StarTuned®

Information for the Independent Mercedes-Benz Service Professional

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Inside:

- Mercedes-Benz PRE-SAFE System Evolution
- Spark Plug Procedures & Precautions
- The Right Stuff
- Automatic Transmission Perfection
- Classics: Model 210 A/C Diagnosis

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StarTuned®

Information for Independent Mercedes-Benz Service Professionals

Welcome to the 21st year of *StarTuned*®, the magazine for independent service technicians working on Mercedes-Benz vehicles. *StarTuned* is sponsored by your supporting Mercedes-Benz dealer.

Mercedes-Benz aims to continue to present the information you need to know to diagnose and repair Mercedes-Benz vehicles accurately, quickly and the first time; text, in-shop photography, graphics, online and other technical sources combine to make this possible.

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

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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StarTuned
One Mercedes-Benz Drive, Sandy Springs, GA 30328
E. blaine.reed@mbusa.com | P. 770.705.3085

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Mercedes-Benz PRE-SAFE System Evolution

Technology Advancements and Avoiding Service Snafus

The Mercedes-Benz PRE-SAFE system was originally conceived as an engineering concept for a driver assistance system rooted in collision prevention and mitigation. The PRE-SAFE system was taken from an innovative concept, to the Paris Auto show in 2002, to its first real-world production deployment in the 2003 model 220 S-Class. The system (to the author's knowledge) is a first-of-its-kind application of multiple networked vehicle systems working in concert to provide occupant protection and impact damage mitigation *before the crash*.

Early PRE-SAFE models' features included tensioning the seat belts, closing door windows and preparing the chassis and occupants for impact. Now, PRE-SAFE involves nearly every major vehicle system, surrounding the occupants with incredible levels of safety and dynamic vehicle stability.

In the subsequent years, the PRE-SAFE concept has morphed into a multi-system symphony of sensors communicating on multiple networks, system output devices, and control modules all designed with the original concept of PRE-SAFE in mind: collision prevention and impact mitigation.

Starting in 2006, Mercedes-Benz introduced one of its first steps toward autonomous vehicle controls with the addition of the Brake Assist PLUS system. This innovative technology uses brake speed and force measurements, radar returns and other inputs to sense, process and command an assist to the power brakes in the event the system determines an impending crash, or in a panic stop situation. In fact, the BAS PLUS system can even help prevent a crash from even happening.

Today's PRE-SAFE concept is no longer limited to seat belts and BAS, but has been transmogrified into a cacophony of multiple systems, including engine, transmission, SRS, ABS/ESP, steering control, instrument cluster, body control and gateway. Long-, medium- and short-range radar sensor nodes (which include the radar sensor, processor and CAN

node in one module), proximity sensors and cameras are in play. The technology utilizes modules that operate on six separate CAN or FlexRay networks and a LIN network.

First, consider the sheer volume of input data, output control and communication that must occur seamlessly to get a visual picture of the "symphony of signals" to which we refer. Then, consider that these signals are sensed, analyzed, run through truth tables and algorithms, then CAN or FlexRay messages are configured and sent to the reacting output device(s) via control module data transfer. This entire process occurs in millionths of a second.

The Progression of PRE-SAFE Technology

So let's take a dive into the progression of PRE-SAFE technology. The best way to understand this is to follow the progression of technological upgrades on a single model, in this case the S-Class since PRE-SAFE started with the S-Class.

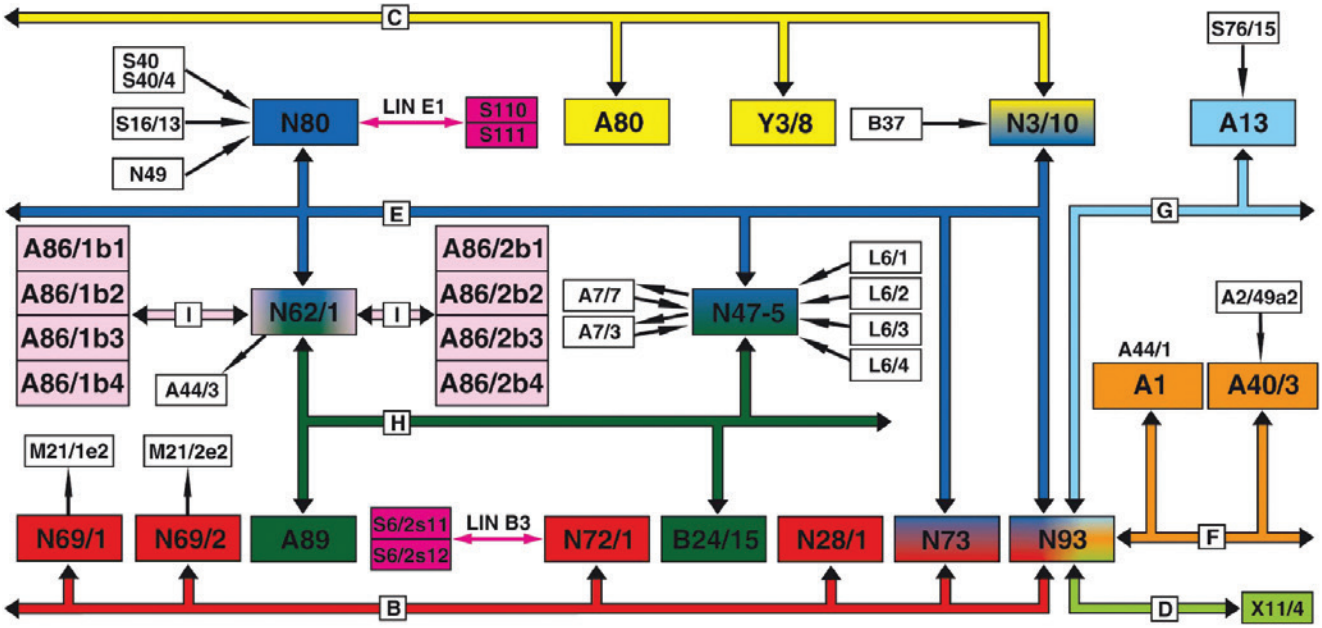
W221 Chassis Advancements

We start with the 2006 W221 S-Class because, for the most part, this model year is where the technology really starts ramping up big-time. The Mercedes-Benz engineering team took things to a whole new level with the addition of BAS Plus, DISTRONIC Plus and Park Assistant (option code 233). This option package is one of the first multi-system ADAS (Advanced Driver Assistance System) packages in the industry, and with it a new generation of smart automotive technology was born.

PRE-SAFE Brake, Mercedes-Benz' Collision Mitigation System (CMS), prepares the passengers and vehicle for an impending collision by pre-tensioning the seat belts, closing the windows and adjusting the front passenger seat as well as providing autonomous emergency braking.

DISTRONIC PLUS with BAS PLUS

The BAS PLUS system is the next evolution of assisted braking. The system uses brake force calculations and other dynamic vehicle inputs to provide precisely the correct amount of braking assist for the amount of brake



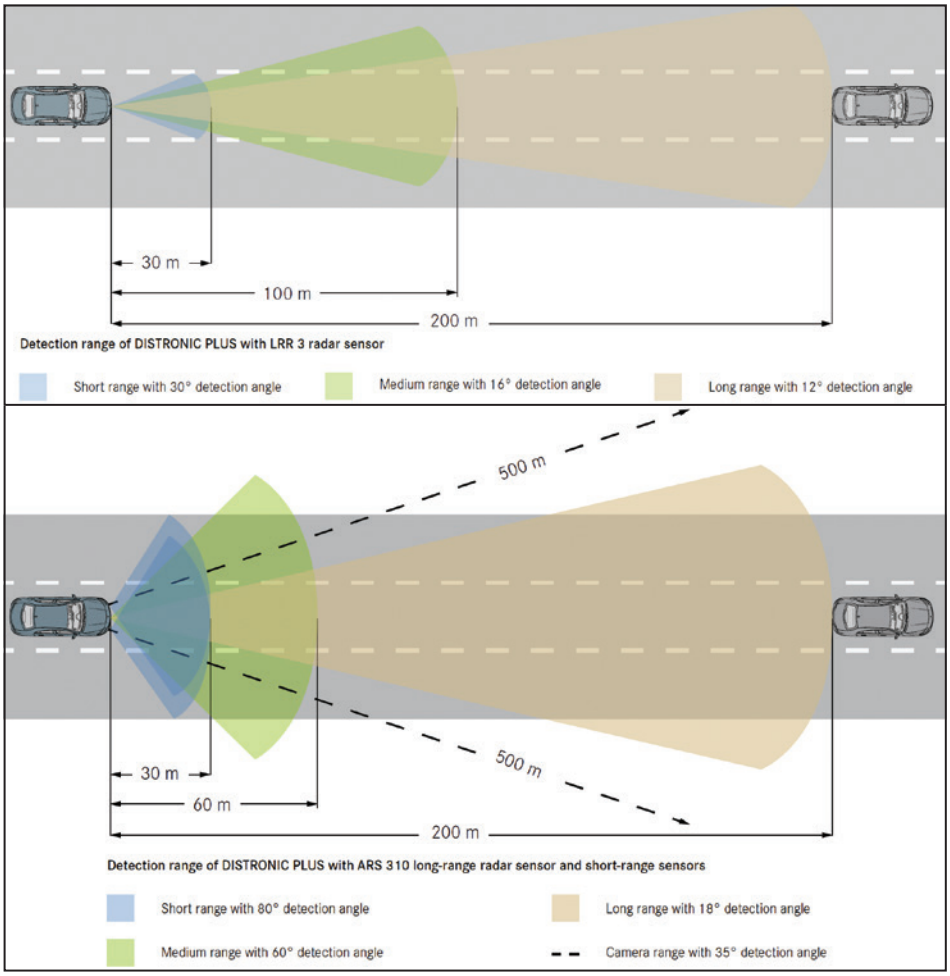
The PRE-SAFE system is comprised of many systems all working together like a symphony, but on a millionths of a second timescale.

force being applied by the driver. In the event that there is no input from the driver, when the DISTRONIC PLUS radars, cameras and sensors detect that a crash is imminent, the system will apply between 40 and 60% braking force to the wheels to help mitigate a crash. BAS PLUS works in concert with several other systems as well.

DISTRONIC PLUS, *aka DISTRONIC on Steroids*

This system technology upgrade adds short and mid-range radar to supplement the long range radar of the original DISTRONIC, so PLUS just adds the short and medium-range radars. The two radar detection angle images (right) show how these radar sensors (both early and later versions) operate over various ranges and angles.

The driver has the option to set the following distance to the vehicle ahead, using the left



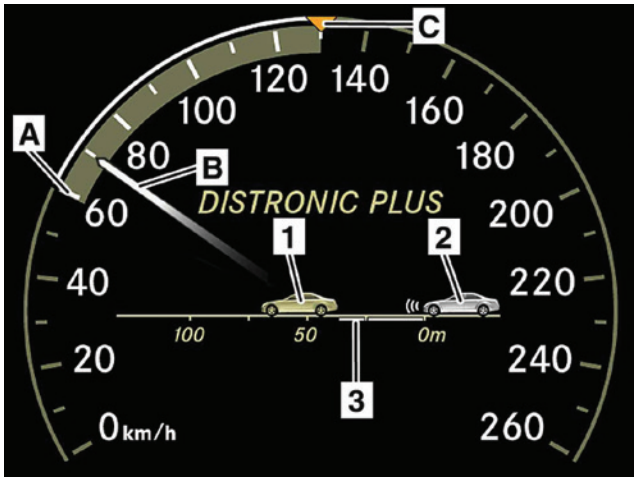
Radar detection angles and distances of the short, medium and long range radars. Both early and later radar assemblies are shown.

and right steering wheel controls and watching the distance indicator on the cluster. When the system detects a vehicle slowing down or speeding up ahead, the system is designed to automatically brake or accelerate (up to the maximum speed set by the driver) to maintain a safe following distance. If the system detects a vehicle ahead stopping suddenly, the system senses an impending collision and takes action: A warning is displayed in the instrument cluster, a tone sounds and, if necessary, emergency braking is commanded as PRE-SAFE prepares the occupants and vehicle.

The S-Class also incorporates several other driver assist functions, including a distance warning system and, on later models, an active distance warning system. This is integrated into DISTRONIC PLUS and also includes Park Assist, which uses proximity sensors to provide visual parking distance assistance on the instrument cluster and the rear headliner. The Advanced Parking Guidance (APG) system assists the driver in finding a sufficiently sized parking spot but, on this model, the driver must then physically park the vehicle in the slot themselves.

Blind Spot Monitoring is included as well. This system's blind spot sensors also feed data into the overall ADAS scheme by providing data regarding objects or traffic at the sides and rear of the vehicle. The system throws this data in the mix with the cameras, radars and sonic proximity sensors to provide a more complete "total picture."

A Night View Assist (NV) option was also offered on the 221 chassis and uses infrared light-based emitters and camera systems to detect pedestrians, animals and wildlife using reflected infrared light. Adaptive High Beam Assist uses camera-based light sensing and automatically adjusts the range of the low beam headlamps to the distance of



An example of the instrument cluster display during distance setting

detected vehicles which are in front of or coming towards the vehicle. The optimal headlamp range of up to about 1000 feet is thus made available to the driver if it won't dazzle another driver.

222 Chassis Advancements

The 222 chassis, built from 2014 to 2020, boasts even more PRE-SAFE related advancements. On the 222, we see the following additions and upgrades:

- DISTRONIC PLUS continues in the 222 as option code 233 until the mid-model run addition of Steer Assist, (DTR+Q). The +Q designation adds electric steering assist to the DISTRONIC PLUS system.
- Active Blind Spot Assist (BSM+) watches the sides and rear, and can intervene to help avoid a collision.
- Night View Assist PLUS (NV+) enhances the infrared signature and highlights the danger on the screen. This helps quickly identify the location of that deer *before* it runs out from the roadside.

223 Chassis Advancements

The all-new model 223 seventh-generation S-Class takes PRE-SAFE to a stratospheric technological level. Additions to the DTR+Q system include:

- Rear collision warning system if equipped with the Driving Assistance Package. This includes a new, medium-speed radar unit in the back to detect potential rear collisions.
- PRE-SAFE Occupant Side Collision Protection. This innovative feature, in addition to prepping the seat belts, door and sunroof windows, deploys air bags in the seats to quickly force the occupant inward toward the center of the vehicle to help mitigate potential injury from a side impact.
- The reversible seat belt system works in conjunction with this feature, reducing tension on the seat belts restraining the passengers seated opposite the side of the impact.

These last two features actually re-position the occupant, but also counteract the physical forces applied to the body by suddenly accelerating the occupant in the direction of the impact, thereby reducing the physical forces absorbed by the body during the impact. The nearby photos will help explain the extent of this system.

The Mercedes-Benz model 223 S-Class with driver assist feature and electro-hydraulic suspension can instantly raise the body of the vehicle by about 8 cm just milliseconds before impact, directing side-impact collision forces

downward toward the lower door and frame area and away from the occupant's proximity to the door.

This is Star Trek stuff on four wheels, folks. And as techs, we've got to be able to sort them out professionally and cost effectively when the various systems might be feeling a bit tipsy, such as in the case of an intermittent communications fault. There are so many high-tech upgrades to the PRE-SAFE, DISTRONIC PLUS and Driver Assistance Systems in the new 223, again, it would simply be impossible to list and explain them all here and do the information justice.

So, with all of this quantum-leap computing technology, let's consider some service, repair and diagnostic thoughts:

The passengers are surrounded with technological love and protection in a PRE-SAFE vehicle. In the case of an accident, the vehicle seemingly transforms into a version of the Stay-Puft Marshmallow Man.

When a customer comes in with a strange complaint, a common one for us is "my car keeps forcefully braking itself for no reason from time to time." Another common complaint is: "My cruise control just suddenly stops working and I get a warning message on the dash, yet five minutes later, it is working fine." What could create such issues, when the vehicle otherwise exhibits no DTCs or other causal symptoms?

And why does it seem we are rarely able to duplicate the condition?

To answer these questions, the best technicians learn to work with the service advisor to really drill down into the customer complaint and discuss with the advisor or customer the possibility that some of the system's limitations may be at play. Mercedes-Benz service information does a great job of warning us about these system limitations and what may happen in certain driving situations.

The first diagnostic warning for technicians about these systems relates to low voltage issues. A low voltage issue in any module can and will cause communication errors, motor and actuator functional issues, along with control unit resets and a host of other "glitch" conditions.

Mercedes-Benz does a fabulous job with the engineering of their quiescent (at-rest) power management. A strong recommendation is to first track down any voltage- or current-related codes, check for excessive current consumers and check battery state-of-health and power management logs. Solve communication faults next, in your general strategy. Fix any voltage related DTCs first though, because this can be a major source of communication faults and DTCs.

After addressing voltage- and communication-related faults, you may find that your circuit and component related DTCs do not reappear. This thought is often missed while chasing specific DTCs, and should be considered in your overall diagnostic strategy.

There are many function triggers from the various interconnected systems that will instruct the PRE-SAFE system to apply warnings and prepare the system for a crash. Vehicle speed characteristics for example, radar and sensor feedback, deceleration rates, panic braking forces, steering angle and force inputs, all of these and many more can "trigger" some combination of vehicle and occupant prep for the crash. *Was that Steering Angle Sensor relearned properly?*

A conscientious technician must read circuit description and operation material, and understand these triggers in order to accurately pinpoint the fault. Additionally, pay attention to the individual system's disclaimers regarding operation in weather or dirty, muddy, snowy or other adverse conditions. For example, in the 221 models Mercedes-Benz Service Information specifically warns that the cameras, radar units or sensors can be dirty, damaged, out of calibration or otherwise physically obstructed to the point that the software decides to disable the system and return control to the driver. There are numbers of things even on clear sunny days that can cause the system to hand control back to the driver, *including* sun glare or reflection glare that blind the cameras on a perfectly beautiful day.

Another thing that can trip up any ADAS system is no visible lane markings or lines on the road surface. On these roads, the ADAS systems will typically become disabled or unavailable when the system cannot identify the proper lane positioning. A light covering of leaves or snow is enough to obscure the lane markings.

NOTE: An important diagnostic service information warning: all DISTRONIC-type systems (by law) must automatically shut down around any radio astronomy or other sites where interference from the vehicle's radar may disrupt critical communications. Pay attention to this one, it's a sleeper, and not often considered in the diagnostic. This has even happened to me in my own car! The GPS system is used to determine when the vehicle is passing through these areas.

Also beware of high-resistance corrosion in wiring, contact pin drag tension issues, interference from other RF (radio frequency) systems, communication data line termination and wiring problems and, of course, cars doing weird things because of mis-calibrated cameras and radars, hardware and software faults. Pay particular attention to recalibration if the vehicle has recently visited a body shop, where they might not be aware that 'no MILs lit' doesn't mean all is OK. I jokingly call this the 'Animal Factor.'

The Animal Factor is a term I coined (but don't use) to refer to someone slam-banging through a flat rate job and not paying attention to instructions or details. The Animal Factor is in play in a huge way when it comes to not calibrating modules and components, post-repair on all vehicles with this technology. This is in my opinion one of the most prolific problems in the ADAS world today, next to communications issues. Let me explain why:

A keynote speaker at a major industry event last year, an engineer from an ADAS system controller and software company told us in his speech that a simple two degree offset of a front radar unit or camera's calibration can result in that radar reading off-target by over 150 feet out at the radar's maximum range. *When a customer complains of the vehicle doing weird things, consider what can happen if the radar is reading traffic 150 feet to the left or right of where it should be looking.*

One of the most ignored warnings issued by Mercedes-Benz (and all manufacturers of ADAS systems) is that the system absolutely must be calibrated if and when related parts are replaced, or the front or rear suspension is modified in any way. Let us define modified: Not only does this mean we need to recalibrate if one were to 'upgrade' the tires or suspension components, but modified also refers to alignment of the suspension (i.e., wheel alignment).

This instruction warning applies to the camera, radar and other devices. Just due to the sheer liability involved, shop technicians must heed and follow these warnings and post-repair instructions to the letter. The Animal Factor is alive and well in our industry, we must not be animals when repairing these vehicles!

Bear in mind there are probably tens or even hundreds of thousands of vehicles out there right now that have been 'aligned' at tire stores, shops and, yes, even dealerships without systems being properly re-calibrated. It happens every day. In several of our support cases regarding ADAS complaints over the last year, this has been found to have been the root cause of the customer complaint. Note that Mercedes-Benz USA requires technicians to document on the repair order the system realignment or calibration whenever a job calls for it.

In summary, when servicing any Mercedes-Benz PRE-SAFE equipped vehicle, please either invest in the equipment needed to perform these functions, or for heaven's sake and your customer's sake, get the vehicle over to the local Mercedes-Benz dealership or licensed XENTRY specialist for proper calibration. Lives can depend on it.

Remember to decipher customer complaints, listen, learn, do your best to understand the theory and don't be afraid try new methodology in your testing when dealing with Advanced Driver Assist System complaints. Good luck, and happy diagnosing! Until next time, enjoy the upcoming springtime!

Spark Plug Procedures & Precautions

This essential component was invented about 160 years ago, but is still evolving in terms of design, materials, and service.

Ah, the lowly humble spark plug. At one time it was king of the ignition system (or at least part of the royal court!). If an engine wasn't running properly or misfiring, the go-to in terms of diagnosis always had the spark plugs at the top of the diagnostic charts. They required frequent adjustment and replacement, and fouled easily. Today it's common for some spark plug change intervals to be up to 100,000 miles. This isn't due strictly to the improvements to the spark plugs themselves per se, although there have been many.

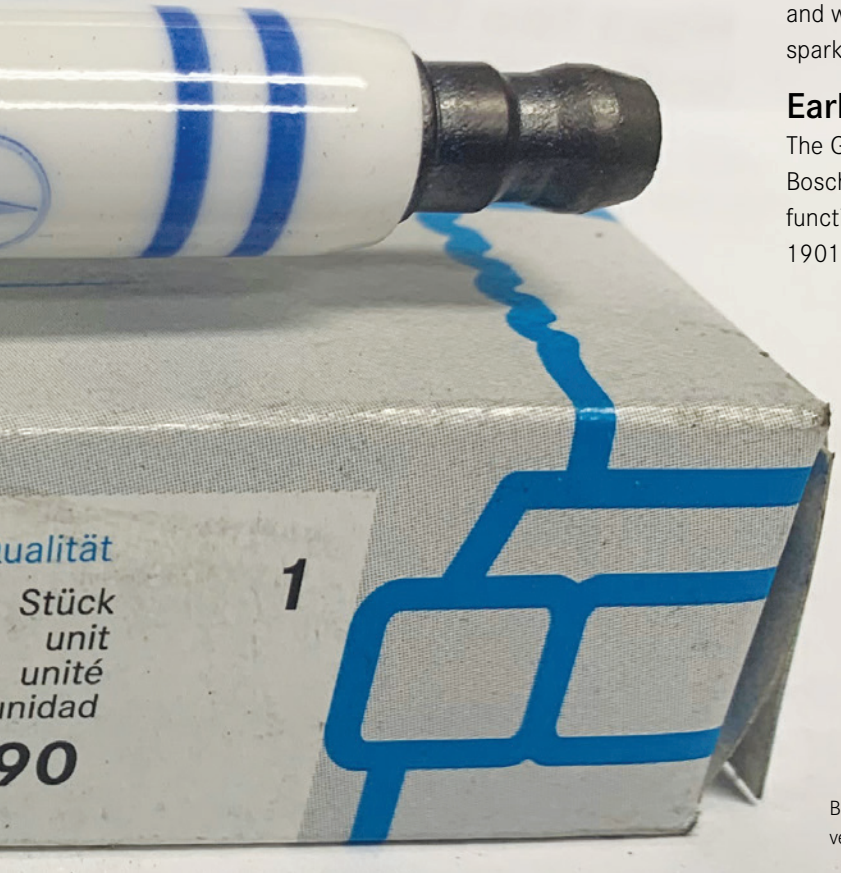
The many improvements to the ignition and fuel systems and even the engine's mechanical components themselves have helped to contribute to the longevity of the spark plug, so much so that they are often overlooked in terms of maintenance. That is why keeping proper records of service intervals is paramount to making sure they do get changed on time.

Older technicians remember the days of ignition contact points, distributors, carburetors and a single coil to fire multiple spark plugs. To the younger techs out there this may seem to be like reading about the ancient Roman Empire! As often as every 3,000 to 7,000 miles the points, condenser, cap and plugs needed to be changed in order to keep the engine running smoothly. Not to mention frequent carburetor adjustments. Ignition contacts sets were a wearable item so as they began to get pitted and the rubbing blocks would wear, ignition voltage would change as well as timing, leading to poor spark which, in turn, would begin to foul the plugs. Carburetors and air intake systems were terribly inefficient compared to modern day systems and were responsible for premature wear and fouling of spark plug electrodes as well.

Early Beginnings

The German inventor Robert Bosch developed the first functioning spark plug in 1901, then received a patent

Here is a picture of the first patented spark plug, from 1902. (Courtesy Robert Bosch Corp.)



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the following year. Although the history of spark plugs is traceable to the mid-1800s, it really isn't certain who invented the first one since it was never patented. While others had a hand in developing the spark plug, Herr Bosch was the one to perfect and patent the technology. It is interesting to note that the spark plug itself was in fact only a by-product that Bosch had to manufacture in order to be able to offer a 'complete' ignition system to manufacturers of the time.

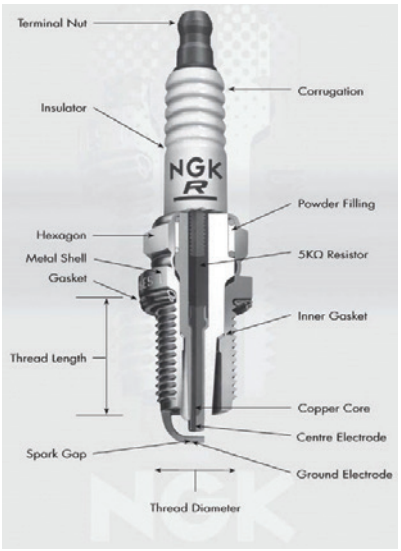
When automobile manufacturing was still in its infancy around 1900, car inventor Karl Benz observed that ignition was proving to be carmakers' "trickiest problem." Gottlieb Daimler's glow-tube ignition created a constant hazard of fire, and battery-powered ignition systems restricted the range of cars to a few dozen kilometers, since there were as yet no on-board systems like today's alternators to recharge batteries while driving. Enter the Magneto.

Two engineers for the Bosch Company, Arnold Zähringer and Gottlob Honold, after much trial and error developed the high-voltage magneto ignition system based on what was known as electric-arc ignition. By means of two coils on the armature, it generated a high-voltage current. This current was conducted to a spark plug via a cable connection. The high-voltage current jumped the gap between its electrodes in the form of a spark. As mentioned earlier, some spark plug designs were around since the 1860s or even earlier, however with little success. The main issues were in the design of the insulating material and the electrode. Honold developed a highly insulating ceramic for the insulating body and a heat-resisting alloy for the electrodes. Thus the first direct ancestor of the modern spark plug was born.

Anatomy

A spark plug is made of a center electrode, an insulator, a metal casing or shell, and a side electrode (also called a ground electrode). The center electrode is a thick metal wire that lies lengthwise within the plug and conducts electricity from the ignition cable or coil pack connected to one end of the plug to the electrode gap at the other end. The insulator is a ceramic casing that surrounds much of the center electrode while both the upper and lower portions of the center electrode remain exposed. The metal casing or shell is a hexagon-shaped shell with threads, which allow the spark plug to be installed into a tapped hole in the engine cylinder head. The side electrode is a short, thick wire made from various alloys that is connected to the metal shell and extends toward the center electrode.

The tips of the side and center electrodes are about 0.020 - 0.080 inch apart from each other (depending on the type of engine), creating the gap for the spark to jump across. The basic design has been relatively constant through the years but many advancements have been made in the raw materials used as well as the construction techniques.



A look at the inner workings of the modern resistor spark plug. (Courtesy NGK.)

According to NGK, a leading manufacturer of spark plugs, ground electrode type spark plugs come in all shapes and sizes. Standard spark plugs typically feature a traditional ground electrode. Ground electrode variations include DFE (double fine-wire electrode), flat, hybrid, low-angled, multi-ground, PSPE (projected square platinum electrode), semi-surface discharge, slant, square, surface discharge, taper cut, and trapezoid cut, to name just a few.

Double fine-wire electrode (DFE) spark plugs apply a fine wire pin to the ground electrode in addition to a fine-wire center electrode. A smaller electrode requires less voltage to jump the gap, resulting in fewer misfires, which translates to increased fuel economy and horsepower. A smaller electrode also reduces flame quenching. Reducing the electrode size on a standard nickel plug would result in a drastically shortened life span, so smaller electrodes require exotic metals such as platinum or iridium to maintain and often surpass the longevity of a traditional spark plug.

A flat ground electrode is shorter and closer to the metal shell and center electrode, providing a faster path to transfer heat away from the ground electrode. Its low profile design is resistant to vibration.

Developed for engines that tend towards increased carbon deposition as a result of their design, hybrid spark plugs have a standard ground electrode as well as two smaller ground electrodes on each side. When the insulator

becomes clogged with carbon, the ignition voltage jumps over to the side electrodes, enabling the plug to operate even under severe conditions. Once the plug has reached operating temperature and the deposits are removed, it returns to "normal" operation, with the spark jumping between the center and main ground electrode.

A trapezoid cut ground electrode is just another variation of a taper cut ground, which serves a similar function to a cut-back ground, fine-wire ground and angled ground electrode.

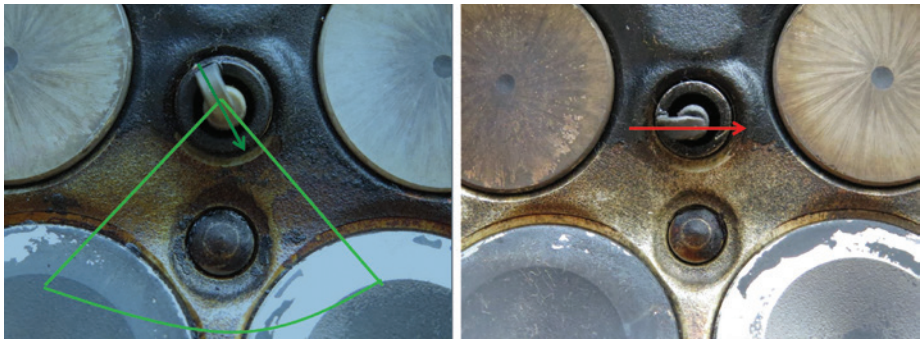
This is not even an exhaustive report on the different types of ground electrode spark plugs used in today's modern engines. What is important to understand from all this is that there are very specific engineering characteristics built into each spark plug based on the engine design. It is therefore critical to use the correct spark plug for the application you are working on. Mercedes-Benz uses various manufacturers of spark plugs for their engines and your Mercedes-Benz dealer's parts department will have the correct plug in stock based on the VIN of the vehicle you are servicing.

Use the Right Part!

It is important to understand that not all spark plugs are created equal. Your local independent parts suppliers may show a particular spark plug for the model of Mercedes-Benz you are servicing, and they even may say they meet OE specifications, but they are not always the same! According to a technical update from the Mercedes-Benz USA's QEC/ES department a critical difference is noted particularly in the spark plugs used in direct-injected engines (such as M276, M278 and M157). The indexing of aftermarket plugs is not the same and can cause detonation and even melted pistons. Be sure to use only genuine Mercedes-Benz spark plugs to avoid engine failure.

In addition to the various types of electrode configurations, spark plugs will basically have two types of seats that contact the entrance to the combustion chamber: Flat (or level) seat, where a captive outer gasket acts as a seal around the plug body, or tapered (or conical) seat, where the conical surface of the plug body fits into a correspondingly shaped contact surface in the cylinder head to create a seal. Knowing which of these two you have is important when it comes to installation methods, which we will discuss in a moment.

In this photo, an NGK spark plug is compared to a Mercedes-Benz spark plug. The Mercedes-Benz spark plug has the correct thread length for proper indexing and meets the correct heat range criteria.



The Mercedes-Benz approved spark plug at the left has its electrode gap facing a correct 45 degrees from the injector nozzle. The aftermarket plug on the right, torqued the same as the Genuine Mercedes-Benz plug, is facing the wrong way. This caused a melted piston and required complete engine replacement, at the independent workshop's expense. Definitely not covered by warranty!

Removal and Installation

Not much has changed over the years in the actual removal and replacement of spark plugs. They still screw into the cylinder head as always. Access is always the issue: Can you get to it without removing the engine? In most newer Mercedes-Benz engines, carefully removing the coils provides access to the spark plugs themselves for servicing. A high quality thin-walled deep socket, perhaps with a swivel end for easier access and a spark plug retention feature, is needed. Note that some models have the newer bi-hex 14mm 12-point head spark plugs, so you'll want to have one of those sockets in your arsenal. When in doubt as

to access to the spark plugs, consult the repair manual for the model you are working on.

Proper torque is absolutely critical to seating the spark plug to ensure good contact with the seat and to ensure it doesn't back out over time due to expansion and contraction. Too tight can also be a problem as this can lead to cracking of the porcelain, not to mention not being able to remove it later. In the old days we could just install the spark plugs what we called "gootentight," but today you really must observe the torque specs for the application.

A few cautions before beginning work:

- The ignition system needs to be off (obviously).
- Before removing the spark plugs, be sure to blow out the spark plug wells in order to prevent any loose debris from entering the combustion chamber.
- When servicing Mercedes-AMG engines M133, M176, M177 and M178, the spark plug wells need to be vacuumed out after removing the spark plugs to ensure no particles whatsoever remain on the seats.
- It is important on all engines that no particles interfere with the spark plug's ability to seat in the cylinder head properly. Look carefully with a bright light or borescope.
- All ignition components which are worked on during the spark plug change should be visually inspected for damage and repaired or replaced as necessary.
- Before installation, the rubber tips of the spark plug connectors must be greased with an approved dielectric silicone grease, such as Mercedes-Benz part A002 989 80 51 09. This facilitates easier installation and removal, and helps prevent carbon tracking.

Carbon Tracking and Corona Stain

We mentioned carbon tracking above in the use of dielectric grease. Electricity follows the path of least resistance and when diagnosing misfires be careful to examine the ceramic portion of the plug for a black "track" from the tip to the hex portion. This is burned in and cannot be removed. If you find this when doing a spark plug service is wise to carefully inspect and or replace the coil boot as it may be damaged as well.

Corona stain is a light brown or tan discoloration on the outside of the ceramic insulator above the metal shell/hex. Corona stain is created by the high voltage traveling thru the plug that attracts the dirt or oil particles surrounding the exposed ceramic insulator between the wire/coil boot and spark plug metal shell. Corona stain is completely normal and should not be mistaken for exhaust gas blow-by or a broken seal inside the spark plug.

A quality spark plug socket with a swivel end helps in tight spots. Also be sure it has an internal grip to keep the plug from dropping into the spark plug well.

Proper torque is critical to spark plug seating! It only takes a few extra seconds and is the only way to do the job correctly.

Mercedes-Benz requires the use of dielectric silicone grease on the spark plug boot to aid in future removal as well as protect from carbon tracking on the spark plug.

Gap

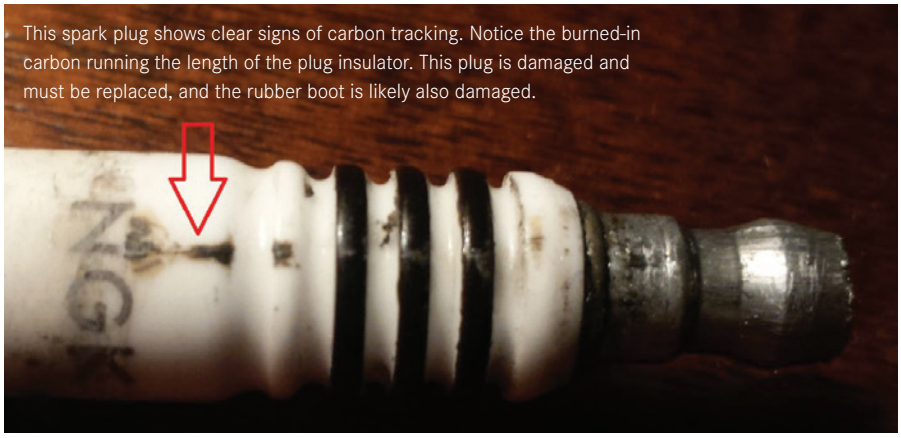
As mentioned earlier, the spark plug gap is the distance between the outer or ground electrode and the inner electrode. Since the gap dimension has a direct effect on the voltage necessary to jump the gap and ionize (ignite) the air-fuel mixture, careful attention is required. While most plugs are pre-gapped from the factory, it is imperative to closely inspect the box and the plugs for damage and any obvious discrepancy in the gaps. Genuine Mercedes-Benz Spark plugs should not need to be gapped. If you find one that is way off it's best to exchange it for another, although small variances can be adjusted with a high quality spark plug gapping tool. The voltage requirement is directly proportional to the gap size and has been determined by the engineers for the specific engine and model. Don't try to run with a wider gap thinking better spark! That's an old racer's myth and won't give very good results.

If the gap must be adjusted, use a tool that only moves the ground electrode and does not pry between or against the electrodes. NGK also recommends adjusting the gap no more than +/- 0.008" from the factory preset gap.

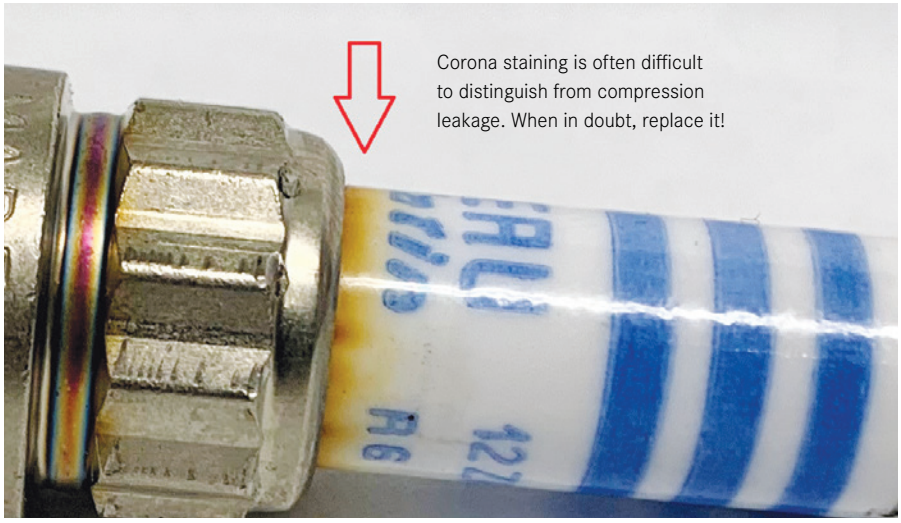
To Anti-seize or Not

That is the question! Many technicians, especially those who have experience with air cooled engines, advocate using an anti-seize product on the threads of the spark plugs. The reasoning behind the practice is due to the nature of the two dissimilar metals – the steel outer jacket of the spark plug and the aluminum alloy of the cylinder head – there can be expansion and contraction between the different metals and spark plugs tend to get "stuck" in the cylinder head and even break off, necessitating a costly repair.

According to NGK (and others echo the same thing), their spark plugs feature tri-valent plating. This silver or chrome-colored finish on the threads is designed to provide corrosion resistance against moisture and chemicals. The coating also acts as a release agent during spark plug removal. NGK spark plugs are installed at the factory dry, without lubrication or anti-seize.



This spark plug shows clear signs of carbon tracking. Notice the burned-in carbon running the length of the plug insulator. This plug is damaged and must be replaced, and the rubber boot is likely also damaged.



Corona staining is often difficult to distinguish from compression leakage. When in doubt, replace it!

Anti-seize can act as a lubricant, altering torque values by up to 20 percent, increasing the risk of spark plug thread breakage, metal shell stretch, and/or incorrect indexing. Thread breakage can sometimes involve removing the cylinder head for repair. Metal shell stretch changes the heat rating of the spark plug and can result in serious engine damage caused by pre-ignition. Bottom line: Do not use anti-seize or lubricant on spark plug threads. It is completely unnecessary and can be detrimental. If you were taught to use anti-seize, now you know better and need to stop.

So there you have it: The humble spark plug has more to it than meets the eye. Use the right plug for the application, pay attention to the basics, keep that torque wrench handy, and your customers will never need to worry about a spark plug as a source of trouble.

The Right Stuff

The easy way to identify the correct service fluid

One of the more challenging tasks in this business is identifying the correct service fluid for a vehicle system. Some fluids, such as engine oil, are easier than others, such as for a transfer case. But if you know how to approach the problem, the answer is actually easy to find.

To identify any service fluid, the primary information source is the Mercedes-Benz Workshop Information System (WIS) where the so-called Specification Sheet for a service fluid will be given. From there, you can identify the approved fluids in the BeVo online database. From there, you should have no trouble getting what you need.

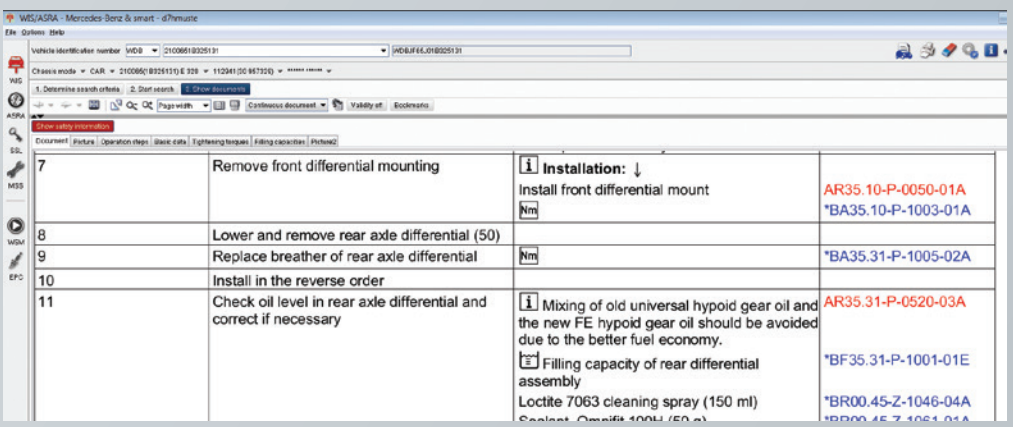
The first step is to determine what it is you are looking for. Sounds simple (and it is) but skip this step and you risk "going down a rabbit hole" and wasting time looking. Positively identify the vehicle component you need information for. This might be the transfer case, the transmission, the power steering system, or the rear axle differential. Once you know what part it is, find it in WIS.

Find a job in WIS that has something to do with the component. A good choice is to look for a repair instruction (AR document) that both applies to the vehicle and is likely to require a fluid change or addition. For some components, you'll find a job with a name like "Drain and refill fluid" or "Oil and filter change" or "Capacities," while for other components "Remove and reinstall <part name>" is usually a reasonable choice.

Within the repair instruction document, find the step where the service fluid is checked or filled: On that instruction line, you might see a reference to a "Sheet No." for the service fluid, or more likely there will be a blue or red Hyperlink to additional information. In some cases the part number for the needed product is shown at the bottom of the document, so be sure to check.

Blue links lead to another part of the same document. Red links lead to a different document. Pay careful attention to the actual link number, particularly for the blue links. Nearby "Image 1" shows an example of the information you will find, in this case a (blue) link to the filling capacity specification *BF35.31-P-1001-01E.

Following the link you will generally find both the fluid capacity and a red link to the specification sheet (BB document), as seen in "Image 2." Note that the actual blue link number is shown at left. Since we have a Model 210.065, the right-most column is what is correct for this vehicle: A filling capacity of 1.1 liters, and a Red link to document BB00.40-P-0235-07A.

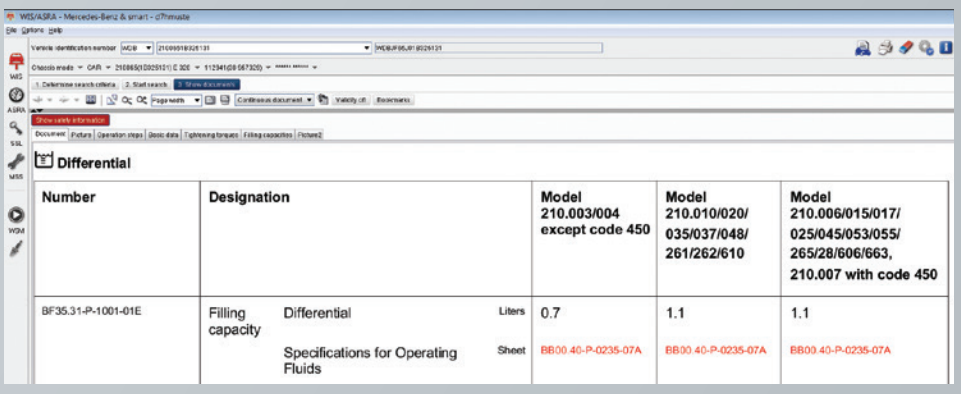


7	Remove front differential mounting	Installation: ↓ Install front differential mount Nm	AR35.10-P-0050-01A *BA35.10-P-1003-01A
8	Lower and remove rear axle differential (50)		
9	Replace breather of rear axle differential	Nm	*BA35.31-P-1005-02A
10	Install in the reverse order		
11	Check oil level in rear axle differential and correct if necessary	Mixing of old universal hypoid gear oil and the new FE hypoid gear oil should be avoided due to the better fuel economy. Filling capacity of rear differential assembly Loctite 7063 cleaning spray (150 ml)	AR35.31-P-0520-03A *BF35.31-P-1001-01E *BR00.45-Z-1046-04A

Image 1: In this example, step 11 contains a blue link to the filling capacity table (*BF35.31-P-1001-01E).

Clicking the red link brings up the specification sheet 235.7, seen in "Image 3", containing three approved products. On every specification sheet you will always find at least one approved product, and its supplier, for the specific fluid. In most cases there will be several products shown, with those available from Mercedes-Benz shown at the top, with the part number.

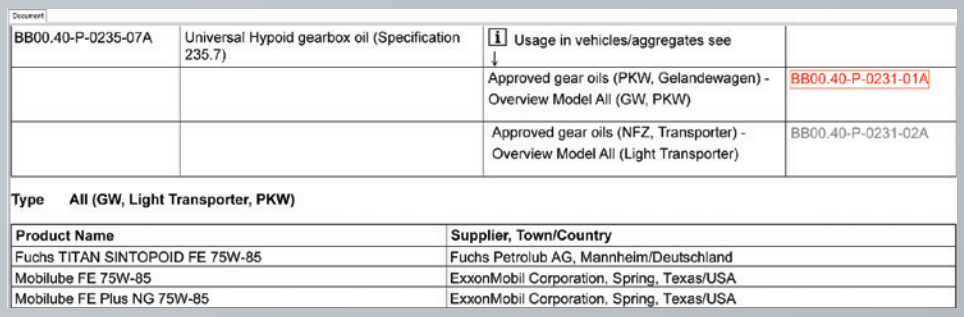
Although the WIS document should be up-to-date, the Mercedes-Benz BeVo website <https://bevo.mercedes-benz.com/index.php?language_id=1> also contains all the Specification Sheets, and should be considered more up-to-date than the Specification Sheets in WIS. In "Image 4" we see that the BeVo site also has two Mercedes-Benz part numbers listed, which you can order from your dealer. Missing is the package size, two additional digits after the part number, but your dealer can look up what's available for you in the parts catalog's Parts and Operating Fluids section.



Differential

Number	Designation			Model 210.003/004 except code 450	Model 210.010/020/ 035/037/048/ 261/262/610	Model 210.006/015/017/ 025/045/053/055/ 265/28/606/663, 210.007 with code 450
BF35.31-P-1001-01E	Filling capacity	Differential	Liters	0.7	1.1	1.1
		Specifications for Operating Fluids	Sheet	BB00.40-P-0235-07A	BB00.40-P-0235-07A	BB00.40-P-0235-07A

Image 2: The table shows a red link to the fluid specification for the listed models (BB00.40-P-0235-07A).

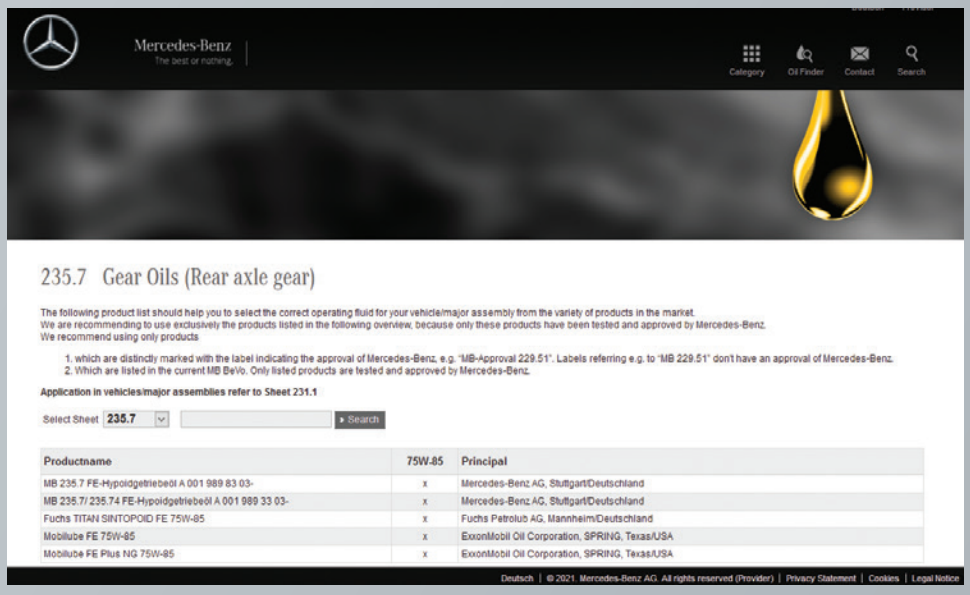


BB00.40-P-0235-07A	Universal Hypoid gearbox oil (Specification 235.7)	Usage in vehicles/aggregates see ↓	
		Approved gear oils (PKW, Gelandewagen) - Overview Model All (GW, PKW)	BB00.40-P-0231-01A
		Approved gear oils (NFZ, Transporter) - Overview Model All (Light Transporter)	BB00.40-P-0231-02A

Type All (GW, Light Transporter, PKW)

Product Name	Supplier, Town/Country
Fuchs TITAN SINTOPOID FE 75W-85	Fuchs Petrolub AG, Mannheim/Deutschland
Mobilube FE 75W-85	ExxonMobil Corporation, Spring, Texas/USA
Mobilube FE Plus NG 75W-85	ExxonMobil Corporation, Spring, Texas/USA

Image 3: Specification sheet 235.7 shows three approved products for this hypoid gear oil.



Mercedes-Benz
The best or nothing.

Category Oil Finder Contact Search

235.7 Gear Oils (Rear axle gear)

The following product list should help you to select the correct operating fluid for your vehicle/major assembly from the variety of products in the market.
We are recommending to use exclusively the products listed in the following overview, because only these products have been tested and approved by Mercedes-Benz.
We recommend using only products

1. which are distinctly marked with the label indicating the approval of Mercedes-Benz, e.g. "MB-Approval 229.51". Labels referring e.g. to "MB 229.51" don't have an approval of Mercedes-Benz.
2. Which are listed in the current MB BeVo. Only listed products are tested and approved by Mercedes-Benz.

Application in vehicles/major assemblies refer to Sheet 231.1

Select Sheet 235.7 Search

Productname	75W-85	Principal
MB 235.7 FE-Hypoidgetriebeöl A 001 989 83 03-	x	Mercedes-Benz AG, Stuttgart/Deutschland
MB 235.7/ 235.74 FE-Hypoidgetriebeöl A 001 989 33 03-	x	Mercedes-Benz AG, Stuttgart/Deutschland
Fuchs TITAN SINTOPOID FE 75W-85	x	Fuchs Petrolub AG, Mannheim/Deutschland
Mobilube FE 75W-85	x	ExxonMobil Oil Corporation, SPRING, Texas/USA
Mobilube FE Plus NG 75W-85	x	ExxonMobil Oil Corporation, SPRING, Texas/USA

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Image 4: The Mercedes-Benz BeVo site shows five products for specification sheet 235.7, two which have part numbers your dealer can order. Tip: Google "MB BEVO" and you'll find the web link faster than typing it in; then add that to your Bookmarks.

Take a look at the other products: Since all of these are approved, if you can find that product locally it is a perfectly acceptable solution to your problem: If you can buy the exact product, it is OK to use in the vehicle. The key word here is exact: Mobilube 75W85 is not the same as "Mobilube FE 75W85."

There's nothing worse than using the wrong service fluid, since your customer will surely return with bigger problems than before, and you might be liable for the repair if you used the wrong stuff. But WIS tells you the specification sheet, and the sheet in WIS or BeVo tells you which approved products you may use. If you always use a Mercedes-Benz approved product, you know it's the right stuff.

Performance. Reliability. Success.

With our competitively priced Genuine Remanufactured Parts, you no longer have to settle for anything less than Mercedes-Benz quality. But that's just part of the story. You see, our AIRMATIC® struts, catalytic converters, turbochargers and steering racks all carry a 24-month, no mileage-restriction warranty. So our parts are not only a great deal. They're a great value. And since they're genuine Mercedes-Benz, you can have confidence they'll last, and so will your relationship with your customers.

Mercedes-Benz

The best or nothing.

*MSRP excludes state and local taxes, and freight if applicable. Price excludes core deposit. Price valid as of January 2020. Prices may vary by dealer. See your authorized Mercedes-Benz dealer for additional details or a copy of the Mercedes-Benz parts limited warranty.

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

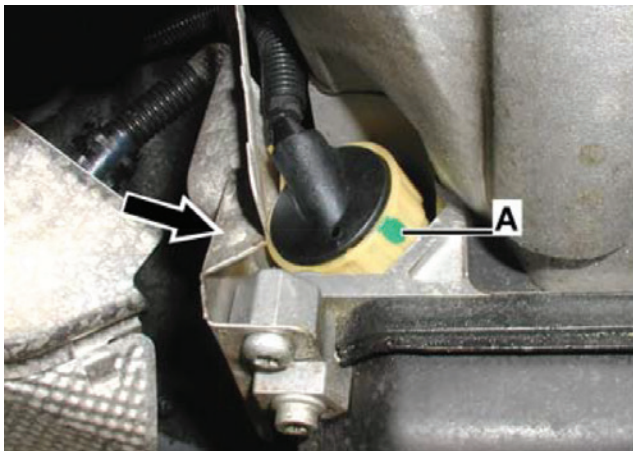
One remanufactured engine pulls the plug on climate-damaging CO_2 and saves 447 days of power for one laptop.

Automatic Transmission Perfection

Get ahead of shifting complaints

The modern day Mercedes-Benz automatic transmission is a complex, efficiently-engineered marvel with a harmonious synchronization of digital electronics, mechanical gears, and hydraulics. These characteristics deliver a proven drivetrain that rivals none. But what happens when things get out of kilter? Transmission diagnostic trouble codes, rough shifting, stuck in gear or skipping gears? Equipped with a factory-compatible scan tool and some knowledge, you don't have to be fearful of taking on these issues in your shop. Some might be solved with a simple fluid and filter change or a software update. Sometimes it's as simple as educating the customer on how the system operates. In this article, we'll take a look at some of the common issues associated with today's transmissions.

Before we get started, we need to point out the fact that without either a XENTRY Diagnostics system or at least a J2534 v05.00 API tool (preferably with a 4CAN channel), as well as a subscription to the Mercedes-Benz ISP Portal (formerly known as STAR TekInfo) you won't be able to do much in the way of diagnosis and certainly no programming or SCN coding.



This old style 'pilot bushing' (electrical connector) is a common source of leaks and communication issues in the 722.6 transmission. When replacing, be sure to observe the 3 Nm tightening torque, which is barely finger-tight!

Opposite Page: You'll need a transmission service kit like this available from your Mercedes-Benz parts dealer when servicing a transmission. Don't forget the single-use aluminum screws!

722.9 Transmission

One of the most popular transmissions in the Mercedes-Benz line, the 722.9 NAG2 is also the one that often you will find that a module replacement or software update solves a lot of drivability problems. This transmission is an electronically controlled automatic transmission with 7 forward gears and 2 reverse gears. The ratios for the gear stages are achieved using planetary gear sets. All the transmission functions and components for this transmission are combined in one assembly module. The integration of the electric controller unit (VGS, Y3/8) in the transmission means that the interfaces to the wire harness have been minimized. This improves the shift quality, increases the service life and reliability, and also has the added bonus of lower maintenance costs.

The famous plug connection at the transmission housing where it enters above the pan is a spot that can routinely cause some issues. Obviously a module update isn't going to fix that, but if you have CAN communication errors with the VGS, check the plug, especially on the 722.6 NAG1 transmissions found in older models. Many times you will find it leaking and a thorough inspection of the electrical contacts may reveal the source of your communication error. Also important, check the other ends of the harness: fluid can wick all the way up the harness at times even into the ECM connector.

Torque Converters

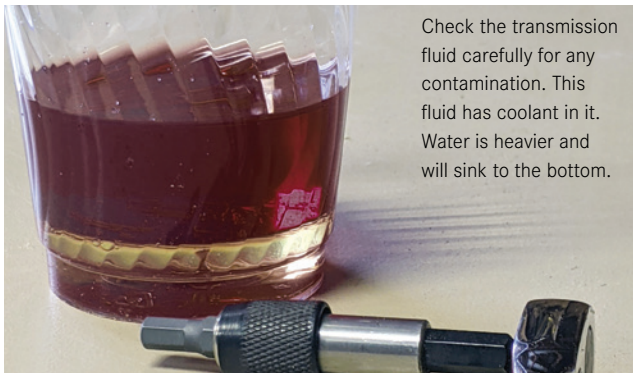
One possible complaint that may turn up in your bay is a car that has a shudder, often described as an ignition misfire under partial load. Another possible complaint is when a faulty torque converter lockup operation seems like the throttle is not working. This may be due to a self-protection feature to keep the transmission from overheating, or it's waiting for the converter to lock up before returning to normal throttle. A scan and thorough inspection of the engine reveals no actual ignition or fuel problems.

This vehicle has the 722.9 7-speed transmission. With a factory scan tool, complete a quick test and look for any relevant transmission fault codes. Using the freeze-frame data

and torque converter actual values, try to determine when the fault occurs, gear range, torque etc. Temporarily deactivate the torque converter lockup solenoid then road test to verify that the issue is with the torque converter. The menu on the scan tool may read something like "Closing of torque converter lockup clutch." If no further shudder is found after deactivating the torque converter you now have narrowed down the culprit. The issue is due to failed or improper torque converter operation. There could be a malfunction at the torque converter lockup clutch or the torque converter lockup clutch valve, as well as a worn lockup clutch in high-mileage vehicles.

Before condemning the torque converter, check the basics, such as fluid level. Verify the correct transmission fluid is being used, perhaps by questioning the customer if any fluid has been added, and checking the dipstick seal isn't broken. The incorrect fluid can damage both seals and clutches in the transmission. Also verify that no coolant contamination exists. Use the glycol test procedure in DTB P-B-27.55/50g (or later), or take a sample and put it in a clear container and let it sit for a few minutes. The coolant will separate out and be visible at the bottom of the transmission fluid. This can be caused by a faulty transmission cooler, so be sure to identify and address the root cause. Note that service bulletin LI27.20-P-046908 advises that in Model 211 E-Class vehicles with the 722.6 transmission, worn fluid can cause shuddering. After verifying the fluid isn't contaminated with coolant, perform a fluid flush to restore proper operation.

Check the transmission pan for metal contamination. If a significant amount of metal is found in transmission, it may be time to recommend complete replacement, and be sure to flush the system thoroughly. Verify all software is updated for the transmission control unit. Re-adapt the torque converter and transmission shift points with the scan tool. It is important also to verify that there are no issues with the engine or transmission mounts, as these have been known to cause shift or judder complaints.



Check the transmission fluid carefully for any contamination. This fluid has coolant in it. Water is heavier and will sink to the bottom.

If you find a significant amount of metal in the pan and fluid, it may be time to replace the transmission assembly. This shows metal particles attracted to the magnets in the pan.

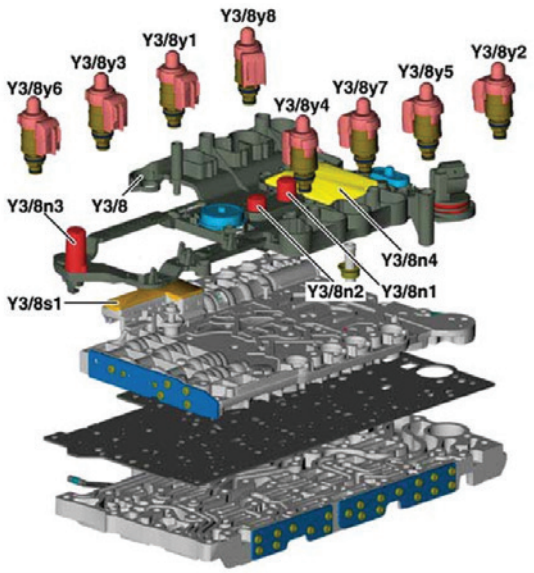
If your customer's concern is more of a slipping issue or the vehicle doesn't appear to accelerate normally, read the torque converter slip speed. See bulletin LI27.20-P-057339 for more information. This bulletin states that a slip speed of 10 or lower is good, and if a slip speed higher than 10 over a long period with active actuation (e.g., highway driving) is found, there is probably a fault in the torque converter lockup clutch, which means the torque converter needs to be replaced.

For vehicles with transmission production dates of April 2011 to August 2015, see service bulletins LI27.20-P-064558 (passenger cars) and LI27.20-P-055758 (vans, but only to December 2013 production). These bulletins address a complaint of poor acceleration, and will store codes FC 2783 (Friction power of torque converter lockup clutch is too high) or FC 0741 (Actuation of torque converter lockup clutch not possible) in the transmission control unit. This can affect all 722.9 transmissions (7G-TRONIC PLUS) from the listed production months. The two fault codes can also occur in combination with rpm sensor faults, but these are unrelated to this complaint.

The possible cause is increased wear of the torque converter bearing bushing, due to a rough microsurface of the journal at the transmission end. The solution is to polish the transmission input shaft using a special 15 µm polishing film (available from Mercede-Benz) and replace the torque converter, except in vehicle with engine M271, where a software update might provide a remedy. If you have these fault codes and complaint, it is important to follow the instructions from the service bulletins (they both deal with this topic) carefully, as we don't have the space to deliver complete details here. Also note that replacing the torque converter requires it's lifecycle data to be reset.

Sensors

Customer concern: check engine light is on with erratic shifting, sometimes going into limp mode ('stuck in gear'). Customer can shut the vehicle off and, after restarting, shifting may be normal for a short period of time. After performing a test drive to verify the concern, a thorough inspection should be performed including a fluid check and history of maintenance. Scan tool diagnosis reveals DTCs 2767 and 2768 (Y3/8n2 Internal speed sensor (VGS) is faulty) and possibly others. Y3/8n2 is also known as the RPM sensor. It is important to consult the XENTRY Tips article LI27.50-P-049710 as this has specific instructions pertaining to this and several other codes.



The inner working of the VGS control unit (Y3/8). Don't mix up the solenoids when servicing!

The VGS control unit is accessed by removing the transmission oil pan. Follow the replacement instructions in WIS to ensure a leak- and problem-free job.

Follow the guided test steps in XENTRY and you may be directed to replace the electrohydraulic controller unit. It should be noted that in some cases there is a repair kit available when directed to do so, which is detailed in Mercedes-Benz WIS (Workshop Information System) document AR27.19-P0220B. It is also important always reinstall the solenoid valves to their original positions, otherwise the calibration mismatch will trigger poor shifting. If you have to replace a solenoid, re-learning the solenoids along with proper programming will have the transmission shifting properly again.

The transmission control unit and sensors are part of the valve body. Replacement requires an online connection with Mercedes-Benz to perform module coding and flashing of the control unit software. Replacement of just the control unit per the service bulletin differs from a complete valve body replacement as the adaptation data, coding and valve body calibration data can be transferred from the old VGS control unit to the new VGS control unit. This data from the old VGS control unit is temporarily stored in the XENTRY Diagnosis unit by processing one of the above codes, and by using the same XENTRY system to perform initial startup of the new unit the data is transferred. Failure to do so will result in the necessary data not being transferred and improper transmission function.

Here is important information to note when replacing a transmission electro-hydraulic control module: on some models, it is crucial to consider any fault codes for the respective model year and note the presence or absence of an auxiliary oil cooler. It is therefore necessary to inspect models with or without auxiliary oil coolers before ordering the transmission electro-hydraulic control unit when the vehicle production date is after 01/2007. The auxiliary oil cooler in models with Engine 273 and Engine 642 is in front of the radiator and air-conditioning condenser and is connected in series with the existing oil/water cooling system of the radiator. Failure to do this may prevent Star Diagnosis from correctly programming and coding the valve body.

Connectors

As we mentioned previously, the electrical connector to the automatic transmission was notorious for developing a leak, which can not only result in low fluid levels (itself a cause for some complaints) but also poor electrical contact. You also need to check the wiring harness for possible fluid contamination and correct it, using contact cleaner spray and compressed air, if found. When you replace the connector and its O-rings, be sure to check that the wiring harness is routed in a completely tension-free manner,

with sufficient slack to ensure the wiring never pulls on the connector.

This harness is under tension and has damaged the electrical connector. After replacing the connector, re-route the wires to be completely tension-free.

Juddering or Shuddering

Not every complaint of juddering or shuddering is caused by the transmission. It could be entirely mechanical, or an engine control concern. Conduct a thorough inspection including a short test for codes. If your diagnosis doesn't turn up anything surrounding the transmission it's time to look at other possibilities.

Note the leaking fluid from this engine mount. A damaged mount could be the cause of a judder complaint that the customer thinks is a transmission issue.

1. Inspect all engine and transmission mounts.
2. Inspect all sub frame and differential mounts.
3. Remove driveshafts and operate/inspect flex joints or U-joints to detect any binding. Mark drive flanges on disassembly so that they are matched on reassembly.
4. Consult WIS for a description of the transfer case on the 7-speed transmissions, as faults here can cause shuddering complaints.
5. Further tests should be conducted by referencing bulletin LI28.00-P-051499. There is diagnostic tree that specifically deals with judder complaints.
6. If the transfer case is the cause of the vibration or noise, be aware that the transmission and transfer case may only be sold together as an assembly.

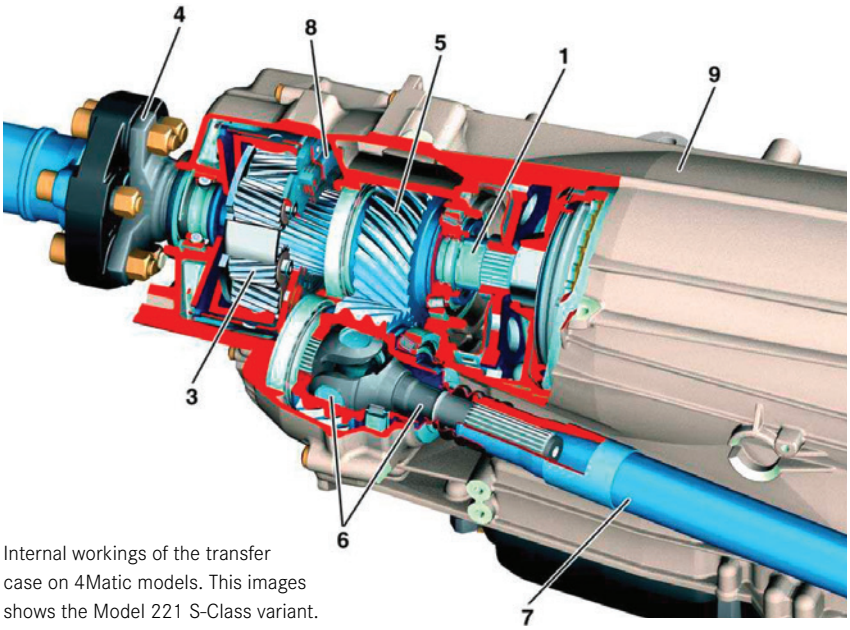
Communication

Many times your quick test may turn up a communication error with the transmission control unit. To narrow this down, remove the electrical connector from the 722.9 transmission. Using a voltmeter test for battery voltage between pins 4 and 5. Leave the voltmeter ground connected to pin 5 and connect positive lead to the communication wires at pins 1 and 2. DC voltages should be about 2.4 and 2.6 volts with the CAN Bus active. If the voltages are incorrect, check the wiring and CAN potential distributors.

On pins 1 and 2, use a lab scope to verify a correct-looking CAN signal pattern on both CAN high and CAN low. If the signal appears distorted or missing, use the wiring diagram for the model in question to inspect the wiring between the CAN Bus and the transmission. If you find you have correct CAN signals, power, and ground, suspect a faulty control unit. As with all intermittent problems, verify that the fault reappears after clearing any codes.

About Fluids

The 5-speed automatic transmission 722.6 and the 7-speed automatic transmission 722.9 up to transmission production date June 21, 2010 use only transmission oils meeting MB-specification sheet 236.14, such as Mercedes-Benz part number A001 989 68 03 10. The 722.9 versions built after June 21, 2010 use only transmission oils meeting MB-specification sheet 236.15, such as A001 789 78 03 09. Note that other transmission models, such as the newer 725.0 NAG3, use a completely different oil altogether, so be sure to verify the correct fluid for the job, as explained in the article "The Right Stuff" elsewhere in this issue. In all cases, visit the MB BeVo web site (just search "MB BeVo" to find it) to verify the part number.



Internal workings of the transfer case on 4Matic models. This images shows the Model 221 S-Class variant.

It is important to note that the two types of 722.9 transmission oil are not compatible with each another and cannot be mixed. The later oil can be identified by its blue color as opposed to the previous which is red. Your local Mercedes-Benz dealer's parts department may be able to sell you fluid in bulk if you have larger containers to store it in.

There is one exception you should be aware of: transmissions, electrohydraulic controller units and torque converters made available through the parts department are checked at the production plant with FE ATF-134 only, which is blue. These parts may exhibit traces of FE ATF-134 and are not cause for concern. Simply fill the system with the corresponding fluid for the model you are servicing.

Your local Mercedes-Benz dealer may be able to offer you service fluids, such as the transmission oils shown here, in bulk to save you some money.

Check the TSBs

Every model in the Mercedes-Benz lineup has different engineering characteristics, and there is a wealth of information available with an ISP Portal subscription and XENTRY Diagnostic system. Always consult every available bulletin and repair manual to be sure to have the latest information. In some cases, an internet search can turn up useful information, but if it's not from Mercedes-Benz, be careful because not everything in the internet is accurate.

So there you have it: Many of the causes of the most common transmission performance complaints have long since been identified and are published as service bulletins. Of course, never forget the basics before starting an expensive repair, where an extra 10 minutes checking can save hours of labor. Careful research and the right tools can lead to one satisfied customer after another which, if you think about it, is everyone's goal.

The Mercedes-Benz Certified Collision Program, Part 3

Instructor-led Training that Works: Getting Even Better

Previously in *StarTuned*, we discussed the three tiers of Certified Collision Centers, as well as the significant benefits to the independent collision center of becoming a Mercedes-Benz Certified Collision Center. While certification does require effort and commitment on behalf of the shop, the benefits of certification are considerable, particularly in terms of profitability and cycle times. The training required to realize these benefits is delivered by experienced instructors at Mercedes-Benz USA's modern state-of-the-art facilities near Dallas, TX and Trenton, NJ, as well as through MBUSA's extensive online training offerings.

In this issue of *StarTuned*, we'll discuss this training, some of the things you and your technicians can expect, and what makes it so effective.

One of the greatest benefits of earning collision center certification is access to Mercedes-Benz factory training. Hands-on exercises are emphasized, ensuring students are ready to tackle complex jobs with confidence and efficiency back at their shop.

Top: A technician learns how the mounting clips are different for a new bumper.

Editor's note: This is the third and final article about the Mercedes-Benz collision repair certification program. All content in this article was developed through conversations with three Certified Collision Program instructors, and we thank them: Kevin King, Technical Collision Instructor & Welding Inspector and Clint Allen, Collision and Technical Trainer, both teaching at the Mercedes-Benz Learning & Performance Center in Grapevine, Texas; and Bob Laurino, Collision and Technical Trainer at the Learning & Performance Center in Robbinsville, New Jersey.

Training effectiveness

Clint Allen, Collision and Technical Trainer at the Mercedes-Benz Learning & Performance Center (LPC) in Grapevine, Texas was a collision technician for over a decade, and still enjoys working with his hands. "I can read it in a book or watch a presentation, but when I get my hands on it is when I really learn," he said. "It really sinks in when you're in the shop and can see how this bumper comes off. Theory and hands-on learning complement each other."

Mercedes-Benz USA has been delivering collision training for decades, and they know from experience and talking with participants just what works best. When students disassemble and install a non-structural part, Mercedes-Benz instructors spend time discussing the implications for the advanced driver assistance systems (ADAS) on that vehicle, for example. "Students get to see all of the sensors and other ADAS technologies that live in that bumper, door, fender, or other component," said Kevin King, Technical Collision Instructor & Welding Inspector at the LPC in Grapevine, Texas. "They learn what needs calibration or other digital configuration procedures performed in order to restore key vehicle systems to full, safe operating parameters."

New body repair technicians have historically learned on the job from a guy who may have been doing that work the same way for many years. Much of ADAS technology, vehicle metallurgy, and structural reinforcement design did not exist fifteen years ago. The technologies and design elements that were on vehicles as little as ten years ago have evolved so much that a five-year-old or younger Mercedes-Benz now requires completely different diagnostic and repair procedures.

The structural components under the rocker panel on this 2019 AMG G63 are very different from those of just ten years ago. Repair requires new technician training, new procedures, and new equipment.

"If you're repairing collision damage the same way your mentor did ten years ago, you're doing it wrong," said Allen. "Still using methods from five years ago? You're also probably doing it wrong. Collision repair has evolved so rapidly in recent years that if you're not up-to-date, you're risking repair safety." The required biannual facility recertification and six-month cycle of instructor-led training (ILT) for technicians is the Mercedes-Benz way of helping body shops keep up.

Joining Techniques

The joining techniques course covers riveting, adhesive bonding, and welding (not including aluminum welding, which is taught in the separate Elite certification track). Students do hands-on work with Mercedes-Benz adhesive kits, all of the approved spot welders, and various rivet guns, including the XPress 800 Riveting System and the PNP 90 XT2 Universal Riveting System.

Structural Repairs

In Structural Damage training the number of students is limited to six per class. The instructor pairs technicians in

Technicians use Mercedes-Benz model-specific jig sets to ensure that the vehicle meets tight factory tolerances as collision damage is repaired. Shown here is a C-Class sedan on a CarBench with jigs.

groups of two and assigns each group a different project. For example, he may task one group to replace a frame rail extension, the second to remove and install an A-Pillar, and the third group to repair another structural component.

The instructor checks the student's choice of repair documents, including component removal, repair preparation, installation steps, and parts list. "We review the documents they find, make sure they've correctly identified every necessary resource, and then have them start the repairs," said Bob Laurino, Collision and Technical Trainer at the LPC in Robbinsville, New Jersey. "Because classes are small, the students get a lot of attention," he notes.

Instructors watch over their progress while the technicians work. "We point out things like when a rail is too far off the specified measuring point and must be replaced, not straightened," said Allen. "We give examples of hidden damage and walk them through the procedure to remove and replace the affected section or component. We point out components that contain or are connected to devices that must be calibrated or initialized after that component is removed and replaced or reinstalled."

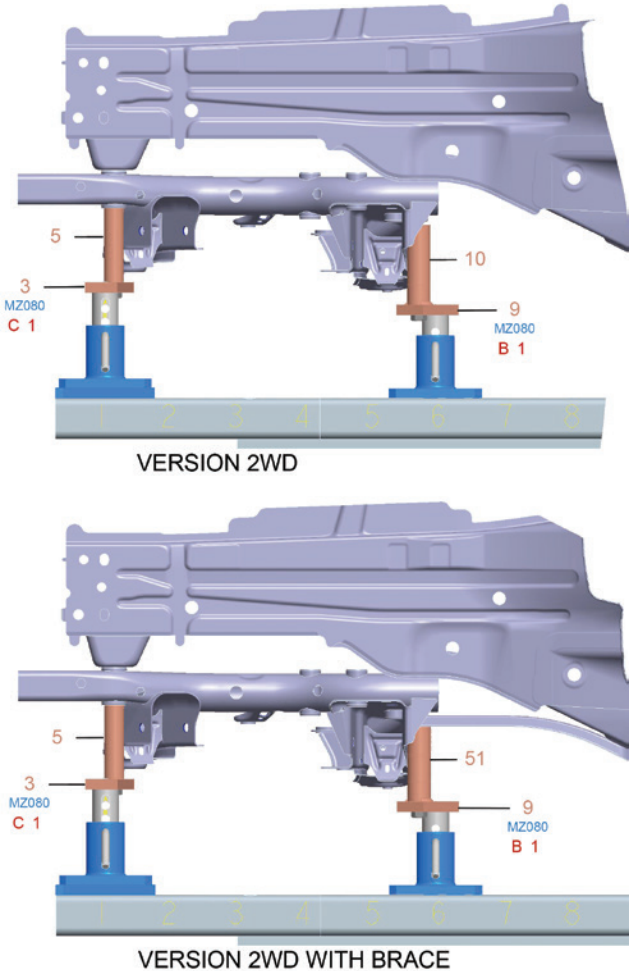
The Business Side

Training isn't just for technicians: Running a more efficient business benefits everyone. Topics like how to do thorough damage assessment and repair planning helps the facility manager develop a good estimate. When estimators know what details to include in the repair estimate, and have familiarity with the specifics of a given model, they are far less likely to later need a supplement. Detailed estimates help prevent job delays, limit car rental expense, and maintain customer satisfaction.

Instructional Staff

As you might expect, Mercedes-Benz has some of the best instructors in the industry. Daimler AG, the parent company of Mercedes-Benz, insists that all technical trainers become Master Trainer Certified. This multi-year program emphasizes instruction delivery techniques, classroom flow and the psychology of learning. "It's a lot easier to just show the students what to do, but that's not how most people learn," said Allen. "Instead, we have to let them make their own mistakes and get them to think about what they are doing. If I see something wrong, I'll ask them to explain why they are doing it that way."

"Asking questions is the Socratic method of teaching, and it gets them thinking," agreed Laurino. "Then we'll talk about why Mercedes-Benz procedures ask that it be done in a certain manner."



Certified shop technicians have free, in-bay access to accurate procedural information in the Mercedes-Benz Workshop Information System (WIS). Without it, you risk setting up the jigs improperly for the engine cradle in this C-Class, depending on whether the cradle has a mounting brace. The anchoring jig for the engine cradle with brace (51) is different from that for the cradle that has no brace (10).

Hands-on is how most technicians learn best.

The instructors guide students to the correct repair solution without telling them what to do. Encouraging the technician to dig deeper until he or she understands the documents prepares them so when they get back to

their shop they confidently interpret instructions. “They no longer need an instructor looking over their shoulder,” said King.

Cycle Times

Instructors also emphasize cycle time, to help shops run more efficiently and to increase customer satisfaction. “We have them use the XENTRY Diagnostics tool, so they can be familiar with recalibration for Advanced Driver Assistance System sensors,” said King. While a XENTRY tool is not required for a collision center, the value quickly becomes evident. “Most calibrations take ten minutes or less using XENTRY, avoiding the time involved with a trip to the dealer,” said Laurino.

Peer Interaction

One often-overlooked benefit to instructor-led training is the chance to interact with peers from around the country. Once in the Mercedes-Benz training facility, students often get excited upon seeing something they have not seen before. “They call each other over,” Allen explains, “‘Hey, you have to see this new bumper. It has a different inside pull,’ or ‘They moved the plug over here.’”

Students work alongside colleagues they haven’t before, and get exposed to different work styles. Because they come from different markets, some see a lot of one type of Mercedes-Benz model while others often see different models and problems. Or one technician comes from a market that has a harsher winter, while another hails from a region with higher average temperature and humidity. They learn a lot just from interacting with each other.

Get Certified!

This concludes our series explaining the Mercedes-Benz collision repair certification program. To learn more about the program, or to apply to become a Mercedes-Benz Certified Collision Center, go to mbcollisioncenters.com and scroll down to the link “Become a Certified Collision Center.” Once there you will find links to answers about a variety of questions, including a list of required tools and equipment, a document explaining the standards by which repair facilities, technicians, and staff are evaluated, a brochure that provides an overview of the entire program, and a program application form.

All you need to attend a Mercedes-Benz hands-on training class is a willingness to learn something new.

Classics: Model 210 A/C Diagnosis

Accessing Self-Diagnosis and What the Numbers Mean

Introduced in 1995 with its "4-eyes-look", the model 210 E-Class was remarkable in its revolutionary design when compared to the relatively stringent lines of its immediate predecessor, the model 124 E-Class.

Anyone working on Mercedes-Benz cars will recognize the 1996-2002 Model 210 E-Class as a true classic, with millions produced worldwide and many still showing up for maintenance and repair. In this continuing series of articles on Classic Mercedes-Benz models, we will take a closer look at the 210 chassis climate control system and its self-diagnostic capabilities. Essentially the same system was used throughout production, but to ensure consistency everything here will be based on the 2001 model year version.

Warnings

Before we get started, a comment about safety and environmental regulations: You must not work on a refrigerant system without being trained on, and fully understanding, the dangers involved. Escaping refrigerant can freeze skin and cause respiratory distress, causing injury and death. Be sure to use proper personal protective equipment. You must also have a way of safely and properly reclaiming refrigerant. Releasing refrigerant to the atmosphere is a Federal offense in the United States punishable by up to $27,500 per day per violation and can include jail time. If you don't have a way to safely and properly reclaim the refrigerant, find someone who does, as getting caught (informants can get a $10,000 reward) just isn't worth it. Please be safe and do the right thing.

The climate control controller (N22) is located just above the radio in the center stack. Use the standard radio-removal tools to remove N22 from the dash.

The Basics

The climate control system is electronically-controlled by the in-dash controller and display, with the flaps actuated by vacuum. The passenger and driver can set different temperatures, but of course there is a limit to how different the temperatures can be within the passenger cabin. Air ducts lead to the rear of the center console and to the rear seating foot wells, in addition to the expected dash and under-dash vents. Standard is the REST feature, which allows the use of residual engine heat to keep the cabin warm (or cooler using circulated air) for up to 30 minutes after the engine is switched off.

There are two sets of filters, one behind the glove box to filter dust from incoming air, and another in the passenger foot well to remove odors using activated charcoal. Unlike the model 124 predecessor, the blower motor is easily accessible in the passenger foot well. The in-car temperature sensor is located within the upper control panel, near the sunroof switch. There is a sun sensor in the center of the dashboard – not easily replaced – that modifies the blower speed slightly to account for sun load. An air quality sensor at the intake ducting detects external pollutants (such as diesel exhaust) and switches the system to Recirculate mode temporarily as needed.

The heating system uses a duo-valve, accommodating the dual temperature controls, and an auxiliary water pump in the engine compartment to help coolant flow through the heater core. The washer fluid reservoir is heated by a coolant circuit also from the auxiliary pump. The air conditioning compressor is a traditional belt-driven type with a magnetic solenoid clutch. A thermostatic expansion valve regulates the flow of refrigerant to the evaporator.

Self-Diagnosis

With the ignition on (ideally with the engine running), pressing and holding the REST button for several seconds starts the self-diagnosis display. Although the Mercedes-Benz diagnostic manual (DM, available in Star TekInfo) states to set both temperature displays to 72°F (or 22°C in early models), we have found this to be unnecessary. There

Pressing and holding the REST button on the climate control controller (N22) starts the diagnostic display mode. Diagnostics are best performed with the engine running.

are about a dozen and a half different parameters that can be read out using this system, and we will explain what each one means.

In the self-diagnosis mode, the parameter number appears on the left side of the display, and the actual value is displayed on the right side. You scroll forward through the parameters using the left 'auto' button, and backwards using the right 'auto' button. After reaching the last parameter, the display moves back to the first one again. To exit self-diagnosis mode, press REST again or switch off the ignition.

Display Code 1 is the in-car temperature sensor (B10/4) reading in the same temperature units as seen by the customer (Fahrenheit or Celsius). If not a close match to the actual interior temperature, test the sensor itself for resistance: At 20°C (68°F) you should measure between 11.9kΩ and 13.0 kΩ. Also verify that the tiny aspirator motor, which draws cabin air over the temperature sensor, runs by supplying 12 volts. If OK, check the wiring according to the Star Wiring diagram.

Display code 2 is the outside temperature sensor (B14), which also supplies the instrument cluster. This sensor is located in the front bumper on the left side. If this doesn't agree with the instrument cluster, suspect a wiring issue on the K1 line from the instrument cluster.

Display codes 3 and 4 are the heater core temperature sensors (B10/1) for the left (code 3) and right (code 4) heater cores. You can expect these to be different (cooler) from the engine coolant temperature (unless full heat is being called for) since they are regulated by the duo-valve. The sensor has two sensing elements (left and right) with the same specs: at 20°C (68°F) each should read between 11.9kΩ and 13.2kΩ, and at 45°C (113°F) between 4.2kΩ and 4.6kΩ. Be sure to check both sides.

The refrigerant pressure (B12, top) and temperature (B12/1, left) sensors are both located on the receiver-drier, found behind the driver's headlamp. They are at system pressure, so be sure to evacuate and recover the refrigerant before loosening them.

Display code 5 is the evaporator temperature sensor (B10/6). This sensor should read just above 0°C (32°F) with the air conditioning running. This sensor isn't particularly trouble-prone, but could generate a customer complaint of poor cooling and low air flow if it has failed. Measure the sensor if necessary: 3.2kΩ at 20°C is normal.

Display code 6 is the engine coolant temperature sensor, B11/4. As with the outside temperature sensor (display code 2) the engine coolant temperature, displayed on the instrument cluster gauge, is received by the climate control system from the instrument cluster via the K1 line. As before, if this doesn't agree with the instrument cluster, suspect a wiring issue.

Display code 7 is the value reported by the refrigerant pressure sensor (B12) located on the receiver-drier just behind the left headlamp. The values are reported in Bar (1 Bar = 14.7 PSI). The pressure sensor needs to have a 5-volt (± 0.25 V) power supply to return a reading. If this sensor has failed, you'll need to evacuate the refrigerant to replace it. This sensor value may be the most useful reading you can get, since it can confirm an over- or under-charge of refrigerant. We'll get into the details in a moment in the Diagnosis section.

Display code 8 is the refrigerant temperature sensor (B12/1) also located on the receiver-drier. Measure the sensor resistance and estimate the temperature of the refrigerant it is reading. At 20°C (68°F) the sensor should read less than about 13kΩ, at 40°C less than about 5.5kΩ and at 70°C less than about 1.8kΩ. If the measured values seem reasonable, check the wiring before condemning the sensor.

Display code 10 (9 is not used) is the blower control voltage, which can vary from about 0.8 volts to about 6 volts (displayed as 08 and 60, respectively). If the climate control unit (N22) is delivering the correct voltages to the blower motor controller, but the fan isn't operating correctly, it could be the fan motor, the controller, or wiring. Again, we'll discuss this in Diagnosis in a moment.

Display code 11 is the emissions sensor (B31) voltage. Normally this will vary between 4 and 6 volts, but as this only affects recirculation operation, it is rare that anyone would notice a malfunction. In other words, your customer didn't show up because this sensor failed.

Display code 12 is the sun sensor (B32), which can nudge the blower speed up a bit to compensate for sun load.

The climate control panel N22 is easily removed from the dashboard, to access the electrical connectors, by using a set of Becker-style radio tools as seen here.

Expect to see voltages from 0 (dark) to about 4.5 volts (full sun) but, as with the emissions sensor, a malfunction would generally not be noticed by a customer.

Display code 20 (13-19 are not used) displays the control current for the auxiliary fan motor (M4) located behind the radiator. To test, exit test mode and switch the ignition on (engine off). Monitor the voltage at pin 16 on N22x2 (ground the other voltmeter lead). Press both AUTO buttons to command the auxiliary blower motor to run, but for not more than 10 seconds. The voltage should be greater than 2.0 volts and the motor should run. Switch the ignition off. A failed test indicates a fault in the wiring, N65 (the controller, near the left front fog lamp), N22 or the fan motor itself. Perform some diagnostics on N65 by measuring voltages before replacing anything. Note that some later models use CAN via the front SAM for this.

Display code 21 is the engine speed (x100 RPM), received from the instrument cluster via the K1 line.

Display code 22 is the vehicle speed in km/h. The climate control system uses this to reduce blower speed at higher vehicle speeds, compensating for the ram air effect that occurs. Again, this comes via K1 from the instrument cluster.

Display code 23 is the Terminal 58d (ambient lighting) voltage as a percentage of battery voltage. If the lights in N22 are not working, but the bulbs are OK, use this to verify that circuit 58d is being received. This value is adjusted via the instrument cluster.

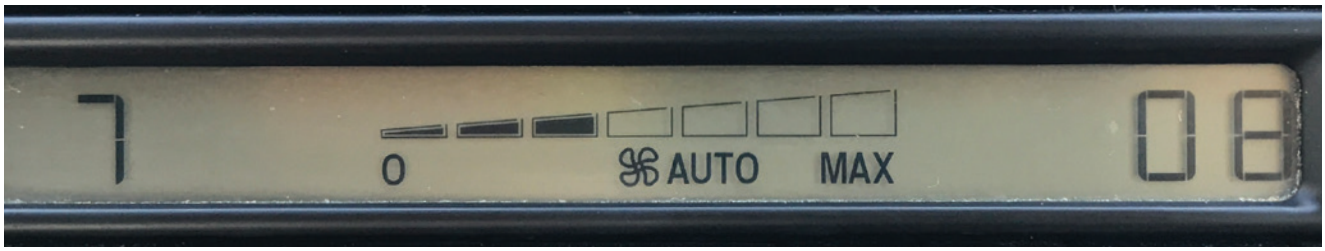
Display code 24 is the battery voltage in volts, as seen by N22. If this seems abnormal, check the wiring carefully for voltage drops on both the power and ground wires.

Display codes 40 and 41 (all the rest are unused) show the software and hardware version of the climate control controller, and is not very relevant for diagnosis.

Diagnosis

Of course, a Mercedes-Benz Hand-Held Tester was (and still is) the best instrument for diagnosis, but these are quite rare today. Many aftermarket testers can read the system fairly well, but the vast majority of problems can be properly diagnosed with the self-diagnostics, a wiring diagram, and a multimeter.

Looking at display code 7 (refrigerant pressure) we can expect to see a high-side value of about 5 bar with the system and vehicle at ambient temperature. In operation,



Here we see the diagnosis mode display code 7 showing a system high-side pressure of 8 bar. Since the engine is running and A/C is on, a low reading such as this indicates a low refrigerant charge, confirmed by noting the passenger-side vent is delivering cooler air than the driver-side vent.

values typically range from about 9 bar to 15 bar, with higher pressures seen when cooling demands are high. Really low system pressure will cause the EC light in the control unit to light, and the compressor cannot be engaged. If you find that the passenger side vents have cooler air than the driver side vents, it indicates the refrigerant is just a bit low, likely from a slow leak.

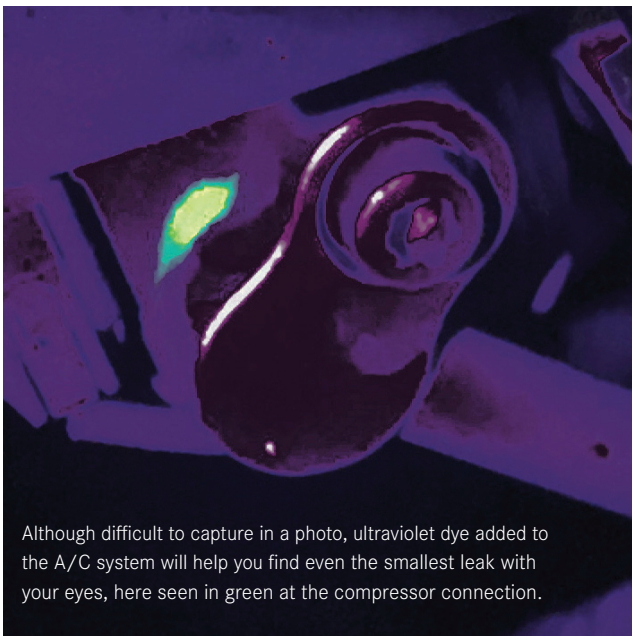
In any case, leaks need to be identified and repaired. Evacuate the system and take note of how much refrigerant was recovered. Compare that to the A/C label under the hood, which shows the quantity of refrigerant needed. Find the cause for any discrepancies.

Display code 10 can help diagnose blower fan issues, which can have several causes. In these older models, we almost always find a failed motor as the cause of blower complaints. Remove the motor, located above the passenger foot well, and apply 12 volts directly to the motor on the bench. (Be careful, the motor will 'jump' violently. Clamp it securely and stay away). Check this several times to see if there's a dead spot in the motor. If it spins ferociously, then check the voltage being delivered to the motor controller, both the big 12 volt wiring and the smaller control wire, at the connector near the passenger door hinge area. Compare the control wire voltage to display code 10, they should agree.

Replacing the blower motor is fairly easy, but be aware there are two versions, and only the later version is available now. The early version has a motor controller with several metal 'spines' used to dissipate heat, while the newer version does not. If the older version controller or blower fails, you'll need to buy both. Aftermarket components are available, but we've never had good luck with them.

Leaks

If you suspect a leak in the refrigerant circuit, the first task should be to sniff as much of the system as can be accessed using a refrigerant detector. It may be necessary to add some refrigerant if the system is extremely low or empty. Modern refrigerant detectors are reasonably priced and very sensitive.



Although difficult to capture in a photo, ultraviolet dye added to the A/C system will help you find even the smallest leak with your eyes, here seen in green at the compressor connection.

If the sniffer doesn't find the leak, which sometimes happens with very small leaks, a good approach is to evacuate and recharge the system, adding some leak detection dye. For many years Mercedes-Benz did not approve dye for this purpose, but in the last 20 years some models were even factory-charged with dye. Be sure to scan the system carefully with your ultraviolet lamp before charging, and clean off all dye residue that might be present from previous diagnostic attempts.

With the system clean and charged, send your customer off with a request they return in a few days, and carefully scan the system again to find the leak. Be sure to check the evaporator drain hoses.

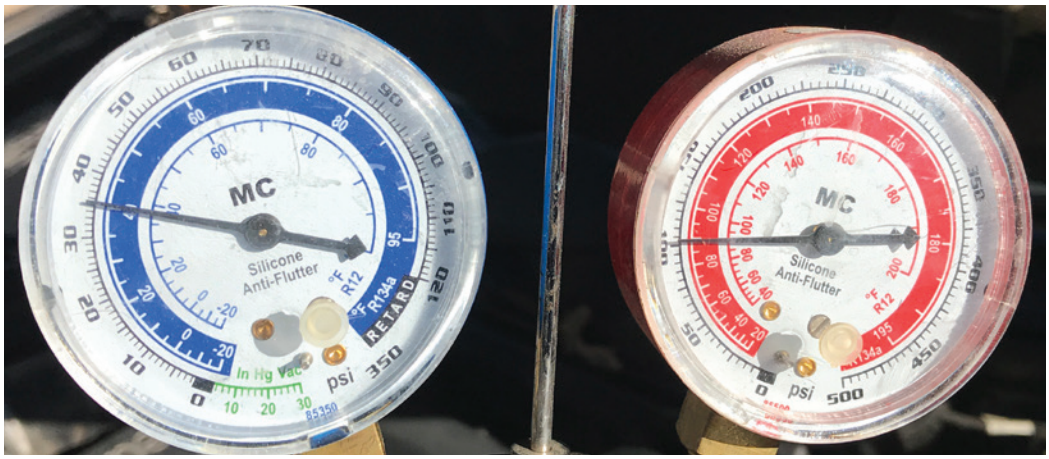
Big leaks will be seen on a vacuum test: Pump the system down to vacuum and let it hold for at least half an hour. If the gauge moves, there's a leak.

Old-school Diagnosis

Finally, any air conditioning system's refrigerant circuit can be accurately diagnosed using refrigerant pressure gauges. While there's simply not enough space in *StarTuned* to deliver a comprehensive A/C theory of operation and diagnosis guide, some basics are in order.

Two gauges are usually used for system diagnosis, one on the low-pressure side and one on the high-pressure side. These are connected to the ports at the driver's inner fender (low-side) and at the condenser (high-side). At rest, both gauges should read the same, with the pressure roughly corresponding to the system temperature (gauges have 'temperature' markings along with pressure). If these are both low, it is an indication of low charge, while if these are high, the system could be overcharged. In both cases, use your A/C machine to evacuate the system and measure the quantity recovered.

Old-school manifold gauges can be used to understand the problem. With the engine off, both gauges read the correct pressure corresponding to the system temperature (73°F, scale with white numbering for R134a), meaning the system is properly charged.



In the same car as the previous gauge photo, but with the engine running and A/C engaged, these gauges, with the high-side low and the low-side high, indicate a faulty A/C compressor.

A 'normal' reading for high- and low-side with the compressor operating depends on several factors, but are generally about 250 PSI for the high-side and 20 PSI for the low-side. Check the Mercedes-Benz diagnostic manual and Workshop Information System (WIS) for performance charts and tables to calculate what is normal.

With the compressor engaged, low refrigerant is indicated by low readings on both gauges, with the low-side approaching vacuum. If the high-side reading is low while the low-side is not, the compressor might be faulty.

If both readings are normal at first, but then the high-side rises above normal and the low-side drops, this indicates moisture has entered the system and is icing up. If both readings are high, the system is likely overcharged. In the case where pressures are normal, but cooling performance is poor, it could indicate that there is excessive refrigerant oil in the system.

In closing, we hope that this overview of the self-diagnostic capabilities of the model 210 E-Class was useful. Just knowing how to get into the system and what each code means can make diagnosis easier. The basic test values included should help in finding a faulty component or sensor. With summer fast approaching, we are starting the busy season for air conditioning repairs, and our goals are aligned with yours: Happy customers.

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