StarTuned®

Information for the Independent Mercedes-Benz Service Professional

December 2015
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Volume 15 | Number 5

Return of the Hybrid

Mit Kompressor

Tracing Parasitic Drains

Adhesive Bonding & Riveting

Mercedes-Benz

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

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

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

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

Convenience…Accuracy…Profitability…Delivery

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STARTUNED®

December 2015

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.

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In This Issue

After a Century in Hiding...

The Return of the Mercedes-Benz

A major hybrid automobile and truck innovator just after the turn of the 20th Century, Mercedes-Benz has engineered advanced versions of the concept that are not only highly economical, but also have a big "Wow" factor.

Turn your clock back to those heady days near the turn of the 20th century. As we all know, Karl Benz designed and produced the first real automobile in 1886, and followed this with rapid advancements in his fledgling gasoline-powered vehicles plying the rudimentary roads of the time. Meanwhile, Gottlieb Daimler was doing much the same. Early internal-combustion engines were quite unreliable and cantankerous, however, and they were vying with more-dependable electric cars at the very beginnings of the automobile era.

Seeing the potential advantages of combining the two options, Daimler-Benz developed hybrid-powered vehicles to complement its gasoline-only vehicles. The firm successfully marketed hybrid automobiles and trucks for several years as the 20th Century began, even winning road races with them. But, in Europe as in this country, steady advancements in the power and reliability of internal-combustion engines, the availability of cheap gasoline, and the avoidance of the need for periodic recharging eventually relegated both hybrids and pure electrics to the back burner, then almost completely out of sight.

Today, of course, the driving constraints of environmental concerns and unpredictable fuel prices have made the pursuit of motorized-vehicle efficiency one of the primary concerns of any auto manufacturer. Always in the forefront of innovation, Mercedes-Benz is addressing the needs of many of today's motorists with hybrid vehicles offering substantial fuel economy gains combined with environmental responsibility, reliability, and enjoyable performance.

A driver can get behind the wheel of a Mercedes-Benz hybrid, start the car, and go on his or her way without a thought about it being just that: a hybrid. The company's hybrids mesh internal combustion power with a supplemental electrical motor smoothly and virtually unnoticably to deliver highly-economical driving with strong vehicle performance. The only tipoff to the driver is the dashboard display indicating the status of the vehicle's supplementary electrical-propulsion system.

Mercedes-Benz hybrids accomplish this with a combination of several components working in complete synergy, including:

- A conventional, though highly-sophisticated, gasoline or diesel engine
- A high-voltage lithium ion battery
- The "electric machine" – a robust electric motor inside the transmission incorporating a wet clutch
- A regenerative braking system (RBS) control unit

"Sailing" generates significant fuel economy improvement

Mercedes-Benz hybrid vehicles are renowned for their ability to reduce fuel consumption dramatically by "sailing" – cruising along with the gentle power of the electric motor to maintain speed with the conventional engine shut off when conditions are right, such as coasting on a freeway or driving downhill. In this mode, the central Engine control unit ensures that the battery charge is sufficient to utilize the electric motor, activates the wet clutch to decouple the engine, shuts the engine down by deactivating the fuel injectors, and tells the electric motor to supply power to propel the vehicle.

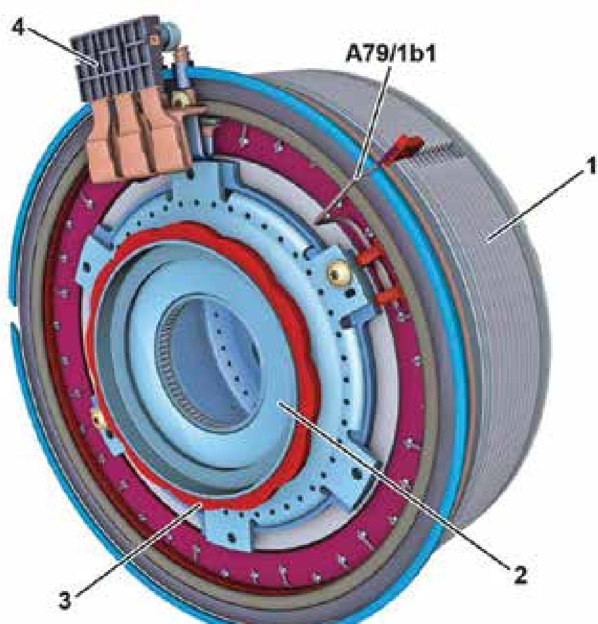
All Mercedes hybrids utilize 7, 30, or 45 amp batteries, 15kW, 45kW or 65kW hybrid modules, R4 or R6 gasoline or diesel engines, and 7G-TRONIC or 7G-TRONIC PLUS automatic transmissions. In operation, the systems operate in either conventional, hybrid, or all-electric modes:

- When driving solely with the conventional engine, power flows directly to the rear axle, while also driving the electric motor in its generator mode to produce AC voltage that is converted by the power electronics control unit into DC voltage and stored in the high-voltage main battery.
- When operating as a hybrid in "boost" mode, conventional engine power is supplemented by the electric motor, which is directed to generate torque to support the conventional engine, enhancing

In 1907, the Austrian affiliate of Daimler-Motoren-Gesellschaft introduced the Mixte, a hybrid (Benzine over electric) that saw service mostly as taxis and work vehicles.

Mercedes-Benz seamlessly combines these elements so that the driver doesn't need to take any notice that the vehicle is a hybrid.

Opposite Page: Svelte, capable Mercedes-Benz hybrids combine robust internal-combustion power with supplemental assistance from the electric motor.



The "electric machine," or electric motor, augments propulsion from the primary internal-combustion engine, and allows the vehicle to "sail" under the right conditions using little or even no fuel.

performance. The electric motor is powered by AC voltage suppled from the battery after being converted from DC voltage by the power electronic control unit.

- During braking in regenerative mode, power from the rear axle flows into the electric motor acting as a generator, and is converted to electrical energy to charge the battery. This also relieves some of the load from the service brakes.
- The system allows propulsion of the vehicle for a brief time as a pure-electric using energy stored in the battery driving the electric motor in the transmission, with internal-combustion power entirely off.

The major domo of the hybrid system

The primary manager of the hybrid system is the Engine control module, along with the power electronic control module, which determines which mode the vehicle utilizes and directs all power from the appropriate source. They are integrated and installed with a heat shield on the combustion engine.

The "electric machine," a three-phase synchronous electric motor, is installed as part of the automatic transmission and housed in the bell housing. It utilizes electrical energy from the battery to add torque support to conventional power, operates as primary power, or generates electricity in braking regenerative mode. It also can act as the starter for the conventional engine.

When is the vehicle in conventional power mode, hybrid mode, and even all-electric? Basically, the determining factors are:

- The power request from the driver – how far down is the driver pushing the accelerator?
- What is the road surface inclination?
- What is the available high-voltage battery charge?
- What are the demands from air conditioning, power steering, 12V onboard electric system, and what are other auxiliary needs?

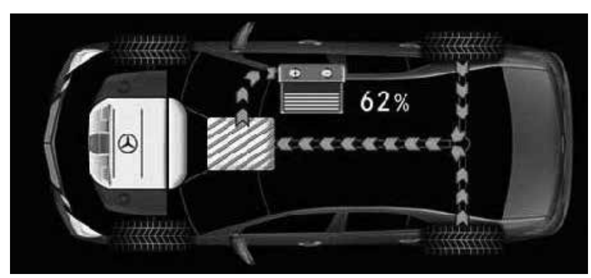
If the driver is going uphill with his or her foot hard into the accelerator, the air conditioning on, and electric power steering working hard to conquer a serpentine road, the conventional engine must power the vehicle to the limits of its torque capacity and, if necessary, utilize assistance from the electric motor. But if the driver is cruising on relatively level roads under mild power demands, assistance from the electric motor comes into play and can dramatically increase fuel economy by lessening the load on the conventional engine – this is when a hybrid vehicle really shines.

The hybrid is managed by the Engine control unit to designate either conventional engine power, hybrid combination of conventional engine with electric motor assistance in the 'boost' mode — usually utilized during acceleration — or in all-electric mode with the electric motor alone powering the vehicle for a short time (when the battery has sufficient charge).

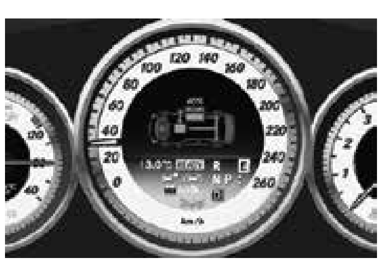
The Engine control unit manages the mode the vehicle operates in and continuously coordinates the source of energy to meet power requirements. The objective is to generate the best fuel economy with satisfactory performance, and a wet clutch is activated when appropriate to equalize the rotational speeds of the conventional engine and the electric motor.

Regenerative braking

A highly-important aspect of the hybrid system is regenerative braking, which helps keep the lithium-ion battery charged whenever the vehicle is braked. Run by the regenerative braking system (RBS) component of the Engine control module, the electric motor acts as a generator and actually brakes the vehicle with magnetic drag in most normal deceleration activity above six mph, unless more braking force is needed and the traditional hydraulic brakes must be actuated. The three-phase AC



Regenerative braking utilizes the electric motor to slow the vehicle and turns the kinetic energy from the rear wheels into battery charging voltage.



This dash display informs the driver that all driving-mode options are ready to propel the vehicle.

Momentary electric power use is indicated by this gauge.

voltage generated by the electric motor during braking is converted to high-voltage DC energy and fed into the main battery, recharging it for future use.

In operation, the brake pedal uses part of its free travel to activate regenerative braking, with that travel growing shorter once regenerative braking is engaged — pushing the brake pedal past this actuates the traditional hydraulic brakes. Regenerative braking cannot occur below two mph, and if an automatic braking system (ABS) event occurs, regenerative braking is shut down and all deceleration is handled by the hydraulic brakes.

If the battery is fully charged, regenerative braking cannot occur, and hydraulic braking takes over entirely.

The lithium-ion battery is highly efficient, but needs temperature control

The lithium-ion main storage battery, crucial to the success of the hybrid concept, is charged by regenerated braking forces and by the conventional engine. It provides 33% more storage and 50% greater power/weight than a conventional lead-acid battery. Controlled by the high-voltage battery module, this highly-efficient battery powers the electric motor to provide torque to supplement the conventional engine, or even operates as solely-electric power for short periods of time.

Highly temperature-sensitive, this battery should be maintained at 50% to 75% optimum charge to deliver greatest output, dependability, and long life. The vehicle's battery maintenance system (BMS) control unit monitors battery temperature, and if cooling is needed transmits this information to the Engine control unit and then to the electric refrigerant compressor to maintain optimum battery temperature.

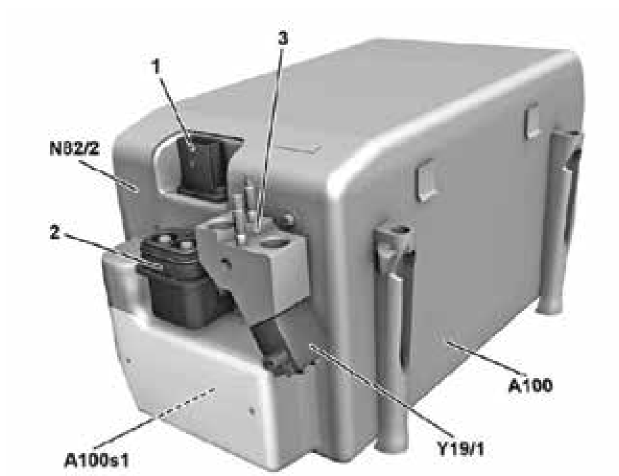
If the vehicle sits unused for a lengthy period, exhaustive discharge can damage the high-voltage battery. It is best to operate the vehicle for a few minutes at least every four weeks with all unnecessary electrical units turned off to charge the battery. If the battery is discharged and does not provide power to start the car, the vehicle should be jump started.

The high-voltage battery should be charged in the "charging while stationary" mode, and battery chargers should not be connected to the high-voltage battery for personal safety and to avoid damaging the vehicle's high-voltage electrical system. Charge the battery to at least 60% if it has been discharged significantly.

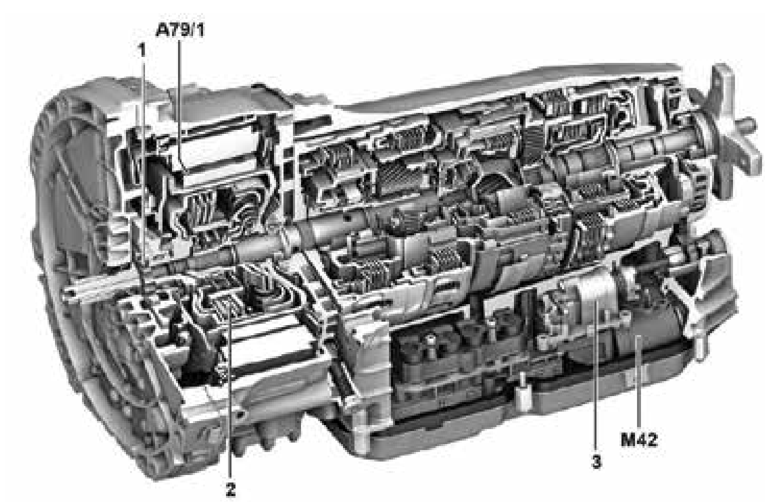
Electric motor and special automatic transmission make the vehicle a hybrid

The "electric machine," or electric motor, turns the otherwise-conventional sedan into a hybrid. Housed in the automatic transmission bell housing, the motor is a three-phase synchronous unit excited by a permanent magnet and is connected to the wet clutch, and, through the clutch, connected to the combustion engine. The motor:

- Works in boost mode to supplement the combustion engine.
- Provides power to actually propel the vehicle by itself for about 15 miles if acting alone and the combustion engine is shut down.



The high-voltage lithium-ion battery provides the power to the electric motor to boost internal combustion engine performance, or can function alone to power the vehicle for limited driving.



The special automatic transmission adapted for hybrids houses the electric motor and wet clutch in the bell housing, ready to take electric power to the road.

- Operates in generating mode to provide electricity to charge the battery, either regenerated from braking, or generated by the internal combustion engine when it is powering the vehicle.
- Acts as a starter for the internal combustion engine.

Switching between electric power mode and generator mode is handled by the power electronics control unit, and when the power mode is selected utilizes a rotational movement with actuation of the wet clutch to engage the internal combustion engine and either help drive the vehicle, or start the engine.

If the electric motor is capable due to sufficient battery charge to either power the vehicle by itself or to restart the engine, the engine is shut down with an automatic stop by switching off the fuel injectors without turning off the ignition while the transmission is either in “D” or “N.” The electric transmission oil pump is immediately activated when the engine is shut down.

When the electric motor can no longer solely provide propulsion, the CDI unit calls for an automatic engine start, actuates the wet clutch to connect the engine to the transmission, then actuates either the vehicle starter or the electric motor to start the engine. If the vehicle is already in driving operation, the starter is utilized to crank the combustion engine – the electric motor can only start the vehicle when it is at a standstill, with the hood closed.

Rather than having the electric motor installed as a separate component, it is integral with the automatic transmission, where it engages the wet clutch to provide motive power when called on. The 7G-TRONIC seven-speed transmission is specially adapted to hybrid drive, and, in addition to the electric motor, houses the wet clutch and an electric transmission oil pump to provide the necessary oil pressure for transmission lubrication when the combustion engine is shut off and the vehicle is in electric drive mode.

As we noted at the beginning of this article, all these actions are virtually seamless with nothing required of the driver, and normally occur without the driver even noticing – except when he or she realizes this Mercedes-Benz is providing perhaps 40 mpg on the open road.

High-voltage training for service, or you could be a fatality

Technicians should only service hybrid vehicles with specific, appropriate training – there’s dangerously high voltage under the hood, and Mercedes-Benz requires that personnel performing diagnosis on hybrids must have completed a special qualifying course. Voltages greater than 60 volts DC and 30 volts AC are present on components of the on-board electrical systems, and touching these components can cause burns, spasms, damaged blood cells, or death.

NOTE: Please read the article in the Spring 2015 issue of *StarTuned* online for a more complete discussion of hybrid service safety.

All electrical lines carrying high voltage are identified by an orange warning color and carry a graphic high voltage warning sticker. Anyone wearing electronic implants such as heart pacemakers should not work on high-voltage on-board electrical systems.

The high-voltage electrical system must be de-energized and protected against re-activation before any service operations involving high-voltage components can be performed on hybrid vehicles. The system is de-energized by disconnecting the positive and negative high-voltage battery terminals from the high-voltage on-board electrical system by unscrewing the plug connection on the high-voltage battery module and replacing it with a high-voltage activation lock. This prevents accidental reactivation of the electrical system and safeguards the health and survival of technicians servicing the vehicle.

Select “E” for economical driving, utilizing electric drive whenever possible. Want sport? Select “S” for sporty driving with boost mode. Choose “M” for manual gear selection, strictly for internal combustion engine driving.

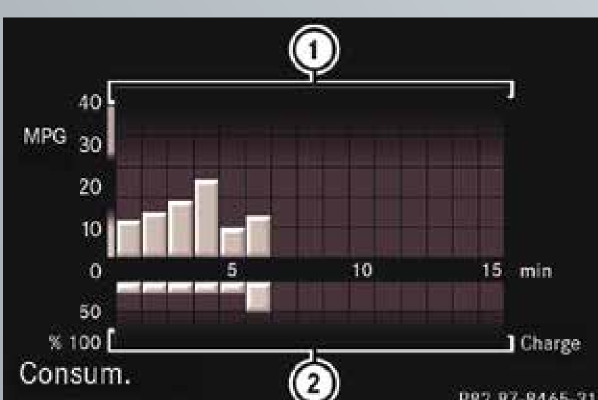
Help prevent a potentially fatal accident or damage to your health by avoiding all wiring and components labeled with a graphic warning sticker.

Once the electrical system has been deenergized, a special lock must be inserted and secured before any service can be conducted to avoid accidental re-energizing.

Ready for 1200 miles on 20 gallons?

What kind of mileage can a Mercedes-Benz hybrid driver expect? In extended highway driving, 35-45 mpg is fairly normal, less for stop and go. But what about a really long trip? British journalist Andrew Frankel recently drove with a co-driver in a Mercedes E 300 BlueTEC Hybrid equipped with a 21 gallon (80 liters) fuel tank from Tangier in Morocco, crossed through Spain and France and reached their destination in Goodwood in England after driving 1222 miles (1968 kilometers) for 27 hours – on one tank of fuel, which is about 60 mpg.

After reaching his destination Frankel reported that the fuel gauge showed enough fuel left over for another 90-100 miles, which puts the potential range of this hybrid vehicle about 1300 miles on a 20 gallon tank of fuel. At this rate, one could drive from New York to Miami, about 1280 miles, in a Mercedes-Benz hybrid with a 20 gallon fuel tank without stopping for fuel - and have fuel left over. |



No need to guess mileage on the road with graphic dashboard screen mpg indicator.

Mit Kompressor

While the latest Mercedes-Benz turbochargers “spool up” much faster than older designs did, until recently there was still a lag before they reached the rpm necessary to provide boost. In 1998, the SLK got a supercharger that provided the “right now” feeling normally associated with larger engines. These and other later models should be showing up in your shop by now, so you’d better know how they work.

In 1854, the brothers Philander and Francis Roots of Indiana tried to improve the efficiency of their textile mill by redesigning its water driven machinery. What they came up with was a pair of wooden figure eight shaped rotors inside a metal casing. The choice of materials was unfortunate – the wood swelled when it got wet and jammed the contrivance. While waiting for it to dry out, Philander spun the rotors by hand, and a blast of wind blew his hat off. Being reasonably alert fellows, this effect was not lost on them, and they developed their invention to the point that it was patented in 1860. It found commercial use in coal mine ventilation.

Auto engineers at the beginning of the 20th century were quite alert, too, and they realized that this type of pump could be used to stuff more air into the cylinders of an engine than atmospheric pressure could, thus increasing its output.

Artificial respiration in the form of a clutched supercharger helped make the original SSK an automotive icon. How about 250 hp and 146 mph in that era? By1931, the SSKL produced 300 hp and topped out at 150 mph.

Although race cars as early as 1909 were using blowers and Daimler technically started developing them in 1921, the 1927 SSK was the first vehicle to really put supercharging on the map.

Of course, exhaust-driven turbochargers also provide a breathing boost, but a blower is different. There's no wait for the extra power to kick in. It's just there, all the time as if the engine had a much-larger displacement than it actually has. As you must realize in this era of increased concern over mpg and carbon footprints, big engines aren't very "green," so getting sprightly performance out of small ones, or to put it another way, achieving more power per unit of displacement, is a worthwhile goal.

Lag and drag

The adoption of mechanically driven, positive displacement superchargers is a good way to achieve that goal. You might argue that a supercharger is less efficient than a turbo since the latter gets a free ride in the exhaust stream. But is it really free? Backpressure is increased, you know.

True, spinning a supercharger does indeed result in a parasitic loss, but this is mitigated during part throttle operation because vacuum helps drive the rotors, taking

While this blown "Hemi" with its six "deuces" is about as impractical an installation as you could imagine, the supercharging principle can be tamed and put to good use through intelligent engineering.

the load off the crankshaft. As far back as the original SSK, drag was eliminated altogether by means of a disc type clutch that only engaged the supercharger when you floored the accelerator.

Mercedes-Benz introduced the SLK (170 chassis) two-seat sports car in 1998. To help keep it light and nimble, the new 2.3L four-cylinder was used (designated M111). While this is a solid engine, a sports car really should offer more performance than an entry-level C-Class (C230).

The solution to this was the addition of forced air induction in the form of supercharging. In '02, the SLK by AMG received a 3.2L supercharged V8, in '03 the C230 got a 1.8L supercharged engine, and all of the AMG 5.5L engines of the time were "blown" as well.

Managing boost and minimizing acceleration lag were engineering challenges that the Mercedes-Benz engineers dealt with very well indeed. You should definitely have an understanding of the configuration and operation of the supercharging system so that you can diagnose any problems logically. Not that there have been many problems – a search for TSB's on the topic turned up exactly one result (a tear in the partial-load vent hose at the connection to the crankcase, which allows air to bypass the MAF and cause a lean condition), but it's still a factor in the overall engine performance picture, and as such part of the puzzle.

Theoretically...

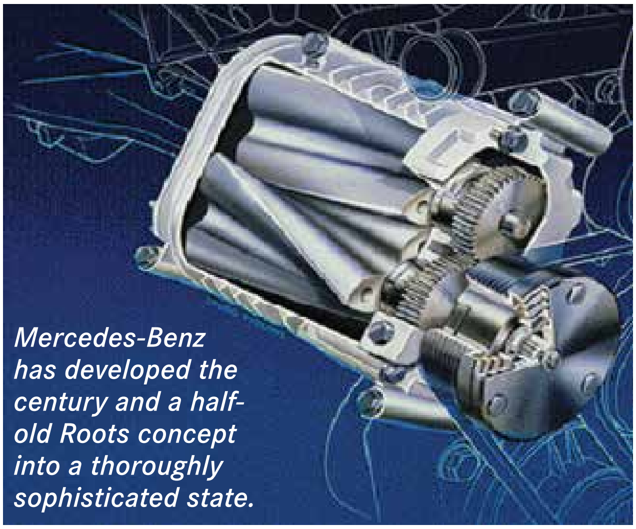
A review of the principles involved makes a good beginning. As an engine rotates through its four cycles, it generates a vacuum in the cylinder as the piston drops to BDC. The atmosphere provides outside pressure to the tune of approximately 14.7 psi (one Bar), depending on your altitude and the weather. This pressure flows toward the vacuum in the cylinder through the open intake valve. At this point, the intake valve closes (depending on the camshaft profile and "scavenging" designed into the system), and the piston starts to travel upwards toward TDC, creating more and more pressure. The power produced by the following combustion stroke is limited by how much air has found its way into the cylinder during the intake stroke, thus how much fuel can be turned into useful work.

By increasing the pressure in the intake system to something higher than 14.7 psi, we can force a greater quantity of air into the cylinder, therefore creating more power. Supercharging achieves this by using the engine's crankshaft rotation to drive a belt that spins the air-compressing mechanism. This forces higher-pressure air into the engine's intake. This "boost" can produce significant horsepower gains.

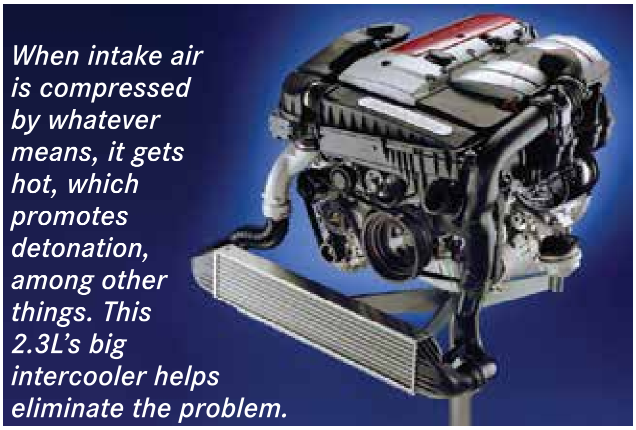
There are limits to this, however. With too much pressure, the mixture may ignite before the intended time. This pre-ignition (also known as detonation) can quickly destroy an engine. This is why on turbocharged and supercharged engines the compression ratio is typically reduced. Also, lower-octane fuels compound this problem by being easier to ignite. So, there must be some pressure-limiting feature built into the supercharging system. A pressure "pop-off" valve can be used, but it's inefficient to waste engine horsepower to drive a supercharger only to blow-off excess pressure that's not needed.

Roots routes

Using the supercharged 2.3L as our example, filtered intake air can take two different paths. Under acceleration, it is directed into the Roots unit, which is a positive-displacement pump that starts to build pressure at relatively low rpm (about 2,000). Pressurizing air makes it hot, so it is routed through an intercooler, which may be of the air-to-air or air-to-water type. The SLK's air-to-air unit travels along the lower front bumper and resurfaces on the driver's side of the engine, entering the throttle body upstream of the plate. Later-model larger-displacement supercharged engines use an air-to-



Mercedes-Benz has developed the century and a half-old Roots concept into a thoroughly sophisticated state.



When intake air is compressed by whatever means, it gets hot, which promotes detonation, among other things. This 2.3L's big intercooler helps eliminate the problem.

water intercooler.

The SLK has a “fly-by-wire” electronic throttle, or EA (Electronic Accelerator), mounted on top of the intake manifold on the driver’s side. But how does Mercedes-Benz control the boost pressure in the intake? Perhaps you’ve noticed what looks like an electronic throttle assembly right at the air-box. This is indeed a similar assembly, but it has a different task. Called the Recirculating Air Valve Actuator flap assembly, it controls which path the air takes.

When it’s closed, intake air is routed through the supercharger, then the pressurized air is sent to the engine. If too much boost is being created for the throttle position (determined by monitoring CPS, TPS, and MAP sensor signals), the Recirculating Air Valve Actuator is opened incrementally to allow air to bypass the blower and continue straight to the intake manifold, or to allow any boost pressure to bleed off back through the airbox. This reduces the amount of air entering the supercharger, thus limiting boost pressure. The actuator flap is not just open or closed. The ME control unit can vary the position of the valve to maintain consistent boost pressure. This helps reduce lag when changing from deceleration to acceleration, and also reduces boost if the level becomes dangerous to the engine.

The Recirculating Air Valve Actuator flap is normally open, and is controlled by a pulse-width modulated signal. The larger the duty-cycle (positive slope), the more the flap is commanded closed. When fully closed, all of the intake air goes through the blower.

On early M111.973 engines, an electromechanical clutch was used to drive the supercharger, in the fashion of an A/C compressor clutch. This allowed the blower to be disengaged entirely so it didn't generate any boost or cause any parasitic drag at low rpm. Above 2,200 rpm, the clutch is engaged and boost is produced. In 2001, the clutch mechanism was phased out, so boost was managed by the Recirculating Air Valve Actuator alone.

Diagnosis and service

When you're presented with a complaint that might be related to supercharging, do a visual examination first, then it's logical to investigate DTCs. If you pull a code P0805 and/or P1235, you're dealing with overall supercharger function. Connecting a pressure gauge to the intake will tell you if proper supercharging pressure is being achieved. With the 92- to 94-octane gasoline that's typically available, any forced-air-induction engine will detonate if boost is excessive, so it is limited to just under eight psi. The codes mentioned are letting you know that even though rpm, throttle application, and load should be leading to boost, it's not actually being achieved. This could be caused by a binding air flap, but it's more likely that there's an air leak in the intake path. A torn boot or a leak at any plumbing joints will often lead to these codes, which may be accompanied by a driveability problem such as a sudden loss of power, or "bogging."

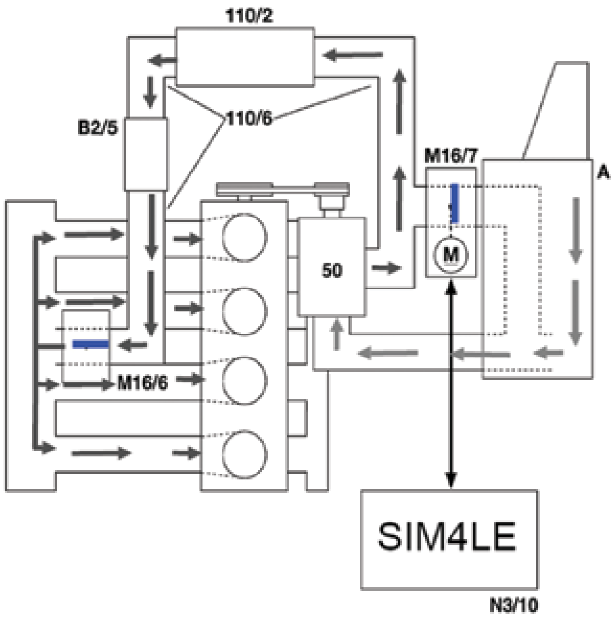
Using your smoke machine might not help you find the source of the leak since it may only open when significant pressure is applied. Keep in mind that worn or broken motor mounts can add stress to air intake plumbing.

Monitoring boost pressure with a gauge while under load is a good way to determine if it is being lost — just verify proper operation of the actuator flap.

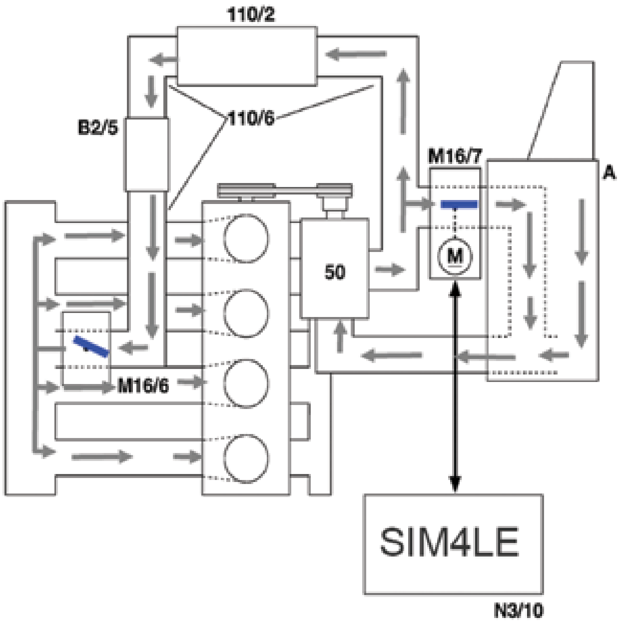
Code mode

Codes P0806 and/or P1236 deal with supercharger clutch operation. There is no speed sensor for the blower, so proper operation is determined by monitoring the clutch's electrical circuit. You can visually check for proper activation, then measure the voltage and current draw of the clutch. This is most easily achieved at the powertrain control unit. For example, on a '98 SLK 230, power is provided to the clutch from fuse F2 in the relay module (mounted in the under-hood, passenger-side electrical box). This fuse also powers up the O2 sensor heaters and the Canister Vent Shut Off Valve, so be sure you know what you're looking at. By evaluating the wiring diagram, you can see that the control unit, connector F, Pin 21, is the ground control of the clutch. By monitoring the voltage and amp draw of the solenoid, you should be able to determine proper clutch operation and isolate a fault between the clutch and the ME's driver.

Codes P0803 and P1243 are for the operation of the Recirculating Air Valve Actuator flap assembly. As already mentioned, a pulse-width modulated signal sent from the ME to the flap's actuator commands it to close and produce boost pressure when the driver wants to accelerate vigorously. As a general rule, the wider the duty cycle (positive slope) of the signal, the more the



This is the path airflow takes when the Recirculating Air Valve Actuator flap is closed. All intake air is routed through the blower so maximum boost can be achieved.



Here, the Recirculating Air Valve Actuator flap is open, so any boost generated is recycled back into the airbox. No positive pressure builds up.

flap is commanded closed. The ME monitors the boost pressure, throttle angle, and mass air flow signals and determines if the flap is working. If you are using a dual-trace scope, you should scope the pressure sensor and the flap actuator command signals. As long as rpm is increasing, the pulse width on the command line should increase as the signal voltage on the pressure sensor indicates more boost. If the pressure is dropping while the duty cycle command is increasing, either the actuator flap is malfunctioning, or boost pressure is leaking out of the intake system.

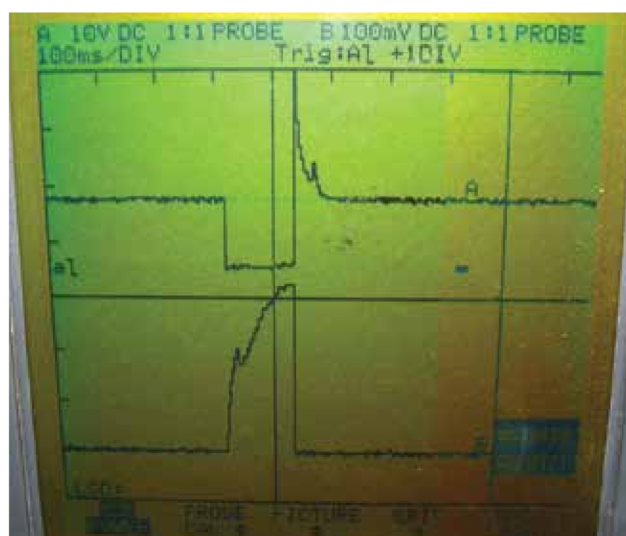
Oil contamination may soften the intake boots over time. If the clamps are not tight, pressure may be lost at these boot connections. This is difficult to detect since it may take eight psi to force the leak to open, but visual and tactile inspection should uncover any problems.

Double duty

On the M111 engine, the supercharger doubles as the secondary air pump. This means the supercharger clutch must be activated for 30 to 90 seconds after the vehicle is started to supply the exhaust system with fresh air to aid in heating up the catalytic converters. So, diagnosing a secondary air injection code includes testing supercharger function. Activating the blower clutch and the secondary air control solenoid while at idle should pump fresh air into the exhaust. You can monitor additive (idle) adaptation to see that fuel is being added. Remember to have the fuel system in closed loop so that fuel trim adaptation is functioning. You can also watch O2 sensor voltage to see that it drops to under 100mV indicating a lean condition.

Specific super lube

Any Roots-type supercharger has a non-contact air gap, so rotor vanes should not be rubbing together. The supercharger assembly, however, does require special lubrication. The C230K and SLK230 have their own oil, Part Number 000 989 62 01. It is added through the fill/inspection plug hole. The 3.2L and 5.5L AMG engines use a different supercharger lubricant – Mobil Jet Oil II. Also, the 3.2L and 5.5L AMGs have a Charge Air Cooler Circulation pump. This uses liquid coolant to keep the temperature of the supercharger within bounds. As mentioned earlier, the 3.2L and 5.5L engines by AMG use an air-to-water intercooler, so be sure to drain coolant and bleed the cooling system when servicing the intercooler. As with any other belt-driven component, belt wear and proper tension are important.



On this scope, we are monitoring the voltage pattern (top trace) and amperage pattern (lower trace) of a supercharger clutch. Notice how the draw peaks at just over 3.0 amps. About 3.5 amps is the maximum you should see on a good one.

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Mercedes-Benz

Why did that Battery Have to Die?

Tracing Parasitic Drains

Tracking down mysterious current draws that gradually drain batteries seems as if it should be simple, but it rarely is. More often, tracing them can require a substantial amount of detective work. That's the tough part. Once you've identified the source of a key-off current draw, the repair is usually simple.

Even a high-quality O.E. battery with substantial reserve capacity can't hold out for long against parasitic drain.

Tracking down mysterious current draws that gradually drain batteries seems as if it should be simple, but it rarely is. More often, tracing them can require a substantial amount of detective work. That's the tough part. Once you've identified the source of a key-off current draw, the repair is usually simple.

Start at the beginning

Before you start digging into wiring schematics and fuse boxes, it's best to get detailed information from the customer as to the exact symptoms he or she is experiencing.

- What makes the customer think there's an unwanted current draw? The answer is normally a battery that goes dead after some period of time, but query in detail; don't let the customer perform the diagnosis for you. Today's Mercedes-Benz vehicles carry advanced electronic systems, and some symptoms that were pertinent decades ago, which your patron may have heard from an aging relative, no longer apply.
- Get specifics from the customer. Exactly what circumstances precede or precipitate the problem, presumably a dead battery? How long does the vehicle have to sit before the battery goes dead? Does the problem appear after a long drive? After a short drive? After the car's been sitting for a week? Does the problem only occur in warm weather? Cold weather? After a teen-age son or daughter has driven the car? Any recent collision repairs?

Although Mercedes-Benz recommends the use of the sophisticated battery testers from Midtronics, some technicians still like to double-check real-world capacity with an old-fashioned VAT and its carbon-pile load.

- Determine if any service was performed just before the problem developed. Battery, alternator, or starter replacement? Installation of any aftermarket products like sound or anti-theft systems? Any other electrical system-related service? Have any fuses blown lately or repeatedly?
- Are there any other electrical system problems or issues? Are headlights or any other lights dim or even flashing? Turn signals slow? Windshield wipers slow? Any driveability issues?
- Mercedes-Benz has produced a detailed "Current Draw Customer Questionnaire," which should be filled out with the customer, not by the customer. See your local Mercedes-Benz Dealer Parts Department for a copy.

Look first for the obvious

Certainly, you want to start your diagnosis with the most obvious steps. Check the condition of the battery posts and cable clamps, the main chassis and engine grounds, the state of charge by voltage, then test capacity either with an electronic impedance tester, or even an old-fashioned VAT with its carbon-pile load (in fact, many techs still prefer the latter). You may have to give the battery an external charge if it has been run down.

If you're not completely satisfied with the battery's basic health and the cells have removeable caps, you might want to do a traditional hydrometer check. At 80 deg. F., a reading of 1.260 1.270 (subtract .004 for every 10 deg. below 80) corresponds to the proportions that constitute a full charge – 24% acid by volume, 35% by weight. If the float only rises to, say, 1.120, enough acid has turned to water to render the battery deceased for all practical purposes. Charge it and try again. If any cell reads .050 less than the others, and doesn't shape up after another blast on the charger, replacement is the only remedy. By the way, hydrometer testing isn't accurate immediately after adding water, if there's been a recent heavy discharge, or during charging.

Make sure the charging system raises the voltage sufficiently when the engine is started (13.8 to 14.2V depending upon temperature) to assure that the battery is being properly replenished. Look to see if there are any stored DTCs that would point to a particular problem area. And use your sense of hearing as well. Listen carefully under various circumstances for the possible sound of a relay clicking, which might well point to the source of the problem.

Next, you should check to be sure there actually is a parasitic power draw beyond what's normal with the key off, and after the vehicle has been sitting unmolested for a reasonable time. Depending on the year and model, normal draw will range from 30mA or less all the way up to 100 mA (CAN asleep). You can use a digital multimeter (DMM) to measure a parasitic current drain, which Mercedes-Benz refers to as "quiescent" current draw.

Traditionally, this was done by inserting your DMM's leads in series between the battery's negative post and the negative battery cable.

But there's a catch in modern vehicles. You must complete this procedure without breaking the electrical connection between the battery post and cable. If you accidentally or intentionally break the circuit when removing the terminal from the battery, it's possible that, when you re-make the connection via your DMM, one or more modules may "wake up" and re-enter an initialization process. This might blow the fuse in your DMM, and would also create a current draw that would complicate your measurement and tracing of a true, abnormal parasitic loss, which would be masked by the current draw of the module.

If you do inadvertently break the circuit during this process, you'll have to postpone further testing until the module completes its initialization cycle and goes back to sleep. Or, if your scan tool has the capability, you can command the module to go to sleep quickly.

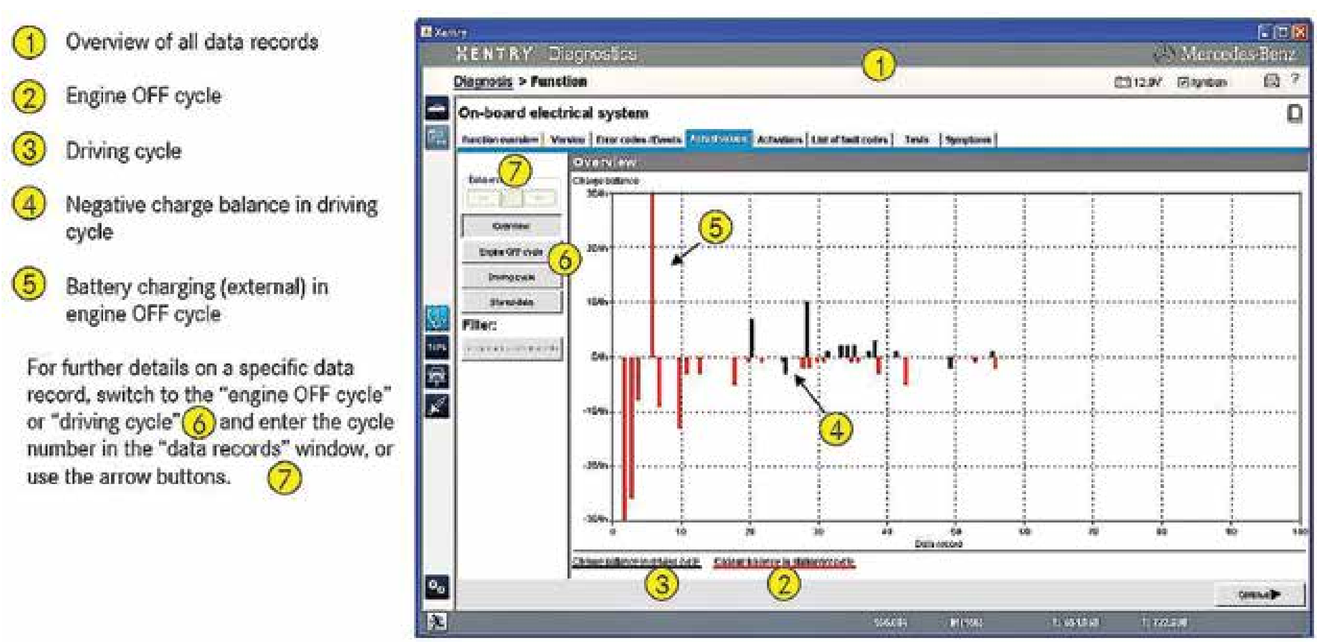
As such, you need to be careful to establish a shunt circuit with a jumper wire when connecting your DMM in series with the negative battery cable and terminal. You also want to implement this procedure with as many electrical devices turned off as is possible. So, for instance, you want to complete this step with doors closed so that courtesy lights are off.

Mercedes-Benz service training suggests that you avoid that extra effort by simply connecting your DMM in series between the negative battery post and a good chassis ground so no disconnection is necessary.

With your DMM now duly connected, you can determine the actual amount of current draw in milliamps, or — heaven forbid — amps. The amount of current flowing with everything off will help you determine likely sources of the parasitic power draw. It will be helpful to know the amperage draw immediately after the ignition is turned off, and how long it takes for all of the circuits to resume slumber. Bear in mind that if the current draw drops after some period of time, it may be necessary to switch the measurement range of your DMM in order to get accurate readings if it is not auto-ranging.

The amount of current draw can help point you toward the source of the power loss. Look to assure that, on vehicles without the Keyless Go feature, the ignition key is removed, all devices are unplugged from any power outlets, and the doors, hood and trunk are open with their switches defeated so the car thinks they are all closed. This allows you to poke around without opening something and waking the vehicle.

Note too, that your 12V incandescent test light is a tool that should be reserved for older vehicles with far less sophisticated electrical systems. The electrical components and circuits in late-model Mercedes-Benz



XENTRY screen with all driving and engine OFF cycles.

vehicles can, in many cases, draw far less current than it takes to visibly illuminate a simple 12 volt test light (although the LED type will work fine). You may be searching for a much more subtle parasitic draw. So leave that antiquated test light in the tool box and stick with your DMM and scan tool for this job.

Of course, if you've invested in the ingenious XENTRY diagnostic system, or you have an aftermarket substitute, you can follow the on-screen menus and directions to investigate parasitic draw. For example, you can look into "bus keepawake unit monitoring in the electronic ignition switch," and you might find an unusually-long waking period for the body CAN.

Also, you can and should access data from the Intelligent Battery Sensor (IBS) for clues that will help guide you to the source of the current draw. But bear in mind that the IBS system, which monitors the battery's condition about four times a minute when the vehicle is "sleeping," will not necessarily point you directly to a faulty component.

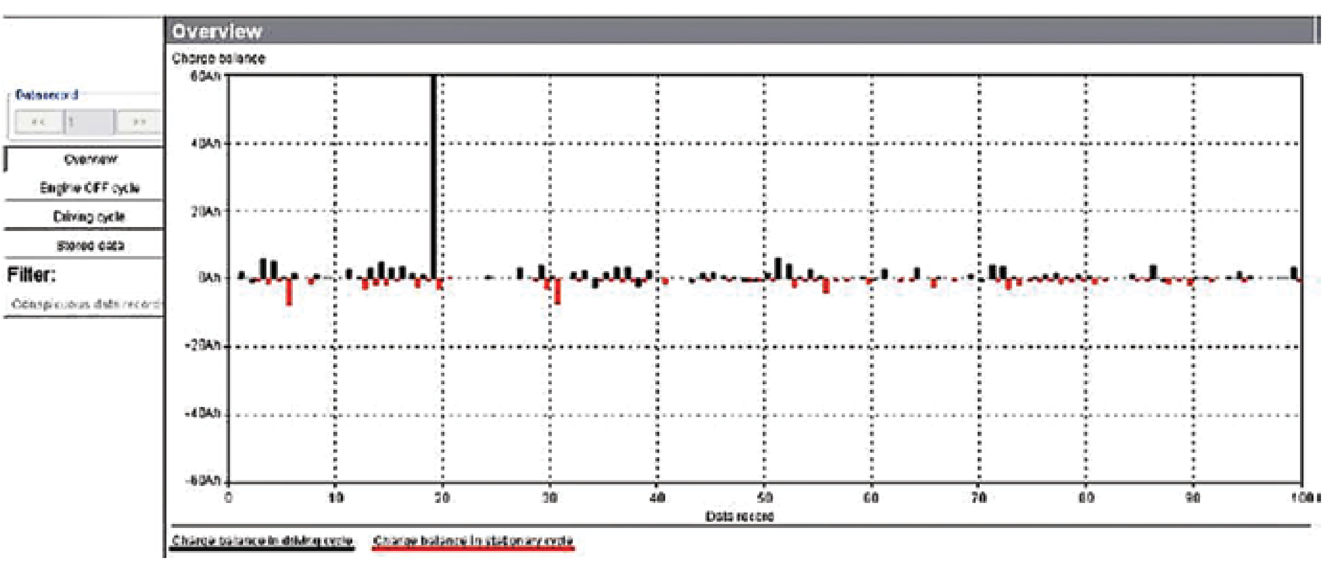
Choose the fuse

The fuse box is your friend, but not for the reasons technicians have traditionally believed. While pulling fuses and watching for the current draw to disappear worked well for the cars of yesteryear, that procedure will not help you given the advanced electronics of today's Mercedes-Benz vehicles. Doing so will only confuse the modules, circuits, relays, and the CAN itself, all of which operate off of battery power.

But don't despair. The fuse box really can be your friend in tracking down parasitic current draws. It's just that you have to avail yourself of that friendship in a different way. Start by assuring that all CAN bus networks are inactive and all fuse boxes are readily accessible. You'll need your DMM, an amp clamp, and test leads/probes. The key in this process is to track the current path of the parasitic drain from the battery to the device that's drawing current without disturbing any electrical circuits in the vehicle. That's why pulling fuses is not a suitable process for modern times .

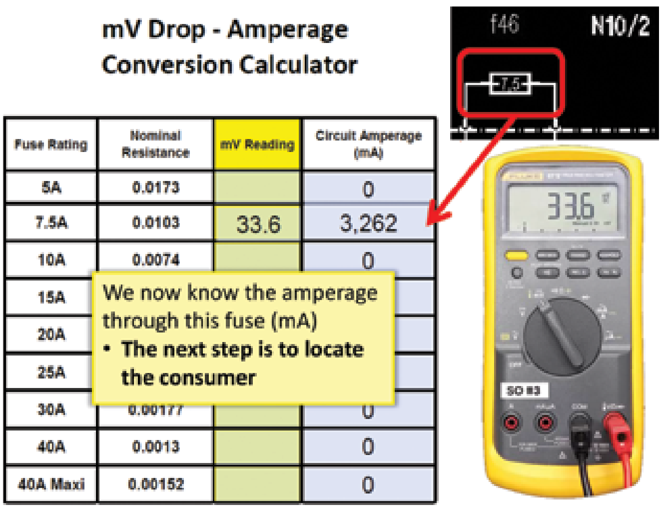
Rather, what you want to do is track the parasitic (quiescent) current draw from the battery to the guilty device. You can start by using your amp clamp on the battery negative/ground cable. As a general rule on

These days pulling fuses one at a time while watching the milliamp draw reading taken between the negative battery post and the cable clamp is "Verboten." Instead, read the mV drop across the fuse, then convert that to mA.



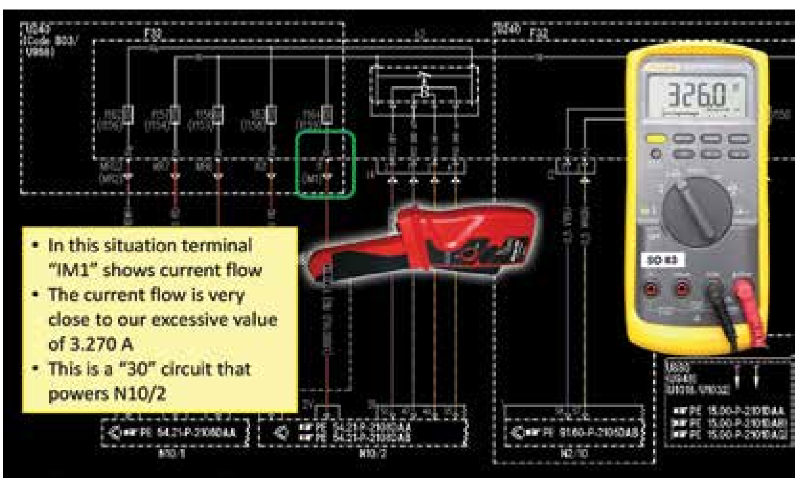
The IBS system provides this kind of readout from a vehicle with a dead battery.

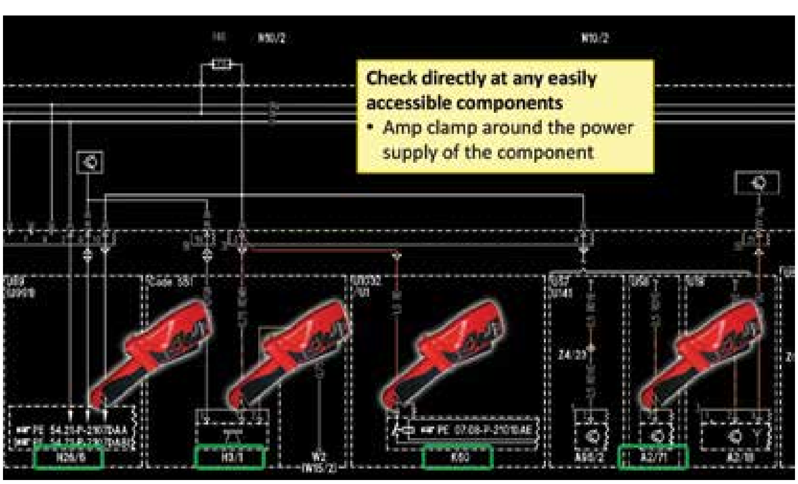
Mercedes-Benz vehicles, you should observe current draw of less than 100mA after one hour, although this spec may vary from model to model.



Fuse Rating	Nominal Resistance	mV Reading	Circuit Amperage (mA)
5A	0.0173		0
7.5A	0.0103	33.6	3,262
10A	0.0074		0
15A			
20A			
25A			
30A	0.00177		0
40A	0.0013		0
40A Maxi	0.00152		0

The voltage drop across a fuse, minus the known nominal resistance for a fuse of that amperage, will yield the actual current draw in mV, which can then be converted to a more helpful reading in mA.





Compare the spec against the actual reading in milliamps; the difference is the unwanted, abnormal parasitic current draw.

Next, proceed to the pre-fuse box if it is accessible, and, using your amp clamp, measure the current from each output in search of a draw that matches your calculations from above. If you find a circuit whose amperage draw closely matches that which you calculated, then you have likely found the faulty circuit.

Now to the fuse box itself. Do not pull fuses, but rather use your DMM to measure voltage drop across each fuse using the narrow pointed probes you set aside earlier. Circuits with no current draw should show zero voltage drop across the fuse, since no current is flowing. A circuit that is drawing current will show a tiny, but measurable voltage drop in millivolts across the fuse, reflecting the fact that the circuit being protected by that particular fuse is powering something, normal or abnormal.

Note that the resistance and voltage drop across fuses will vary with the amperage rating of the fuses, and that you're dealing with very small units of measure when detecting millivolts, so you will need a highly accurate professional-quality DMM for these measurements.

Once current draw (in millivolts) is measured across one of the fuses, use an appropriate chart to convert the mV reading to milliamps (mA). This will identify the exact amount of parasitic current draw. At this point, the detective work becomes much easier, as you now know which circuit is responsible for the draw, and the amount of the draw. Now, the much simpler task is to identify the component protected by that fuse that is responsible for the current draw and correct the problem.

A given fuse typically protects several circuits, so you can use your amp clamp to probe each of the circuits protected by that fuse.

See the example at left.

At this point you can replace the faulty relay and road test the vehicle to confirm that the excessive quiescent current draw has been eliminated. Of course, the procedure is similar if your diagnostics point to some other potentially faulty component. Once you identify and correct the fault, you'll certainly want to perform a road test, current draw test, and perhaps an overnight test as well in order to confirm that you have indeed found and corrected the fault.

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® 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
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.

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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 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		

Adhesive Bonding and Riveting
The Cold-Joining Advantage

The heat of welding can seriously compromise the strength of the advanced materials used in the building of modern Mercedes-Benz vehicles, so adhesive bonding and riveting have become mandatory skills for collision techs. Also, cold joining has other advantages that you may never have realized.

Complex phase (CP) martensitic steel has been used in side impact beams and B-pillar reinforcements in the Mercedes-Benz M-Class for over a decade.

Images courtesy of Mercedes-Benz Workshop Information System (WIS), and RAE Systems, the leading supplier of Wielander+Schill equipment.

Mercedes-Benz has responded to ever-increasing fuel economy and emissions reduction goals by designing and building lighter vehicles. The high-strength steel, aluminum, composite polymers (plastics) and other advanced materials used in these lighter vehicles required new joining technologies to avoid heat-related loss of strength in joints and adjacent panels. Post-collision repairs to these vehicles require technicians to replace arc, metal inert gas, and, in some cases, even resistance spot welding with newer cold-joining techniques of adhesive bonding and riveting. There is a dizzying array of different rivet types and repair procedures, but the instructions are pretty straightforward. It is now more important than ever to use the Mercedes-Benz procedural information when planning repair or replacement of collision-damaged components made of these advanced high-strength materials.

Steel deal

Unibody vehicles have historically been fabricated primarily from mild steel sheet parts joined using resistance spot welding and, where access was limited, to one side only, metal inert gas (MIG) welding. Mild steel can tolerate brief application of heat almost up to its melting point of 2,660 deg. F. (1,460 deg. C) without losing significant strength properties.

The advanced materials in today's lighter, more fuel efficient Mercedes-Benz vehicles, including dual-phase (DP), boron, and martensitic steels, as well as aluminum, magnesium, and plastics, although significantly stronger, are less able to resist heat damage than mild steel.

Advanced high-strength steels (AHSS) are produced using thermal techniques that result in internal chemical structures that are degraded by exposure to heat. High heat reverses, or at minimum weakens the chemical bonds that were created in the steel during the manufacturing or forming processes. The threshold at which heat can damage AHSS is well below the temperatures at which technicians have traditionally welded mild steel. High heat is Kryptonite to these super-strength materials.

For this reason, DP, martensitic, transformation-induced plasticity (TRIP) and other advanced high-strength steels are not to be joined or straightened using heat. Different joining procedures, materials and tools are specified as needed based on the type of AHSS being replaced or repaired.

DP steel is used on Mercedes-Benz C-Class and E-Class models. TRIP steel is used on S-Class, C-Class and A-Class models. Complex phase (CP) martensitic steel is used in side impact beams and B-pillar reinforcements in the Mercedes-Benz M-Class, S-Class, and C-Class models from the early 2000s. Repair instructions may not mention which steel the component is made of, but each type of advanced steel is in use on one or more Mercedes-Benz models. If you guess wrong about the type of material a structural component is made of, or deviate for any reason from the OE-recommended procedures, you risk failing to restore the vehicle to the specifications required for safety in a future collision. You absolutely have to access and follow the OE repair instructions.

The new materials spread from initial use in applications such as reinforcement of front strut towers, door hinges, and engine cradle cross members, to hood and trunk lid, roof and exterior body panels, and, ultimately, into all structural components. The broad use led to many applications that required connection of two or more different materials into one joint. This hybrid construction, or combining of different material types in one joint, led to even greater numbers of components beyond just those made of advanced steels, for which use of heat during repair is unacceptable. As carbon fiber, plastic, and other composite materials find expanded use in making automobiles lighter, heat will be used on even fewer joints.

Dissimilar metals make a wet cell

Where aluminum and steel must be joined together, the aluminum softens at a far lower temperature than steel. It cannot be welded using MIG and other high-heat joining methods. Additionally, there are currently over 400 aluminum alloy designations listed by the North American Aluminum Association, which maintains the official registry of aluminum alloys. Each has possibly different responses to heat or to specific mechanical joining technologies. To further complicate matters, an aluminum alloy may be formulated one way for a given component application, and a different way for use in another part or vehicle, even though the original alloy designation is the same. Knowing that two different vehicles use the same alloy designation for some parts does not guarantee that each aluminum part made of that alloy will respond to heat or mechanical joining technologies in the same manner.

Refer to the Mercedes-Benz Workshop Information System (WIS) or other sources of OE information for detailed replacement or repair procedures for any work on parts made of new materials. This is especially important for work on structural components, which are critical for restoration of vehicle crashworthiness.

Hot joining technologies can cause problems beyond just a generalized reduction of the strength profile of advanced metals. For example, the heating and cooling cycle that occurs during welding affects weld microstructure and the surface composition of the surrounding metal. It can make the weld area vulnerable to corrosion due to deformation of joined parts in the heat affect zone (HAZ), moisture ingress, incomplete weld penetration or fusion, porosity, cracks and residual contaminants.

Also, galvanic corrosion occurs when aluminum and steel are in direct contact with each other and there is moisture in the air. High heat may draw moisture into the weld joint. The moisture provides electrical conductivity, and enables the two different metals to behave like an anode and cathode pair. They create a battery-like electrolytic reaction that over time, corrodes and eats through the softer metal. This is especially true in coastal areas, where moisture from sea air contains salt that accelerates the galvanic reaction.

Resistance spot welding is often combined with adhesive to strengthen and seal the joint, and to reduce the risk of galvanic corrosion. By providing a bond along the entire length of the joint, adhesive spreads the impact load of a collision. The impact energy may be strong enough to snap a few localized spot welds, but less likely to destroy a joint that has both spot welds and adhesive. The non-metallic adhesive also provides a barrier that prevents the electrical conductivity between aluminum and steel (or any two dissimilar metals) that would otherwise allow the start of galvanic corrosion.

Unfortunately, adhesive cannot be in the immediate weld area. It would alter the chemistry of the weld nugget, and weaken the weld bond. At the factory level, precision spot welding robotics and far more sophisticated control of weld parameters than we have in the field allow vehicle manufacturers to minimize risk of galvanic corrosion. In the repair environment, the higher percentage option is to use cold-joining techniques such as riveting for zero heat damage, combined with adhesive bonding for increased joint strength, sealing, and protection of hybrid joints against galvanic corrosion.

One size does not fit all

Rivets come in different types, shapes and sizes, and must be matched to the vehicle application. Mercedes-Benz uses pop rivets, punch rivets, self-piercing rivets, flow-form and other rivet types. Hardness of the materials being joined, the required strength of the joint, compatibility with the materials for corrosion resistance purposes are just a few of the factors that determine which rivet is appropriate for the job.

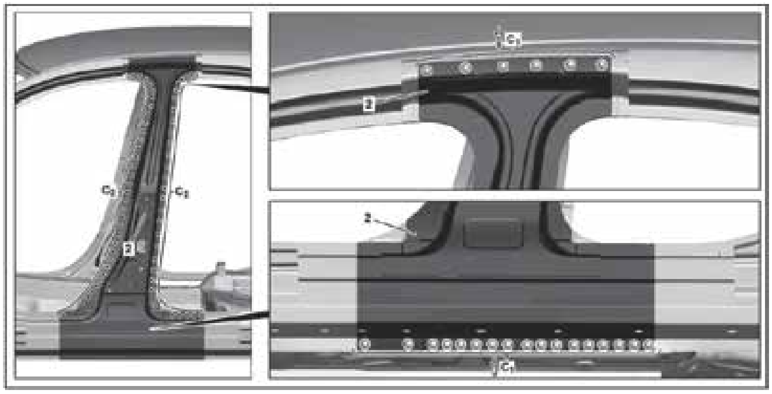
For example, rivet length is decided by the panel stack thickness. Different rivets have a specifically designed break point. Choose a rivet that is too long and it will not hold the panels tightly, too short and it may break off inside of the hole and allow one or more panels to separate from the joint.

The rivet tool must also be matched to the job. Are attachments available that allow you to access the flange or panels to be joined? Different rivets vary widely on how much clamping force is required. Too little, and the tool fails to set the rivet at the correct depth for long-term durability of the joint. Too much, and the tool may deform or weaken the flange or material surface. Refer to Mercedes-Benz repair information for identification of the correct rivet and tool for a given rivet bonding application.

Riveting plus impact-toughened adhesive

Its high tensile strength makes it difficult to pull a riveted joint apart vertically. Riveted joints resist peel damage during a collision.

However, a rivet is by itself less able to resist shearing under the stress of horizontal movement of riveted panels in a collision. The addition of adhesive to a riveted joint increases its shear strength by cementing the entire length of the joint. Adhesive also increases vehicle body stiffness and NVH benefits, as well as providing the aforementioned corrosion resistance and sealing.



The B-pillar reinforcement (2) on the Mercedes-Benz S-Class is riveted at the top and bottom (areas C1), and spot welded along the vertical sides (C2).

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Crash Durable Adhesive (CDA) differs from conventional structural glue in that it has the ability to stretch under impact without losing its grip. Tests of a collapsible rail with and without adhesive show that the rivet-bonded joint without adhesive ripped open, while the rail with riveting and CDA collapsed in a more controlled fashion, and did not split open.

Mercedes-Benz uses Crash Durable Adhesive (CDA) on many models, including those in its C-Class, GL-Class, and ML-Class lines. CDAs may be recommended for use in A, B and C-pillars, roof joints, and panel bonding. It works on steel, aluminum, and other materials. Failure to use the correct OE-recommended CDA can have a negative impact on repair quality and safety in the event of a future collision.

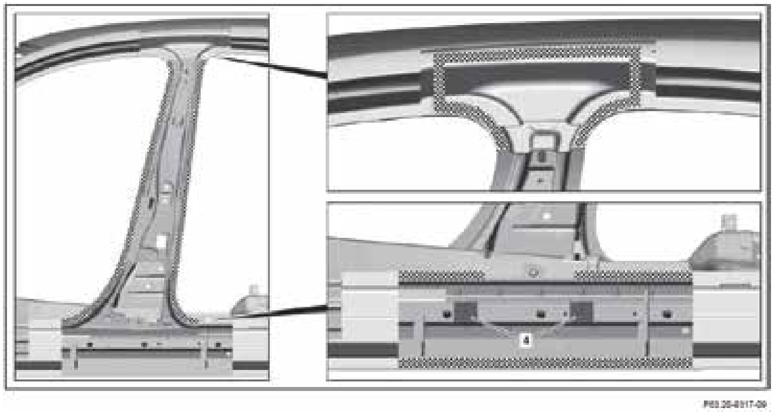
You call that clean?

Preparation for adhesive bonding is extensive and mandatory. First you'll clamp or screw the parts to be joined into place and check for proper fit and alignment. Drill and deburr rivet holes as needed. Remove metal shavings and swarf from the work surfaces. Once you're happy with the results of your inspection, take the parts off and clean all surfaces that are to be bonded.

To ensure a good bond, surfaces must be ground bare. You can grind steel with a steel wire brush or sandpaper. For grinding aluminum, you must use a stainless steel brush or silicate sandpaper – never regular paper. Next, clean the surfaces with the Mercedes-Benz approved solvent to ensure removal of all oil, grease or paint.

Don't trust what you see. Apply the recommended indicator fluid to confirm that surfaces are free of any trace of contaminants. If blotches appear in the indicator fluid, repeat the solvent cleaning and indicator application steps until the indicator fluid application results in a uniform color. Once the surfaces are clean, wipe away the indicator fluid with solvent. When the solvent evaporates, the surfaces are ready for application of two-component adhesive.

Place the adhesive cartridge in your applicator gun. Squeeze out an inch or so, just enough to be sure that the two parts come out in equal amounts. Affix the mixing nozzle to the cartridge, and you are ready to begin.



The body and inner B-pillar on the Mercedes-Benz S-Class receives two-component structural adhesive all around the outer (cross-hatched) areas. Two-component adhesive is also applied on structured foam parts (4), to hold them permanently in position.

The XPress 800 Modular Rivet System is used here with a small C-clamp adapter to insert punch rivets in the rear trunk flange on a Mercedes-Benz E-Class. The Xpress 800 features adjustable operating pressure and rivet insertion speed, for complete control over setting riveting strength, with no workpiece distortion.

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Using an acid brush or plastic spreader, apply adhesive to the surfaces to be bonded. Follow the manufacturer's instructions for the thickness of the adhesive layer. Unless they are to be spot welded, cover all bare metal areas. In any areas to be welded, apply weld-through primer instead of adhesive.

When adhesive application is complete, check alignment and clamp the work together. Do not separate adhesive-treated surfaces once you have pressed them together. Insert rivets. Run a flat tool along the bonded edges of the joint, to seal the seam and remove excess adhesive. Stand back and admire your work.

Explosion, corrosion, and respiratory problems

A by-product of drilling rivet holes and grinding to expose bare metal is the creation of fine metallic dust that is light enough to become airborne. Set up partition curtains or a separate room for working on aluminum. Mask adjacent panels and nearby body parts so that dust from working one type of metal has no opportunity to settle on the other, where the combination of aluminum and steel will cause galvanic corrosion.

You'll need a wet mix vacuum to extract metallic dust and chemical fumes generated during repairs. Aluminum dust is highly explosive even in small concentrations, making it a risk for a shop environment in which sparks can potentially occur. The vacuum also helps prevent the dust settling on adjacent steel panels and components, laying the groundwork for corrosion formation. Last but not least, it will help keep metallic dust and adhesive and solvent fumes out of technicians' lungs, where they could otherwise cause respiratory problems.

To prevent dust from sticking to tools and transferring back and forth between dissimilar metals, get a separate set of tools for working aluminum. Mark them so they are readily identified. Something as simple as wrapping red tape around the tool handles makes it easy to keep tools used for aluminum repair separate from those used on steel.

The untouchables

Some components cannot be repaired. With rare exceptions, aluminum structural components must be replaced rather than repaired. Any damaged magnesium components, structural or not, must be replaced.

Attempting to repair magnesium components using welding, cutting, soldering, grinding or any spark-producing method is strictly prohibited. Like with aluminum, grinding or cutting magnesium can create a very fine dust that has a high explosion risk. Worse, magnesium can auto-ignite at temperatures as low as 883 deg. F., and burns at over 5,600 degrees! And you can forget about putting out a magnesium fire with water. Magnesium burns hot enough to separate the hydrogen and oxygen atoms in water. You'll be feeding the fire with hydrogen, a flammable gas, and oxygen, a gas that helps fire spread more readily. Your water hose will function like a really good flame thrower.

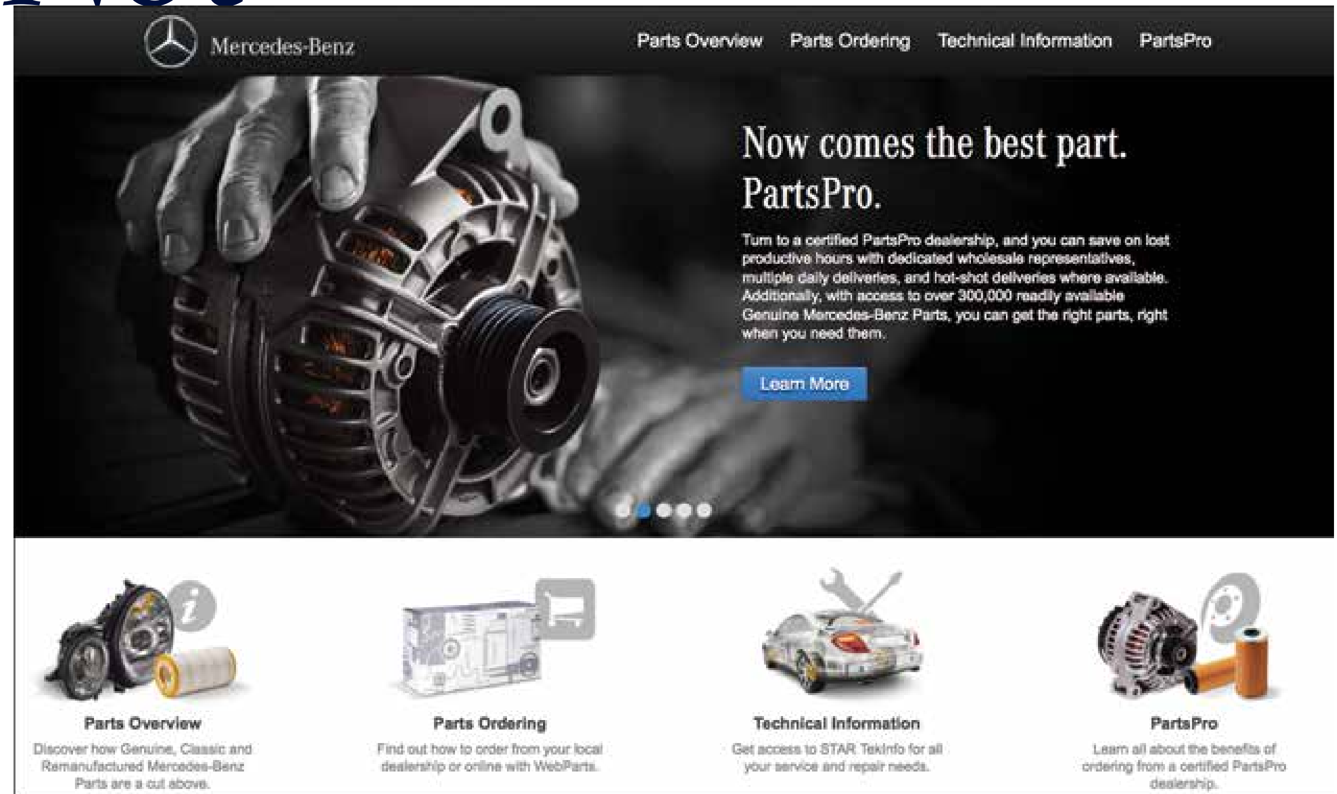
Say goodbye to welding heat

There are a few more rivet choices to make than there are welding parameters to set, but cold-joining is the smarter way to create durable joints with the advanced materials in today's lighter, stronger vehicle bodies. Get rid of the Kryptonite. Adhesive bonding and riveting techniques are here to stay.

This aluminum work area is clean, neat – and separate!

the Net

Sourcing Mercedes-Benz Repair and Parts Information



Model Indicator Index provides the ability to find chassis, model year and engine detail from the VIN which assures proper catalog identification of the vehicle when using the EPC.

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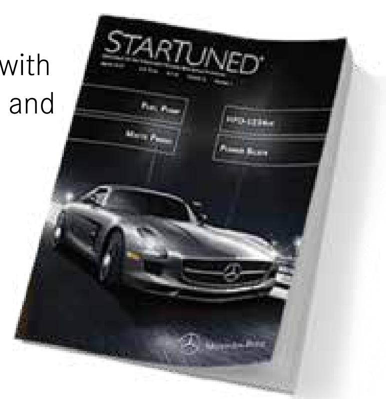

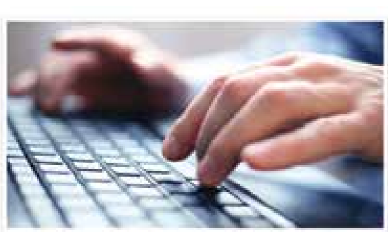

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