared sensor transmitter and receiver
- Multifunction camera and stereo multifunction camera, essentially the same as multifunction camera
- Night view assist camera
- Windshield wiper arm angle check and adjustment
- Radio functionality if glass includes antenna
- Transfer registration/inspection stickers

After calibration, the Mercedes-Benz is ready to drive – with a clean, fresh view!

This special adhesive nozzle enhances the application of the proper adhesive bead.

Apply a precise 13 mm-high adhesive bead to either the windshield to be installed or the frame in the vehicle.



Now comes the best part.

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- Access to over 300,000 readily available Genuine Mercedes-Benz Parts
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Mercedes-Benz
The best or nothing.

Pascal's Legacy
Mercedes-Benz Hydraulic Systems

Core principles, evolution, flushing, bleeding, and service tips.

When you think about it, it's pretty hard to believe that a teeny tiny column of fluid can transmit enough force to stop a ton or two of hurtling automobile, but that's the magic of hydraulics. Early cars used mechanical apply set ups – cams, cables, and levers. No matter how clever the design, however, they were almost impossible to equalize perfectly, and required constant adjustment, so the idea of using hydraulics to do the job intrigued engineers from the 1890s onward. But it took many years to develop reasonably dependable systems, so the first production cars with fluid pressure actuated brakes didn't appear until the early 1920s.

With refinements, hydraulic systems essentially the same as those originals got us through four decades. But in the mid 1960s the changes and complications started. First there were disc brake calipers and dual circuits with metering, proportioning, and a warning light, then came combination valves, diagonally split systems, low drag calipers, step bore masters, load sensitive proportioning, etc. ABS started another whole ball game that was to include the most important safety advances ever seen.

French genius and prodigy Blaise Pascal, who lived a short life in the 17th century, defined the law of physics upon which all hydraulic systems are based. ABS and its derivatives mess with it, but they can't violate it.

Opposite Page: You might be surprised when you first see the twin calipers on an electro-hydraulic brake system, but you can handle it.

A firm grasp of the modern Mercedes-Benz hydraulic system and the service procedures it requires is about as important to anybody doing brake work as knowing which way to turn a wrench. Unfortunately, we've found that lots of techs out there still have some fuzzy areas in that essential understanding and also harbor a few misconceptions and prejudices. So, we figured we'd better lay it all out for you, including some important service tips.

We've run many articles on the incredible advancements that Mercedes-Benz has made to control the hydraulic systems of its cars for the benefit of human safety, from ABS to ASR, ASC, ABR, etc., but here we're going to look at the core: how brake actuating pressure is generated and applied to the calipers, Pascal's Law, evolution, fluids, and real-world information involving calipers, lines, hoses, and potential problems.

Although he was also a mathematician, Christian philosopher, inventor, and writer, French scientist Blaise Pascal (1623-1662, a short, productive life) is mostly remembered for formulating Pascal's Law, also known in fluid mechanics as the principle of transmission of fluid pressure. It's simple, but profoundly important: Pressure change occurring anywhere in a confined incompressible fluid is transmitted throughout the fluid such that the same change occurs everywhere. Just think of the implications!

You can extrapolate it to many practical uses, and combined with conservation of energy you get an understanding of why a small piston moved a long distance pushes a big piston a short distance, and how its force is multiplied – master and slave.

While ABS and related systems with their pumps and solenoid valves may seem to mess with Pascal's Law, they can never violate it.

Fail safe

The prime mover in brakes is the dual, split, or tandem master cylinder, which has been used on every car sold in this country since 1967. Believe it or not, plenty of people still aren't comfortably familiar with its construction and operation.

A typical modern specimen will be of the composite variety (in other words, aluminum with a plastic reservoir), but iron one piece units are still around in vintage vehicles. Two pistons ride in the bore, the rear piston being the primary, and the front the secondary.

Each piston has a primary cup at its front and a secondary at its rear, so you'll be hearing such combinations as

primary piston secondary seal, secondary piston secondary seal, etc. The primary seals are the most important because they trap the fluid that's about to be squeezed into the lines. The primary piston's secondary seal keeps fluid from escaping out of the back of the cylinder, and the secondary piston's secondary seal acts as a barrier to make two essentially separate cylinders out of one.

In normal braking, the pushrod from the pedal or booster forces the primary piston forward. No pressure is created until the primary seal covers the compensating, replenishing, or vent port from the reservoir, but once it does fluid is trapped in the chamber between the pistons and becomes, for all intents and purposes, a solid column. Pressure is routed from this chamber to two wheels. A combination of the trapped fluid and the primary piston coil spring bears on the secondary piston, moving it forward also and creating pressure in the chamber ahead of the secondary piston's primary seal, to which the line to the other two wheels is attached.

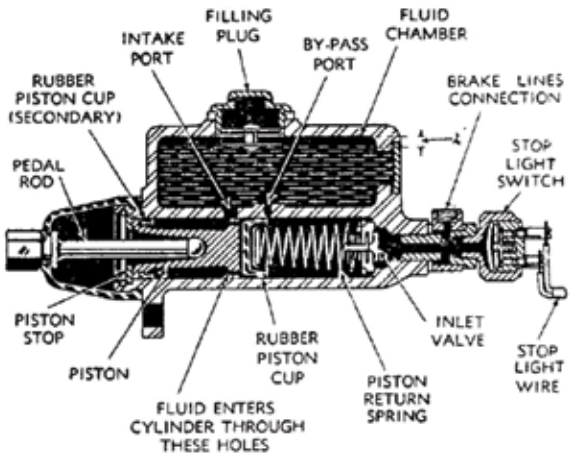
When the pedal is released, a partial vacuum occurs in both pressure chambers because the fluid is too lazy to return from the lines fast enough. So, in order to re arm the brakes instantaneously, the primary seals are designed to allow fluid to flow one way (forward) from behind each seal into the pressure chambers.

The replenishing ports allow fluid to move freely between the chambers behind both pistons' primary cups and the reservoir according to demand and expansion and contraction from temperature changes.

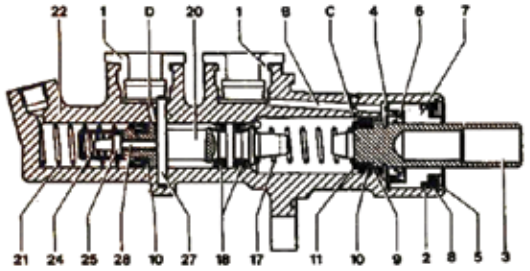
Blown

If a hose lets go or a saboteur has sawed through one of the brake lines so there's a catastrophic loss of fluid in half the system, the other half will still provide a means of decelerating the vehicle, albeit with a lower pedal and reduced stopping power. Both pistons have extensions which project out in front of their primary seals. A failure in the circuit that's connected to the primary piston's pressure chamber will allow the piston to move forward enough so the extension will bear on the secondary piston, push it ahead, and generate pressure in the other circuit. If, on the other hand, the circuit that gets its juice from the secondary chamber blows, the extension on the secondary piston will bottom out on the front of the cylinder and the fluid trapped between the pistons will operate the alternate set of brakes.

But a master cylinder alone does not an integrated brake system make. Means of fine tuning the pressure for the situation and warning the driver of a partial failure are equally important. All kinds of individual and combination valves have been used to perform the metering, proportioning, and warning light activation functions, but that's all ancient history now, especially with discs all around and ABS.



For two generations, this simple master cylinder design ruled vehicular deceleration. The whole function became much more complicated from the 1960s onward. The only place you'll see one of these today is on an antique, or a trailer surge brake.



1. Reservoir busing (rubber)
2. O-ring
3. Primary piston (primary circuit)
4. Stop washer
5. Snap ring
6. Secondary sleeve
7. Plastic Bushing
8. Stop washer
9. Filler washer
10. Primary sleeve
11. Supporting ring
12. Compression spring
13. Separating sleeve
14. Secondary piston (secondary circuit)
15. Compression spring
16. Housing
17. Valve spring
18. Valve seal
19. Cylinder pin
20. Valve pin

A. Filling bore
B. Compensating bore
C. Filing and compensating bore

Although it's been around for 50 years, many people still don't understand how the dual or tandem master cylinder works. We're sure the universal adoption of the idea may have saved lives.

Tubes

We've always been particularly concerned with the metal brake lines that route pressure to the wheels. Since we live near salt water, we often get cars in that have been partially dunked at a boat ramp, so much so that the double wall steel lines rust out, resulting in a complete loss of stopping power in that circuit. The same is true where lots of salt is used on the roads in winter.

If a line runs up over the chassis so that it's hard to see, use a mirror and your sense of touch to examine it. Replace lines if the rust has reached the scaly stage. When installing replacements, follow the original routing as closely as possible. We've heard of fade or low pedal problems because of a line being mounted too close to an exhaust pipe, or has a hump or loop in it that traps air.

All Mercedes-Benz vehicles use brake lines with the ISO (International Standards Organization) flare, which is not compatible with traditional domestic double flare tube seat connections. Because the shoulder of the nut bottoms in the fitting, sealing pressure is uniform and over tightening isn't a problem. Also, only one simple die is required to form the flare.

Standard double-wall steel brake lines serve us well, but be careful of corrosion. Note that this is the ISO flare that's used on all Mercedes-Benz vehicles.

It was once considered smart to isolate wheels using clamps like these. Not anymore. You'll crush the plastic lining.

Liquid link

Then there's brake fluid, the stuff that makes everything happen. Mercedes-Benz specifies DOT 4 glycol because of its high boiling point and its ability to hold a lot of moisture so that slugs of water don't form in the system. But in the past, that hygroscopic characteristic made another type seem attractive: silicone, rated DOT 5 and color coded purple. It doesn't absorb H_2O (so it was expected to practically eliminate corrosion), has a 500 deg. F. boiling point, and won't dissolve paint the way ordinary glycol does.

There were, however, unintended consequences in the use of DOT 5 that spelled its demise. First, as a brake engineer told us years ago, he had trouble getting cylinder and caliper seals to make it through the SAE longevity test with silicone because they got hard and wore out. Worse, any moisture that found its way into the system collected in slugs. When elevated temperatures were encountered, especially at high altitudes, these boiled into bubbles resulting in a total loss of stopping power. By the way, this stuff is in no way related to DOT 5.1, which is a glycol fluid. Regardless, your choice should always be Mercedes-Benz-branded DOT 4.

Misconceptions and profitable service

Now for some service tips that'll help you avoid problems. First, there's the myth that you should always clamp off the hose before bottoming out caliper pistons to keep from backflushing nasty sediment up into the works. That may have been fine in the old days of plain rubber hoses with braided reinforcement, but today's hoses have stiff plastic linings that may be crushed if clamped and stay that way. Just open the bleeder.

Then there's flushing and refilling the system with fresh fluid. In the old days, some brake experts said it wasn't worth the effort because you can't get all the old stuff out unless you disassemble the calipers. True, you won't be able to eliminate every drop of the contaminated liquid, but you can get most of it, and that will effectively reduce the amount of moisture in the circuits.

This has always been important for corrosion prevention, but now higher operating temperatures make maintaining

a high boiling point critical to safety even for the average motorist. Besides water, there's sediment, which is a combination of rust and the ashy residue of burned glycol. Expensive and intricate ABS and related hardware is further justification for this maintenance. Most systems are vented to the atmosphere, and there's also contamination from under hood vapors in some layouts. Fluid changes are cheap insurance against big bucks repairs.

For generations, Mercedes-Benz has recommended a two-year interval for this service, which you should recommend to your customers.

When the hose goes ...

Whenever you've got a car up in the air, take a careful look at the rubber hoses. In our shop, we've seen total circuit failures due to blown hoses several times. They're so well made they often last for the life of the car, but why push your luck? A related item is the high-pressure ABS hose between the pump and the accumulator, which sometimes carries a replacement interval of 60,000 miles.

Bubbles

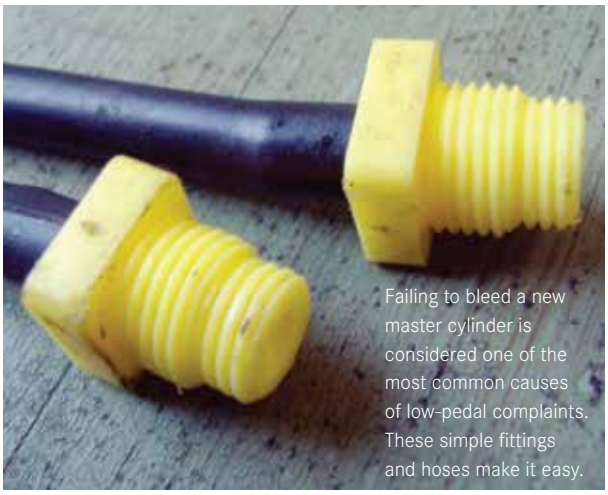
Air expulsion definitely deserves some space because there's more to it than just observing the proper sequence (Right rear, LR, RF, LF). Bench bleeding master cylinders, for instance. Brake experts have told us that neglecting this is the number one reason for spongy pedal complaints.

One way to block off a caliper for diagnosis is to use two copper washers and a nut and bolt on a banjo connection.

You can do this job by just holding your fingers over the outlet tubes to keep air from being drawn in on the return stroke, but that's pretty messy, so use tubes and fittings. Clamp one of the master's mounting ears in a vice so the unit is level. Position the tube tips well below the level of fluid in the reservoir, then use a rod or drift to stroke the piston SLOWLY. Wait at least 15 seconds between strokes to allow the chambers to release all their bubbles and fill completely. Keep stroking until there's no more evidence of air at the tube tips and ports.

Should you get a car with a replacement cylinder that some other tech didn't bench bleed, you might be able to do it with the master in place providing you can jack the rear of the vehicle high enough to get the cylinder level. Surge bleeding where you pound the pedal violently a bunch of times to get the bubbles mixed up with the fluid, then crack the line is frowned upon by experts who don't think aeration is ever a good idea.

While over the long history of hydraulic brakes numerous means of flushing and bleeding the system have been used, with a conventional brake system (master cylinder, ABS/



Failing to bleed a new master cylinder is considered one of the most common causes of low-pedal complaints. These simple fittings and hoses make it easy.

For a couple of decades, a scan tool has been required for proper bleeding and flushing. XENTRY handles the process.

ASR control unit, and calipers), the only procedure approved by Mercedes-Benz is the use of a pressure bleeding unit installed on the master cylinder reservoir, which keeps the reservoir full while the bleeders are opened.

As all of you know by now, proper bleeding requires the use of a scan tool. XENTRY, for example, will walk you through the procedure. We know seasoned technicians who say they do it "the old-fashioned way" without a scan tool on Mercedes-Benz systems and don't have problems. Personally, we wouldn't take the chance that entrained air might impair stopping in a panic situation.

Process of elimination

When you get a low-pedal complaint, you can find out all you need to know about the master cylinder by removing the lines, screwing brass or plastic plugs into the outlets, then applying the brakes. If the pedal's high and hard now, the master's properly bled and its seals are okay because the pedal would sink gradually if it were bypassing (that is, fluid is finding its way around the sliding seals).

Over the years, various testers have been available for finding out how much water the brake fluid has absorbed.

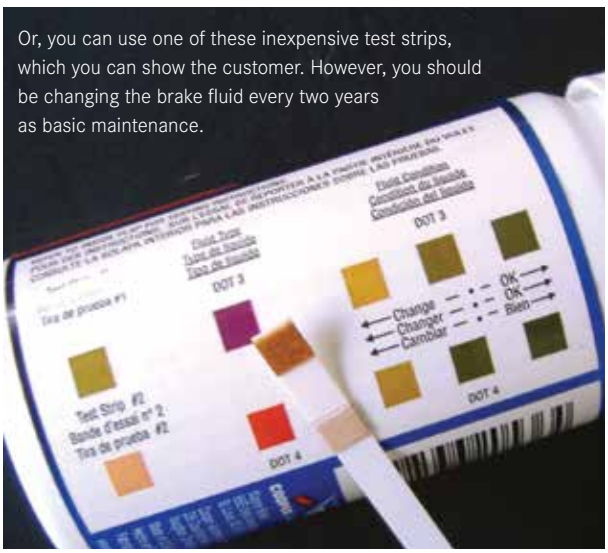
Continue in this investigation by blocking off hoses to isolate each wheel. As already mentioned, don't use clamps at the hoses. Instead, remove them from their calipers and cap them in whatever way you deem practical.

Seized!

Then there are the bleeder screws themselves. You haven't worked on cars very long if you haven't encountered a frozen one that wants to break off before opening. You can use the rather drastic and primitive method of clamping Vise Grips to the screw and shaking it while you heat the caliper around the port with a propane torch until it moves, but what's all that heat doing to the piston seals? Buying a pair of new calipers from your local Mercedes-Benz dealer's parts department is the professional alternative.

By the way, whenever you get a vehicle in that hasn't yet developed the problem, unscrew the bleeders and coat their threads with just a touch of anti seize compound. If you get it back later for brake work, you'll be glad you took the time.

In an ideal world, every caliper would be overhauled during a reline to insure against piston seizure and seal failure. That's what most authorities recommend. But when was the last time you encountered a leaky caliper? They last and last in most cases, especially if brake fluid changes are done regularly. So, if you're under time or cost pressure, you could just push those pistons back for a reline. One caveat: If you feel any roughness or binding as you force a piston home, you'd better get a genuine Mercedes-Benz replacement.



Or, you can use one of these inexpensive test strips, which you can show the customer. However, you should be changing the brake fluid every two years as basic maintenance.

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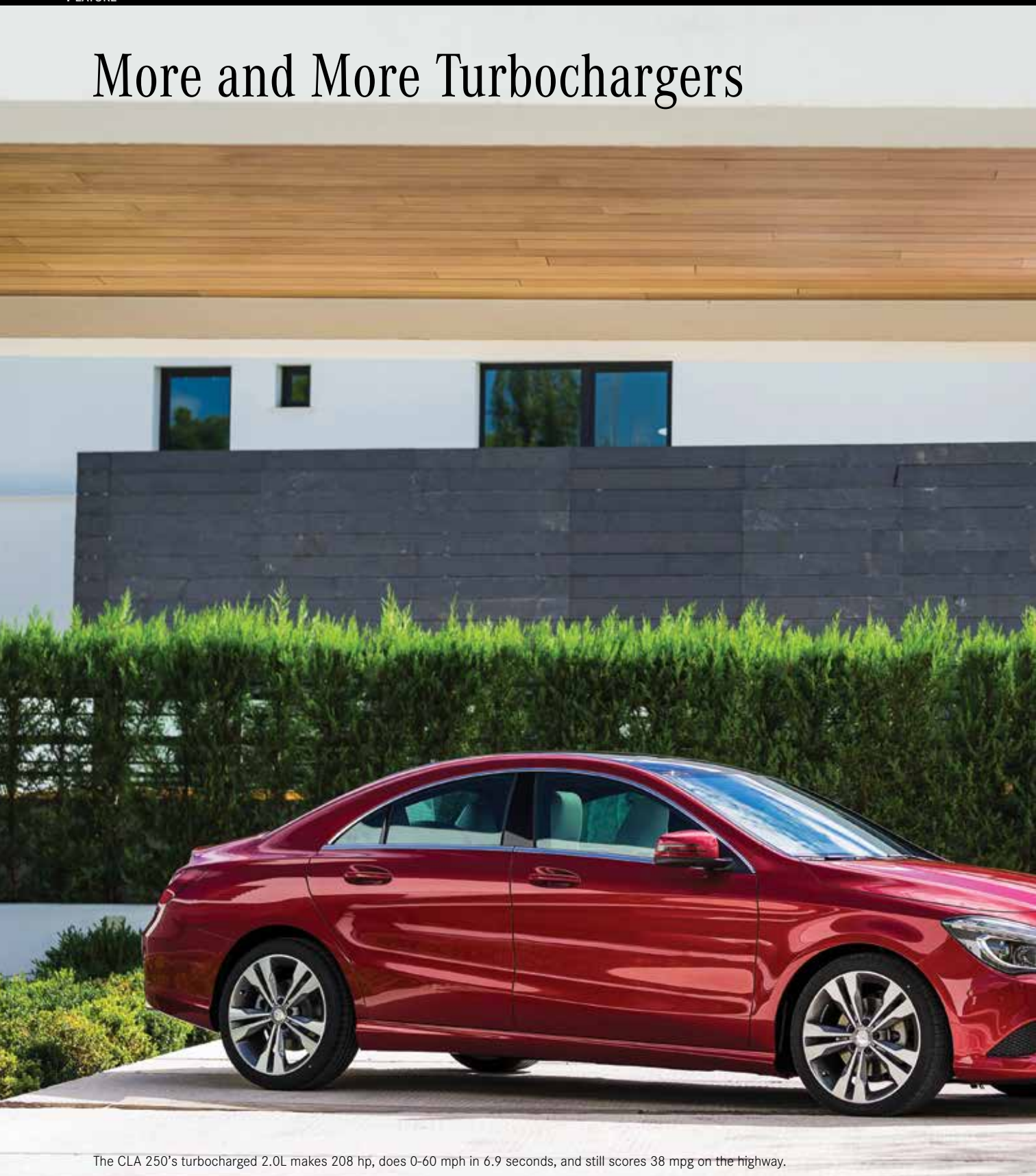
One remanufactured engine pulls the plug on climate-damaging CO_2 and saves 447 days of power for one laptop.

More and More Turbochargers



The CLA 250's turbocharged 2.0L makes 208 hp, does 0-60 mph in 6.9 seconds, and still scores 38 mpg on the highway.

Turbocharging is all about making use of energy that would otherwise be wasted to pack the cylinders and make a little engine act like a big one, or a diesel perform like a gasoline burner. A new wave of turbos is arriving from Mercedes-Benz to take advantage of the concept, and here we'll prepare you with operating principles, design fundamentals, and service info.

Once a car reaches cruising speed, it doesn't need very much power to keep up the pace. But acceleration – especially the thrilling sort that makes driving fun – requires plenty of horses. Wouldn't it be great if you could have a small engine to propel you down the highway economically, but with the ability to grow miraculously in displacement when you ask it to do so by the action of your right foot?

And that's the idea behind the turbocharger. It allows you to have the seemingly magical combination of small-powerplant mpg and gorilla-motor 0 to 60 times.

111-year-old patent

The history of turbochargers began in 1905 when Swiss engineer Alfred J. Buchi patented the first supercharger powered by exhaust heat. It took another ten years to develop a prototype of a turbocharged diesel engine, but the industrial processes and materials did not yet exist that would allow the manufacture of a true production model.

By 1920, the first turbocharged diesel locomotives and ship engines appeared. That same year Mercedes-Benz began turbocharging cars. By World War II, turbochargers – often equipped with charge air coolers – were used in warplanes such as the Lockheed P-38 Lighting and B-17 Flying Fortress to overcome the lack of oxygen per cubic foot of intake at high altitude. The demonstrated reliability of turbocharging as used in aircraft opened the door to automotive

and truck use after the war. Practical turbo-equipped diesel trucks appeared in 1957, and today most light- and heavy-duty diesels are turbocharged.

Flash in the pan?

Although a few decades ago this idea was hyped by quite a few carmakers as the ideal means of putting high-performance excitement back into cars after emissions and fuel mileage regulations took it out. Back then it was really just a stopgap, a temporary phenomenon with several drawbacks. Besides bearing issues and the cluttering-up of the underhood environment, there was throttle lag. The T charged engines of the ’70s and ’80s just didn’t have that “right now” feeling.

Then, multi-valves, ingenious intake manifold designs, seriously-efficient engine management and fuel injection systems, and VVT started to give us that sought-after combination of high performance, great fuel mileage, and low emissions without the need of an expensive add-on. So, turbos faded away except in some premium sporty cars — and diesels. Ever since Mercedes-Benz built the first-ever turbocharged passenger-car diesel in the form of the 1977 300 SD, any boost possible was sought after to get the performance of compression-ignition-powered vehicles up at least somewhat near that of the gasoline-burning competition. So, those are really the only turbos any dedicated Mercedes-Benz shop is familiar with.

There’s no denying the benefits of the basic concept, however, especially in the current environmental and regulatory climate, so Mercedes-Benz has expended tremendous amounts of engineering and R&D time refining turbocharging systems, and has lately produced some spectacular results. The CLA 250 2.0L, for example, makes 208hp, does 0-60 mph in 6.9 seconds, and still scores 38 mpg in highway driving. High-performance hasn’t been neglected, either. How about the AMG version at 375hp(!), 0-60 in 4.1 seconds, and 31 highway mpg? Even more impressive is the mean-looking AMG GT-R with its 4.0L bi-turbo V8 that pumps out 577hp for a 0-60 time of just over three seconds.

The lag mentioned above? Just about gone with twin turbos (not the type in the GT-R) — one small high-pressure stage to spin up fast, the other a large low-pressure stage for max power.

Blueprint

A basic turbocharger consists of an axial inflow, radial outflow compressor on the intake side coupled on a common shaft with a radial inflow, axial outflow turbine on the exhaust side. “Radial” and “axial” refer to the direction of gas movement.

The heat and pressure of the exhaust side is harnessed in the turbine, which drives the compressor through the common shaft. The shaft may be supported by a pair of plain bronze journal bearings and a separate thrust

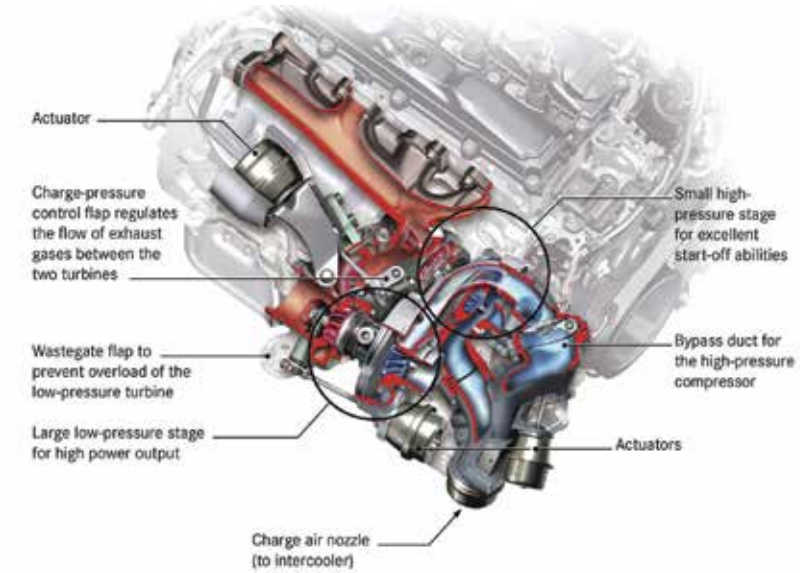
In WWII, turbocharging gave many of our warplanes, such as this Lockheed P-38 Lightning, superior performance at high altitudes where the air is thin. (Courtesy Airforce Image Gallery.)

Introduced in 1977, the 300 SD was the first-ever turbodiesel passenger car. With a 0-60 time of about 14 seconds, its performance was a lot better than that of a normally-aspirated diesel.

The 4.0L V8 in the breathtaking AMG GT-R has its two turbochargers mounted inside the "V." Electronically-regulated blow-off valves guarantee immediate response. Charge pressure can reach 18 psi, which provides 2.3 times as many oxygen atoms for combustion as natural aspiration would.

system, or by the newer ball bearing design with integral thrust control, and there are good reasons why the former is giving away to the latter. Ball bearing center housing rotating assemblies don't need separate thrust control since the shouldered faces of the two ball bearings are installed opposing each other, thus controlling thrust in both directions. Plus, ball bearings are more tolerant of lubrication shortcomings, and also spool up 15% more quickly, dramatically reducing the dreaded turbo lag.

If you were looking for a word to describe turbochargers, that word would be "precise." The turbine and compressor wheels are carefully positioned in their respective housings with .010-.020 in. of clearance to the contour bores. The precision-machined housings change in volume from inlet to outlet to maximize energy extraction on the turbine side and air movement on the compressor side. The size, shape and contour of the volutes (the spiral, scroll-shaped form of the housing that resembles a ram's horn) are critical to turbocharger flow rates and efficiency.



The twin turbos of this GLK 250 eliminate that dreaded throttle lag.

By convention, the inlet of a turbine or compressor section is called the inducer section and the outlet the exducer section. A ratio of the relative sizes of the inducer and exducer is often expressed as a trim number, helpful in sizing the turbo correctly. Blade shapes on the turbine and compressor wheels are engineered to reduce losses as gases make the 90-degree turn through the housing. Turbine blade shape constricts at the exducer to extract maximum power from gases that are gradually slowing and cooling.

It's hard to imagine the number of pressurized cfm these AMG turbos can flow.

Inlet pressure on the turbine (hot) side is generally within a few pounds of the actual boost, about 15-20 psi, which translates into a pressure drop of about 13-18 psi across the turbine wheel at full load if the exhaust system backpressure is two pounds. Typically, full-load temperatures drop about 300 deg. F. from a 1,200-1,500 deg. inlet reading. It's that

temperature and pressure drop across the turbine wheel that provides the energy necessary to spin the compressor.

On the compressor side, the amount of boost is controlled by a wastegate or by a variable nozzle arrangement on the turbine side. The wastegate is a simple bypass system. Inlet pressure is routed over to a spring-loaded diaphragm that opens a passage to bleed exhaust gas around the turbine. Less flow and heat through the wheel means slower turbine speed, hence slower compressor speed and less inlet pressure. Simple and elegant.

Limits

Of course, no matter how rugged the design or advanced the materials, there are limits to the power you can get out of any internal-combustion engine. With turbocharging (or supercharging, for that matter), there's always the risk of destructive detonation, or finding the mechanical limits of the head gasket, block, fasteners, or cylinder head. The engineering challenge is getting as much benefit from artificial respiration as possible without breaking anything, but today's electronic engine management systems make that easier.

If you're wondering about the possibility that a pressurized intake manifold could keep the intake valves from closing, that's only an issue in all-out racing engines with tremendous amounts of boost – an ordinary two-inch valve with 15 psi in the intake only has about 50 lbs. of force counteracting the valve spring.

Tough enough

They spin 30,000 rpm at idle and spool up to almost two hundred thousand during boost on some late models, all the while with one side cooking in exhaust heat and the other bathed in cool air. Regardless, turbos have turned out to be quite reliable and durable. As long as they are treated to frequent oil changes using synthetic oil and excellent cooling system maintenance, the number of failures has been quite low. Not non-existent, however.

Over the years, we've collected information on turbo troubles from independent service providers. While much of it doesn't apply to new-generation models, some of it does.

The most common complaint historically? As one shop owner told us years ago, "Noise, usually whining – the customer may say it sounds like he's got a police car following him. We see this on high-mileage cars, usually with over 80,000 miles. There's no severe change in power. The loss is gradual."

High oil consumption from a leaky seal on either the intake or exhaust side isn't unusual, and another shop owner mentioned a different type of failure that showed up in his California shop: a seized turbine. Naturally, the drop in power was dramatic.

Examination

As far as diagnosis is concerned, one expert said, "Pull the boot off the intake and spin and rock the rotor by hand. Look for too much side play, but it's interesting how many have play, but aren't causing problems.

"For example, we had a Mercedes-Benz turbodiesel in for other service, but checked the turbo anyway. I saw what seemed like excessive side play, so I advised the customer that it was okay for now, but that he ought to bring it in after 5,000 miles or so for me to check it again. Well, it was exactly the same, and I expect it to just keep going with no problem."

Worrying about excessive side play is common among techs, but it's the result of a perfectly understandable feature of older turbo designs. Floating bearings are used, meaning there's oil clearance on both sides and the bearing itself rotates at one-half shaft speed. This provides extra protection, yet makes the fit seem loose.

A whole lot of sophisticated engineering and manufacturing processes were needed to produce this compressor wheel.

This situation illustrates a basic point: Turbos are different from anything else you're used to working on. They require a little special knowledge.

Another turbo expert told us, "Stress the basics before jumping on the turbocharger. If a car's blowing smoke, the turbo often gets blamed when the problem is actually the valve seals.

"Next, you have to make absolutely sure to diagnose the cause of the failure before you install a new turbo, or there's a good chance it'll fail immediately," he says. "For instance, the biggest reason for bearing failure is lack of oil supply. Oil supply lines tend to coke up. Some technicians disconnect the line and see oil squirt, so they think it's okay. But what they've got is pressure, but no flow. If you try to clean the old line, you'll dislodge the deposits, but might not get them all out. And the oil passages inside a turbo are very tiny, so just a small piece of coke can clog them. Buy a new line.

"Oil return is by gravity only, so the drain line is important, too. If it gets plugged, excessive pressure will force oil past the seals. But you can clean these lines because you don't have to be so worried about particles. The oil goes back into the crankcase and through the filter anyway.

"You can disassemble a turbocharger and see very clearly why it failed. The parts read like a book. If the shaft and bearings are blue, you know there's been a lack of lubrication. If they're scored, contaminated oil is the trouble."

Lube loss and codes

When excessive oil consumption or smoking is the complaint, you've got to enlist a little logic to determine the cause. If the plugs are clean, a bad shaft seal on the exhaust side of the turbo is a good bet. If only a few plugs are oil fouled, valve stem seals are implicated. But if all the plugs show equal evidence of oil burning and there's a film of lube on the inside of the duct to the manifold, the turbo is leaking on the compressor side.

Oil burning brings up a related situation: too much backpressure due to a clogged cat, which may have destroyed the shaft seal, and will do the same to the new one if not corrected.

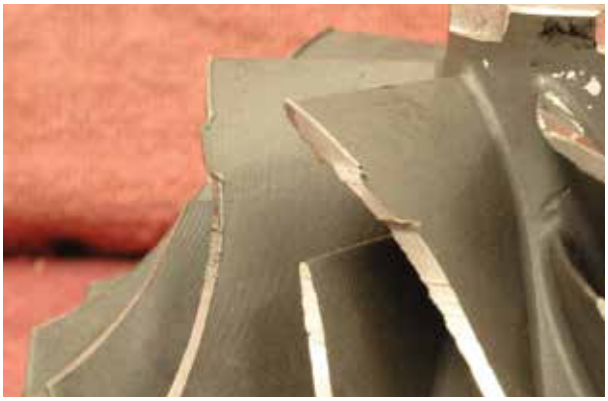
Troubleshooting the electronics involved in boost control is beyond the scope of this article, so we'll just mention that there are sometimes fault codes in the OBD system that pertain, and that your XENTRY will show you if there's been a lot of detonation sensor activity, and walk you through diagnosis.

Keep 'em alive

At installation, make sure to prime the bearings with fresh lube, and, as was mentioned above, get a new oil supply line and clean the drain line. Kill ignition or injection and crank the engine for half a minute or so to get the oil pressure up before starting. Of course, you already did an oil and filter change as S.O.P., right?

And this brings up recommendations you should be making to your customer. Oil change intervals should never be stretched to the limit, and here's a case where the synthetic Mercedes-Benz recommends is absolutely mandatory. Also, caution him or her not to run around a quart low, and that allowing a short idle period before shut down will help those bearings survive. As one turbo authority said, "When you suddenly shut off the oil flow to something that's spinning that fast, you're going to have problems." Not as critical today as it once was, but still good advice.

Unless you work on race cars, you'll probably never see a burst compressor wheel.



FOD (Foreign Object Damage) only happens if somebody drops a bolt or a socket into the intake.

Mercedes-Benz Mobil 1

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 MB 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	12x1 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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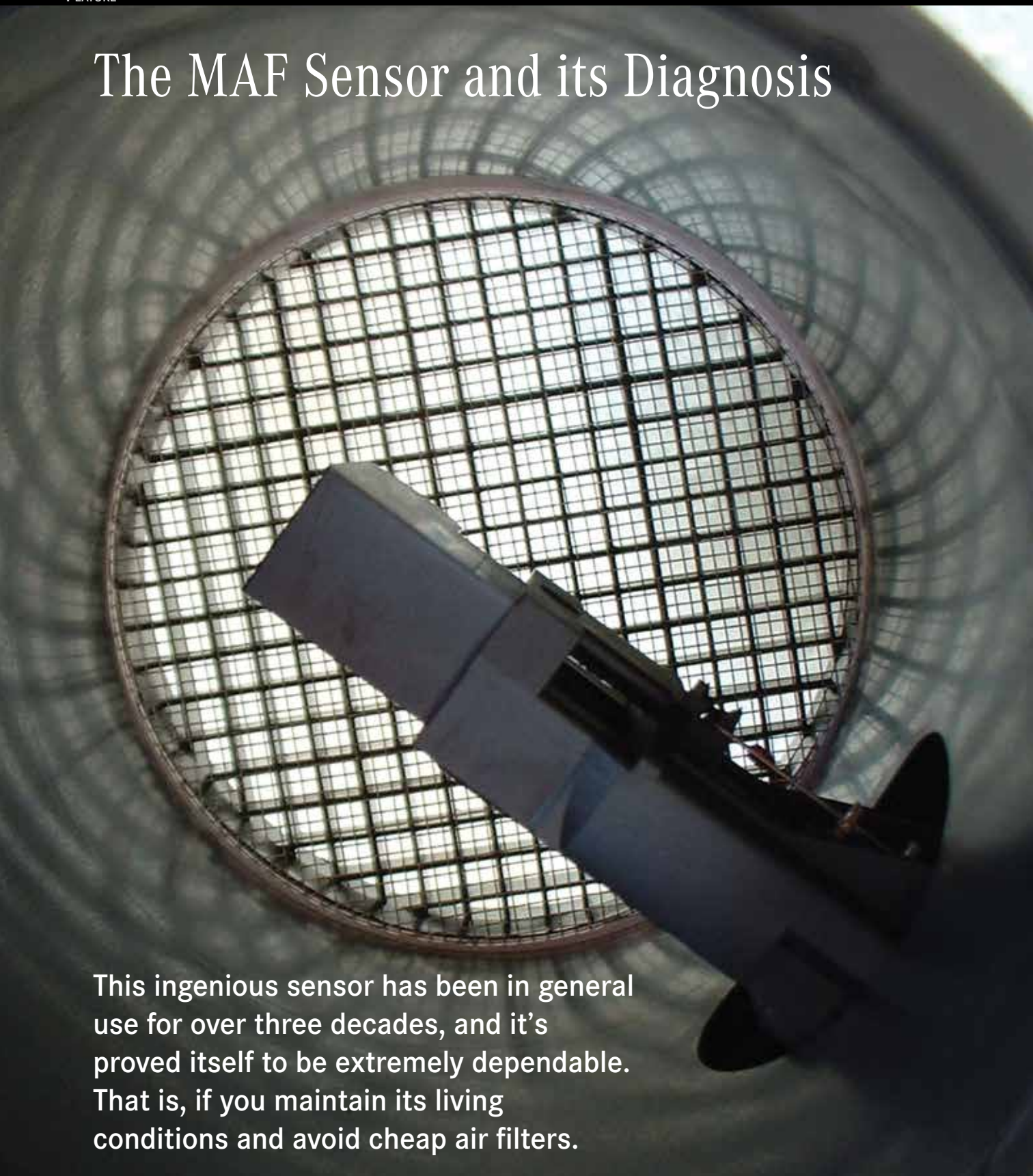
Please have a look at our oil portfolio which is available through your local Mercedes-Benz dealer. Our dealers are able to offer you a wide variety of oil grades at competitive prices.

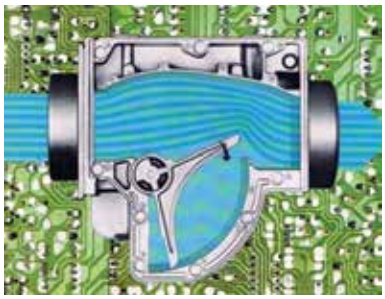
Product Name	Part Number	Quantity	Product Description	Recommended Consumer App.
Mercedes-Benz SPEC.				
Mobil Special 5W-30	BQ 1 09 002464	Bulk - No Equipment	Formulated from quality base stocks combined with modern performance additives to give the engine the expected protection and performance under 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		

The MAF Sensor and its Diagnosis



This ingenious sensor has been in general use for over three decades, and it's proved itself to be extremely dependable. That is, if you maintain its living conditions and avoid cheap air filters.

Diagnosing MAF (Mass Air Flow) sensor faults on Mercedes-Benz vehicles requires that you obtain as much information as possible from the customer as to the nature of the problem. Does it have a Check Engine light (MIL) on? Is there poor performance? Hesitation? Fast or uneven idle? A test drive of the vehicle to verify the complaint and then a proper scan for trouble codes is, of course, another prliminary. A trouble code of 2646 may turn up indicating a fault with the left MAF sensor if you're working on a 164 chassis. Any number of other fault codes may show up that may be related to this important input to the PCM (Powertrain Control Module, the standardized SAE term that replaces ECU and ECM).



Although you probably haven't seen one in decades, the VAF (Vane Air Flow) meter was an ingenious Robert Bosch invention – the rotating flap turned a variable resistor to provide a signal to the computer. It's just not accurate enough for modern requirements, however.

Whether hot wire or hot film, the principle of measuring actual mass, instead of just volume, is the same.

Overview

A full understanding of how the MAF sensor operates will definitely help you in fault-finding. An internal-combustion engine is basically a sophisticated air compressor. Air comes in, gets compressed, oxidizes the injected fuel, and whatever may be left exits through the exhaust system. The amount of air coming in needs to be measured accurately for the PCM to be able to produce the proper air/fuel mixture for combustion to happen efficiently.

Some historical perspective is appropriate here. In 1968, mankind was preparing to visit the moon, the environmental movement was becoming big news, and Robert Bosch produced the first popular electronic fuel injection system. That original D Jetronic EFI used a vacuum sensor (the "D" is for "Druck," which means "pressure" in German) to inform the electronics about the intake situation.

Six years later, the air flow meter showed up on L Jetronic (the "L" stands for the German word "Luftmengenmessung," meaning "air quantity measurement"), also known as AFC (Air Flow Controlled) fuel injection. At the time, we thought the concept was ingenious: A vane rotated against spring pressure according to the volume of air the engine was ingesting, and this movement turned the shaft of a variable resistor, thus changing the 5V reference signal before it returns to the computer. Simple, and much more accurate than anything else previously conceived.

We should mention the older-style speed-density EFI systems that used computer power to calculate the mass of intake air from input on rpm, vacuum, throttle position, and the signal from the intake air temperature sensor. They reached a pretty high state of development, especially among Asian brands, and worked quite well. One of the requirements of OBD II (mandated in 1996), however, was that a MAF must be present in all passenger cars and light trucks sold in the U.S.

Since air/fuel ratios are by weight (stoichiometric is 14.7 units of air to one unit of gasoline – by volume, it would be about 2,000 to one), measuring mass makes more sense anyway. So, LH-Jetronic (to continue our foreign language lesson, the "H" stands for "Heiss," German for "hot") with its hot wire sensor was introduced in 1984. Why is measuring mass better than measuring volume? Because air

changes its density – the number of O2 molecules per cubic unit – as it expands and contracts with temperature and pressure. In automotive applications, air density varies with ambient temperature, altitude, and the use of forced induction, which makes MAF sensors more appropriate than volumetric sensors for determining the quantity of intake air (hence oxygen) that's entering the engine, upon which (among other things) the PCM bases the pulse width of the injectors.

Wire to film

There are two types of MAF sensors: the early hot wire variety, and the other, now much more common, hot film sensor, or HFM. The theory of operation of the hot wire sensor is similar to that of an anemometer (which determines air velocity). Measurement is achieved by heating a wire suspended in the engine's intake air stream – like a toaster's resistance wire – with either a constant voltage over the wire or a constant current through the wire. The wire's electrical resistance increases as its temperature increases, which varies the electrical current flowing through the circuit, according to Ohm's Law. When air flows over the wire, it cools it, decreasing its resistance, which in turn allows more current to flow through the circuit since the supply voltage is a constant. As more current flows, the wire's temperature increases until the resistance reaches equilibrium again. The current increase or decrease is proportional to the mass of air flowing past the wire, not the volume. The integrated electronic circuit converts the proportional measurement into a calibrated signal, which is then sent to the PCM.

The hot film MAF works on the same principle, but is more robust and less prone to problems from contamination.

For any MAF, volume and pressure are not important, only the weight of the air entering the engine is. That is why it is called a Mass Air Flow sensor, using the scientific definition for mass: The property of a physical object that measures the amount of matter it contains. Mass is also what causes an object to have weight in the presence of gravity.

Keeping it hot

A MAF sensor has some other advantages besides its ability to account for density: no moving parts, restrictions, or compensating sensors. An early MAF's wire element is kept heated to a specified temperature above ambient (82 deg. C, or 180 deg. F. in a typical unit) and is exposed to intake air. Through a Wheatstone bridge circuit and dedicated electronics, the amount of current required to maintain that temperature becomes the signal to the computer. High air flow obviously has a greater cooling effect than low, but so does the denser air of cold days and low altitudes, so the engine management computer gets the true data on mass it needs to provide the proper injector pulse width for efficient combustion.

Damage and perforation of the duct between the MAF and the throttle body may have caused many perfectly good sensors to be mistakenly replaced. Better materials and construction are gradually eliminating the problem.

At idle, the low airflow level requires little additional current to maintain MAF temperature and the signal to the computer is typically about 0.6V. At wide open throttle, the rush of air requires a much greater current to maintain film temperature, and the signal to the computer can be more than 4V.

Complaints

Problems with a MAF typically generate consumer complaints of low power, stumble or hesitation, rough idle, both cold and hot hard starting, and possibly stalling. Of course, the symptoms you may want to blame on a bad MAF can also be caused by other defects. So, always check the basics first: ignition, compression, fuel pressure and volume, etc.

Always do a through visual inspection for an air leak downstream of the MAF. Unmetered air, commonly called "false air," entering the engine behind the MAF isn't accounted for by the computer as it sets injector "on" time. The resulting lean condition causes all kinds of drivability complaints. Leaks from deteriorating air ducts, PCV hoses, etc. can be hard to find, so do an eyes and hands inspection – look closely at the ducts and hoses and squeeze them to detect cracks, holes or mushiness.

Where there's smoke there's a leak!

The use of a smoke machine is one of the best ways a technician can confirm the integrity of the intake ducting. Of course, the engine

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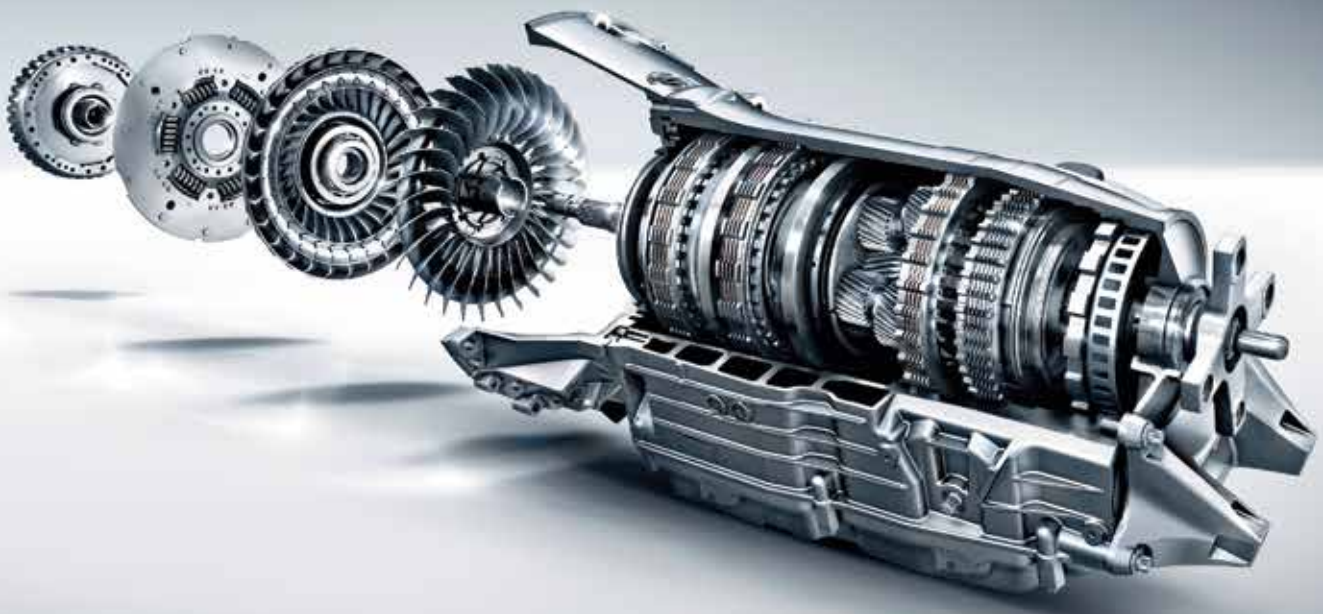

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needs to be off in order to use this leak-detecting device. Find a place in the intake system where you can introduce the smoke. A vacuum port is ideal, but most smoke machines will have adapters that you can use to put the smoke where you want it. Be sure to block off the ductwork where outside air is pulled in. Simply look for smoke – you'll often be surprised at where it's coming from.

Sealing problems between the air filter housing and throttle body can cause faulty readings in air flow numbers. The intake air line upstream of the air filter and the clean air line between the air filter and the turbocharger are places to inspect. Check the intake air lines for leaks. Visually inspect all connections for leaks, cracks, incorrect assembly and correct as needed. Check the charge air system (green seal ring between turbocharger and charge air line to noise damper, seal rings at the connections between the charge air hoses and the Henn couplings). Visually inspect all of the connections for oil leakage, cracks, incorrect assembly, and pinched or damaged O-rings on the charge air hoses.

There is one somewhat dramatic approach to MAF testing you can use, especially when engine performance is really raggedy. With the key off, unplug the MAF harness, and start the engine. If performance is noticeably better in the resultant "limp -in" or "fail-safe" mode, it's time for a new MAF.

No MAF can do its job if it isn't getting power. There are two power feeds to a MAF. One is the OBD II input voltage, and the other is the current feed to heat the wire or film. If either feed is missing, the MAF won't work, but the problem is somewhere in the wiring, not in the MAF itself. You can check MAF output voltage with a digital voltmeter or a lab scope. You should see a smooth, linear change in output voltage to the PCM as engine speed changes. Some technicians blow shop air into the MAF when testing to see if the voltage increases. In addition to a smooth change in voltage, compare output readings at different engine speeds to the Mercedes-Benz specs for the model and engine you are working on.

If output voltage shifts are jerky, not smooth, or if the readings don't match specifications, it's time to replace the unit with a new MAF from Mercedes-Benz. Make sure the output voltages match the Mercedes-Benz specs. On some systems, close isn't good enough. A variance of as little as 250 millivolts from spec can be enough to cause problems.

OBD II continually examines the MAF, looking for out-of-range signals. OBD II also compares the actual MAF output signals received by the computer to expected values based on rpm, manifold absolute pressure, throttle position, and intake air temperature. If there is a discrepancy between actual and expected MAF readings, a trouble code will be set.

A word of caution: Blind faith in codes can get you into trouble. Consider DTCs as guideposts, not as the absolute word on what's wrong. Do basic testing and rely on your experience before you accept a code as the final verdict on what is wrong.

Dirty

With no moving parts, a MAF won't break or wear out, but things can still go wrong. One problem is MAF contamination that insulates the hot wire or film, so air movement doesn't have the same cooling effect. The MAF signal will be sluggish and the value won't accurately reflect the true mass of the air going by. Contamination typically is caused by a faulty air filter that releases fibers, an air filter long overdue for replacement, aftermarket filters that use any type of oil coating, and prolonged driving in extremely dusty conditions.

If the MAF is contaminated, you have to do two things: Replace the MAF

We know of no better way to find elusive intake tract leaks than with a smoke machine.

Before you start thinking about replacing a MAF sensor you're dubious about, look into the filter situation. If it's not a genuine Mercedes-Benz part, that could be the whole trouble.

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with a new Genuine Mercedes-Benz unit AND solve the source of the contamination–replace the defective air filter, recommend more frequent maintenance service, remove an aftermarket filter that uses oil and replace it with a Mercedes-Benz OE filter, etc.

Genuine article

Why is it important to use genuine Mercedes-Benz air filters? Because aftermarket filters aren't engineered, tested, or manufactured with anything like the care that goes into the genuine articles. They will probably have different flow characteristics, which can set DTCs. And the real thing will not break down – loose fibers are the main culprits in MAF contamination.

In models with two air filters, make sure each is on the correct side. Be sure to check all the ducting for particles of broken-down filters if an aftermarket unit has been used. When it's time to replace an air filter, there are some adaptive values that need to be relearned. With your XENTRY or other scan tool, access the CDI engine control unit and follow the path to "Control Unit Adaptations." Both "Reset Air Filter Learned Values" and "Reset Values for HFM Drift Compensation" have to be performed to ensure proper function of airflow volume calculations in the engine control unit. In many cases, a change of air filters and resetting these adaptives will solve any problems you may have uncovered.

All air filters are not created equal

Why is it that simply replacing the air filter is the answer to solving some of the HFM issues you might encounter? Even after only 18,000 miles, the filter element can become clogged enough to cause trouble.

What are we measuring, after all? Airflow, of course, in the form of air density. Another reason is that all air filters are not created equal. A well-designed and manufactured air filter has a good balance between a high airflow rate and filtration performance. Airflow significantly affects a vehicle's performance (hp) and fuel consumption (mpg). Proper air filtration protects the internal engine components from damage. In a recent test, Genuine Mercedes-Benz air filters scored highest in five categories:

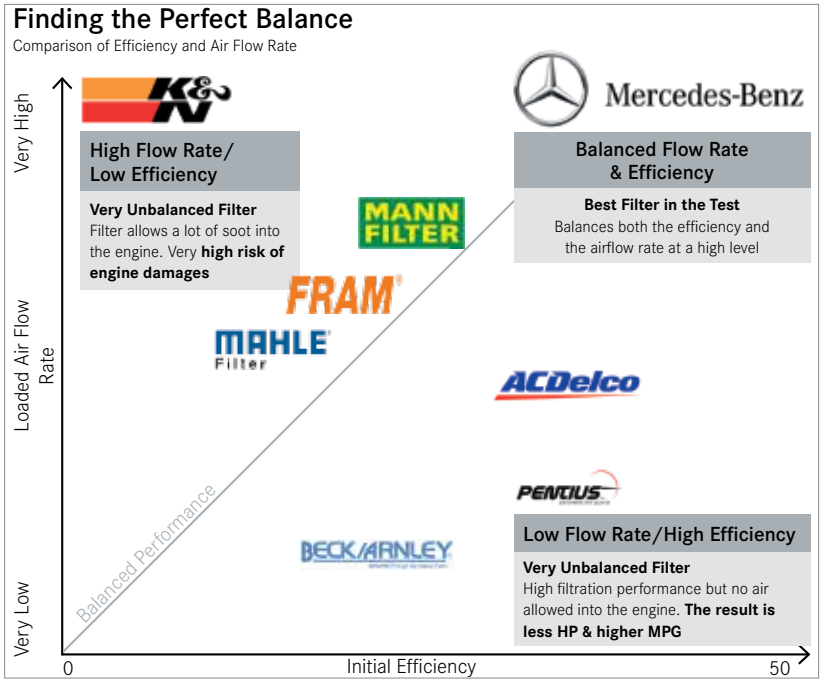
- Filter pleat count
- Dust capacity
- Quantity of particulates filtered
- Filter efficiency (in percent)
- Airflow Rate (pressure drop)

You can see from the exhaustive testing done that using anything but genuine filters can cause you frustration in servicing the HFM systems in Mercedes-Benz vehicles. According to Star Bulletin #S-B-09.10/30, an improperly installed air filter assembly can cause the MAF element to receive turbulent, instead of laminar, airflow due to air leakage at the sealing ring. This in turn can cause 0745, 0749, 2091, or 2095 ME fault codes. Take the time to make sure you've installed the filter correctly.

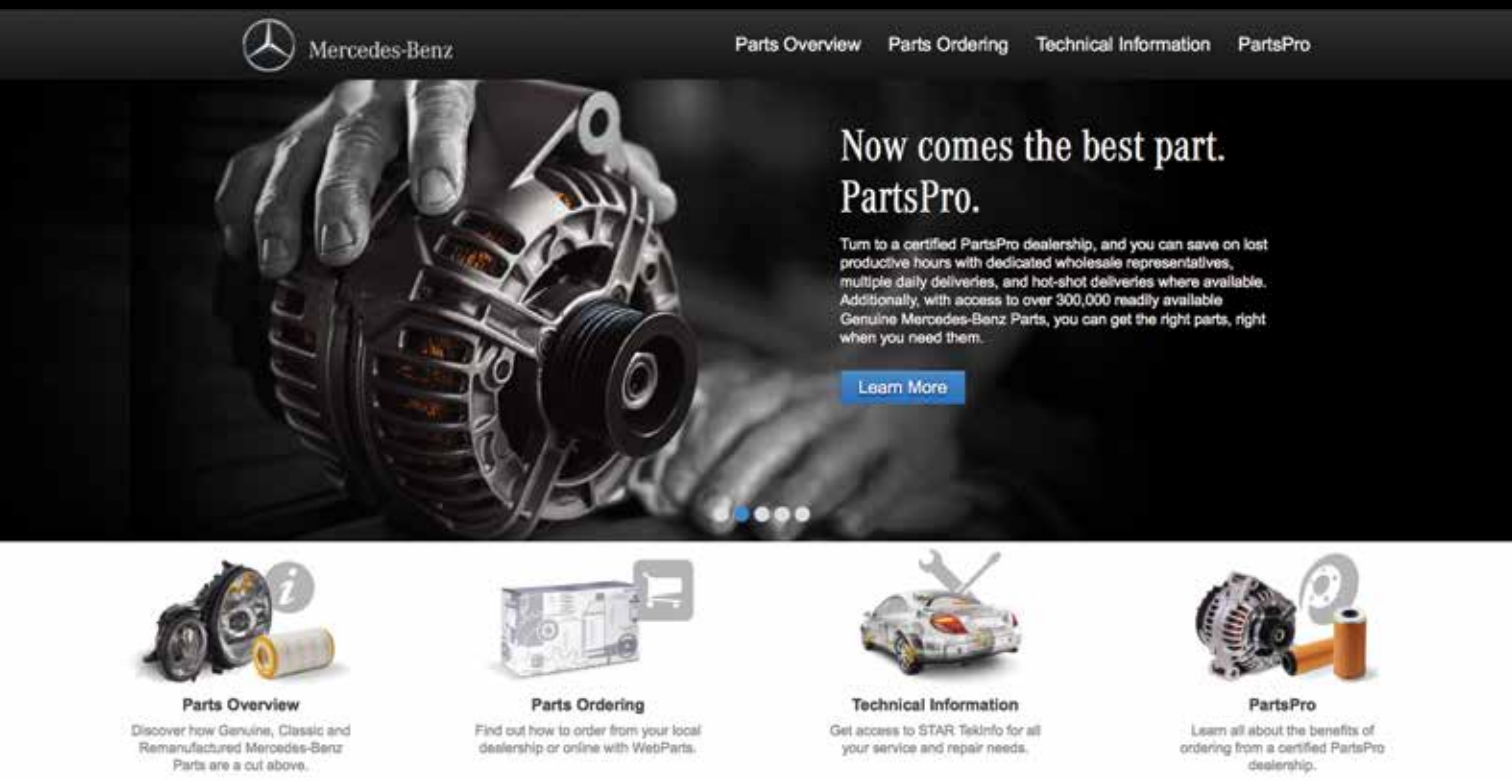
Note: While some technicians may attempt to clean MAF elements with alcohol and a cotton swab, that's more likely to cause damage and comebacks than it is to cure a problem.

Bottom line

In any case of a possible MAF sensor fault, one of the most important steps will be to consult a Mercedes-Benz service manual and any possible technical service bulletins associated with electronic engine management. There are many good sources and publications both on-line and in print to help with proper service and diagnosis. Working the proper steps and troubleshooting diagram for the particular system you're working with will save you time, thus help your bottom line.



Rigorous testing proves that no aftermarket brand comes up to the quality of genuine Mercedes-Benz air filters.



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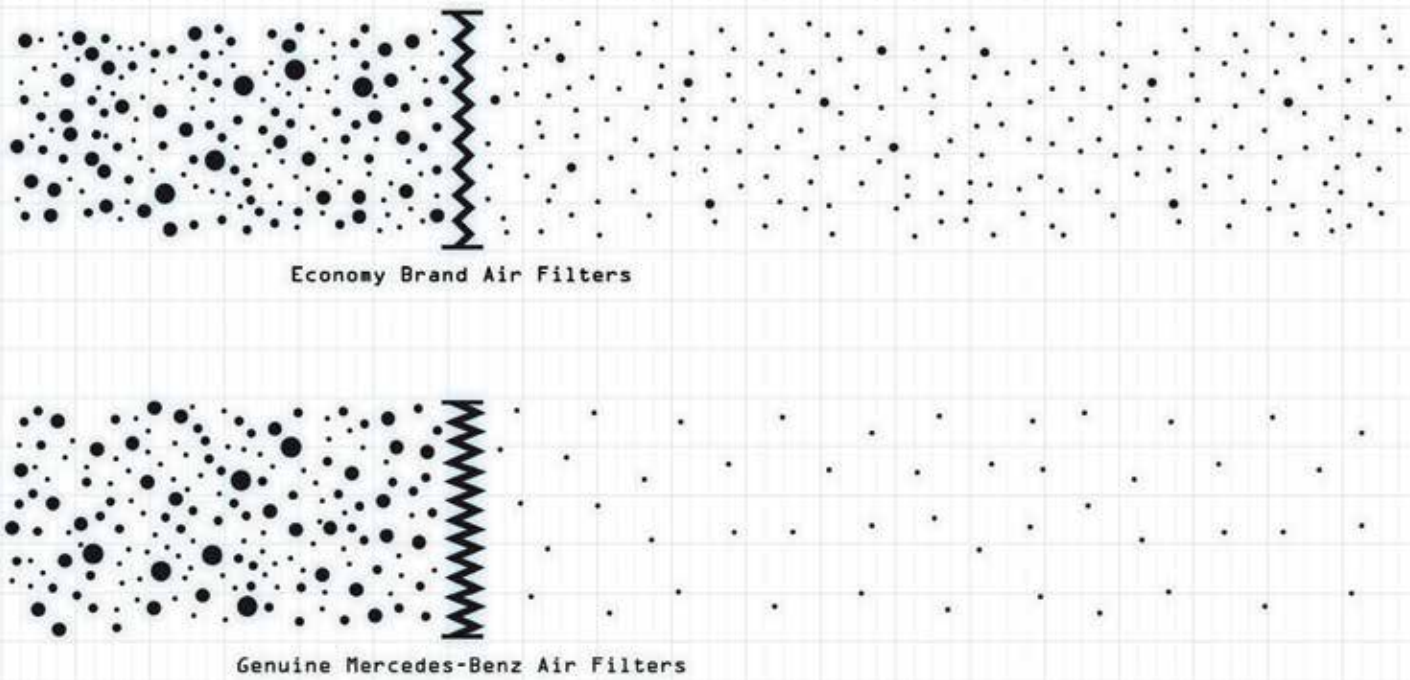

Some think any filter will do. This will clear the air.

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*As compared to leading paper air filters and based on test #ISO 5011-2000, which measures filtration efficiency using diesel soot.

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