STARTUNED®

Information for the Independent Mercedes-Benz Service Professional

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TO OUR READERS:

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

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

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

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

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

Send your suggestions, questions or comments to us at:

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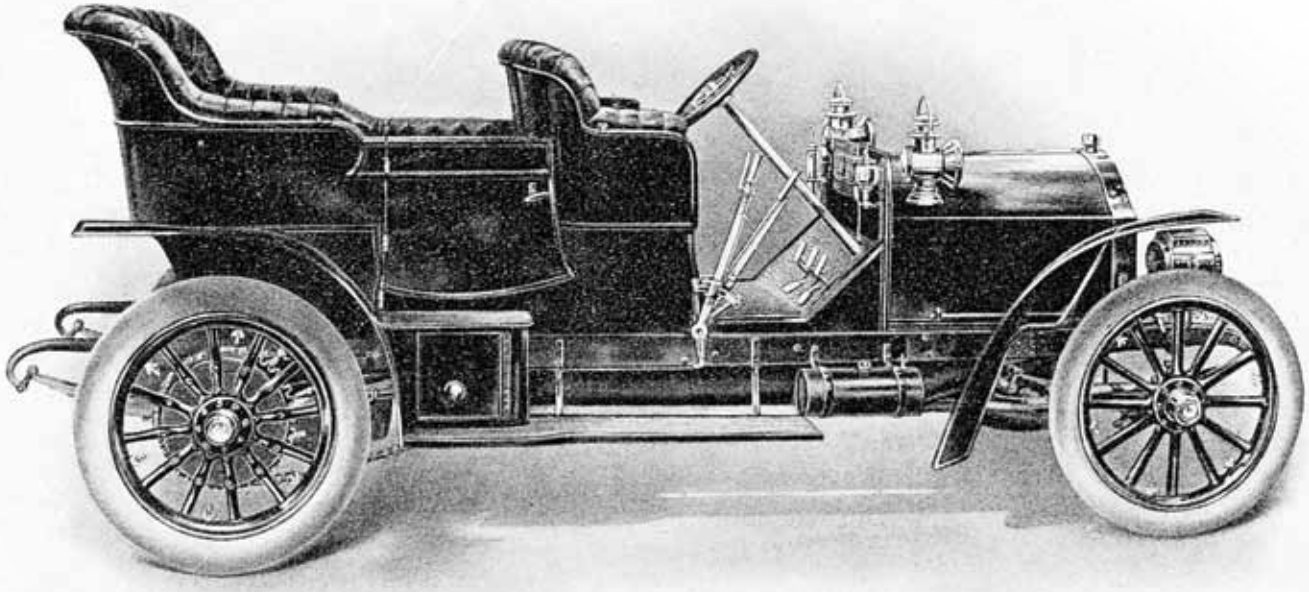
In 1888, the New York piano maker Steinway & Sons obtained the rights to all Daimler patents in the U.S., and produced the "American Mercedes" from 1905 through 1907.



45 HORSE-POWER AMERICAN MERCEDES

Mixture Formation

With emissions and mpg both looming so large right now, you can't have your customers driving around with the MIL on, but it's not always so easy to find the cause of a fuel system glitch

Check fuel pressure before you get into high-tech diagnosis.

Some of the most common driveability/emissions repairs we are asked to perform involve the engine's fuel control system. This is not just because of gas mileage concerns and illuminated MILs (Malfunction Indicator Lamps), but also because more and more states have adopted some sort of emissions inspection program. Typically, if the MIL is on, the vehicle will not pass. Also, your customers don't like seeing that warning light any more than they want to be burning extra gasoline. They know there's a problem with the system, so they want it fixed, and who could blame them? So it becomes your job to identify the source of the malfunction and correct it. That may sound simple enough, but we know from experience that if the DTC (Diagnostic Trouble Code) that's present is related to the fuel system, there are often many twists and turns in the trail that leads to the source of the trouble. What tools do we have to identify the problem?

First Things First

Since the fuel system is one of OBD II's three continuous monitors, if a problem exists it is probably going to set a DTC. Of course, attend to the basics first, such as measuring fuel pressure

Vehicle 203.064 Control unit ME-SFI 2.8

Self-adaptation

No.	Name	Specified value	Actual values	Unit
008	B28 (Intake manifold pressure sensor)	<= 500	335	hPa
181	Self-adaptation enabled		YES/NO	
576	Selfadaptation in idle speed range, right bank of cylinders	[-1.000...1.000]	0.374	ms
596	Selfadaptation in idle speed range, left bank of cylinders	[-1.000...1.000]	0.365	ms
577	Self-adaptation in lower partial-load range, right bank of cylinders	[0.680...1.320]	1.000	
597	Self-adaptation in lower partial-load range, left bank of cylinders	[0.680...1.320]	1.000	
578	Self-adaptation in upper partial-load range, right bank of cylinders	[0.680...1.320]	1.000	
598	Self-adaptation in upper partial-load range, left	[0.680...1.320]	1.000	

On this '02 C320, you can see that the idle fuel adaptation is displayed in milliseconds and the part-load readings are split into two different rpm ranges, lower part load and upper part load. In this case, the injectors are pulsed .3 more due to a lean condition at idle.

and doing a visual check of electrical connections, wire integrity, hoses, etc. Then there are the many sensors and solenoids that determine how much fuel is actually injected. If you have an SDS, you will have access to the most comprehensive data available. For example, look at coolant temperature as the engine warms up to verify that the thermostat is keeping the coolant within the proper range. Typically, if the thermostat is opening too soon the PCM will flag a Code P0128. Engine speed and load signals determine the base pulse width, so have the largest affect on mixture formation. This is providing the Mercedes-Benz self-diagnostics have not found a problem with other input sensors.

Feedback, Feedback, Feedback . . .

Believe it or not, the oxygen sensor arrived on the automotive scene over three decades ago. The PCM looks at the signal voltage it generates to tell if the mixture is rich or lean. If the signal indicates lean, the PCM will add fuel by increasing pulse width, and vicesa versa. You can see the fuel trim indication in the data stream. Mercedes-Benz breaks down these fuel trim numbers into two readings. The first is "Additive" fuel trim. This reading tells you what the PCM is doing to the mixture at idle and just off idle. In the SDS, it is also referred to as the "Idle" trim reading, and, on older systems, "lower part load." If you see this number deviating from the center point, you should perform testing while the engine is at idle. If the problem is above idle and under vehicle load, you should look at the "upper part fuel trim," or "Multiplicative" number. This represents fuel trims throughout the rpm range.

A Rose By Any Other Name

These numbers can be represented on several different scales. The SDS typically displays them as either a millisecond adaptation (ms), or in Lambda. If you'll recall, Lambda is a scale based on stoichiometry, the ideal ratio of 14.7 parts air to 1 part fuel by weight. This is represented by the number 1.00. If the adaptation number is below this, the computer has seen a rich condition from the oxygen sensor, so is reducing fuel. If the number is above 1.00, the mixture was lean and the PCM is adding fuel. The ms scale is simple. This is how much time in milliseconds the injector is being held open or closed. A negative ms number means fuel is reduced. If it's a positive number, then fuel is being added. You should compare Bank 1 and Bank 2 readings where applicable, but you can also tell if the engine has a problem at idle or at part throttle. Use this information to isolate the problem.

One Bank, Or Two

When dealing with an engine with two banks, compare the fuel trims from one to the other. If you have a problem with only one bank, focus on that side's O2 sensor. Once you have isolated the problem bank, use the Additive and Multiplicative fuel trims to determine if it occurs at idle or part throttle. If the problem is at idle, you need to perform additional testing. If you have a lean condition and a P0171/4, check for vacuum leaks. This can easily be done with a smoke machine, but keep in mind that the oil is being burned, which can contaminate the MAF element, so remove the MAF first. If you have

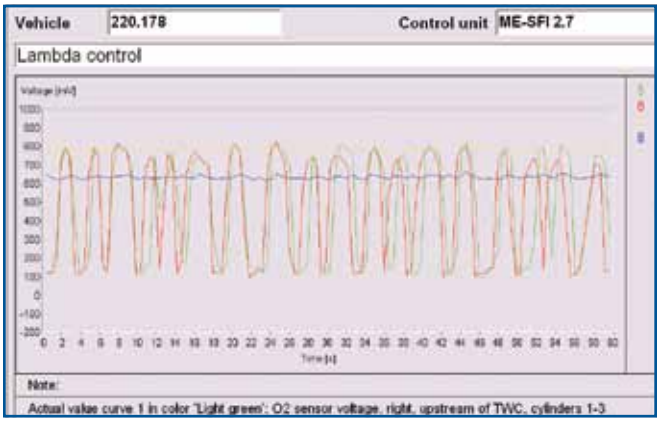
Vehicle	220.178	Control unit	ME-SFI 2.7	
Lambda control, upstream TWC				
No.	Name	Specified value	Actual values	Unit
001	Temperature of coolant	[176...221]	207	°F
004	Engine speed	[599...699]	887	1/min
608	Lambda control, upstream TWC , Cylinder 1-3	[0.770...1.230]	1.003	
609	Lambda control, upstream TWC , Cylinder 4-6	[0.770...1.230]	1.016	
610	Lambda control, upstream TWC , Cylinder 7-9	[0.770...1.230]	1.004	
611	Lambda control, upstream TWC , Cylinder 10-12	[0.770...1.230]	1.000	
215	Lambda control, upstream TWC , Cylinder 1-3	ON/OFF	ON/OFF	
216	Lambda control, upstream TWC , Cylinder 4-6	ON/OFF	ON/OFF	
225	Lambda control, upstream TWC , Cylinder 7-9	ON/OFF	ON/OFF	
226	Lambda control, upstream TWC , Cylinder 10-12	ON/OFF	ON/OFF	
600	G3/9 (right O2 sensor, upstream TWC, for cylinders 1-3) , Signal	[-200...1000]	156	mV
601	G3/10 (right O2 sensor, upstream TWC, for cylinders 4-6) , Signal	[-200...1000]	508	mV
602	G3/7 (left O2 sensor, upstream TWC, for cylinders 7-9) , Signal	[-200...1000]	239	mV
603	G3/8 (left O2 sensor, upstream TWC, for cylinders 10-12) , Signal	[-200...1000]	122	mV

This 12 cylinder breaks fuel trims down to two six-cylinder engines, then down further into two banks of three cylinders each. This is an overall Lambda reading. As you can see, each group of three cylinders is close to 1.00.

a rich condition, you may have a leaking injector. If the problem is with both banks, you should look at sensors that affect both. A lean condition can still be a vacuum leak, but it can also be low MAF output. At this time you may want to start looking at the MAF.

Problems Over The Road

Small problems like a vacuum leak usually do not affect the fuel trim much above idle. An injector with a weak return spring can still cause a rich condition, but it probably won't if it is only leaking.

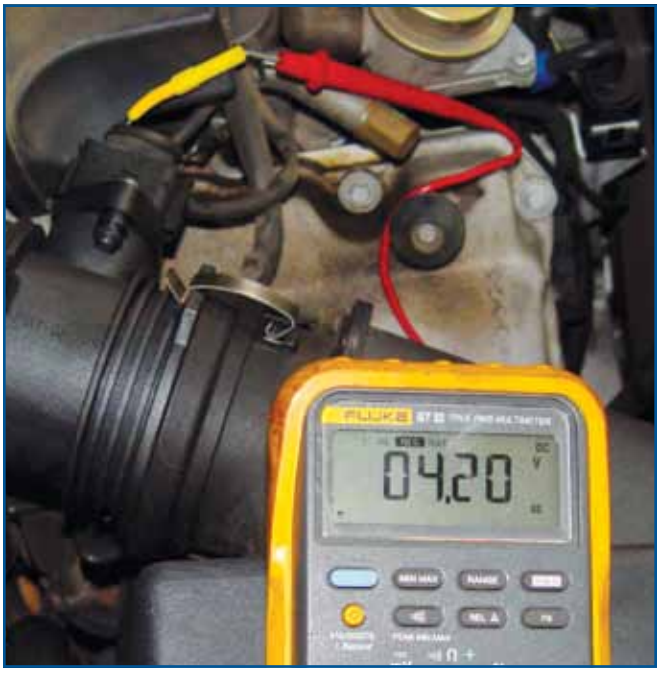


The accuracy of the feedback system is based on good O2 sensor readings. Here, you are looking at cylinders seven through 12, and two pre-TWC and two post-TWC O2 sensors. The red and green traces are the two front O2 sensors, which are switching normally.

This is the MAF signal reading on an E320 at idle. You should see between 1.3 and 1.4 volts. If your reading is higher or lower than this, you probably have fuel trim codes. If this is severe enough, you may also be facing a drivability problem.

If dealing with a lean condition at higher rpm, the MAF should be at the top on your list of suspects. Also, you may have a fuel delivery problem. Check fuel volume as well as fuel pressure, particularly with return-less systems. All of these fuel trim numbers are based on O2 sensors that are working well and promptly. They should be able to switch rich-lean-rich at least once a second. Then, race the engine and you should see a sudden rich condition, a result of acceleration enrichment (as would've been provided by the accelerator pump in a carburetor – remember those?). If yes, you have a good O2 sensor. If you have multiple codes, try clearing them, then clear out fuel adaptations. Let the engine idle for five minutes and look at the idle (Additive) fuel numbers. Follow this with a short road test and look at the part throttle (Multiplicative) numbers to see if it looks like codes will set again.

Of course, there are many causes of fuel trim codes, but using your SDS and fuel trim numbers should help reduce your diagnostic time. It also leads to accurate diagnosis and satisfied customers.



With a quality DMM (Digital Multi-Meter) you can measure signal voltage using the MAX/MIN feature. While recording, accelerate to WOT and see what your maximum voltage is. A good MAF should read over 4.0V. If not, you probably have a fuel trim code with high Multiplicative readings.

Power Distribution

When diagnosing electrical problems, the more you know about modern power distribution systems the faster you will find the problem. Rapidly changing technology has revolutionized how power is applied.

This is the battery tester Mercedes-Benz recommends. It's good/bad accuracy is the best we've seen.

While the 12-volt automotive battery is still the electrical storage device of choice for all non-hybrid vehicles, the similarities in late-model electrical systems to those of the past stop there. Mercedes-Benz still used conventional lead-acid batteries in the last few years, so you can continue to follow traditional testing methods. But Mercedes-Benz has also introduced a dual-battery system that uses the AGM/VRLA battery (Absorbent Glass Mat/ Valve Regulated Lead Acid). You need to be able to identify the differences between the two so that you can properly recharge and test each different type. Having two batteries to deal with also poses some questions. For example, does one battery do one thing while the other does something else? These newer vehicles draw significant current with the key on and the engine off, and even while the engine is running electrical loads from computer control units, blower motors, auxiliary coolant pumps, wipers, defrosters, heated seats and steering wheels, etc. can exceed what the alternator can provide at idle. Adding a second battery provides the extra electrical storage capacity needed.

If you see a large auxiliary battery on an earlier dual-battery system, it's for starting. The battery in the rear powers the main system. A white case tells you it's not an AGM battery, but the regular lead-acid type.

Know What You're Working On

Starting with modern chassis like the 211, there's a main battery mounted on the passenger side of the spare tire. It is of the AGM type, which means you need to use different methods to recharge and test it. In recent years, you've been told to rapidly charge lead-acid batteries. While AGMs can be charged with conventional equipment, they require a low charge rate. Fast charging will damage the internal parts of the battery. We also cannot use typical testing methods such as applying an electrical load with a carbon pile, or checking specific gravity. Mercedes-Benz recommends the

use of the Midtronics MCR 717 battery tester or equivalent. It applies a specific AC voltage to the battery and monitors the responding current flow. Many new battery charger/testers are available and have selections for AGM batteries, so it's okay to use them. Look for and read the red protective battery positive terminal cap and it will warm you if it is an AGM.

This rear-mounted battery is the main electrical power supply in some newer systems. A black case tells you it is an AGM battery. Read the warning on the red cover and look for the letters "VRLA" to confirm. You'll need a special battery tester to check this one.

This auxiliary battery has seen better days. It should supply 12.6 to 12.8 volts when properly charged. This one can no longer hold a charge. The black case tells you to check if it is an AGM type. In this case, it is. Using an OEM battery is the safest way to repair the problem and prevent false alarms in the future.

Power Flow

The rear-mounted battery is the main power supply of the vehicle – it powers the rear pre-fuse box. There are large high-current fuses of 150 and 200 amps that bolt down, and blade-type fuses in the box, which power up the front and rear SAMs. This is necessary since the SAM modules provide "wake up" signals for other systems. It also supplies battery voltage to the interior fuse box. There is a second pre-fuse box mounted in the passenger side foot-well under the carpet. It has a high-capacity capacitor installed in it, so be careful with tools in the area. Since electrical loads can exceed the main battery in the trunk, there is an auxiliary battery mounted under the hood, typically on the passenger side of the firewall. This battery is always grounded, but is not always connected to the vehicle on the power feed side. It is cut in through an auxiliary relay.

Who Pulls Whose Chain

On the 211 chassis, the relay is mounted under plastic covers at the base of the windshield.

The battery control module, pictured here, monitors the rear battery voltage, the front battery voltage, and alternator output through the body CAN B. You can talk to it with your SDS unit and program it if it needs to be replaced.

This is the auxiliary battery relay. It turns on to allow the auxiliary battery to charge and, if system voltage is low, to add current under heavier loads. It is not on all the time, so do not expect the auxiliary battery to always indicate charging voltage.

With a paid subscription to **www.startekinfo.com**, you can look up component locations with Starfinder for your particular model. When extra electrical current is needed, the relay is turned on. The auxiliary battery supply voltage is applied through a 150-amp fuse to the front pre-fuse box. This battery is also an AGM, so the same rules apply for charging and testing as for the main battery. The relay is operated by a Battery Control Module, which is mounted by the main battery in the trunk. The module activates the auxiliary battery relay in two cases: First, to recharge the auxiliary battery, and, second, to connect the auxiliary battery when system voltage is low. The control module looks at the voltage of both batteries and the alternator output through a CAN. You can access this control unit with your SDS and retrieve DTCs.

Warnings

If the battery control module detects a fault, you'll see a message in the instrument cluster warning the driver. The problem can be no charging, low voltage, or overcharging. If the voltage is just low, the warning message tells you to cut off accessories. The module is also in control of a cut-off relay that interrupts power to the auxiliary cigar lighter/power supply sockets to help reduce electrical loads. The control unit can also request that consumers be shut down according to its preprogrammed priorities. There are two stages of power reduction. If both stages do not bring up system voltage, then the auxiliary battery relay is energized (connecting the auxiliary battery to the front pre-fuse box) and the red warning message is displayed on the dash. In this case, you will need to check the condition of both batteries with your tester, and alternator output to see what is causing the problem. Remember, before condemning any component, make sure the system is not being shut off due to excessive electrical load. Pull and clear codes after a Quick Test and see if it starts working again.

A Known Quantity

The alternator can be tested as any other alternator, but you need to make sure the batteries are in at least adequate shape for testing. If the batteries need replacement, make sure you get the AGM type that meets the specifications of the originals. If not, you may get false warning messages in the cluster and improper charging and activation of the auxiliary battery. Using OEM batteries is the best way to avoid this. The specifications are printed on both the front and rear batteries. Also, Battery Control Modules are reprogrammable and your SDS will prompt you if updated software is available.

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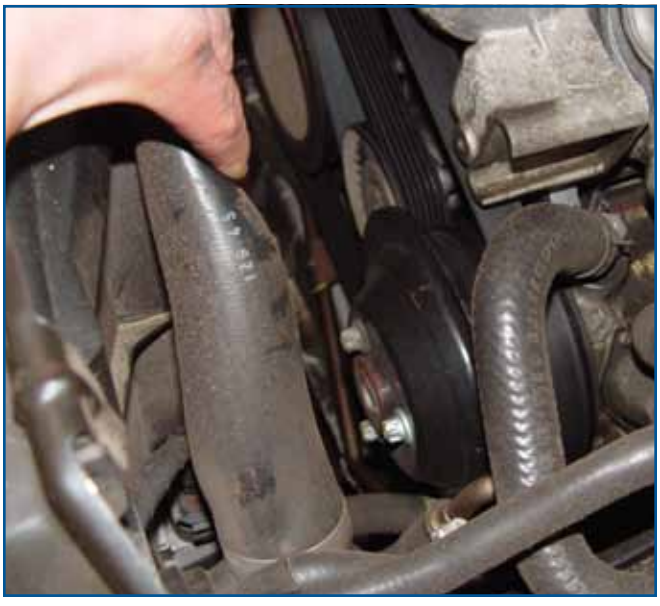
Learning Our ABC's

One technological advance that's largely unsung is computer-controlled suspension. Mercedes-Benz's Active Body Control (ABC) is a sophisticated system that deserves your attention (and we'll throw in a peek at Semi-Active Suspension, too).

The suspension system is often considered the personality of a vehicle. A soft suspension gives a compliant, comfortable ride, but doesn't provide enough road feedback for sporty driving. A taut suspension is well suited for motoring fun, but may not be very comfortable on rough roads. Mercedes-Benz engineers believe in the use of creative technology to provide a combination of the two. With electronics, they can change ride heights, suspension stiffness, body roll, etc. The two main systems the company offers are Active Body Control (ABC) and Semi-Active Suspension (SAS). ABC is hydraulic, whereas SAS is pneumatic, using air springs, but also incorporates ADS II, which controls the vehicle's dampening hydraulically. Of course, it's very important for proper diagnosis and repair to be able to know for sure what the vehicle you're working on is equipped with.



The hydraulic pressure of the ABC system is provided by a belt-driven pump, the same one that feeds the power steering system. It will be damaged if allowed to run dry for over four seconds, so make sure the fluid is up to the proper level and that the reservoir filters are not clogged.

Certain models, such as the early 230 chassis SL-Class, use the ABC hydraulic system, which controls ride height. With its built-in intelligence, if the driver has selected a high setting, it will be overridden whenever the vehicle exceeds 68mph – the body will descend to its lowest position for optimum center-of-gravity and handling.

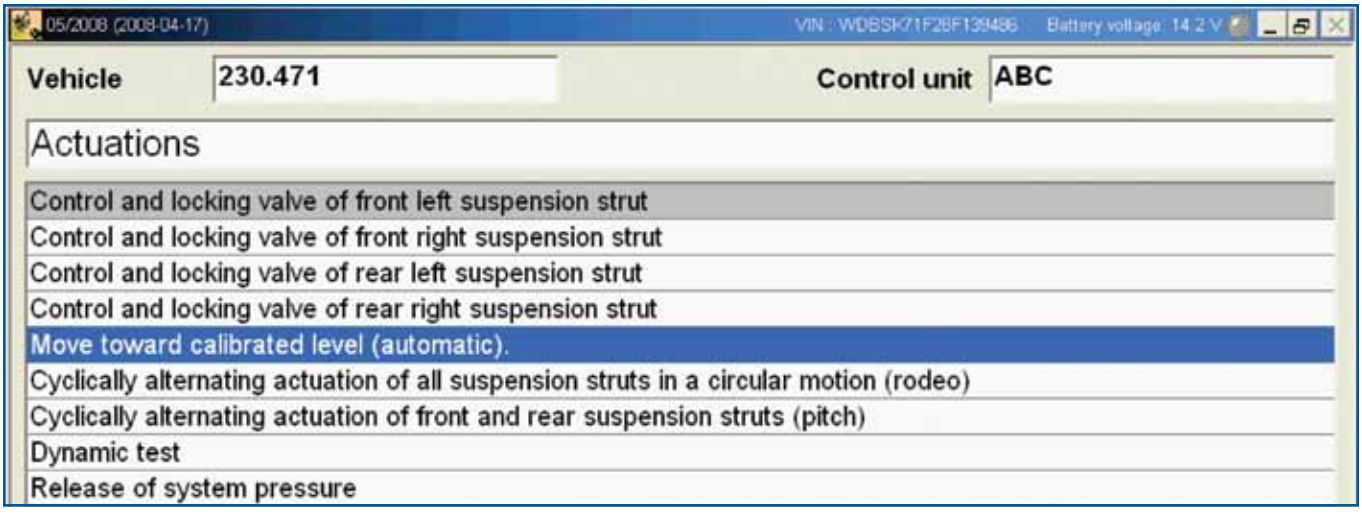
SAS can be found on later chassis, such as the 211 E-Class. It is an evolution of the older Airmatic system found in the 220 chassis S-Class. It still uses pneumatics, but now it has two-chamber struts. Dampening is controlled by decreasing or increasing the air volume through opening either one or two chambers in the air spring. The ADS II hydraulic system provide four levels of dampening control that the driver can select with a switch mounted in the LCP (Lower Control Panel).

You'll find a screen in the banjo bolt of the pressure feed line. It protects the system by blocking debris. It should be removed and cleaned whenever service work is done to prevent pressure drop in the system.

The ABC hydraulics operate at over 2,900 psi, so it is important to reduce this pressure to safe levels before attempting repairs. With any Airmatic or SAS system, you should also relieve the pressure before starting any suspension work to prevent damage to the components. It will also make reassembly much easier because a collapsed strut can be positioned more easily than an inflated one. The SDS is used to safely reduce this pressure. With ABC, pressure is generated by a belt-driven hydraulic pump (the same one that provides psi to the power steering). A return-flow solenoid controls fluid being drawn in from the reservoir. There are two levels on the dipstick, one for high suspension levels, and the other for low. The return lines for both the power steering and ABC reservoirs have filters in them, which should be replaced any time the system is opened and refilled with new fluid.

As an example, in the 230 chassis ABC fluid pressure is routed to a pressure supply valve unit

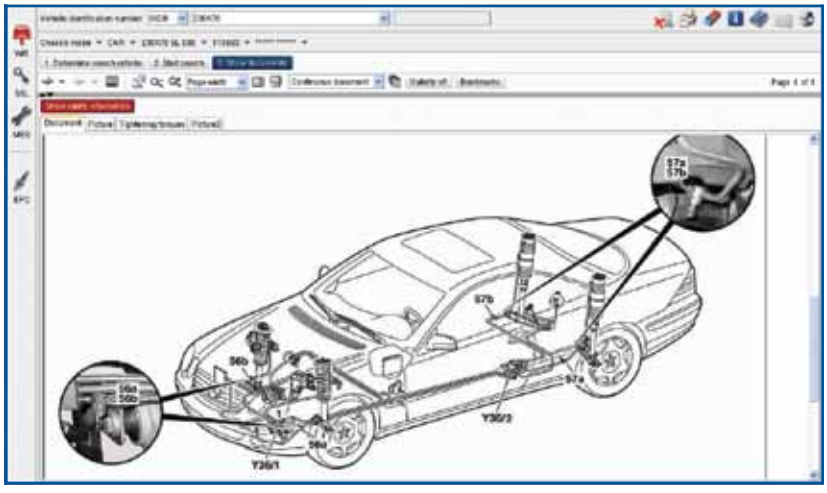
The return-flow filter is mounted in the reservoir. While you're visiting your Mercedes-Benz parts dealer, you should pick up these filters and at least four liters of hydraulic fluid. This will protect your work and give components the longest possible service life.



Using your SDS, you can control each corner. Move to the calibrated position and perform a "Dynamic Test" (Rodeo mode). Selecting "Release System Pressure" will also allow you to start disconnecting lines for repair.

mounted behind the driver's side front tire in the fender. It controls the pressure applied to the front and rear axle valve units. The front valve unit is mounted in the front driver's side fender. It controls both front corners individually. The rear unit is mounted in the driver's side rear fender in front of the wheel, and controls the rear corners individually. A reservoir mounted in each valve stores pressure until the pump replenishes the supply. When opening the system, you should know that there are four bleed screws, one in each corner, which you can open to let the fluid drain before removing lines. Crack the screws open slowly to prevent spillage. Your SDS unit can also be used to relieve fluid pressure. Support the vehicle so the pressure loss does not allow the chassis to drop. Union and banjo fittings are used to connect metal lines. Push-lock fittings are used on rubber lines. Push the plastic lock rings in evenly while you pull the line out to prevent damage to the connection.

You can read all of the safety precautions in WIS with a paid subscription to **www.startekinfo.com**. The ABC control unit monitors fluid temperature and pressure, and controls solenoid operation. With your SDS, you can look at this data, and under "Actuations" you can manually control each corner of the vehicle as well as engage the "Rodeo" mode where all four corners are raised and lowered. This allows you to completely test the system and check for any potential trouble codes and leaks. If you've opened any connections, you'll need to refill the system and purge it of any air. Once again, Startekinfo provides this step-by-step procedure. This will prevent the reservoir from running dry and damaging the pump. The system should always be allowed to sit for 10 minutes to allow fluid to return to the reservoir for an accurate fluid level reading. After purging air and testing with your SDS, you can confidently return the vehicle to the customer knowing the system will perform as it's supposed to.



With your paid subscription to Startekinfo you can review all of the safety procedures before attempting a repair. You can also look up locations of the bleed screws to depressurize the system so you can start work.

FIRE...

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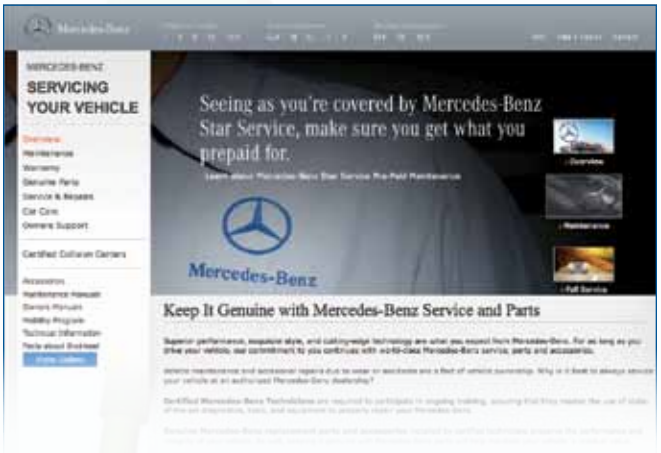

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- ***Links*** to other informative sites like the ***Classic Center*** and ***Collision Program***.

- ***Direct link*** to the Electronic Parts Catalog (EPC) to look up parts.

- ***Downloadable*** Remanufactured Parts Catalog and Reman Parts policies.

- User friendly links to tools such as ***STAR Tekinfo*** and ***WIS***.

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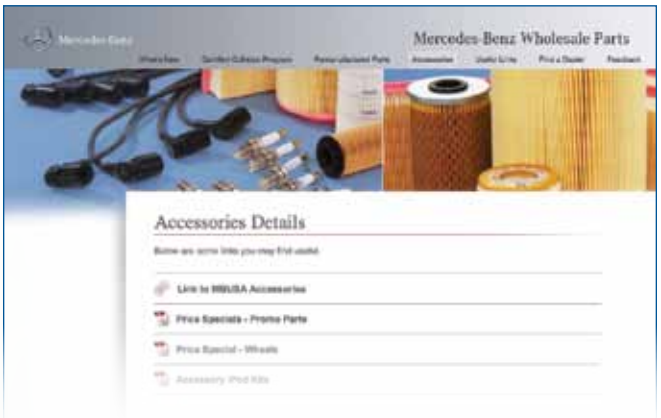

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