StarTuned®

Information for the Independent Mercedes-Benz Service Professional

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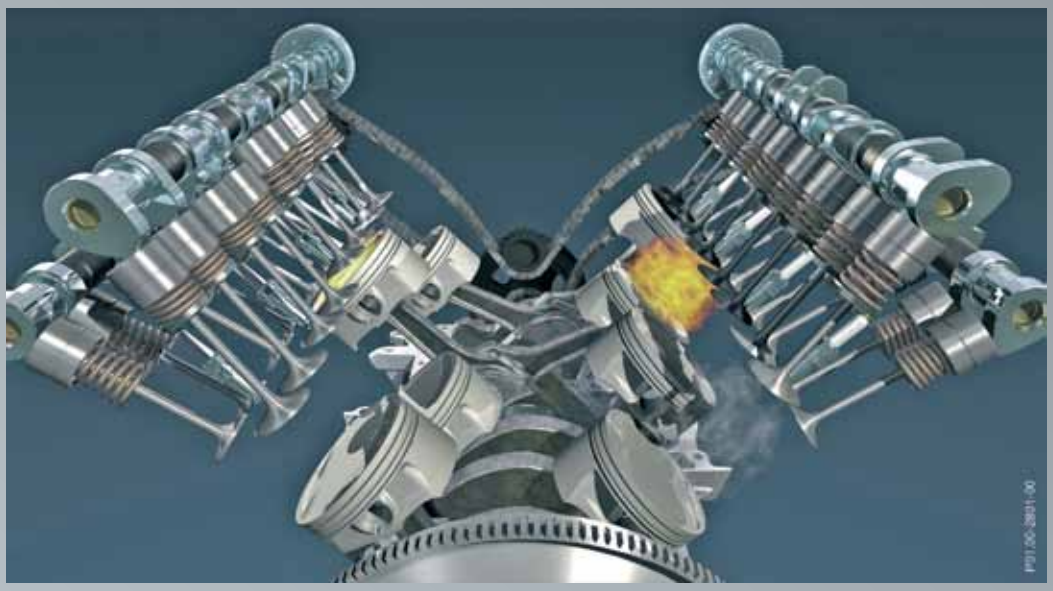
Carbon Fiber Repair

Temperate Climate

Throttling Away

ABCs of Suspension

FIRE...



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Mercedes-Benz

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.

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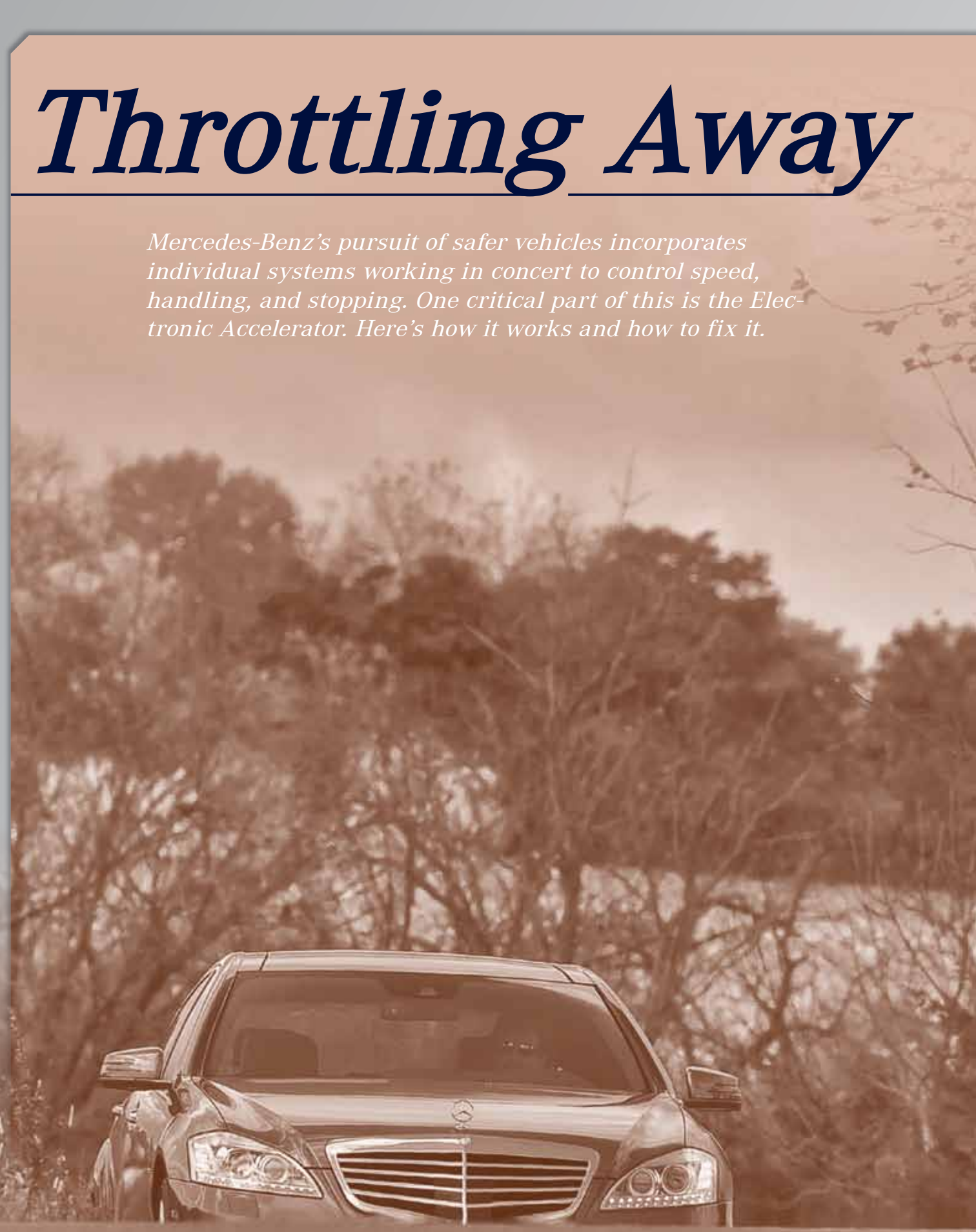
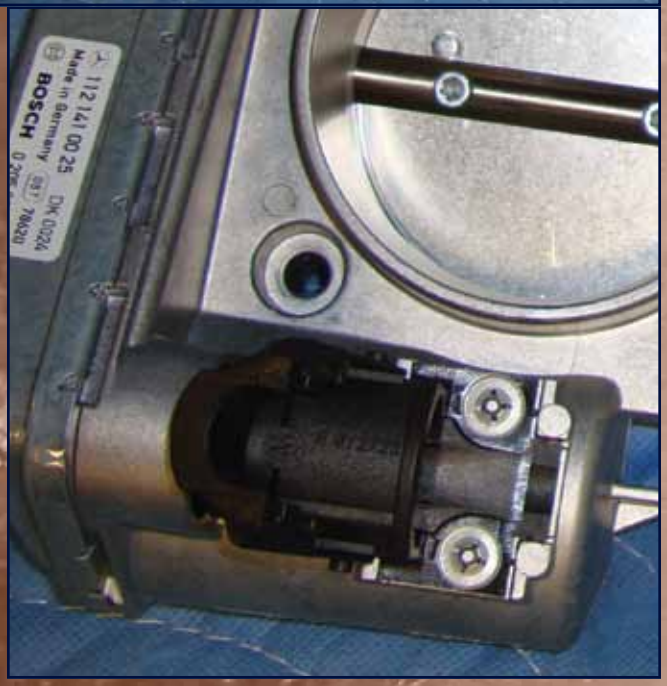
In This Issue

Throttling Away

Mercedes-Benz's pursuit of safer vehicles incorporates individual systems working in concert to control speed, handling, and stopping. One critical part of this is the Electronic Accelerator. Here's how it works and how to fix it.



It all started with Mercedes-Benz in conjunction with the Robert Bosch Corporation in the mid-1980s. The companies worked together to develop a CAN (Controller Area Network) that debuted in the early '90s on the 140 chassis. CAN allowed individual system control units, such as the ME (Motor Electronics), ABS/ASR/BAS (Anti-Lock Brake System/Anti-Slip Reduction/Brake Assist System) and EGS (Electronic Gearbox System) to co-operate in the control of the vehicle when traction is suddenly lost. In following years, the suspension computer of the chassis CAN was added, and ESP (Electronic Stability Program) combined the drive CAN and chassis CAN. By incorporating an electronic throttle system that reads inputs from various sensors and modules, the driver's control can be enhanced, and traction is restored by closing the throttle until the tires regain their grip on the road.



Later throttle body assemblies are true "fly by wire" because there is no longer a cable coming out to the throttle assembly. A pedal sensor is read by the ME control unit, which commands the throttle plate to open for acceleration.

The Electronic Accelerator continues to open the throttle if input indicates that the driver still wants to accelerate. An added feature is that the electronic throttle can also handle cruise control functions and idle speed. No longer was a separate cruise-control actuator and idle speed motor needed to maintain vehicle speed and engine idle speed, respectively. The Electronic Accelerator can be commanded to open to maintain the selected speed. While this adds complexity to engine management, in another way it also streamlined it. With all of these control units on a CAN, the self-diagnostic system can monitor all inputs and outputs and display them in diagnostic software. In earlier years, you would have had to interrogate each system for DTCs (Diagnostic Trouble Codes) and manually check the signal values at each input and output to diagnose a problem. Now, the Mercedes-Benz SDS (Star Diagnostic System) allows you to look at the data on the CAN, saving time if you have to isolate a problem.

You can and should interrogate the EA system with your SDS. If in addition to using SDS, you want to manually check signals at the control module connector, please remember that damage to the wires, connectors, or pins will most likely require that the entire harness be replaced. If the computer-controlled system sees any abnormality with EA inputs or outputs, the control unit enters a "limp home" mode and prevents the throttle from opening and the vehicle from accelerating. Many safety measures were incorporated into EA hardware and logic. The first item you need to know about is that there is a redundant system on later models just as you have on an aircraft. Two sensors perform the job of one so they can crosscheck each other.

Inputs

In order for an EA system to work, it needs to know what the driver's intentions are, and this is accomplished by means of sensors that report on the

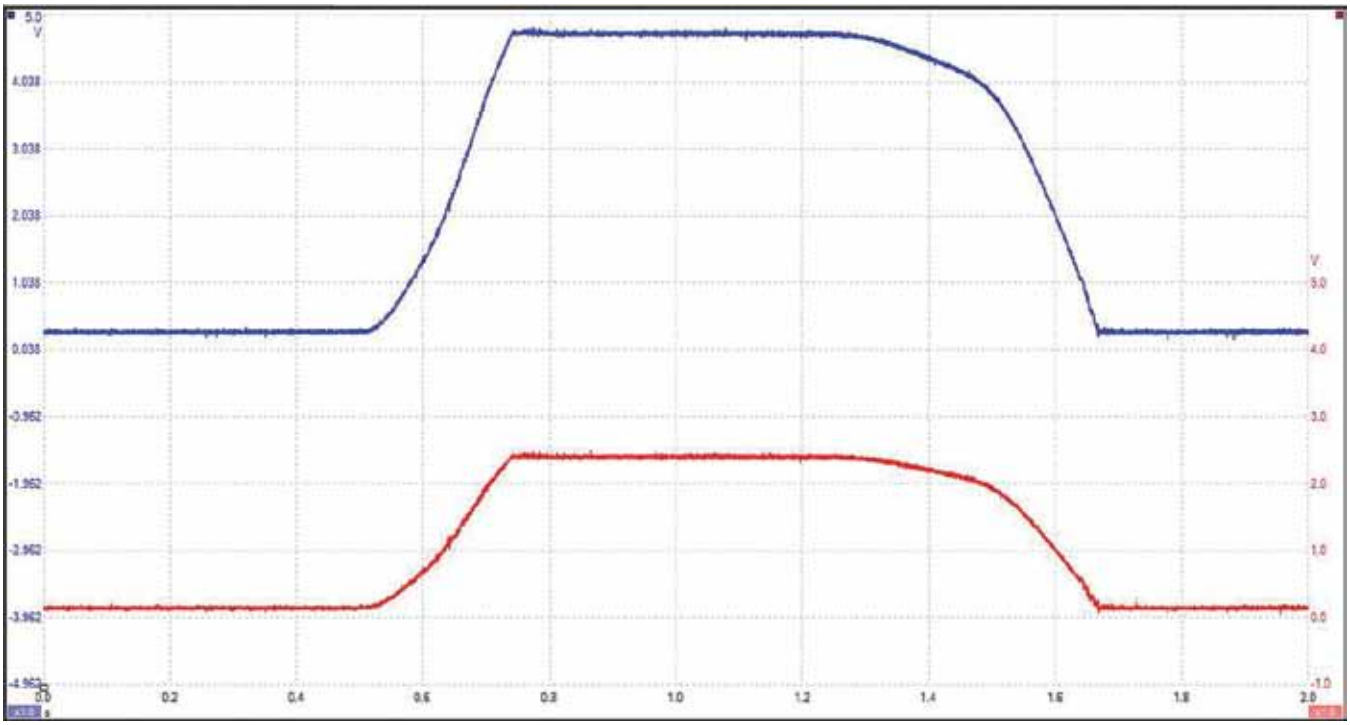
position of the gas pedal. In the early 140 chassis these sensors are mounted in the EA unit (throttle assembly) between the MAF (Mass Air Flow) sensor and the intake manifold. Linkage from the pedal runs all the way up and out to the EA unit, but there is not a direct connection to the throttle plate. Instead, the linkage moves the pedal position sensor. The EA control unit processes the signals and opens the throttle by providing power and ground to a two-wire DC motor. As the motor opens, a second throttle position sensor changes the signal voltage. This sensor lets the control unit know what the actual throttle position is.

For safety, there are two idle contacts in the throttle assembly. These switches indicate when the pedal is in the closed position. One switch is normally open and the other is normally closed with the throttle pedal released. When the pedal is applied, the two switches change states -- the open switch closes and the closed switch opens. If one switch were to send an implausible signal, the other would take over, but the throttle would enter a power-reduction mode, and DTCs would set in multiple control units. There is a clutch that decouples the throttle motor from the throttle plate shaft so if the system were to have a major problem the throttle plate will not be opened and the vehicle will not accelerate. In the case of the M120 engine (early V12), the right throttle body is the main unit that has the pedal position sensor in it. The right throttle assembly feeds the left bank of the engine, and the left throttle feeds the right bank as they cross each other through the intake manifold.

Above: The first Electronic Accelerator design had a conventional cable at the throttle assembly, but it only drove a sensor in the assembly. Here is the second-generation Pedal Position Sensor. A cable still drives it, but it has two potentiometers to indicate the pedal position.

Starting in the ’96 to ’97 model years, the HFM (Hot Film Mass) air flow fuel system was upgraded to the ME (Motor Electronics) system. This had separate pedal position and throttle-position sensors. The throttle-position sensors are still in the throttle body assembly, but the pedal-value sensor is mounted underneath the hood and is driven by a throttle cable. There are now two sensors in the pedal-value sensor assembly. They are both still three-wire units, and they have individual five-volt references, signal voltages, and grounds. The voltage increases on both signal lines, but at different rate. The #1 pedal-position sensor signal voltage is roughly double that of the #2 APP (Accelerator Pedal Position) sensor. With a closed throttle, you may see .18v on the #2 and .28v on the #1 sensor. The sensor signals are sent to the ME control unit, which commands the throttle motor to open.

If the voltages are off by as little as .1 volts, a code will flag and warning lights will illuminate in the



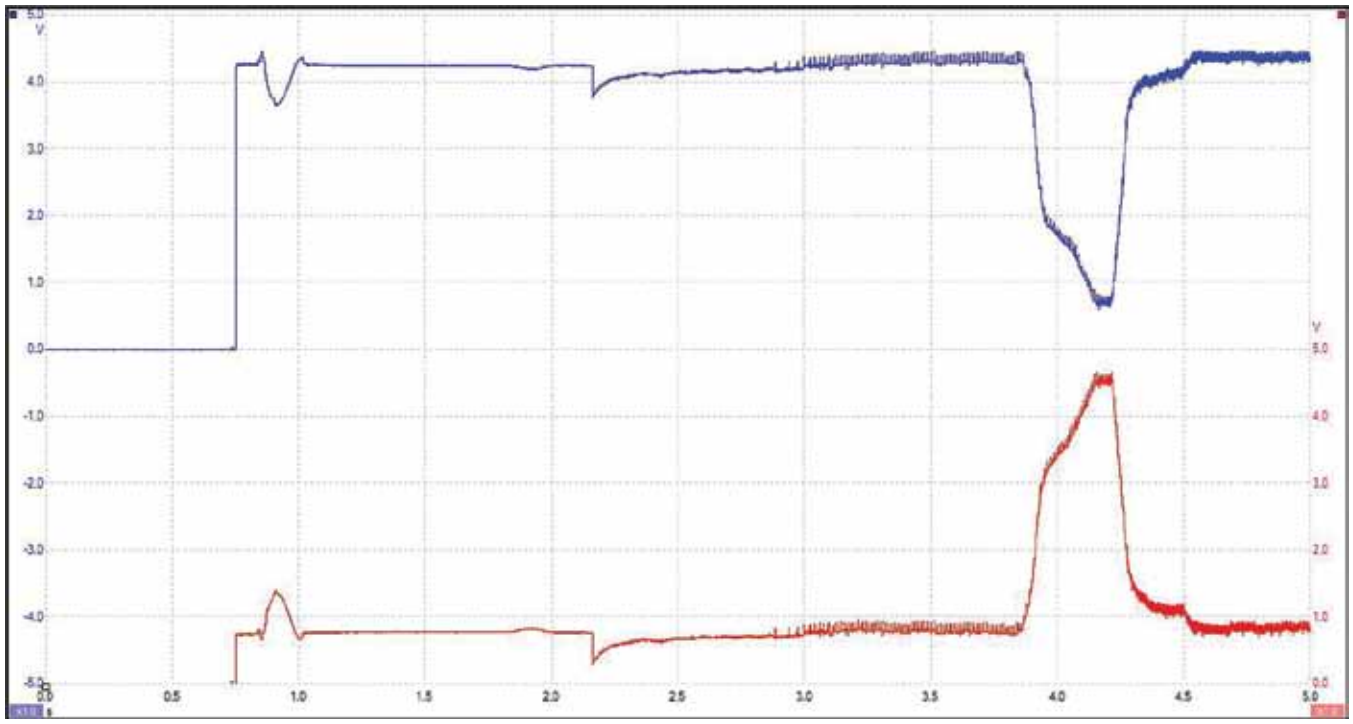
This graph of the Pedal Value sensor shows APP #1 starting off at around 0.3V and increasing to over 4V. APP #2 starts off at a slightly lower voltage and only increases to about 2.5V.

Take a close look at the EA harness connector. A problem here may be the cause of an intermittent throttle code and the customer complaining that the engine goes into limp-in mode. Corrosion at the pins can change the voltage signal enough to set a code.

instrument cluster. The two sensors cross-check each other. If one sensor sends a bad signal, the limp-home mode will give you up to 60% throttle opening, and response is slowed down. If both signal voltages are incorrect compared to one another the engine will only idle. There is also an idle switch on the pedal. The ME control unit expects the pedal sensor to be at minimum signal voltage when the idle switch is closed. If you were to move the APP sensor manually, you would set a code and engage the limp-home mode because the idle switch would still indicate idle. There is a second Hall-effect type of APP. The connector is slightly different with two squared off corners. The same voltage readings still apply even with the different connector design.

Starting with early- to mid-2000 211 and 220 chassis models, the accelerator pedal-position sensor is mounted directly on the pedal. This must be replaced as a unit. It still has two pedal-position sensors in it. It is a six-wire assembly with two five-volt references, two signal wires, and two grounds. The signal voltages are roughly the same as on the previous design. Pedal-value sensor #1 starts off at about .35 volts with the throttle closed and will increase to approximately 4.5 volts at WOT (Wide Open Throttle). Pedal-value sensor #2 will start off at about .18 volts and increase to about 2.3 volts at WOT. In the service bay, do not expect to see these voltages wide-open. With the engine not running, the throttle will only be commanded open part of the way. Keep that in mind while checking the system.

Changes have also been made on the actuator side. No longer are there closed throttle contact switches in the actuator. Only the signal voltages from the motor-position sensors are used to calculate throttle plate



A close look at the signal voltages of the APP sensors in the throttle assembly shows the upper trace starting off at over 4V with the key on and the lower trace starting off under one V. Toward the end of the pattern, under acceleration, one signal voltage decreases and the other increases.

position. These have a six-wire connector. Two wires supply the DC reversible motor to open and close the throttle. The other four are for the position sensors. They share a five-volt reference and a ground, leaving two signal wires. Throttle sensor #1 starts off at approximately 4.3 volts, but this signal decreases as the throttle plate opens. At WOT, you should see about .5 volts. Throttle sensor #2 starts off at about .35 volts and increases to approximately 4.3 volts wide open. The voltages cross-check one another. Theoretically, both signal voltages should add up to about five volts in all throttle positions.

These input signals are sent to the ME control unit, which processes them to control idle speed, cruise control, and rate of acceleration. In reverse gear, the rate of opening is slowed relative to pedal movement. It can also close to reduce engine power if signals come in on the CAN indicating that traction has been lost. This reduction in power helps the tires regain their grip. ME is also in charge of all the limp-home strategies, and monitors the messages on the CAN from the ABS/ASR/ESP and other modules that may affect power application. When the EGS (a.k.a. transmission control module) reports a shift, the ME will retard ignition timing to help with smooth shifting. It also monitors the amp draw of the throttle

Carbon can build up on the throttle plate and in the bore. The ME control unit will adapt by opening the plate to maintain idle speed. If the battery goes dead, this adaptation is lost and the engine may not idle properly. After cleaning the throttle body, you may have a high idle, so clear all adaptive strategies.

actuator motor. If the throttle is sticking or binding in the throttle bore, ME will flag a code and go into limp-home as well.

We already described the limp-home mode of the pedal-position sensor: If one potentiometer produces an implausible signal, you will have a maximum of 60% throttle opening. If both sensors send problem signals, you will be limited to idle speed only. There are slightly different fail-safe modes for the actuator. If one sensor's signal is inappropriate, the throttle opening is once again limited to 60%. However, the second sensor in the actuator and the MAF sensor are used to command throttle position. If both throttle sensors send faulty signals, or the two voltages do not correspond to one another, a spring capsule is activated and throttle opening is limited to 10 to 12 degrees. This will only allow the engine to rev to 1,800 rpm, maximum. Idle speed will be set at about 900 rpm using the injectors for control. If a mechanical fault is determined by the actuator, a safety fuel shutoff program is activated and the injectors will stop delivering fuel at 1,200 to 1,400 rpm.

If you have a hard code for the actuator or throttle position sensors, check the wiring harness for physical damage Unplug the connector and check the voltages on the harness side. Here we followed the harness and found multiple broken wires.

Cleaning the throttle plate and bore has become part of a regular tune-up, but is even more important today than it was. If carbon deposits are present, the throttle plate may stick, setting an actuator code. Do not spray the solvent down on the throttle plate as it can work its way into the motor assembly and damage internal components. Spray it on a rag and, with the key off, wipe away the buildup. This will only help if you have a throttle actuator code. If there is a problem with an actuator, specific limp-home modes are engaged.

The ME control unit is capable of learning if the throttle plate is restricting air flow at idle and gradually opening up the throttle to compensate, which is known as idle adaptation. If the battery were to go dead, the ME may forget these adaptations.

This could cause a low idle speed, or a deceleration stall after the battery has been recharged. You can simply clean the throttle plates to restore a normal idle. Throttle plate adaptation will have to be performed after a dead-battery incident, or whenever the throttle assembly or the ME control unit has been replaced. You can perform the throttle relearn with your SDS (Star Diagnostic System), or by simply leaving the ignition key on with the engine off for 90 seconds. You should hear the throttle actuate as the throttle body is being adapted.

You can also look at idle adaptation under "Actual Values" with your SDS. These numbers show if the ME control unit is opening the throttle to compensate for a low idle speed, or closing it to compensate for a small vacuum leak.

There are no special procedures when servicing either the pedal position sensor or the throttle actuator other than the normalizing of the throttle actuator. Each component should read the correct signal voltages once plugged in and installed properly. Of course, each component is relying on a stable five-volts reference and ground (both provided by the ME) to make the correct signal voltages. You should always verify the five-volt reference and ground with your DMM to make sure you do not have any wiring or control unit problems. There are also safety switches in the actuator. They are the ones that indicate that the throttle is closed and at the idle position. The ME puts out a 12-volt reference that the switch either grounds or not to let the computer know the vehicle is at idle. With the connector at the actuator unplugged, you should measure the five-volt reference and two 12-volt references for the closed throttle switches.

Knowing the different limp-home mode strategies coupled with the use of your SDS (available for purchase from Mercedes-Benz, see www.startekinfo.com) will help reduce your diagnostic time and, more importantly, assist you in making a more accurate diagnosis of this critical system. Your customers rely on you to provide service worthy of their Mercedes-Benz vehicles. This dedication to their safety and well-being will keep them coming back.

Mercedes-Benz Mobil1

Product Name	Part Number	Quantity	Product Description	Recommended Consumer Applications
Mercedes-Benz SPEC.				
Mobil 1 Formula M 5W-40	BtQ 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		
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 Formula M 5W-40	BQ 1 09 0135	Bulk - No Equipment	Advanced full synthetic formulas designed specifically for diesel passenger cars that have particulate filters	Low SPAsh. Available at most MB dealers
	BQ 1 09 0142	6/1 Quart Cases		
	BQ 1 09 0143	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 many Chrysler 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
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		

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Product Name	Part Number	Quantity	Product Description	Recommended Consumer Applications
Mercedes-Benz SPEC.				
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
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		
Delvac 1300 Super 10W30	BQ 1 09 0086	Bulk - No Equipment		
Delvac 1 5W40	BQ 1 09 0051	4/1 Gallon Cases	Fully synthetic supreme performance heavy duty diesel engine oil that helps extend engine life while providing long drain capability and fuel economy for modern diesel engines operating in severe applications	Recommended for use in all super high performance diesel applications, including modern low emission engine designs with Exhaust Gas Recirculation (EGR)
	BQ 1 09 0052	55 Gallon Drum		
Mobil Grease XHP 222	BQ 1 09 0078	60/14 oz Cartridge	Formulated to provide excellent high temperature performance with superb adhesion, structural stability and resistance to water contamination	Recommended for industrial and marine applications, chassis components and farm equipment
	BQ 1 09 0079	120 lb Keg		
	BQ 1 09 0080	400 lb Drum		
	BQ 1 09 0098	40/14 oz Cartridge		
Mobil Lube HD Plus 80W90	BQ 1 09 0096	120 lb Keg	Extra high performance, automotive lubricant formulated from select base oils and an advanced additive system specifically for limited-slip differentials	Recommended for use in limited-slip differentials, axles, and final drives requiring API GL-5 level performance
	BQ 1 09 0097	400 lb Drum		

The ABC's of a Taut Suspension

Mercedes-Benz has always been synonymous with agile handling, a stable feel, and compliant suspensions. Active Body Control is one way the company brings these attributes into modern times.

Think of Mercedes-Benz and you may envision a full-size S-Class. Its compliant ride makes easy work of long trips. The driver would want to feel the feedback of a taut suspension, but not so stiff that her or she feels every bump. Or, you may picture the SL-Class. An SL owner may want a stiffer suspension for carving through winding roads. In either case, handling was one reason they purchased a Mercedes-Benz. The ABC suspension system provides the best of both worlds. With it, the driver is in greater control of the vehicle's ride than was ever before possible, and, where necessary, the ABC control unit reacts to conditions and makes adjustments accordingly. ABC is optional on the S-Class, but standard on some other models.

Active Body Control is aptly named because it is "active." Like any computer-managed system, it has sensors that read the environment around it and pass this information on to a control unit. This is processed with digital logic and decisions are made on how to best to control the vehicle, commands are sent to accomplish that, and this all occurs within milliseconds of input changes.

Even if the driver is unaware of changes in road conditions, or the level of cornering power that's necessary for the way the car is being driven, ABC assists in maintaining stability. It is an electro-hydraulic system that directs pressurized fluid to individual strut assemblies to control adjust vehicle level and suspension compliance.

The Heart

The hydraulic pump is the heart of this system. It is capable of generating over 3,000 psi of force to suspend the vehicle. This is an important factor to know during service. If you are going to be removing hydraulic lines or components, you will need to depressurize the accumulator first. You can perform this task with your SDS, available for purchase though Mercedes-Benz. Contact your dealer, or go to the Mercedes-Benz service information website www.startekinfo.com.

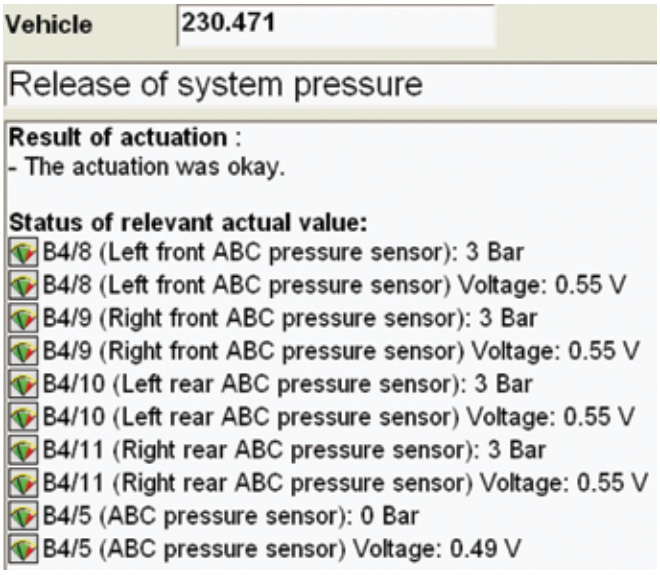
The power steering system shares the same fluid supply and pressure to operate, so when there's a problem check there for leaks as well. These pumps should not be allowed to run dry. If they do for more than four seconds, internal damage may occur. Fill the reservoirs before starting the engine after servicing. There are filters in the reservoirs and they should be changed when the system is opened and the fluid is replaced.

The pump supplies pressure to a distribution manifold with an accumulator. The accumulator is has a nitrogen charge that bears on a on a diaphragm that separates it from the hydraulic fluid. This maintains the high pressure the system needs when demand exceeds what the pump can supply. This pressure is directed to the front and rear suspension control valves. Each of these has its own accumulator to help maintain pressure in its half of the system. The valves house the solenoids that direct fluid into and out of the strut assemblies. When the vehicle is raised on a lift, these valves are supposed to close to prevent the lines from losing pressure. However, if you have the key on at any time the electronics will depressurize the system to try to lower the now fully-extended suspension. This is not a safe way to depressurize the system for service as there will be some significant residual psi.

Strutting Along

Each strut assembly has two individual solenoids. One controls the vehicle level and the other controls the dampening stiffness of the strut. In the front valve assembly, there are two pairs of solenoids, one for the driver's side and the other for the passenger's side suspension. The same applies to the rear valve. There is an internal spring inside each strut assembly. Typically, the ABC control unit supplies power and ground for the solenoids. The level solenoid both allows higher fluid pressure to raise its strut, and releases excess pressure to lower the vehicle. The suspension control solenoid acts the same way. It opens and either lowers the pressure or increases it to change the dampening characteristics of the shock. The overall system pressure is generated by the pump and regulated by the ABC Suction Restrictor Valve. The pump makes pressure and the restrictor valve bleeds off the excess and returns it to the reservoir.

The ABC control unit knows what the system pressure is by means of a sensor. Its location varies depending on the model you are working on. For instance, a 220 chassis has it mounted in the fluid distribution manifold under the sub-frame on the passenger's side. A 230 chassis may have it in the front control valve, which is mounted in the front wheel house on the driver's side, behind the bumper. It reads the main system pressure that is being fed



Any time you are going to open the system, you must release the pressure. Over 200 bar (3,000 psi) may be present, which can be very dangerous to any technician. Through your SDS, you can drop the pressure to a safe level before you begin work.

Above: Using your SDS, you can command a dynamic test (aka "Rodeo Mode") where the system applies and releases pressure to all four corners of the vehicle. Follow the on-screen instructions and accelerate the engine to 3,000 rpm so the pump can supply enough pressure for the test.

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GENUINE MERCEDES-BENZ REMAN A/C COMPRESSORS

MODEL YEAR	VEHICLE MODEL	REMAN PART NUMBER
1984-1992	190D2.2	A000230121180
1984-2002	260E, 190D2.5, 300TD, 300D, 300CE, SL500	A000230241180
1986-1991	420SEL, 560SEC/SEL, 560SL	A000230251180
1986-1995	190/300 series, E300D	A000230111180
1986-2002	300E, 300CE, 600SL, SL600	A000230051180
1990-2002	500SL, SL500	A000230061180
1992-1993	500SEL	A119230111180
1992-1995	400SE, 400SEL, 500SEC, S420, S500	A119230001180
1992-1999	600SEL, S320, S600, 300SEL	A000230171180
1992-1999	300SE, 600SEC, S600, S320, CL600	A000230221180
1992-2004	CL500, 300/400/500 series, S/SLK/C/CLK/ E-Class	A000230701180
1994-2000	C220, C280, C36 AMG	A000230131180
1998-2005	ML320, ML430, ML55 AMG	A000230681180
1998-2010	ML500, ML350	A001230281180
1998-2010	ML350, ML500, E500, SL500, C/CL/S/G-Class	A000230901180

MODEL YEAR	VEHICLE MODEL	REMAN PART NUMBER
2000-2006	CL600, CL65 AMG, S65 AMG, S600	A001230011180
2000-2009	E320, S350	A000230911180
2002-2007	C32 AMG	A000230781180
2002-2007	C230 CL 1.8	A000230971180
2002-2010	CLK-Class, C55 AMG, SLK55 AMG	A001230191180
2003-2009	CLK500	A001230161180
2003-2010	SL55 AMG	A001230021180
2003-2010	E55 AMG, E320, E500, CLS500	A001230121180
2003-2010	E-Class, CLS55 AMG, CLS550	A001230141180
2003-2010	SL550	A001230551180
2005-2010	SLK280, SLK300, SLK350	A001230541180
2006-2010	R350, R500, ML350, ML500, ML550, GL450, GL550	A001230871180
2006-2010	R350, R500, ML350, ML500, ML550, GL450, GL550	A002230521180
2009-2010	C300, C350	A001230501180
2010	GLK350	A002230311180
2010	E350, E550	A002230381180

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*Assembled to original Mercedes-Benz specifications

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Above: In the static position on level ground the body acceleration sensors should read about 2.5V. As the vehicle moves, the signal voltage will increase or decrease depending on vehicle direction. If these sensors are off by more than a few tenths of a volt, the control unit will flag a code.

to the front and rear control valves. It is a three-wire sensor with a five-volt reference, signal voltage, and a ground wire all going to the ABC control unit. You can monitor this voltage and get a corresponding pressure reading in Actual Values on your SDS (Star Diagnostic System). You can also read the pressure in each strut assembly with your SDS software.

A Symphony of Sensors

In order for an ABC system to accurately control each corner of the vehicle, it needs multiple sensors to read individual ride height, suspension events, and the overall direction and movement of the body. This is accomplished with a symphony of sensors mounted in both suspension components and the body. Each strut has one sensor that reads vehicle level and another that reports on the rate of the strut's acceleration. The level sensor helps the ABC control unit set the ride height and the plunger travel sensor monitors suspension movements over bumps. The level control sensors are mounted on the body of the vehicle with a linkage attached to the lower control arm of each corner. The plunger travel sensors are mounted inside the strut assembly and are not serviceable separately. If one fails you will have to replace the strut itself.

There are typically five additional sensors that help the ABC control unit determine direction, rotational speed, and rate of change the body. There are the front right and left body acceleration sensors, the rear left body acceleration sensor (the right rear's movement is extrapolated from the signals generated by the other three), a lateral acceleration sensor, and longitudinal acceleration sensor. They have the job of telling the ABC control unit if the vehicle is accelerating or braking, and to what degree the vehicle is being turned to the left or the right. Normally, without the help of ABC, the suspension on the outside of

Vehicle 230.471 **Control unit** ABC

Level sensors

No.	Name	Specified value	Actual values	Unit
035	B22/8 (Left front level sensor)	[1.70...3.30]	2.45	V
036	B22/9 (Right front level sensor)	[1.70...3.30]	2.61	V
037	B22/7 (Left rear level sensor)	[1.70...3.30]	2.41	V
038	B22/10 (Right rear level sensor)	[1.70...3.30]	2.69	V

With your SDS, you can monitor the voltage of the level sensors to isolate a bad one. You can also monitor system pressures, plunger solenoid amp draw, and body acceleration sensor signal voltage.

the turn is compressed. The height, plunger travel, and acceleration sensors for that side tell the ABC unit that. If it feels it needs to, it can apply greater ABC system pressure to that side's strut assemblies, extending them, much the way a cheetah extends its outside legs in a 60-mph turn. It's simple physics, but the process is high-tech.

The "Active" in ABC

ABC prevents the suspension from unsettling the vehicle or bottoming out if the driver goes over a large bump in the middle of a turn. All of the sensors mentioned are of the three-wire type with a five-volt reference, signal wire, and ground, all connected to the control unit. The body acceleration sensors have to be able to react differently in each situation. The signal voltage is close to 2.5 volts with the vehicle level and standing still, or while driving straight down the road at a steady speed. Under acceleration and deceleration, the longitudinal acceleration sensor will either increase or decrease its voltage from 2.5 volts. If you turn the steering wheel hard enough to the left, right and rear body acceleration sensors will also deviate from the 2.5 volt static position. You can monitor these voltages while someone else drives the vehicle, or you can observe these reading with your SDS.

Some of the functions of the ABC system can be adjusted manually. To improve the center of gravity at higher speeds, the ABC control unit automatically lowers the vehicle, but the driver has some control of the ride height via a switch on the control panel in case he or she wants to raise the car when entering a steep driveway, for example. On the 230 chassis, there is also a sport setting for stiffer damping.

Vehicle	230.471
Move toward calibrated level (automatic).	
Left front vehicle level	3 mm
Right front vehicle level	-6 mm
Vehicle level at rear left	-6 mm
Vehicle level at rear right	3 mm
B4/5 (ABC pressure sensor)	190 Bar
Test prerequisite: - Engine running	
F3: START (The actuation can be terminated when the actual values stop changing.)	

After completing an ABC repair, you should perform a level calibration under "Actuations" with your SDS to match the vehicle to the new components you have installed. This improves ride quality and helps determine if there are any other problems with the system.

Automatic functions may not work properly if the ABC system is not calibrated. If you have to service the system, there are several functions that will need to be performed with the SDS unit. We already discussed the importance of depressurizing before opening the hydraulics. Beyond that, you will have to perform a level calibration, plunger sensor calibration, and a load compensation calibration in that order before the system will work as it's supposed to.

Using Your SDS

There are many dynamic tests you can perform with the SDS to verify that the ABC components are functioning properly. Under "Actual Values," you can monitor the signal voltages of level sensor and plunger travel sensor, and the individual pressure readings for each strut. You can also monitor the current draw of each plunger solenoid that controls pressure to the strut assemblies. This will let you know if a solenoid is sticking, which may cause a corner to stay in the up or down position. Typically, they draw under 750ma when being operated. If you see a reading higher than that, suspect a sticking solenoid. Level sensor signals are given in voltages, which will, of course, vary with the ride-height setting. You can also read the ride heights by their deviation from the calibrated level.

Once you have replaced the defective hydraulic or electrical ABC component, you will have to perform some steps on a level surface before you can return the vehicle to the customer. First, you should reset the system to the calibrated level. You can find this under "Actuations" on your SDS. You will not notice the vehicle moving, but you will see the deviation in millimeters change. When the numbers stop changing the calibration is complete. Performing these last few steps will improve ride control.

Knowing how the system works and how to properly service it will keep your customers coming back to you. Original OEM parts from your Mercedes-Benz dealer will ensure the quality of your repairs. While you are at the dealer picking up parts, you should also remember the filters in the ABC reservoir and the CHF 11s fluid that Mercedes-Benz specifies for its hydraulic systems. Complete the repair by recalibrating the ABC and you will have serviced the vehicle just as the dealer would have.

ABC Service Baselines

When opening up one of these high-pressure systems there are some special procedures you must observe.

As with any computer-controlled electro-mechanical system, there are two sides to the ABC story: the electrical/electronic side and the mechanical side. The former can be identified, monitored, and controlled with an SDS (Star Diagnostic System), available for purchase from Mercedes-Benz USA. This scan tool is capable of reading the control unit information including the software version level, which can be important in determining if an update needs to be performed to fix a problem. Of course, it can also read diagnostic trouble codes (DTCs), but it goes way beyond that by offering a guided fault-finding flowchart when you select the code you want to troubleshoot. In addition, you can read specific data in real time as the vehicle is being operated. Finally, it is a requirement when replacing control units that may need to be programmed or initialized before being put into service.

For example, the code C1531-008 means that despite the fact that the right rear valve has been commanded closed, the height value has changed while the vehicle was shut off. This points to either an external or internal leak in the right rear strut assembly or valve. By clicking F3, you can access a flow chart that will take you through a step-by-step diagnostic procedure to nail down the trouble.

Before you can diagnose such a problem, however, the basics of the system must be in proper order. There needs to be the correct amount of fluid so

With pressures reaching 200 bar (3,000 psi), it makes sense to stick with Genuine Mercedes-Benz replacement parts.

that the ABC pump can operate at the right pressure, and the pump itself needs to be capable of generating enough pressure to raise the vehicle.

As mentioned in the main article, ABC uses the same reservoir and pump as the power steering system. The fluid level should be checked while the engine is running and the system is operational. The dipstick has two levels marked on it. The higher of the two is for when the vehicle is at the lowest height setting, and the lower one is for when the vehicle is at the highest height setting. Obviously, at the lowest height setting the volume in the struts is smaller and therefore more fluid will return to the reservoir, and vice versa. Keep this in mind when checking the level. Also, use only fresh new hydraulic fluid to refill after draining.

Vehicle	230.475	Control unit	ABC

Fault Codes

Code	Text	No.	Status
C1531-008	Right rear suspension strut moves although locking valve is closed.	0	STORED

A filter is mounted in the reservoir, and you should replace it whenever you open the system. This is an absolute must when you have had to replace the hydraulic pump. The ABC system is self-bleeding, so you should not have to open any valves to let air out of the hydraulic circuits. After draining and refilling, however, you should let the vehicle sit for as long as possible to let any air escape that may have entered the system while it was open. Using your SDS to put the system into "Rodeo" mode will not only check the system for self-diagnostic codes, but will also open all of the valves to raise and lower the vehicle. This is an excellent way to expel any air that may be trapped in the system.

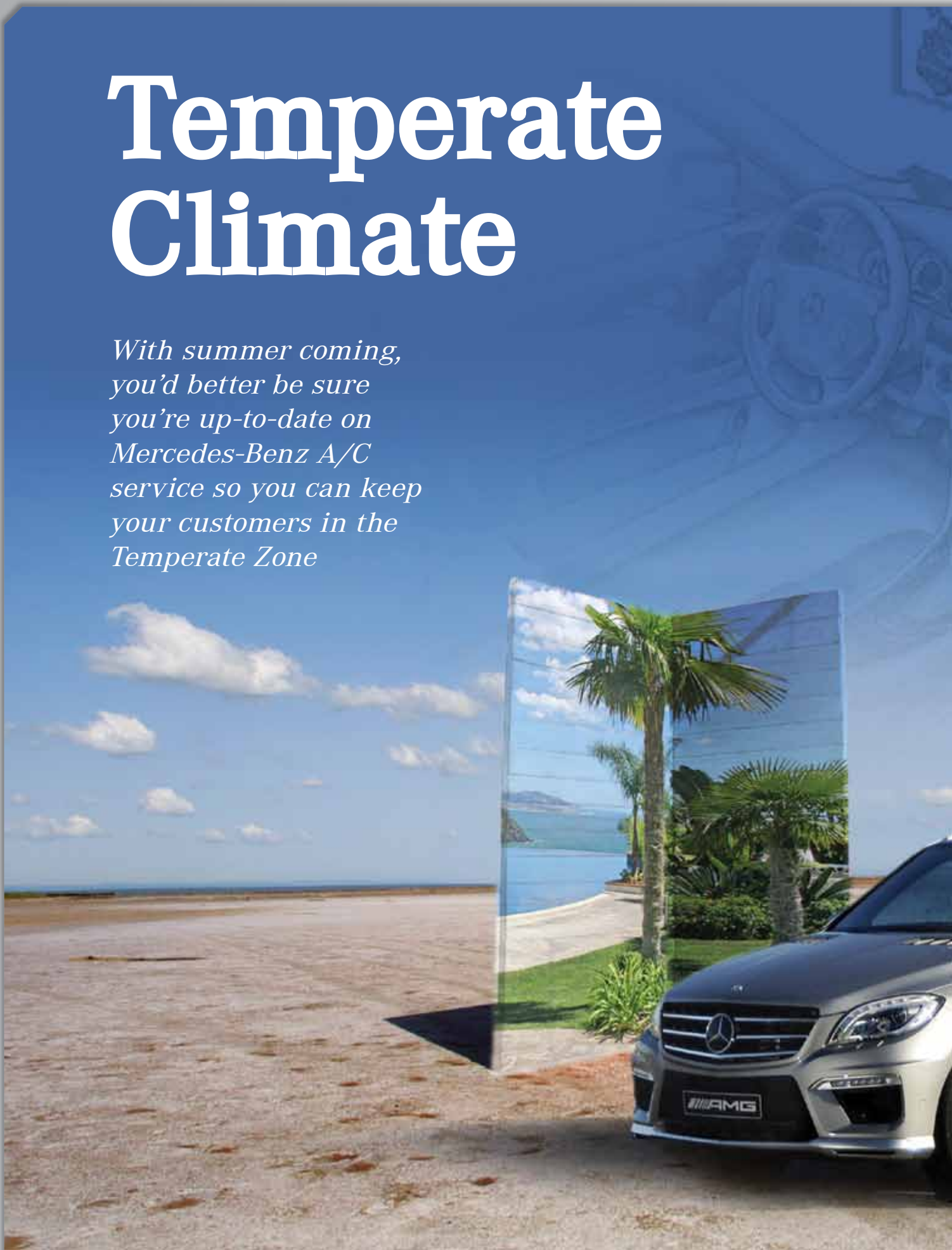
Finally, Mercedes-Benz strictly specifies CHF-11S fluid for its hydraulic systems. This is a green-tinted synthetic fluid far superior to older, non-synthetics typically used in the past for power steering. It's foolish to use anything but the right stuff. |

Left: This kind of SDS DTC explanation makes it easier to zero in on a problem.

Below: Don't neglect that filter, and use only the recommended synthetic hydraulic fluid.

Temperate Climate

With summer coming, you'd better be sure you're up-to-date on Mercedes-Benz A/C service so you can keep your customers in the Temperate Zone



Mercedes-Benz owners expect their creature comforts to work properly. Nowhere is that more important than in the climate control system. Occupants require that they be kept warm in the winter and cool in the summer. Mercedes-Benz offers some of the most sophisticated climate control systems in the world, which means you'll need some specialized knowledge for diagnosis and repair. Knowing how they work is the first step.

Thermotronic is a full-function automatic system that reads the interior and exterior temperatures and changes compressor output, heater valve and blend door position. Tempmatic is another system found on 2000 and later M-Class vehicles in the 163 chassis range. This is a combination of manual and electronic controls that work with other control units to provide air conditioning and heater management. This cooperation helps reduce wiring and saves weight. It also streamlines the diagnostic process by putting more information in the hands of the repair technician through SDS hardware and software, available for purchase from Mercedes-Benz.

Starting Off Simple

The 163-chassis air conditioning system has undergone some improvements over the years. From its introduction in 1998 to almost 2000 (11/99), the push-button controls are only air conditioning and heater switches. They feed their inputs into a separate AAC (Automatic Air Conditioning) module mounted behind the center control panel of the instrument cluster. This module controls the blend door for temperature control of the cabin. It does not have an interior temperature sensor that provides feedback and changes the blend door position. The push-button control unit simply had a variable resistor that works in conjunction with the blend door position sensor. These two switches indicate the desired temperature to the AAC unit, which in turn positions the blend door. The module also has a sensor for evaporator temperature. If the evaporator starts to freeze, the control unit sends out a command to shut off the A/C compressor. The AAC control unit is not otherwise in direct control of the compressor.

The AAM (All Activity Module) works with the AAC module to control air conditioning and heating. It manages the coolant circulation pump and the auxiliary cooling fans, and controls the A/C compressor directly. The electrical circuits for the

Refrigerant pressure sensor input goes to the All Activity Module, and you can measure the signal voltage at the AAM. You should have about .75V with a full system at about 90 psi of refrigerant on both high and low sides with the A/C system off.

pump and fans are completed through relays located in the fuse and relay box under the hood. The AAM has the final say on energizing the A/C compressor. It gets A/C pressure input from the high-side line running from the compressor to the condenser by means of a three-wire sensor with a five-volt reference, signal wire, and ground. The AAM needs to see that the proper amount of refrigerant is in the system before it will activate the compressor. If the refrigerant level is too low, the AAM will not energize the compressor so it does not seize from running dry.

Getting the Compressor Started

You should see about .75V on the signal line with a fully-charged A/C system with about 90 psi on both the high and low sides (system off). This should be enough to get the compressor started. Then, the low side should drop to under 30 psi and the high side should increase to at least 150 psi, or higher if the ambient temperature is hot. Remember, if the evaporator core temperature sensor is indicating freezing temperatures, the compressor will be shut off. If the high-side pressure becomes excessive -- over 450psi -- the AAM will ground the auxiliary fan relay to activate both fans. This should drop the temperature and pressure in the high side of the system. Blower motor controls are conventional switch and resistor types that regulate blower current and therefore speed.

In the 2002 model year (9/01 production date), the 163 chassis received a fully-automatic air conditioning system. Interior temperature sensors were added to the center air and foot-well ductwork. The input from these sensors contribute to the positioning of the blend door motor. The push-button panel is now the AAC control unit and takes over direct operation of the A/C compressor and the coolant circulation pump from the All Activity Module. The AAM is still in control of the auxiliary cooling fans. Rear independent temperature control was also added. A Rear Control Field Control module (RCP) sends switched inputs to the Lower Control Field Control module (LCP), which communicates on the C CAN with the AAC module. The new all-inclusive AAC module directly manages air distribution by controlling six motors. Three motors handle the defrost vent, center vent, and foot-well ducts, and the other three control the temperature blend door, fresh air/recirculation door, and rear air supply.

I'm Venting!

Each motor shares the same three wires from the AAC unit. Pin #1 is a 12V power supply, pin #3 is a ground, and pin #2 is the command signal. It is

Vehicle	230.475	Control unit	KLA2

Function requirements

Preconditions	Specified value	Actual value	Result
Evaporator temperature	1 - 80 °C	40.0 °C	☑
Coolant temperature	0 - 110 °C	94.5 °C	☑
Engine speed	400 - 1400	654.0	☑
Refrigerant pressure	2 - 33 bar	9.0 bar	☑
Fault codes			☑
Function preconditions satisfied			
Continue with button F2			

With your SDS, you can reduce your diagnostic time by evaluating the available data. Here, you can see the evaporator temperature and refrigerant pressure at a glance. You should always back up your findings with electrical testing at the component before replacement.

a time-based pulsed signal that sends individual messages out to each door motor even though they are all attached to the same wire. This means the signal to control each motor is sent on the same wire. There is a little more to the story than that. With a paid subscription to www.startekinfo.com, you can access factory wiring diagrams. This can be important because if you look at the 2002 model year you will see that an Extended Activity Module (EAM) is connected to the AAC control unit and the Lower Control Field Control module through a CAN. This is all referring to the 163 chassis; wholesale changes were made to the 164.

Although the AAM controls the compressor, not all compressors are the same. On the older 163 chassis, the A/C compressor has a conventional clutch to engage and disengage. This is how refrigerant pressure, and therefore temperature, is maintained. On later 163 chassis (2002 forward), a clutchless variable-displacement compressor is used. It has a rubber coupling in place of a clutch. If the compressor seizes, the fixture decouples and only the pulley spins. Compressor output is controlled by positioning a swash plate inside the compressor unit. The swash plate can be positioned from 2% to 100% swept volume. Since the compressor is always engaged at 2%, if offers almost no resistance and does not rob horsepower from the engine. A compressor control valve applies low side pressure to move the swash plate and vary the displacement, and, therefore, compressor output.

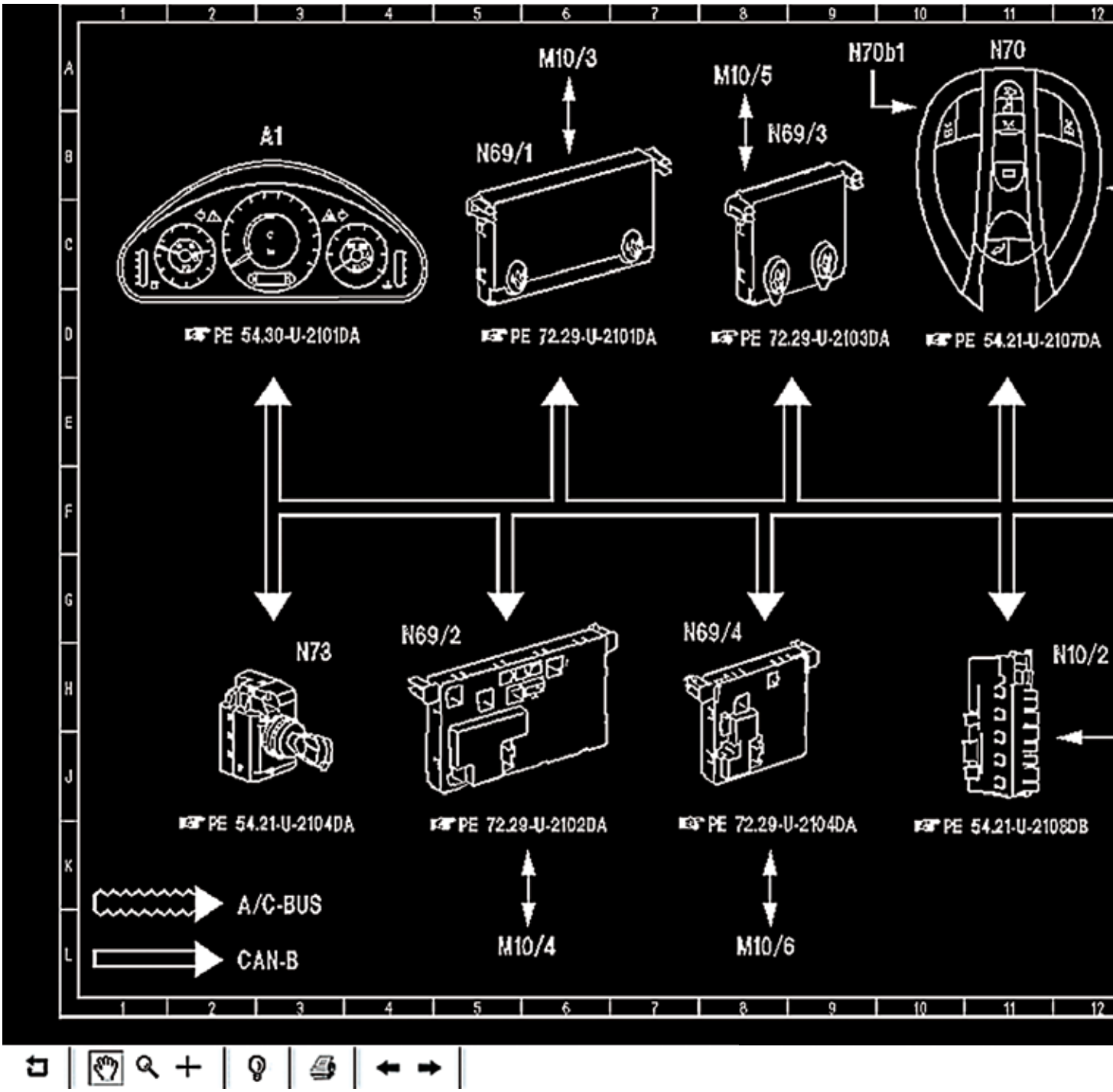
Feeling the Breeze

Not all AAC systems are created equal. The blower controls on a 210 chassis are different from those of an early 163 chassis. The 210 chassis was one of the first AAC systems to use what is sometimes called a final stage blower motor module or blower regulator to control blower speeds. The 215 and 220 chassis have a similar set up. Constant power is fed directly to the blower motor through the fuse panel by the firewall on the driver's side of the engine compartment. The ground wire of the blower motor passes through the blower regulator, which is clipped onto the blower motor assembly. A three-wire connector applies 12V to the module, the command signal to vary the motor speed, and ground. The voltage supply is usually a larger-gauge red wire, the command signal is yellow, and the ground is black. These wire colors do not show up on the wiring diagram since they are not on the vehicle's harness side of the connector.

The voltage command is an analog signal that comes from the AAC control unit. With the blower off, the voltage is zero. As you turn the blower speed control up, the signal from the AAC unit gradually increases from .5V to about 6V peak. If the blower module was replaced in the past, it is possible that it is being over-taxed. While it forms the ground for the blower motor, it carries all of the current the motor is drawing, which is considerable especially at high speed. Normal draw is approximately 30 amps. If you measure more than this, the motor may have a seizing bearing. Also, check to make sure the fan blades are not hitting anything. If the amperage draw is too high, you will need to replace the blower motor before you over-tax another module.

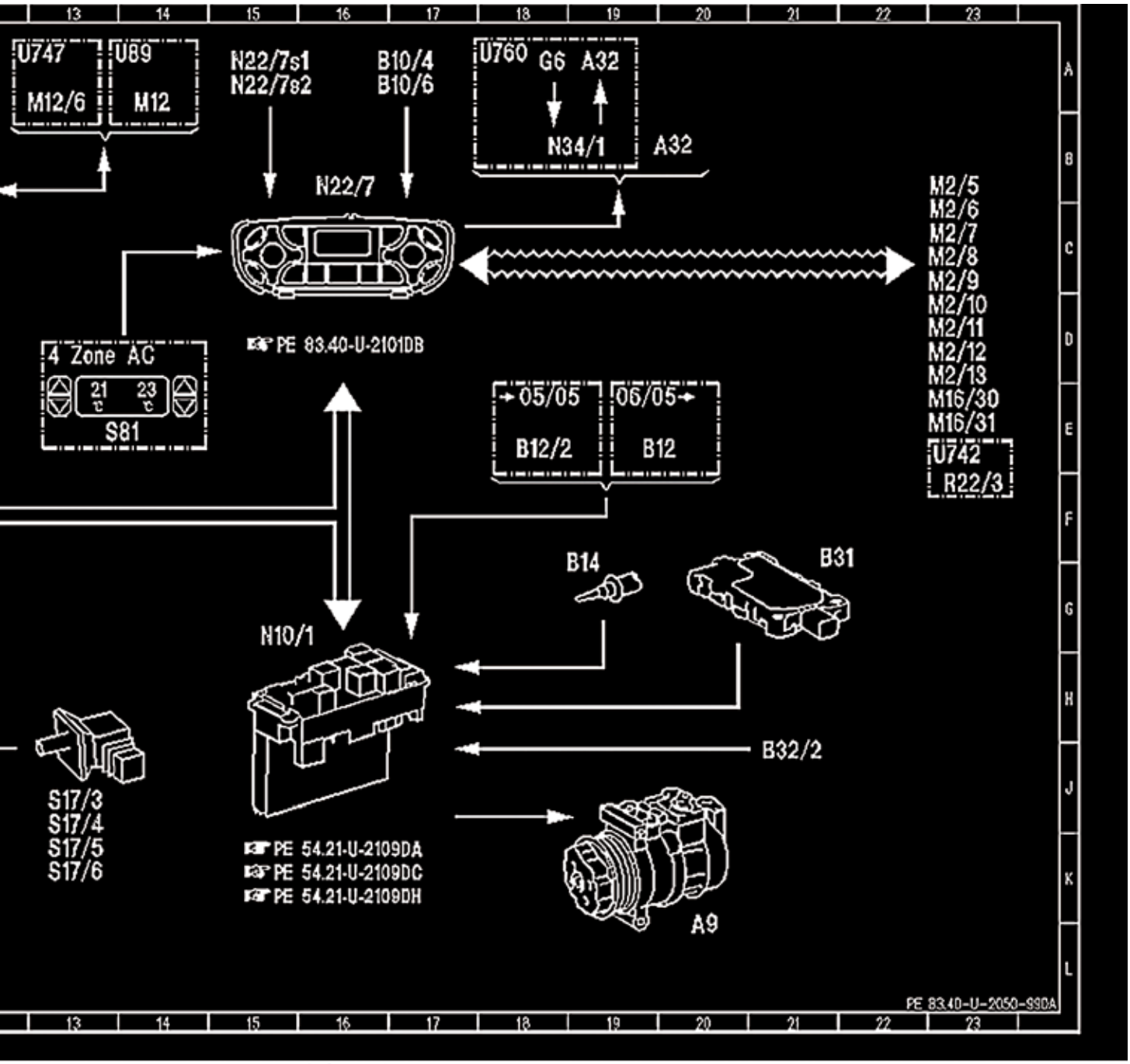
Defrost, Vent, or Footwell?

When dealing with a door mode control problem, you must understand a few things. There is AAC and C-AAC. The AAC system automatically adjusts the air



conditioning and blend door operations to match the temperature selected. The C-AAC system can do the same thing, but there are temperature sensors in the ductwork that can change the position of the door to maintain the selected temperature. Mercedes-Benz uses a few different systems to control the position of the motors. The first is the three-wire system mentioned earlier. A common power supply, signal command, and ground are connected to every motor. The signal wire carries the square wave that commands the position of each motor. This can be found on the 163, 203, 211, and 230 chassis. The 215 and 220 chassis uses a slightly more sophisticated system.

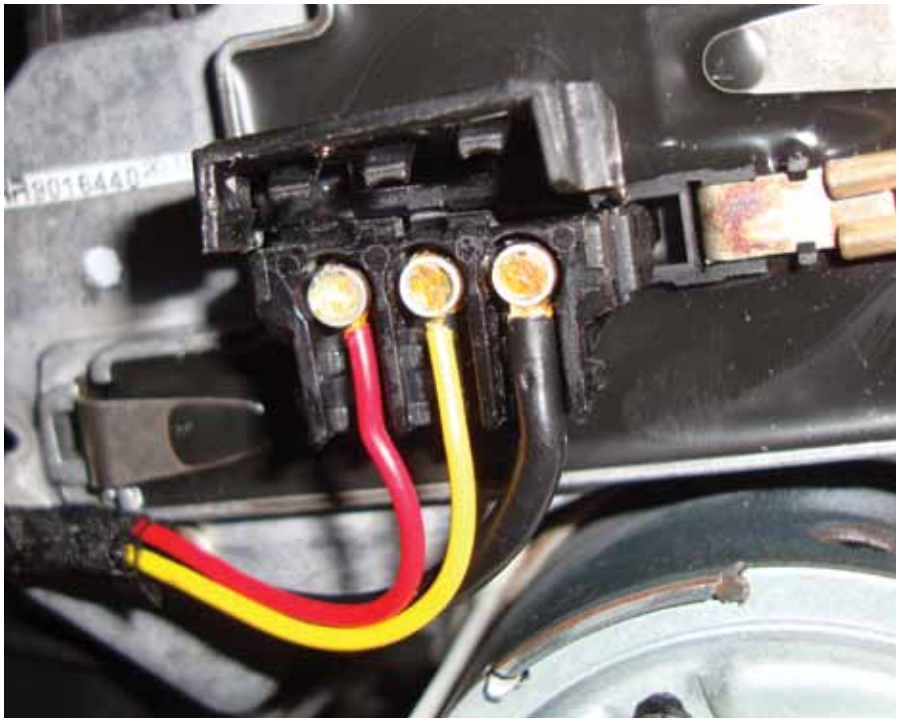
Below: With your paid subscription to Startekinfo.com you can access specific technical information on any system. Here is a function diagram for the A/C on a 211 chassis. Notice that component B14 ambient temperature sensor goes into the front SAM. This reading is used to calculate when the compressor is turned on.



B32/2 C-AAC sun sensor (4 in total)
PE83.40-U-2050DA Function diagram, electrics, interior climate control

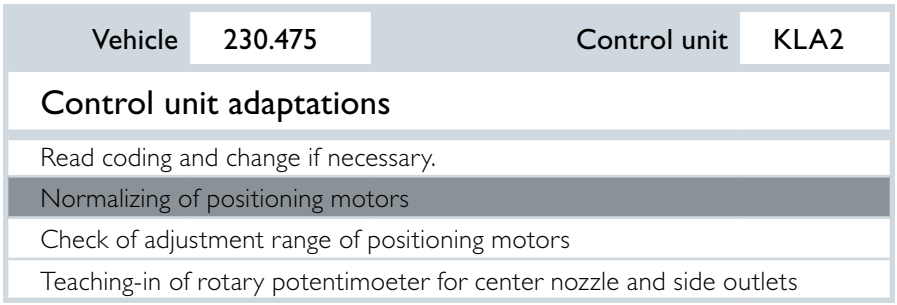
Model 211

The flagship sedan and coupe use a C-AAC to manage the overall climate control system. A separate control unit handles the stepper motors directly by providing an individual power supply to each motor. Just like a normal stepper motor that might be used to control idle speed, EGR flow, etc.,



Right: On the E-Class, the blower motor regulator has a three-pin connector as well as the single spade connector for the blower motor ground. Here, the red wire is the power supply, the yellow wire is the command signal, and the black wire is ground. Look for up to 6V from the AAC unit on the command line at full blower speed.

A "good" blower motor will draw approximately 30 amps when supplied battery voltage and direct ground. You should check the amp draw if you need to replace the blower regulator to verify that you will not have a repeat failure.



Using your SDS you can select "Control Unit Adaptations." From here you can select "Normalizing Of Position Motors." This will start the process of moving the motors through their full range of travel and recording their position for future adjustments.

four wires are pulsed to ground to change position. The stepper motor control unit receives its directions from the C-AAC control unit. The signals are sent over the dedicated AAC CAN, also known as the KLA CAN. Other sophisticated components communicate over this CAN, such as the center vent control unit, sun load sensor, and the multi-function sensor. The multi-function sensor reads various data from the environment. Aside from reading outside temperature, it can read humidity, CO, and NOx. This provides information for an optional air filtration system. Outside air can be directed through two activated charcoal filters that can catch pollutants.

Tools in the Arsenal

No matter which system you are working on, you are going to need an SDS to finish the job. Each AAC control unit has multiple sensor inputs and communicates with other control units to operate the A/C system. You can access all of the data for each of these units with your SDS, which is available for purchase from Mercedes-Benz USA. You can find this information on www.startekinfo.com/StarDiagnosis/Aftermarket. With the new Xentry software, you can either go directly into the AAC control unit or evaluate the data in the AAC unit directly. This will give you data and control from other control units that work with the AAC. This data can be critical to A/C operation. For instance, the outside temperature sensor signal is usually sent to the front or driver's side SAM. This information is used by the AAC unit to control A/C operation.

If the sensor signal indicates a very low temperature from a broken or missing sensor, the circuit would be open. Like any typical NTC (Negative Temperature Coefficient) sensor, the higher the resistance through the sensor the higher the signal voltage. An open circuit would indicate freezing temperatures. In this case, the A/C compressor would not be commanded on since the electronics believe the outside air is cold. The same situation could be said for the evaporator temperature sensor or interior temperature sensor. If both sensor inputs indicate it's too cold, the compressor will not come on. Both of these inputs come directly into the AAC control unit. Only the outside air temperature sensor is sent to the SAM, so you may not see the data in the AAC control unit unless you look at the overall A/C system with your Xentry software. Other functions are required to bring an A/C system online after service.

The SDS to the Rescue

After evacuating the system and then recharging it with the correct amount of refrigerant (see the label in the engine compartment), the compressor may still not come on. If a diagnostic trouble code blocks A/C operation, you will have to clear the code before the compressor will be commanded on. This should be done after the A/C system is serviced. After servicing a mode door control motor, you will also have to normalize the door positions. There is a procedure in the SDS for this. When you perform this function the AAC control unit or the stepper motor control unit commands each motor to the end stops and remembers the positions of each. The automatic temperature and mode door motors can make adjustments to meet the changing conditions. Automatic functions may work incorrectly if this step is not followed.

There are other opportunities for service on Mercedes-Benz A/C systems. Statically-charged particle filters are installed on most models and charcoal activated filters are available for high-end models. Your Mercedes-Benz dealer's parts department can supply you with OEM quality filters, which are better than aftermarket replacements. Mercedes-Benz has a detailed catalog of remanufactured A/C components such as A/C compressors, so your customers can have OEM quality replacement parts. Diagnosing the problem accurately and installing quality parts is why your customers come to you for their service work. Let Mercedes-Benz stand behind your work with warrantied components and your customers should have no problem keeping their cool.

ARE YOU READY FOR CARBON FIBER REPAIR?

Carbon fiber parts will be in certain 2012 Mercedes-Benz production series vehicles

Lightweight vehicle construction continues to be the Holy Grail for leading automakers such as Mercedes-Benz. Driven by environmental, economic, and other considerations, the reduction of vehicle mass is achieved by choosing from a spectrum of lighter materials. The recent shift to lighter and stronger steels and alloys illustrates this. But just as the collision repair industry has begun to adapt from mild steels to higher-strength varieties, there is a new wave of lighter and stronger materials inbound for mainstream automobiles -- carbon fiber reinforced plastics (CFRP). Now is the time to ready yourself and your business for the coming changes.

Carbon fiber is not just coming sometime; for Mercedes-Benz, it is already here

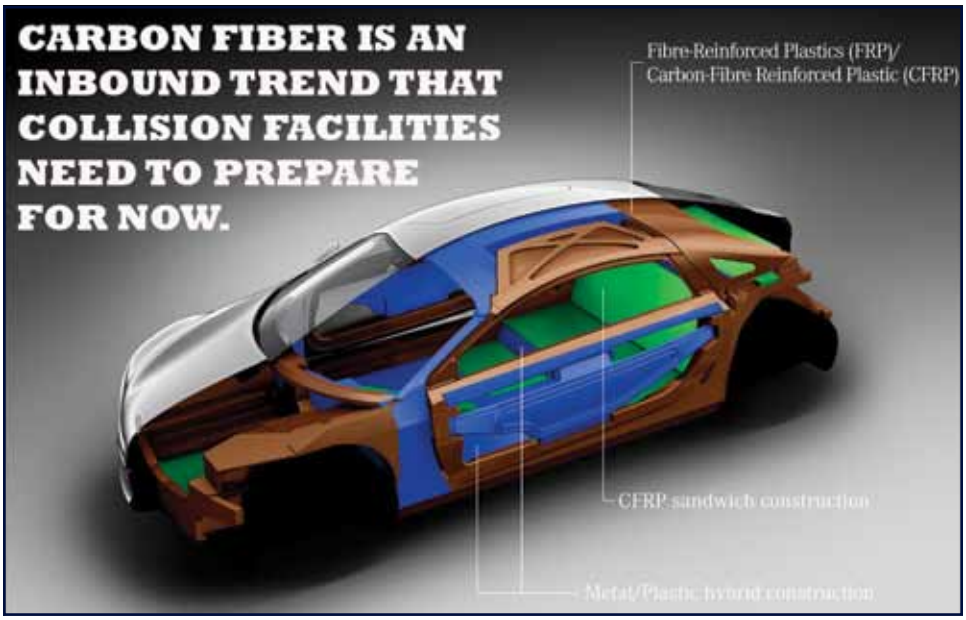
Lightweight construction is an integral part of Daimler's growth strategy toward sustainable mobility, occupant safety, improved fuel efficiency, and reduced exhaust emissions. According to Dr. Dieter Zetsche, chairman of the board of management of Daimler AG (parent of Mercedes-Benz), the company has set a specific development goal of reducing the body-in-white weight for all Mercedes-Benz vehicles by up to 10 percent, when compared with the immediately preceding versions.

This weight-saving initiative will partially offset any increase in weight caused by additional safety and comfort features, or new technologies used in alternative drive systems, or required by regulators. Furthermore, CFRP parts contribute to an increased stiffness of the vehicle body, thereby further increasing the crash integrity of the passenger cell as well as the safety and comfort of vehicle occupants.

Beyond using CFRP parts in Formula 1 racing, Mercedes-Benz demonstrated its CFRP for production-series vehicles over a decade ago with its SLR model. With thousands produced, Mercedes-Benz has put more vehicles with CFRP materials on the road than any other automaker, and demonstrated that CFRP meets the most stringent safety and performance requirements.

In the years since, Mercedes-Benz has worked intensively on the advanced development of CFRP, with the objective of reducing costs so as to enable a broad-scale production-series rollout of the technology. For example, at the automaker's recent Tech Day event, plans to actively adopt CFRP parts and increase the number of models using such parts were shared.

"Daimler will be investing in the expansion of its production network, continuing its product offensive and intensifying the development of new technologies," stated Zetsche. "This includes a joint venture between Daimler AG and Toray Industries Inc. to produce and market automotive parts made of carbon fiber."



Lightweight Construction Via An Intelligent Vehicle Material Mix

By incorporating a mix of lighter-weight materials – higher-strength steels and alloys, fiber-reinforced plastics (FRP), carbon fiber reinforced plastics (CFRPs) – it was possible to reduce the bodyshell weight of the Mercedes-Benz F 125 concept by 550 pounds. But the high CFRP content (body parts and structural components) isn't just futuristic dreaming. CFRP parts and components are now in MY2102 vehicles, such as the SLK, CL, CLS, and other models.

Under this agreement, Toray will utilize its proprietary short-cycle Resin Transfer Molding process technology -- which enables the mass-production of CFRP parts with a significantly shorter molding cycle -- to develop optimized CFRP parts and components for Daimler's brands. Daimler's role will include designing CFRP parts and components,

as well as developing joining technologies and procedures. "We intend to start supplying these mass-produced CFRP parts for more production series Mercedes-Benz passenger vehicles that will be launched in 2012," Zetsche emphasized.

What is a CFRP composite?

Jason Bartanen, technical director for I-CAR agrees that shops and technicians need to prepare now for CFRP. "We're certainly starting to see a lot more carbon fiber applications in production-series vehicles, such as hoods, roofs, body panels, other parts and structural components. We're going to see even more CFRP in the years ahead."

Bartanen shared that the advent of CFRP in everyday vehicles was one of the factors that prompted I-CAR to develop a working relationship with Abaris Inc., a firm with CFRP repair expertise in several industries. The goal is to begin providing CFRP-themed collision repair education to the industry.

Recently, StarTuned had the opportunity to visit with Bartanen, who introduced us to Jay Carpenter, the technical instructor for Abaris Training Resources Inc. His experience ranges from concrete to automobiles (his personal passion) to aerospace to developing CFRP parts that are on the Hubble space telescope.

"CFRP are composite materials," said Carpenter. "They consist of are a combination of two or more materials -- a matrix and some reinforcing element." He used reinforced concrete as an easy-to-understand example of a composite. "Cement is the matrix material, while rebar provides the reinforcement. Together, the composite is stronger, safer and opens up a wider range of applications for the construction industry."

Likewise, fiber composites are also a combination of different materials. They combine resin as a matrix together with some reinforcing fiber. "For fiber composites, the woven fibers carry the load; the weave is effective at handling tension, torsion, shear and compression stresses, but they do not handle heat and fire well," Carpenter explained. "The resin system encapsulates the fiber, resists moisture, maintains the shape and also offers some resistance to compression stress."

Physical properties, such as weight, strength, stress resistance, etc. vary depending on the quality of resins and type of reinforcing fiber used. "But the composite ingredients themselves -- both resin and fiber types -- do not care where they are or what they're doing," adds Carpenter. "They are going to perform to their design specifications where and when a quality repair process is employed.

CFRP collision repair basics

Matrix materials are available in three categories – polyesters, vinyl esters and epoxies. "While each might be able to be used for a specific CFRP repair, think toward high-end quality epoxies when working with CFRP," Carpenter suggested.

"Unlike low-end polyester and vinyl ester resins, epoxies provide a stronger molecular link and better adhesion, which results in a higher-value vehicle repair," he continued. "Epoxies utilize a hardener, rather than a catalyst, which allows more flexible and precise cure times, ranging from minutes to years. To me, it makes zero sense to take a high-end fiber and blend it with a low-end resin, such as polyesters or vinyl esters, because any compromise of the quality of your repair to save a few bucks might come back to haunt you down the road."

Carbon Fiber Has Clear Advantages for Automobiles

The table below lists some of the properties for the three classes of fibers -- fiberglass, Aramid, and carbon fiber -- used in the automobile and other industries. Mercedes-Benz had the foresight to secure a supply of carbon fiber reinforced plastics (CFRPs), just ahead of a growing competitive wave of other automakers now seeking a limited global supply. (Image — ManicMedia LLC)

Fiberglass	Aramid Fiber	Carbon Fiber
• Poor strength vs. stresses • Poor absorption properties • Low cost • Heaviest • Electrical insulator • Can be affected by an alkaline environment	• Good strength vs. stresses • Good energy absorption • Moderately expensive • Lighter than fiberglass • Electrical insulator • Bonds poorly with polyester resins	• High strength vs. stresses • Excellent energy absorption • Most expensive • lightest of all • Electrically conutive • Can cause galvanic corrosion problems with carbon steel and aluminium

There are three primary classes of fiber composites used in collision repair:

- Fiberglass is the weakest and least-expensive type of fiber composite. It consists of a plastic matrix reinforced by fine fibers of glass. Fiberglass composites are sensitive to alkaline environments.
- Aramid fiber is a more expensive, but stronger, class of composites. Aramid has a much tighter weave than fiberglass, which in itself adds strength, but when combined with resin forms a stronger and more solid-feeling composite. Aramid can corrode if exposed to chlorine.
- Carbon fiber is stronger and more expensive than Aramid. Thermal manufacturing processes evaporate non-carbon constituents of a raw polymer leaving a fiber that is typically 93 to 95 percent carbon. Note that carbon fiber can exhibit galvanic corrosion in the presence of carbon steel or aluminum.

Different CFRP composites have unique structural properties and temperature tolerance. Besides outright replacement with a new CFRP part, two other repair options are using pre-impregnated (prepeg) fabrics, or "wet resin systems."

- Although more expensive, the use of prepeg CFRPs provide technicians with more control, as they contain resins that have been applied in a very uniform and controlled manner that achieves the optimal fiber-to-resin ratio. In addition, prepeg materials require controlled storage -- typically freezers -- to hold and retard the resins' natural propensity to advance.
- Repairers desiring a more economical option might employ a wet resin system, wherein they buy the raw fiber materials in rolls and resins in five-gallon pails, then apply the resins themselves. Using a good, readily available wet resin system and sound repair procedures, repairers can effect complete, safe repairs, but doing so requires sound technique to ensure the optimum and critical fiber-to-resin ratio is achieved to match the application.

"When trying to understand the fiber-to-resin ratio, think of achieving the optimal ratio as the Goldilocks effect," Carpenter suggests. "If the composite has too much resin, then the composite will be heavier and more brittle than desired. If there is too much fiber content, then the composite will be prone to coming apart more easily, especially under compression, tension, or torsion stresses that can occur in an accident."

To provide customers with a complete, safe, and lasting repair, Bartanen and Carpenter both agree that technicians should use quality resources from the vehicle manufacturer to determine which of three repair paths are approved and recommended. For instance, technicians must know when and where:

- OEM-approved CFRP replacement parts, assemblies, or components are required.
- Prepeg CFRP products and procedures are approved.
- Using a wet resin system is permitted.

For Mercedes-Benz vehicles, collision professionals can use the StarTekInfo website (www.startekinfo.com) to access service information and procedures, approved parts, tools, and supplies, as well as training details and other resources through traditional Mercedes-Benz channels.

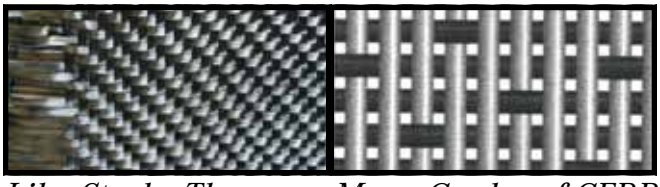
For example, before beginning a repair, technicians should be trained in the use of ultrasonics to detect the presence of delamination or extent of other hidden damage to CFRP parts and components. As another example, an automaker knows the design and composition of its CFRP parts and will require certain resins and procedures to effect repair. Those who rely on non-genuine sources for critical repair information and procedures, if proven to be incorrect or out-of-date, could face expensive consequences.

Preparing now will provide opportunities sooner than many realize

Expect MY2012 SLK, CL, CLS, and other models with CFRP to soon begin arriving at your collision facility. CFRP content will migrate into less-expensive models by 2020.

There is a gulf of knowledge between the general perception of CFRP and the hard-earned expertise of those who deal with CFRP regularly, most of whom work in other industries, or in motorsports. For insurers, CFRP will become more common as new production capacity comes on-stream and is applied to mainstream vehicles. Many initial applications will be bolted or riveted single panels, but future applications will include sub-frames and body structure subassemblies. Those insurers who recognize that CFRP repair is specialized, but far from impossible, should begin today to secure CFRP-ready repair facilities in order to reduce waste as well as cost.

For mainstream collision facilities, understanding the complexity and limitations of new CFRP materials is critical. To achieve this, begin seeking access to CFRP-related information and training to develop CFRP repair expertise. Those collision facilities and professionals who plan and prepare early for CFRP -- like Mercedes-Benz did while other automakers did not -- will be better positioned to seize opportunities than their more cautious competitors. Adopting and adapting to innovation is a matter of choice. In the case of CFRP, that choice is yours to make. Just know that time, like opportunity, moves on. |



Like Steels, There are Many Grades of CFRP

Just as various high-strength steels and alloys are suitable for certain applications and not others, CFRPs also come in various grades designed to fit certain applications. For example, the highest-strength grade may not be suitable where controlled crush in a collision is the goal. Mercedes-Benz engineers choose among the grades on the basis of suitability, not cost.

The type of weave -- the number of fibers and type of repeating weave pattern -- that a CFRP fabric has affects the strength, flexibility, and other attributes of a structural component, part, or repair.

The 2 x 2 Twill Weave (left) has two-CFRP fiber pairs that are woven at a 90-degree angle over two other pairs, then under the next two pairs, and so on. Note how the weave in adjacent rows is offset. This weave will easily conform or drape to complex shapes, but is not the strongest type.

Where more strength is needed, the Eight Harness Satin Weave (right) is available. This pattern has fibers that are woven under one and then over seven fibers that run in the perpendicular direction, repeated across the breadth of the fabric. Like the Twill, each neighboring fiber's weave is offset by one space. In addition, the Eight Harness Satin Weave has less void space, which therefore requires less resin to fill for a quality repair that does not compromise strength, stress-resistance or load-carrying capacity. (Images -- Twill Weave/Mercedes-Benz; Harness Weave/Abaris Inc.)

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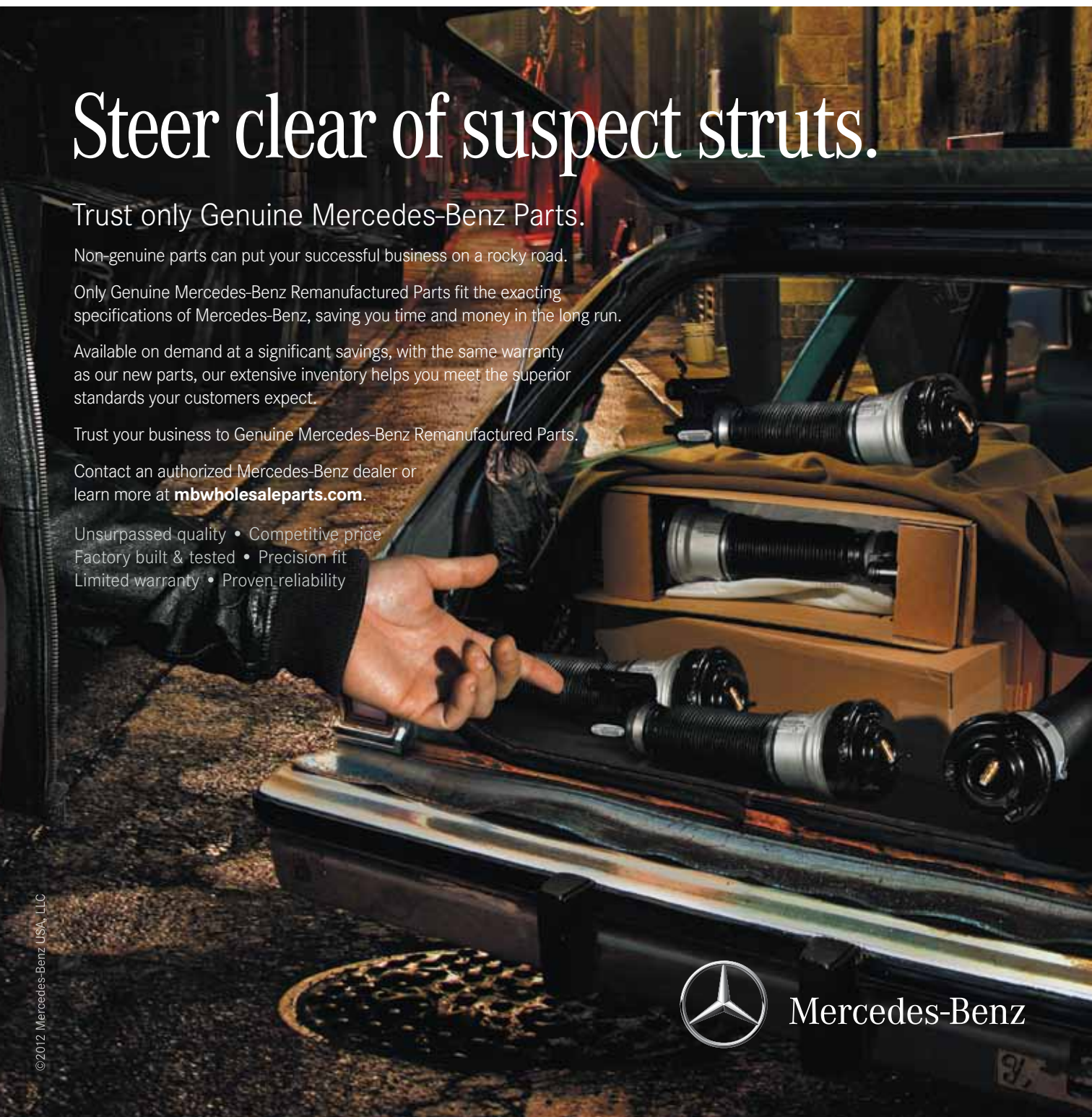
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