

STARTUNED®

Information for the Independent Mercedes-Benz Service Professional

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HYBRID SAFETY

HVAC VENTS

MLS HEAD GASKETS

THE ALUMINUM WORKPLACE



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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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Mercedes-Benz

Hybrid and Electric Vehicle Service Safety

Learning these basics can save your life – what not to touch or do, and when to refer customers to a dealer

Above: The high-voltage battery management system on the Mercedes-Benz S500 hybrid controls temperature, state-of-charge, and performs cell balancing for each individual cell to extend battery life. We've heard no complaints about Mercedes-Benz HV battery life, but if it does fail, the HV battery is unlikely to respond to further cell balancing attempts in the field, and should be replaced.

By now you've likely heard that there is enough electricity under the hood of a hybrid vehicle to kill you. There are many new safety protocols you'll need to follow. Read on to learn more about ways to reduce your risk when a hybrid vehicle pulls into your bay.

Killer Formula Ohm's Law says that current equals volts divided by ohms. From a safety perspective for the repair technician, current (amps) is what fibrillates the heart and freezes muscles, resistance (ohms) is represented by your skin as the body's wall attempting to keep current out, and voltage is the pressure that pushes amps through that defense. Hybrid vehicles dramatically increase the voltage, from the traditional 12 to a range from 350 up to 500 volts, depending on the vehicle model. So, even though resistance uses the old divide-and-conquer trick against volts, hybrids have enough voltage to easily overwhelm the body's defense.

A LITTLE DAB WILL DO YOU

If you're old enough to remember Brylcreme, you know that a little dab made your hair look good enough to win the girl of your dreams. Electric current (amps) is different. A little can kill you. The amount of current a person can accept and still retain control of his or her muscles can be less than 10 milliamps. A milliamp is 1/1,000th of an amp, so 10 milliamps is 0.01 amp.

The chart shows that death is most likely to occur in the middle of a range of electrical exposure from one milliamp up to as little as one amp. Why the middle? If a person is exposed to a low of one-thousandth of an amp up to just under one-tenth, bodily reaction ranges from mild sensation to extreme breathing difficulties. In the middle, from 100 and 200 milliamps (0.1 to 0.2 amps), ventricular fibrillation (violent, abnormal contractions of the heart

Amps	Effect on the Body
1.0	<ul style="list-style-type: none"> • Severe burns • Breathing stops
0.2	DEATH
0.1	
0.01	<ul style="list-style-type: none"> • Extreme breathing difficulties • Breathing Upset • Breathing labored • Severe shock • Muscular paralysis, cannot let go • Painful shock
0.001	<ul style="list-style-type: none"> • Mild sensation • Start of sensation

muscle) occurs, weakens the heart beyond repair, and death is almost inevitable. If more than two-tenths of an amp of current enters the body, the muscular contractions are so severe that the heart immediately shuts down. That immediate clamping force on the heart minimizes the development of destructive ventricular fibrillation. Last you think that if you had to be exposed to electric current, you'd prefer it be on the higher end, remember that your heart has now stopped. It could be revived using artificial respiration or CPR, but only if there is someone nearby with the equipment or skills to begin resuscitation immediately.

NO ROOM FOR ERROR

The technician's only defense is to never touch any live high voltage (HV) power circuit. You can minimize your risk. First, always put on HV gloves before starting any hybrid vehicle diagnosis or repair. High-voltage gloves are heavy rubber and Class O-rated to resist up to 1,000 volts. Do not substitute regular latex or neoprene shop gloves, as they are not insulated as well as Class O high-voltage gloves. Put a second pair of leather gloves over the high voltage rubber gloves to help protect against accidental cuts and abrasions while you work. A tiny puncture could allow current to seep in. Do not use leather gloves that have been previously used for a repair in which they may have picked up metal shavings, glass shards, or other materials with sharp edges. If a sharp object punctures the rubber glove, it creates a path that current can flow through and harm you.

Heavy-duty rubber insulating gloves are certified and date-stamped at the time of manufacture. Because rubber deteriorates over time, OSHA requires re-testing and re-certification of gloves that are more than a year old, to



The battery-powered 1906 Mercedes-Benz "Electric" was an electric vehicle leader almost 110 years ago.

verify that they still offer the required protective benefit. Since the industrial and auto repair shop environments in which these insulating gloves are used is so rough, Class O gloves are also required to be re-certified or replaced after no more than six months of use. The cost of new gloves may be close to that of re-certification, making replacement the cost-effective option based on time savings. Contact your vendor for information on where Class O gloves can be re-certified.

Also, test your gloves before you put them on. Close the open end to keep the air inside, then roll the glove up to above the thumb. The fingers should balloon up. Inspect them to see if there are any pinhole openings, cracks, tears or splits. If any air escapes, discard the gloves and use a new pair. Remember, there is no room for error with the high-voltage circuits on a hybrid vehicle.

Take off jewelry, watches, and rings before putting on the gloves. Rogue electrons want to jump the gap between you and the component on which you are working, and a nearby metal conductor is strong temptation. One last thought about gloves – keep them dry. Some gloves are sold with a little talcum powder for this purpose. Humidity in the glove, like water on the floor or work surface, is a very good conductor. HV safety gloves are also coded with an expiration date. They need to be recertified after this date.

Is This Thing On?

Second, make sure the high voltage system is shut down before you touch any hybrid system component. If it is not already off, shut down the ignition. Make sure the Ready light in the dash is not on. Move the key fob at least six feet away from the vehicle.

You can use the Mercedes-Benz XENTRY system to disable the high voltage circuit on the vehicle. XENTRY is diagnostic software and hardware that helps technicians identify the vehicle and its equipment, communicate with it, and diagnose its systems and performance. Contact your equipment vendor or mbdiagnosis@mbusa.com for more information about XENTRY.

Mercedes-Benz wisely includes what the company calls an “interlock circuit” to easily disable high-voltage circuits on hybrid vehicles. Key HV components include a removable plug that when detached, interrupts the flow of power to the circuit. Monitoring software in the battery management system control unit receives the interrupt signal. On some models, HV power will be lost while driving if the interlock is opened, others will continue to work until you stop moving, and still others will keep moving, but then will not restart after key cycle if the interlock is opened. This applies to not only the originating component, but also every other part of the HV circuit. This includes the electric motor, the power electronics controller, the electric-driven A/C compressor, and other HV components. Lock the plug in your toolbox,

so no “helpful” co-worker can reinstall it without your knowledge while you are still working on the HV circuit.

Wait five minutes before attempting any further repair steps. This allows any high voltage remaining in the capacitors to dissipate. Test the HV circuit with a Cat III multi-meter to ensure that it is completely drained. Cat III rating ensures that your multi-meter can handle up to 1,000 volts. Traditional multi-meters are not HV rated. They do not include an ohmmeter that can push enough voltage to test for leaks through the insulation on HV cables, and cannot conduct hybrid insulation resistance tests.

ORANGE JUICE

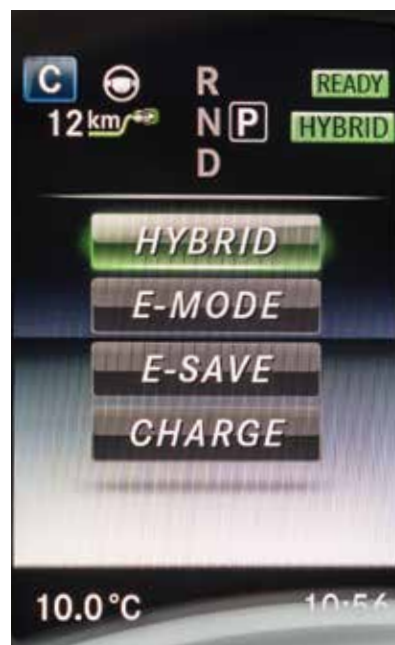
All high voltage electrical lines on Mercedes-Benz hybrid and other HV vehicles are marked with a bright orange color outer sheathing. All component hardware in the high voltage on-board electrical system has a yellow adhesive warning label that shows the symbol for high voltage.

Before attempting to remove or install an HV component, even on a hybrid or electric vehicle that has *already* been de-energized or disabled, the technician must have at minimum received High Voltage Awareness training (only offered to Dealer technicians). This training alerts employees to the need for caution around circuits carrying more than 60 DC or 25 AC volts.

Go to the Experts

A technician involved in diagnosis-based de-energizing or disabling of HV systems, and testing, removal and replacement of the battery or other high-voltage components, must be an expert at working on that particular high-voltage vehicle model. Even within the

The Mercedes-Benz 2016 C350 Plug-In Hybrid features four operating modes, including allelectric (E-SAVE), all-ICE (E-MODE), hybrid combined electric and ICE, and charging through an external power supply, the on-board electric motor, or regenerative braking.



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Mercedes-Benz family of vehicles, certification for a specific model does not automatically translate to other models.

For high-voltage system diagnosis and repair, have the vehicle looked at by a Mercedes-Benz dealer. The Mercedes-Benz technician has completed product training and in-person (live, not online) skills assessment for the specific model.

If damaged, the battery, electrical lines and other HV components in a high-voltage vehicle should not be repaired. To ensure the safe future operation of the vehicle, damaged HV components must be replaced.

DRIVABILITY, PERFORMANCE AND EMISSIONS

Mercedes-Benz E400 hybrid vehicles can use any of three different propulsion modes: conventional driving with the internal combustion engine (ICE) only, operation with the electric motor only, or hybrid driving with both the electric motor and the ICE. The ICE operates primarily when the driving load fits in its ideal torque range. The electric motor kicks into boost mode when extra acceleration or cruising power is needed. When the ICE needs no boost, the electric motor functions as an alternator, sending its power to be stored in the HV battery pack.

IT'S COMPLICATED

Software algorithms in the ME-SFI control unit (for a gasoline ICE), or (for diesel) the CDI controller determine the mix of propulsion modes to balance drivability, performance, and emissions. The software decides, for example, when the ICE should be used, how much the electric-only mode should be used to reduce emissions and enhance fuel economy, and if full-hybrid mode will give the best performance for current driving conditions. Additionally, it maintains the HV and 12-volt battery state-of-charge (SOC) using inputs from the electric motor, the ICE, or regenerative braking.

The ME-SFI controller reviews sensors for wheel speed, engine load, acceleration, torque requests, braking, and other driving inputs, the SOC and temperature of the HV battery pack, the rotational speed, torque and power feed status of the electric motor, the clutch and gear range condition of the transmission, plus sensor inputs from DISTRONIC PLUS, Active Blind Spot, and Lane Keeping Assist. In full-hybrid mode, it propels the wheels using the ICE and the electric motor simultaneously, depending on the driving load. If the vehicle is coasting but not braking or accelerating, the controller switches to regeneration mode and feeds a low level of charge back to the HV battery pack.

A DC/DC converter built into the power electronics module functions as a bidirectional generator of high and low DC voltage. It provides DC power to either the HV (boost mode), or the 12-volt onboard electrical system (Buck mode) on an as-needed basis. When both electrical systems and batteries are fully charged, the DC/DC converter goes

into standby mode. The multiple electronic control units, interaction among numerous components in the HV system, multi-directional flow of energy, and real-time information exchange among various network bus systems requires extremely sophisticated tools. Voltage is a measure of flow, and is orders of magnitude faster in the electric motors and controllers than in the devices they replaced, or in components of the 12-volt system. Traditional millisecond I/O sampling rates won't cut it for measuring HV current flow, pulse width modulation signals, and other HV sensor inputs.

Additionally, the hardware, software, and system management algorithms may differ significantly from one vehicle manufacturer to another. Technicians need training not only in the general sense for the new high-voltage technologies on hybrid vehicles, but also need factory diagnostic and repair information and training for specific Mercedes-Benz hybrid models and components. |

The PSC-700 battery charger from Midtronics is approved by Mercedes-Benz and provides 70 amps of current to recharge the high-voltage battery pack in the S400 Hybrid.



The 2014 E400 Hybrid Sedan crams a 3.5L V6 ICE and a 27 horsepower electric motor under the hood.

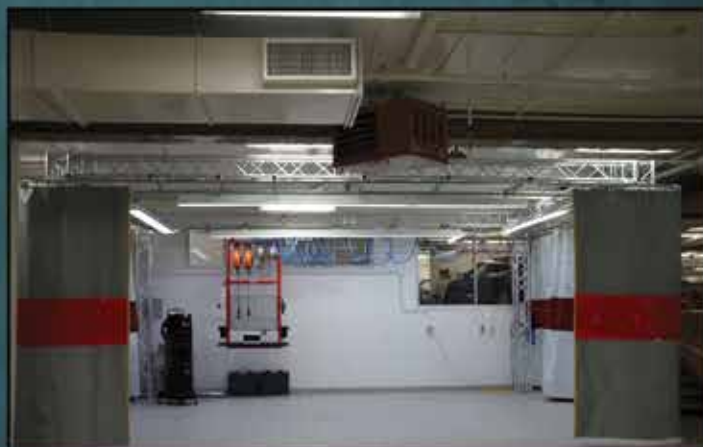


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Climate Control Vents: Fair or Ill Wind?



Mercedes-Benz
has gone far
beyond cables and
vacuum to control
HVAC accurately.

Shown here: A typical cracked lever arm, often misdiagnosed as a bad stepper motor.

As you may have read many times in **STAR TUNED**, virtually all aspects of how we control automotive systems have changed radically in the last several decades, especially as we move ever further from analog to digital. Mercedes-Benz climate control has not been immune to this revolution. In fact, many innovations have made their way into heating, ventilation, and air conditioning (HVAC) systems and all are important in their own way (a few have been covered in previous editions of **STAR TUNED**). In keeping with that theme, we'll take a brief look at airflow; specifically, vent actuation.

A BEHIND THE SCENES PEEK

In the late 1930s, auto manufacturers started taking passenger cabin climate control seriously. In those early cars, heating and air conditioning were completely separate systems from one another. Air conditioning being largely an under-dash add-on with very little control beyond blower speed. It wasn't until the late 1960s that complete behind-the-dash integrated systems started to show up as a factory option (integrated meaning heating, defrosting, air conditioning, and ventilation combined into one "air box"). These first systems were mechanically controlled by either opening or closing dash vents by hand or rotating and slide switches that pushed or pulled Bowden cables to control the positions of

doors located in the heater box. Cable control meant the vehicle occupants had to continually manipulate the controls to maintain a desired cabin temperature and airflow.

The 1970s ushered in the age of pneumatically (negative pressure; a.k.a vacuum) controlled ventilation. This system used diaphragm actuators that allowed the pneumatic system to be self-regulating. This meant that, with the addition of a few sensors, a controller, and vacuum switch block climate control became largely automated. Auto control led to greater cabin comfort and occupants could now set consistent temperature and airflow. These systems for the time were generally very dependable, but had some drawbacks:

- The vacuum source was engine-supplied and thus subject to disruptions in the event of engine problems; in the case of diesels, it required extra duty from the external engine-driven vacuum pump.
- Lots of tubing was used to supply dash vacuum actuators, and these added complexity to the system. Vacuum tubing and connectors were prone to breakage while attempting to repair faults.
- Vacuum actuators were bulky and required larger dashboards to accommodate the system.
- Actuators were slow to react, making accurate interior temperature control difficult at times.

Vacuum-driven systems were in play for decades before the next wave of innovation hit.

MOVING IN A NEW WAY

At the beginning of the new millennium, Mercedes-Benz brought drive-by-wire technology to climate control with an electronic system. Replacing old vacuum elements with electric and digitally-driven stepper motors not only changed the way vents and flaps are moved, but also how the system as a whole is diagnosed and repaired. Stepper motors are different



A replacement actuator lever kit from Mercedes-Benz.

from conventional DC motors -- they are brushless. The motors' outer casing is made up of multiple electromagnets surrounding a central toothed armature. By actuating each individual electromagnet via a pulse-width signal in a sequence or steps, the motor can be precisely rotated. Adding a greater number of electromagnets inside a motor results in finer steps that can be made. Depending on the application, stepper motors can make one step for a simple open-or-closed actuation, a half-step for a partial actuation, or micro-steps in precise degree increments. An example of micro stepping would be the fine control for a blend air door to regulate temperature.

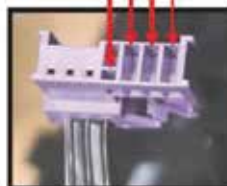
As with any technology, there are almost always pros and cons. Because of their compact design and precise control, stepper motors are ideally suited for climate control. This means that stepper motor use in vent control has proven to be a significant change that has shown virtually no downside. When combining stepper motor technology with all the other innovations, it makes today's HVAC system vastly improved over those of previous generations.

BENEFITS CONTRIBUTED BY STEPPER MOTORS

- High torque in a compact design; smaller actuators take up less space and adds to overall size reduction in an HVAC case.
- Flexibility in the design. These self-contained motors can be placed in tighter configurations to accommodate more ventilation options. This is one of the main reasons Mercedes-Benz is able to offer multiple climate zones within the same cabin space.
- Sealed motors are quiet, and, being brushless, produce no carbon dust to contaminate moving parts.
- Digital operation greatly reduces the network of wiring needed as compared to the maze of vacuum tubing in a pneumatic system.
- Electronic control offers a quicker and more accurate diagnosis. The climate controller is able to determine motor assignment



4 pins for coding



Flap Motor Coding

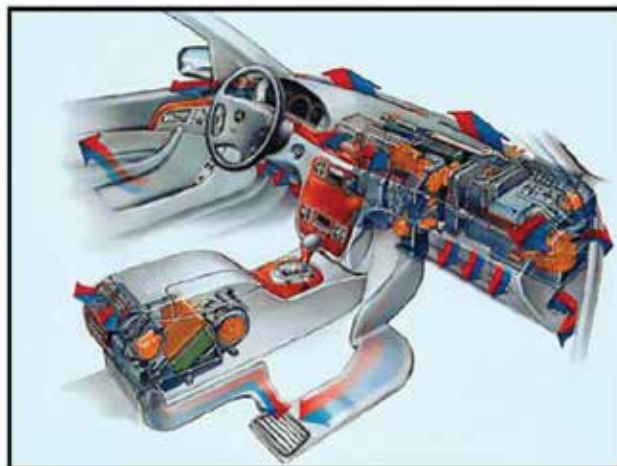
Plastic bridges built into the connector plug act as spreaders forcing shorting pins apart. Since there are 4 pins up to 16 coding variations are available.

Plastic bridges



A coding plug used to assign the positions of stepper motors as seen in W203 W463 HVAC literature.

Ventilation



The dash vents of a typical late-model Mercedes-Benz are quite complex.



We've come a long way from the vent slides and under dash-mounted air conditioner of this 1968 280SL.

and position, and can flag fault codes if a malfunction has occurred.

- Faster and more accurate control. This allows climate control temperature to be achieved quicker and with more accuracy.
- Lower cost to produce and higher reliability.

The only real drawback for stepper motor technology is the loss of torque at high speed. Although not a problem when used to drive HVAC vents and flaps, the loss of torque makes it not suitable for fan or window motor usage. We suspect that engineers are already working hard to improve the design and we in the field will see this technology show up elsewhere in the near future.



With this LIN system stepper motor, there are no color-coded plugs since these actuators are given a digital address.

THE SAME, BUT DIFFERENT

Stepper motors are unserviceable and must be replaced when faulty. That being the case, we'll not specifically look at the inner workings and instead focus on some common issues that show up in the shop. At the moment, there are two basic stepper motor systems employed by Mercedes-Benz, and each has to be looked at little differently when it comes to diagnosis and service.

The first stepper motor system found on vehicles such as the W203 C-Class and W 220 S-Class were Controller Area Network (CAN) based, meaning they operate on the interior CAN, and as such can be influenced by other faults in the network. All stepper motors are identical, so how does the controller know which is which? On the CAN system, all motors work off of a single ribbon cable originating from the climate control panel. Spliced onto the cable are colored connectors. Each connector (depending on color) has specially-placed dividers that open or allow closed control pins on the motor itself. This could be compared to the way you would place jump terminals on a computer hard drive, or flipping dipswitches on older remote controls. These first systems differ slightly with some using a three-wire cable to assign motors, and others a four-wire cable on more complex options that require additional motors.

The second system found on all later Mercedes-Benz models is Local Interconnect Network (LIN) based. LIN is a sub-network used to drive serial or multiple like components. The advantages of LIN are that it's cheaper to implement, reduces the burden on the interior CAN bus, and (because of its simple programming) can be expanded easily as future needs develop. LIN also eliminates the need for special connectors for motor identification. As with the CAN system, LIN-based motors are identical. The LIN system has the ability to assign a motor digitally to a specific location to perform a specific task. In essence, this is a form of version coding accomplished through a teach-in process.

SYNCHRONICITY

As stated earlier, this system has proven to be very reliable; however, from time to time repairs are needed whether there is an internal failure or because of outside influences. By far the most common and misdiagnosed problems with the stepper motors system is a vent not operating correctly. It's sometimes heard as a motor in

perpetual motion, a clicking noise, or just no vent action at all. Time and time again stepper motors are condemned for the problem when, in fact, they work perfectly. The most likely culprit in these situations is a broken or cracked actuator linkage. These linkages are plastic and subject to wear. They are, in some cases, easily replaced with minimal disassembly. In other cases, it may require an involved dash tear-down with a significant cost. This makes accurate diagnosis of this (or any problem for that matter) with climate control by the Independent Service Provider a wise practice. Guesswork could cost both you and your customer financially, or add unneeded stress due to a bad diagnosis not based on facts. Other problems to look out for, as on many other systems on a vehicle, are if there are multiple failures or faults at the same time. The same basic diagnostic analysis is applicable, such as:

- What do they have in common?
- Have you checked fuses for power and grounds?
- Are there network controllers offline?
- Verify vehicle specific coding
- Technical service bulletins?
- Any aftermarket components or recent previous work performed?

No matter the fault, once a repair has been preformed it's important to note stepper motors are not plug-and-play. This seems to be the biggest stumbling block for a lot of shops and the largest reason for tech calls associated with this system. It's almost always the same statement word for word: "We replaced Part X and the vents still do not function correctly." If motors have been disconnected or replaced, then they must all be taught to play together again.

Restoring harmony to the symphony of motion requires a conductor, in this case the Star Diagnosis System (SDS) or an equivalent diagnostic tool. On early CAN system stepper motors, they already have assigned positions because coding plugs are used. That means this system only needs to be resynchronized, or, as Mercedes-Benz calls it, "normalization." During this process, all motors are driven to end stops in both directions. By using motor current and position sensing data pulses delivered by an internal Hall sensor, the controller is able to learn the fine position of each motor and its start and stop position. On LIN systems, normalization is the same as above, but there is an additional step that must be performed before that can take place. Unplugged or replaced LIN steppers must go through a "teach-in" process. SDS will run a sequence of actuation to determine and then assign motors to a specific location. Once the locations have been learned, then fine control can be learned through the normalization process.

Remember, due to the sophistication of today's HVAC system a small disruption can have profound effects. |



In this under-dash shot of a 2004 ML500 W163, if you look closely you can see where transmission fluid wicked all the way through the harness to the transmission controller above. The ATF then spilled out and contaminated the HVAC stepper motors directly underneath. The initial customer complaint was erratic vent operation.



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Breathing Easy: Cabin Air Filtration

One of the defining features of any Mercedes-Benz vehicle is having cabin air filtration as standard equipment. This system is designed to filter 100% of the air entering the ventilation system to provide the cleanest air for the maximum passenger comfort possible. Complete filtration is accomplished through two means. The first is a multi-layer particulate filter that's tasked with capturing dirt, dust, pollen, and other solid pollutants. The second is cleaning such gasses as ozone, exhaust fumes, smoke, and other potentially hazardous or odorous gasses by trapping them within a filter coated with a granulated active charcoal layer. Depending on the model, vehicle filters can be used individually, or both types of filtration can be combined into a single dual-purpose filter known as a combi-filter.

Besides the obvious health benefits, cabin filters help to provide another positive result: HVAC system longevity. Filtering keeps debris out of ducts and moving components, so heating and cooling coils are kept clean. This keeps the system free of clogs and eliminates particles that could add friction to moving parts that would accelerate wear.

REGULAR MAINTENANCE

Cabin filters have a limited lifespan and should be checked and changed when needed along with other vehicle maintenance. Filters should be changed according to the Mercedes-Benz maintenance schedule for the particular vehicle being serviced. In some cases, more frequent filter replacement may be necessary for vehicle operation in densely-developed or heavily-polluted areas. Allowing filters to become saturated to the point where they no longer allow the full flow of air is not good for the customer or



When removing panels to access a cabin filter, care must be taken not to damage components such as this temperature sensor and cable attached to the access panel.



A flimsy, poorly-made cabin filter.



This is the result of poor maintenance -- a clogged filter with mold growth. This vehicle had both low airflow and a bad smell.



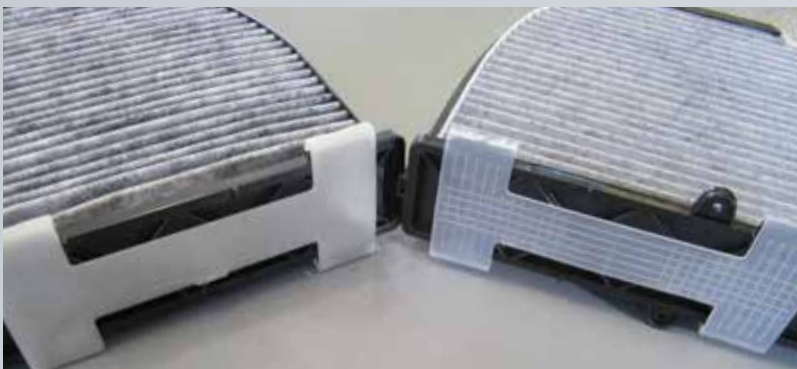
Proper installation of a quality filter. Note the nice seal along all sides that ensures maximum performance.



This vehicle was in for repair, the complaint being a whistling noise from the dash after previous work at a quick lube facility. Inspection revealed that a poorly fitting aftermarket cabin filter would not completely seal, thus letting unfiltered air pass and producing the noise.



Note the solid full-frame construction of the genuine Mercedes-Benz filter on the left compared to the flimsy, distorted, cheap aftermarket filter on the right. Also, note the difference in the carbon layer that can be seen on both. The genuine filter contains much more.



The aftermarket filter on the right has extra screw tabs, which aren't needed on the OE filter since it seals tightly as designed.

the automobile. Clogged filters choke airflow, which leads to bacteria and mold growth. This may pose a health hazard for some occupants.

Additionally, the lack of flow also stresses the system because it's working harder to pull air through dirty filter media that acts as an obstruction. As an independent service professional, you should be able to detect the warning signs of clogged filters. Stale or musty odors in the cabin, low air flow from the dash vents, the sound of a labored blower motor, and excessive dirt and dust inside the vehicle are all signs of a neglected filtration system that may not have been noticed by the owner since the loss of performance would have been gradual. A sign that's a safety concern is fogged windows -- low airflow allows moisture to accumulate.

AVOIDING THE CHEAP PITFALL

When it comes time to replace cabin filters, there is absolutely no substitute for original Mercedes-Benz (OE) parts. Replacing the OE filter with an inferior product because of cost simply means the loss of system integrity. Genuine Mercedes-Benz filters are made with an electrostatic charge, which aids in the filtration process by allowing oppositely-charged particles to be attracted and trapped by the filter while particles with a like charge are repelled from and kept out of the system by the magnetic force field. Electrostatic filters cannot be cleaned and must be replaced; you could lose this technology with a cheap replacement filter. Also, most non-OE replacements have a thinner filtration layer made of poor quality paper or fleece. This means that its ability to filter and trap contaminants has been greatly reduced, and leads to poor cabin air quality as well as a shorter filter life. Another pitfall is poor fit, and they often have very flimsy construction, which leads to difficult installation. Without the correct fit, unfiltered air will bypass through the gaps and compromise the system.

NO SUBSTITUTE FOR QUALITY

OE filters have an engineered multi-layered design made with quality materials to an exact specification for fit and performance. Your local Mercedes-Benz parts distributor has the expertise to get you the right part for the right application, and often at competitive prices. In the end it all boils to a simple question: Would you really sacrifice quality to save a few bucks? |

Performance. Reliability. Success.

With our competitively priced Genuine Remanufactured Parts, you no longer have to settle for anything less than Mercedes-Benz quality. But that's just part of the story. You see, our airmatic struts, catalytic converters, turbochargers and steering racks all carry a 12-month, no mileage-restriction warranty. So our parts are not only a great deal. They're a great value. And since they're genuine Mercedes-Benz, you can have confidence they'll last, and so will your relationship with your customers.

Contact an authorized Mercedes-Benz dealer or learn more at www.mbwheolesaleparts.com



One remanufactured engine pulls the plug on climate-damaging CO2 and saves 447 days of power for one laptop.

*MSRP excludes state and local taxes and freight if applicable. Price excludes core deposit. Price valid as of June 2015. Prices may vary by dealer. See your authorized Mercedes-Benz dealer for additional details or a copy of the Mercedes-Benz parts limited warranty.



\$1036.00
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A 251 320 5613 80



\$1456.00
MSRP
A 164 460 0300 80



Mercedes-Benz

Multi-Layer Steel:

The Forever Head Gasket

MLS technology takes us from spongy to rigid, and from tenuous to permanent, but you have to live by the rules.





Here's a used late-model MLS gasket. Note the loss of the thin sealant layer, which means these gaskets cannot be reused.

If you've been a technician for as long as the contributors to **STAR**TUNED have, you'll believe us when we say we know how easy it is to get stuck in your old ways and assume that you can just keep doing things the way you have all along. In reality, that mentality could cost you big with today's sophisticated engines.

The nature of our industry is that it's always evolving. Sometimes the change is very noticeable, such as the move from carburetors to electronic fuel injection, but other times a change is barely acknowledged, if at all. In this case, we'll take a peek at the often-overlooked head gasket. As simple as it may seem, alterations in gasket design have brought important changes to the way we deal with these parts. Long gone are the days when cylinder head gaskets needed a re-torque after about the first 1,000 miles of operation. And gone are the days of breaking out "ye olde" pneumatic-powered wire brush or abrasive pads to clean up block and head surfaces. Mercedes-Benz engines of today require a delicate touch.

Gaskets of the past were mainly of the composite type, meaning some combination of graphite, brass, copper, and asbestos on earlier versions. These gaskets were good for their time and did their job satisfactorily, although as they aged they were prone to oil and coolant leaks. Typically, these failures were not catastrophic, but they were still the main reason for head gasket replacement. Less common was a total failure: the dreaded "blown head gasket." More times than not, this was the end result of severe overheating.

EXTREME RELIABILITY

Stop and think: Since 1998 or so, have you, the independent Mercedes-Benz service provider, seen a head gasket failure that wasn't caused by extenuating circumstances, such as an internal engine repair done improperly? We're betting very few, if any at all. Why is that? Because in the late 1990s, Mercedes-Benz made the move from composite to multi-layer steel head gaskets (or, as they are commonly known, MLS gaskets). Just as their name suggests, MLS gaskets comprise multiple layers of thin steel. Depending on the application, there are

typically three to five layers of stainless or alloy steel pre-coated with an elastomer sealant.

MLS technology has proven to be extremely reliable and far superior to composite gaskets for a number of reasons:

- Thinner profile – This allows for more accurate cylinder head-to-block tolerances resulting in a more precise combustion chamber size. The benefits being that Mercedes-Benz engineers are able to fine-tune the engine even more than they could in previous generations, producing more power, fuel efficiency, and smoother operation.
- Rigidity – A stiffer gasket provides a more uniform sealing surface and less movement between the castings.
- Steel construction – Metal-to-metal sealing takes advantage of a more consistent and uniform thermal expansion and contraction to promote a better seal. Also, the stainless or alloy composition resists corrosion.
- Multiple layers – This type of construction adds to the gasket's ability to uniformly expand and contract during engine warm-up and cool-down. Thermal expansion is not linear (meaning only moving in one direction) in an internal combustion engine. Heat creates volume expansion (meaning expansion in all directions). Although movement is very minute, multiple

layers are able to shift with the movement to maintain a cohesive seal.

The adoption of MLS gasket technology also set the stage for the latest evolution in Mercedes-Benz engines. Stronger gaskets have allowed for higher cylinder pressures with the additions of turbocharging and direct injection. Now being able to reliably handle the increased force, Mercedes-Benz engines are able to produce some of the most powerful and fuel-efficient engines the world has ever seen.

WORKING IN TANDEM

A gasket is only as consistent as the bolts that hold it in place. MLS gaskets could not perform as well as they do without torque-to-yield fasteners, or, as they are more commonly known, stretch bolts. Having been around since the 1980s, stretch bolts are seasoned veterans of the automotive industry. Developed primarily for economic reasons, the advent of stretch bolts eliminated the need for partial tear down to re-torque head gaskets after sale. They also reduced the number of torque steps needed to achieve specified tightness on the assembly line. This saves time and money for the consumer and manufacturer alike.

A stretch bolt's benefit lies in its ability to be tightened beyond the elastic limit (yield point) into



When cleaned and prepped for reinstallation, discolorations and trace impressions can still be seen from the previous gasket, as on this 272 engine. These are particles embedded in the pores of the aluminum. As long as they can be seen and not felt, they will not affect the new gasket's seal.

Who's Your *Partner* in Success?

Mercedes-Benz's



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. |



the metal's plastic region. This produces a high uniform clamping force that's superior to the harder, non-flexing head bolts of the past. Using this elastic property, these bolts are able to expand and contract with temperature and maintain a reliable clamp. Much the same as if you were to put a good stretch on a rubber band (not to the breaking point) and them let off just slightly. You have some "give," but there's still pressure, or an applied force. Another advantage of stretch bolts is the accuracy of the clamping force. Research has shown that with stretch bolts variations in clamping force are within + or - 10 % from one to the next, compared to the + or - 30% of non-stretch bolts. Such accuracy makes for much more consistent clamping force across the cylinder head. Combine these advantages with those of MLS gaskets mentioned above and you have a very reliable seal.

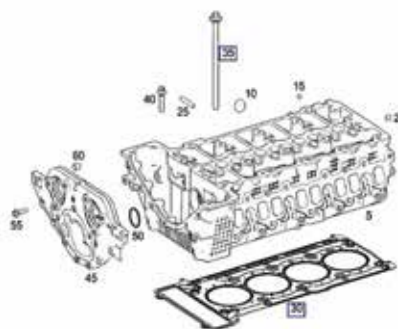
PREPPING FOR PERFECTION

Even though head gasket failure itself is not commonplace anymore, the need to remove a cylinder head for other repairs is still a possibility. Most techniques for disassembly and reassembly of a cylinder head-to-block still apply, but there are some important fundamental differences for installing MLS gaskets that need to be followed to ensure a successful repair.

Older composition gaskets were thicker and more flexible, so they could absorb or accommodate minor defects on sealing surfaces; therefore more aggressive (to a point) cleaning of the mating surfaces was permissible. MLS gaskets being solid with only a very thin coating of sealant, on the other hand, are far less forgiving and cannot conform to irregularities. Engine block decks and cylinder heads must be kept as damage-free as possible. To get technical about it, composite or soft-faced gaskets can generally seal surface roughness of 60RA to 90RA. RA refers to "Roughness Average." Using a special meter that can detect the peaks and valleys of a surface finish, this is the measurement in microns -- millionths of a meter. By comparison, a crankshaft journal usually has finish of about 10RA. MLS gaskets need a finish of 15 RA to 30 RA for optimum reliability. For this reason, extreme care must be taken during disassembly and reassembly preparation. Mercedes-Benz recommends using no metal-to-metal or abrasive friction for cleaning surfaces (i.e. scrapers, sanding discs, or any tool that could scratch). Instead, it is recommended that an

aerosol adhesive remover such as products from 3M and a plastic blade be used for cleaning. Experience has shown that a soft brass brush with very light pressure could be used if needed -- just be sure no bristles are left behind.

Just as on older engines, clean surfaces are a must -- debris can compromise sealing. Bolt holes must also not be overlooked. Debris in the holes could cause a false torque, or liquid that may have spilled into the holes would cause the head bolt to hydro-lock resulting in stripped threads. Checking the



The all-important sandwich.



The tools now needed to prep cylinder block deck and head sealing surfaces for the installation of an MLS gasket.

cylinder head and block deck for warping with a quality straight edge is required whenever they are apart. It should go without saying, but we'll mention it anyway, head gaskets cannot be reused. MLS gaskets have Load Control Embossments (LCE) that are designed to compress during the initial installation. Trying to reuse a gasket that has already been crushed will leak and possibly cause damage to the cylinder head and/or the engine block.

During reassembly no additional sealant is needed as the gaskets are pre-coated, unless directed otherwise by Mercedes-Benz work instructions (such

as where the cylinder head meets the timing cover on some models). It is also recommended that a new set of head bolts be used during repair, even though stretch bolts may be re-used if within the measured limit. A few facts make us lean toward replacement.

- Once the bolts are stretched, they stay stretched. Service limits normally only being 1 to 2 mm longer than a virgin bolt, there is still a risk of bottoming the bolt out in the block during reassembly.
- Stretch bolts have a thin upper shank that allows them to elongate. Once stretched, the shank can become warped depending on stresses it may have been subject to during its initial use. Reusing a warped bolt could deform threads or give uneven clamping pressure at the bolt head if re-installed.

These bolts are responsible for keeping everything together. They're given the task of containing 1,000 to 1,500 psi of combustion pressure every millisecond day in and day out. Given the risk, a new set of bolts can be looked at as cheap insurance. As always, make sure the bolt threads and those in the casting are clean to keep the bolt from binding when screwed in, thus preventing a false torque during the bolts' initial pre-load.

SWEATING THE DETAILS

This brief overview is no substitute for following Mercedes-Benz's official work instructions. Paying attention to the details is the best practice for producing a quality repair. The goal is to fix it right the first time; nobody wins when you have a comeback. Another important detail is making sure you have the correct parts to begin with. Verify you have the right gasket for the cylinder bore size, and correct bolt length. Double-checking could save you from a costly mistake. The best source for correct parts the first time is your local Mercedes-Benz parts professional who will not only ensure that you get the correct part, but also that it's a quality part that was specifically engineered to keep the vehicle firing on all cylinders. |



The tools we used to clean sealing surfaces on older engines are way too aggressive for today's engines, and would quickly destroy any chance of proper sealing with an MLS gasket.



Here's an old-style composite gasket used on a late 1980s Mercedes-Benz M103 engine.

Mercedes-Benz Mobil 1

Product Name	Part Number	Quantity	Product Description	Recommended Consumer Applications
Mercedes-Benz SPEC.				
Mobil 1 Formula M 5W-40	BQ 1 09 0144	Bulk - No Equipment	Fully synthetic formulas designed specifically for gasoline passenger cars	Low SPAsh. Available at most MB dealers
	BQ 1 09 0162	6/1 Quart Cases		
	BQ 1 09 0151	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	BQ1090184	Bulk -No Equipment	Advanced full synthetic formulas designed specifically for diesel passenger cars that have particulate filters	Low SPAsh. Available at most MB dealers
	BQ1090182	6/1 Quart Cases		
	BQ1090183	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 Specification	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 0134	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
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® 1/2 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
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

Mercedes-Benz automobiles are designed to perform on the most challenging roads and conditions. Shouldn't the oil used in Mercedes-Benz engines do the same? We think so.

That's why Mercedes-Benz and Mobil 1 have partnered to offer an unbeatable combination of total engine performance and driving luxury.

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 Applications
Mercedes-Benz SPEC.				
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
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 Aftertreatment 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		
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 Aluminum Workplace:

Getting a Handle on a Finicky Metal

You may think the adoption of aluminum components is the latest thing in the evolution of Mercedes-Benz vehicles, but even so repair procedures have changed substantially over the last decade.





It may sound funny to talk about “the good old days when aluminum repair was simple,” but it’s true. Aluminum use on automobile bodies is not new, but it has until very recently been primarily hard parts and exterior sheet metal such as hoods, deck lids, and fenders. Other than for minor dent fixes, aluminum repair was often a simple remove and replace job. It did not require straightening, heating, or otherwise modifying the properties of the aluminum. If you had experience with adhesives and knew your way around a rivet gun, you could handle aluminum sheet metal replacement.

In the past ten years, that has changed dramatically. Weight reduction for fuel economy mandates have resulted in a major expansion of aluminum sheet metal use, and significant new aluminum load-bearing and structural applications. New aluminum alloys are being joined to a wider variety of materials, including advanced high strength, ultra-high strength, and boron steel, magnesium, plastic and other composite products.

There are different types of adhesives, bolts and rivets, each with specific instructions for how to separate the original and install a replacement. Many of these new materials respond differently from old, low-strength steel to heat and cold-working, and that dictates what can be repaired and what can only be replaced. Technicians must be prepared to use a variety of different procedures, often during the same repair.

NO STRAIGHTENING OF STRUCTURAL COMPONENTS

Mercedes-Benz explicitly prohibits straightening of aluminum structural components. It is simply not worth the risk of unknowingly altering the joint strength and crumple properties of the metal. The one exception is the aluminum panels in the rear floor of the 2013 and newer W-231 chassis (SL500). The floor is a MIG welded frame with a hollow chilled cast longitudinal member as its primary load bearing element. It is closed by sheet aluminum panels which can be straightened, if deviation from the measuring points is not greater than 3 mm.

With the exception of the A-Pillar, the 2013 (and newer) SL500 bodyshell is all-aluminum.

SOME (DON'T) LIKE IT HOT

Aluminum sheet metal softens when heated, allowing technicians to tap, pull out, or straighten minor damage to body panels and non-structural components. This excludes cast aluminum pieces, which resist bending and cannot be reshaped without risk of becoming brittle and forming microscopic cracks. Extruded aluminum channels may be reshaped to a limited extent when heated properly, assuming they are freely accessible and the damage is minor.

But aluminum alloys have a limited temperature range in which they can be reshaped without altering their hardness and strength in the repair area. Mercedes-Benz specifies a temperature range of 250°C - 300° C (482° - 572° F) for reshaping aluminum. Above 300°C, aluminum begins annealing, which is shorthand for softening that is irreversible.

Aluminum does not change color as it heats, so unlike with steel, you cannot judge visually when you are nearing a critical temperature limit. When straightening aluminum you'll need some sort of temperature checking device—self-adhesive temperature measuring strips, infrared thermometer or pyrometer—and check it frequently during the repair. After reaching the 250°C - 300° C reshaping temperature, release tension by tapping the metal carefully with a hammer.

Reshaping using cold straightening results in hardening and can lead to cracking. Aluminum tends to tear quickly when notches or crimps are present in the reshaping area, so avoid high force or jerky hammering. This also applies for high force in the area surrounding weld joints. Reduce the potential for hardening by heating the reshaped area to approximately 170° C (338° F), then letting it cool slowly (no drenching with cool water or forced air).

ADHESIVE WITH SPOT WELDING OR RIVETING

Instead of the high heat of traditional metal inert gas (MIG) continuous bead welding, Mercedes-Benz recommends adhesive bonding in combination with MIG spot welding, squeeze-type-resistance-spot-welding (STRSW), or riveting for most aluminum repair.

Adhesives used in collision repair cure at room temperature. That helps avoid the potential of high heat altering the strength characteristics of the aluminum and other materials being joined. It

also avoids causing thermal damage to the e-coat, corrosion protection, or other coatings near the repair area or on adjacent components.

Some adhesives can be cured at temperatures up to 120°F to shorten repair time. Do not exceed the maximum temperature tolerated by the aluminum alloy or other materials being bonded together. For best results, follow application instructions from the adhesive manufacturer.

Adhesive distributes its bonding strength over the entire length of the joint, unlike spot welding alone, which has its strength concentrated at the specific weld points. Structural glues add rigidity and stiffness, and offer improved noise, vibration and harshness (NVH) control. And for joints that combine aluminum with steel or other metals, a non-conductive adhesive layer between the two dissimilar metals helps prevent corrosion.

When combining adhesive bonding and STRSW on a new connection, the technician applies adhesive to the entire weld area, and makes spot welds through the glue during its working time. The heat is focused on the weld area and causes only a very small amount of stress around the weld.

The arms of an STRSW gun must be able to clamp around both sides of the joint in order for a resistance weld to work. If both sides are not accessible, Mercedes-Benz recommends adhesive bonding plus riveting. The glue and rivet combination is also advantageous for connecting aluminum with composite polymers and with advanced steels, many of which are sensitive to high heat. When joining ultra-high-strength materials, use only high-strength rivets approved by Daimler AG. Only a riveter with increased draw-off strength can properly attach or remove a rivet in advanced steels.

MIG/MAG WELDING

Another alternative is MIG plug welding for aluminum and other non-ferrous metals, or metal active gas (MAG), primarily for steel. The difference between MIG and MAG technology is primarily the type of shielding gas used. Each unique gas mixture has a different effect on arc stability, metal transfer, and the amount of spatter, all of which affects weld pool penetration and the strength of the finished joint.

Continuous MIG welding is still used for joint strength, especially where the gap between materials

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is large. Aluminum has high thermal conductivity, which makes the start of a traditional continuous MIG (metal inert gas) weld a bit tricky. The repair area must absorb enough heat to create a durable weld fusion, but thermal conductivity draws heat away and makes the initial split seconds slow to warm up. One solution is newer equipment that has “Hot Start” capability. It starts the weld with a higher current for a brief initial period and then automatically switches to a lower level for the remainder of the weld.

When combining adhesive and continuous MIG welding, the technician applies glue to every area except those in which a MIG weld is to be placed. The heat would destroy the glue and release chemicals that contaminate and weaken the weld joint.

REPAIRING EXISTING GLUED JOINT AREAS

Before original flange or other glued joints can be separated, they must be warmed up to soften the adhesive. Heat the flange to between 100°C to 120°C (212° to 248° F) and separate using a chisel. Do not exceed a maximum of 180°C (356° F). Always seal riveted body flanges with body sealant. On glued multi-layer sheet metal connections with hardened adhesive, drill out the original spot weld and position

the new resistance spot welds over the existing opening. This minimizes the potential heat damage to the surrounding hardened adhesive.

Be sure to remove metal shavings using a vacuum. Do not use forced air to blow metal shavings and dust away from the repair area. If aluminum dust settles on steel, or vice versa, it can cause bi-metallic corrosion over time. It is not good for shop personnel to breathe. Also, aluminum dust at high enough concentrations in the air is explosive when a spark is present. Vacuum removal is good not only for corrosion prevention, but also for safety.

Some load-bearing sections that were originally adhesive bonded will not get replacement glue during a repair. To meet strength objectives in the repaired joint, be sure to install the specified number of rivets per the Mercedes-Benz instructions.

PART PREPARATION IS CRITICAL TO ADHESIVE PERFORMANCE

Mercedes-Benz uses a two-component structural foam adhesive to reinforce body repairs. Follow the application instructions to ensure a quality bond between parts being joined. All steps, from pre-



With the exception of the A-Pillar, the 2013 (and newer) SL500 bodyshell is all-aluminum.

cleaning to releasing the vehicle to the customer, must be completed in the specified time period in order for the bond to set and cure properly.

1. Remove any old adhesive from the area that will be re-glued. Don't apply adhesive on top of rust, paint, e-coat, or galvanized coating. If the metal has a pewter or non-shiny appearance, there is still galvanized coating that must be removed. On aluminum surfaces, Mercedes-Benz recommends use of a CrNi (stainless steel) wire brush to remove coatings down to the bare metal.
2. Use the specified pre-cleaner and primer. The primer enhances the long-term stability of the bond. Work the primer into the surface with fresh abrasive paper (included with the primer system). When properly applied, you should see a uniform film of primer covering the repair area. If you do not, repeat the pre-treatment steps. When an acceptable film is present, wipe the primer off with a lint-free paper towel. Allow the surfaces to dry for the recommended amount of time before applying the two-component adhesive.
3. Before mounting the adhesive mixing tip onto the tube, squeeze the tube until you see both of the two components coming out. This ensures the proper mix of both components will be applied when the cartridge trigger is squeezed.
4. Squeeze out a test quantity of adhesive at least three inches in length, and visually check to ensure that the two components mix uniformly when exiting the cartridge. Discard this test.
5. Squeeze out an additional quantity equal to one length of the tube. Use this as a reference bead to monitor and confirm the adhesive hardening process.
6. Apply adhesive to the cleaned surfaces to be bonded, making sure it reaches a thickness, or height, of at least 10-15 mm (0.4-0.6 in.). Do not mix or stir the adhesive, as this will alter its curing properties and weaken the bond.
7. You must complete joining within the adhesive's specified application time, or remove the bead and re-start the process at the cleaning step. The instructions will

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specify an adhesive “open” or working time and how that time may extend at cooler ambient temperatures, or shorten if the shop is warmer. Failure to follow the instructions will result in poor bonding performance.

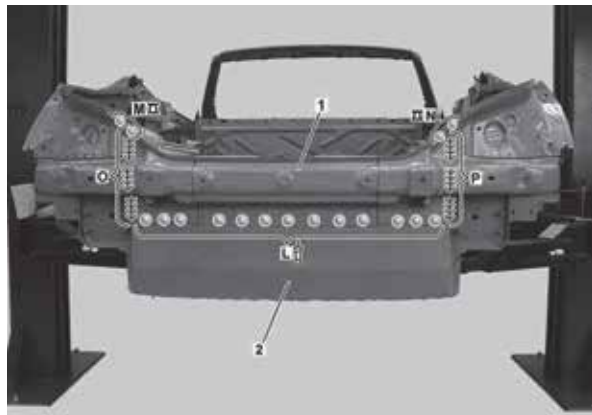
UNFASTENING BOLTED CONNECTIONS

How you unfasten bolted connections such as flow-hole bolts is determined by whether the part is extruded or cast aluminum. Extruded aluminum parts such as frame rails may be unbolted using an electric or cordless driver. Bolted connections screwed into cast aluminum must always be unscrewed by hand. Use a torque wrench, and don't exceed the recommended psi for the connection. If you strip the bolt, cast aluminum is a lot less forgiving than steel.

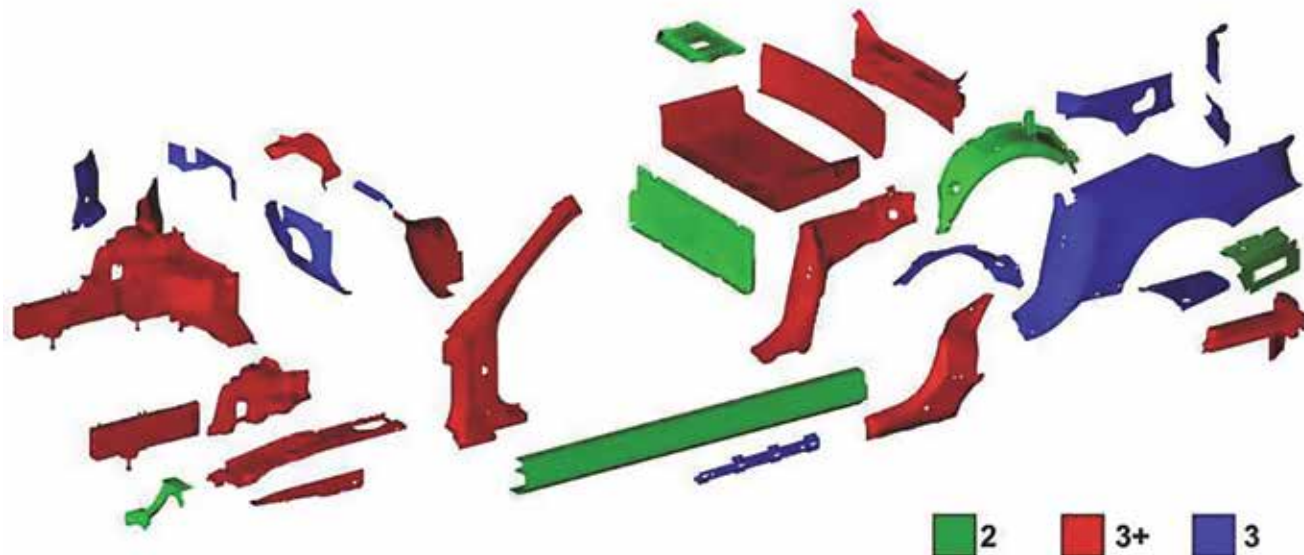
A DEDICATED ALUMINUM REPAIR AREA

No one wants repairs to fail in under a year, but that is likely to occur if you don't have a dedicated space, tools and equipment for aluminum repairs. Mercedes-Benz recommends a separate room or floor-to-ceiling curtained enclosure. Without it, dust and metal shavings from repairs to other vehicles in the shop can cause galvanic corrosion if they settle on your aluminum surfaces before you seal your repair. For the same reason, you need separate tools for working on aluminum, and separate

storage cabinets so that wrenches, sockets and other common tools don't get mixed in with look-alikes that are used on steel. You need a separate vacuum and, if possible, air handling system for the aluminum room. Don't second-guess Mercedes-Benz engineers. All of the recommendations in this article have been developed, tested and field-validated with your repair success in mind. |



The rear center section (1) in the W-231 chassis (2013 SL500 shown here) features a variety of joining technologies. Installation includes flow-form rivets (areas M and N), MIG welding (areas O and P) and blind rivets (area L). There is also structural adhesive under the blind rivets (at area L).



Mercedes-Benz groups aluminum repair into categories based on degree of complexity. Category 1 (not shown) is parts that are bolted on. Category 2 is parts that are adhesive bonded and riveted. Category 3 is welded non-structural, and Category 3+ is welded structural components. Technicians that have not completed the Mercedes-Benz aluminum welding Certification are not authorized to perform repairs in categories 3 and 3+.



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