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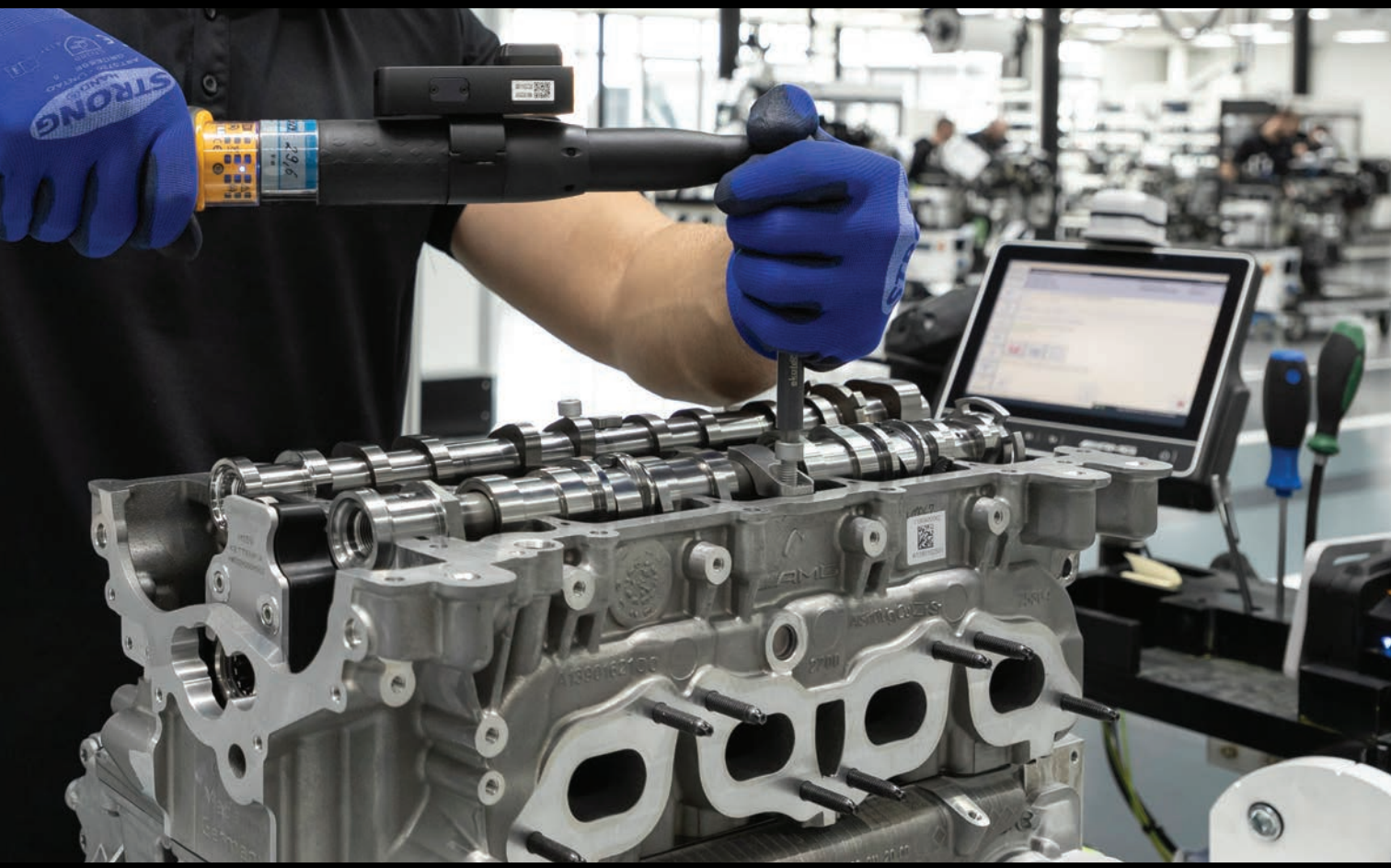

Inside:

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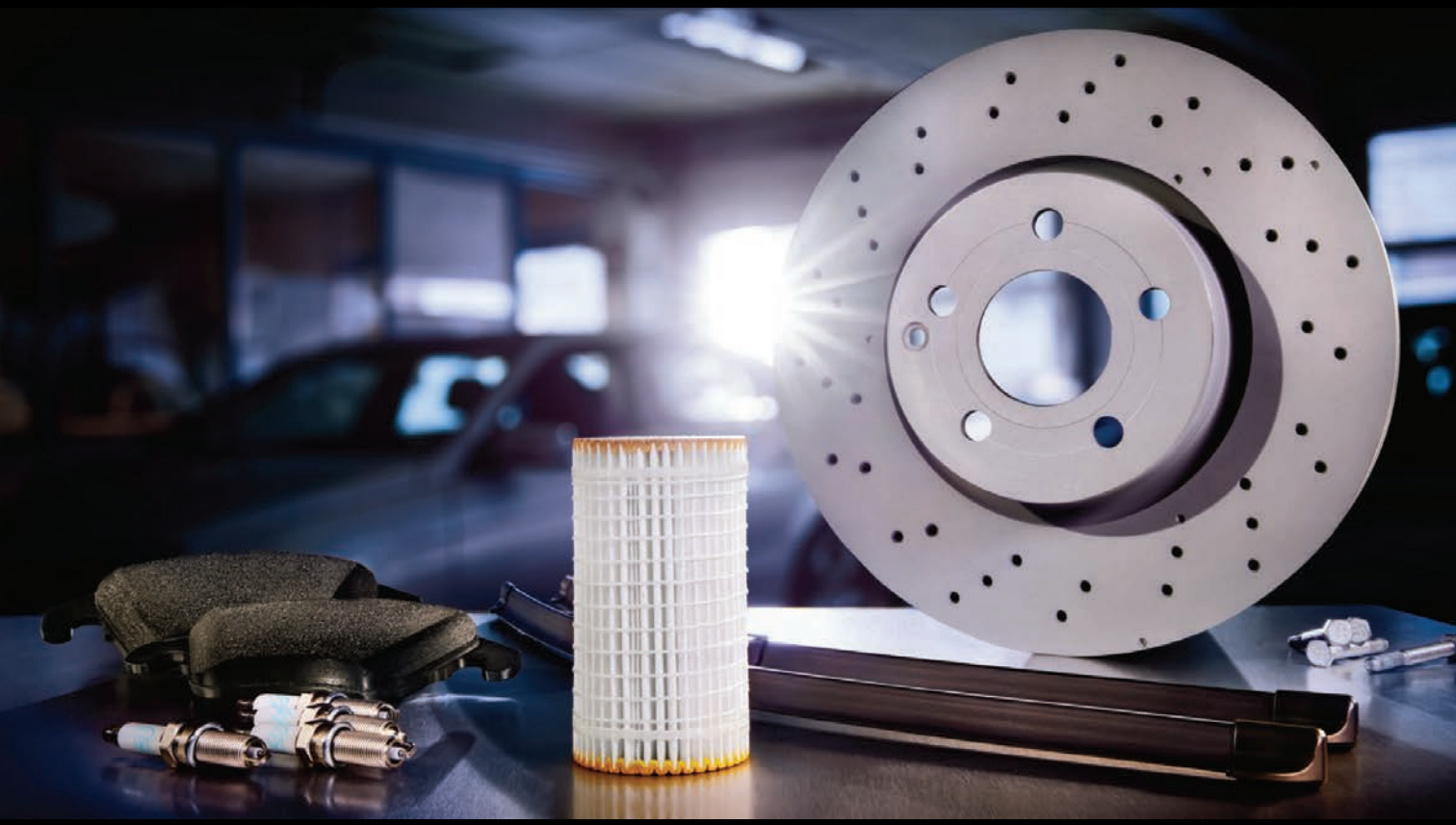

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We are pleased to bring you Mercedes-Benz *StarTuned* in its original format—a 36-page printed layout, packed full of 4+ technical diagnostic and repair information features to assist you in your everyday goal: fixing vehicles right the first time.

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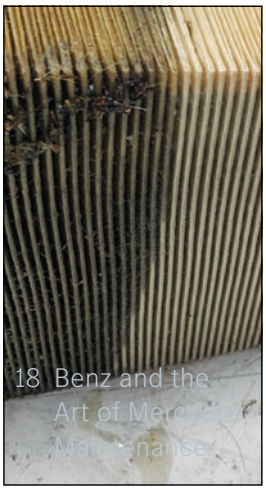
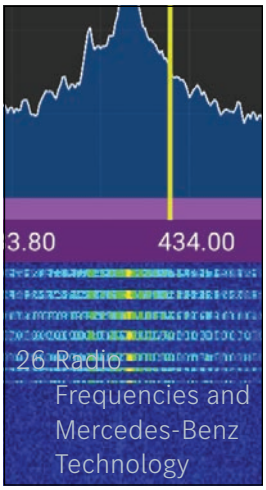




Also inside:

Mercedes-AMG Cylinder Management

A look at how Mercedes-AMG engineers increase efficiency in a large power plant, including CAMTRONIC

The latest Mercedes-AMG power plant, a 4.0L biturbo engine, boasts 577 horsepower!

While you may service a number of Mercedes-Benz vehicles in your shop, the most highly engineered models are from the Mercedes-AMG division. The AMG badge on certain Mercedes-Benz vehicles stands for "Aufrecht Melcher Großaspach." The first two words are the last names of Mercedes-AMG's founders, Hans Werner Aufrecht and Erhard Melcher. The last word, Großaspach, is the name of the city in Germany where Aufrecht was born.

Perhaps the most important feature that distinguishes a Mercedes-AMG vehicle is its engine. With few exceptions, all of the larger-displacement Mercedes-AMG engines are handmade in an exclusive manufacturing facility in Affalterbach,

Germany. In this venue, the developers live by the credo "one man, one engine," with one single person giving their full attention to one single engine until it is finished.

Some of these vehicles have the largest power plants and astonishing power ratings, while still being some of the most efficient engineering marvels to coax even more from each drop of fuel.

Mercedes-Benz CAMTRONIC is part of the Mercedes-AMG cylinder management system. One of the features that sets apart the Mercedes-AMG is using CAMTRONIC to make a larger engine more efficient. By shutting off four of the cylinders, it also makes the remaining four more efficient by themselves, while also saving life on the valves, fuel supply, and ignition systems of the ones that are shut off.

The M152 engine is the earliest version of a power plant using these features and is based on the Mercedes-AMG M157 5.5-litre V8 biturbo engine presented in 2010, which powers the E 63 AMG, CLS 63 AMG, S 63 AMG and CL 63 AMG. Numerous components and systems are basically identical, including the displacement, bore/stroke, distance between cylinders, stop/start system and direct fuel injection technology. The Mercedes-AMG 5.5-liter V8 engine with Mercedes-AMG Cylinder Management and direct fuel injection made its debut in the 2012 SLK55 AMG. Even with peak output increased by 60 hp to 415 hp and torque increased from 376 lb-ft to 398 lb-ft, the fuel consumption is about 30 percent less, which places the newer M152 AMG among the top performers in its class. Features separating it from the M157 include new intake air ducting, new cylinder heads, modified valve drive, an adapted oil supply system and an optimized crankcase.

At the Mercedes-AMG plant in Affalterbach, one single person gives their full attention to one single engine until it has been finished.

Cylinder Deactivation History

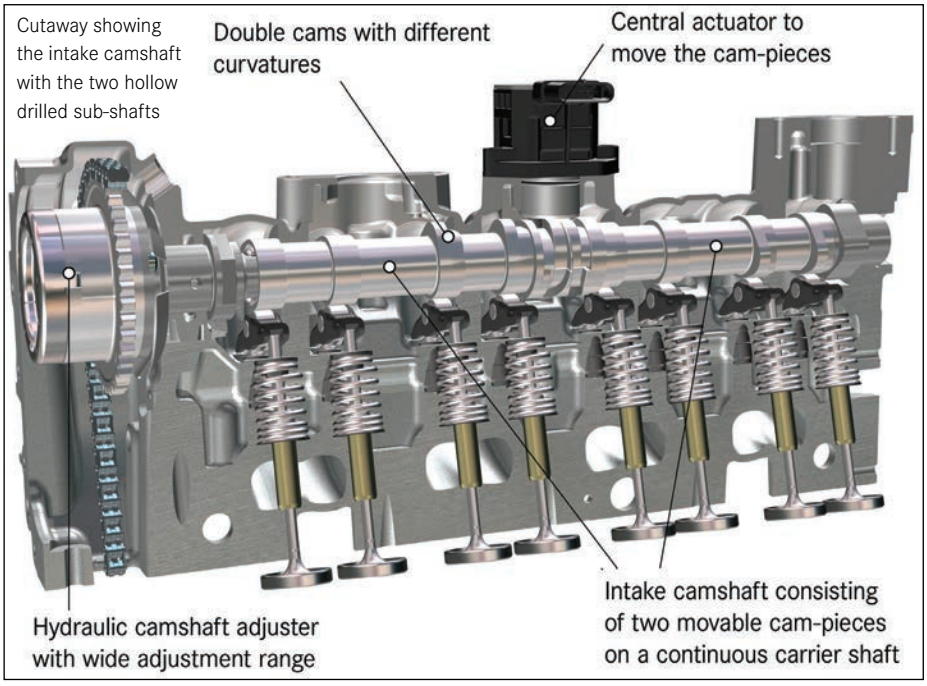
I know what you're thinking, didn't General Motors try cylinder deactivation some 40 years ago and it was a total bust? You'd be right. However, they weren't the first to try it—an honor that goes, we believe, to the 1905 Sturtevant. The driver could cut power to three of the Sturtevant six cylinders by turning off one of the magnetos and lifting their exhaust valves. Imagine the air and fuel passing through the engine being unburned! There were some other attempts in the early automotive era but not until the oil embargo of 1979 was the real motivation in place to try and conserve fuel and still have power.

GM debuted its V8-6-4 engine in 1981 and it was a complete failure, lasting only one year. This writer/technician actually worked for a dealer that had a GM line as well as others (you used to be able to have multiple car lines under one roof) and I was able to attend a training class devoted to the concept. The idea is sound and makes a lot of sense, the biggest problem in those days of course was the processors: they were just too slow, the technology just wasn't there yet. Fast forward a couple of decades and now is it not only possible, thanks to Mercedes-Benz engineers it is "cutting edge."

CAMTRONIC

We briefly looked at CAMTRONIC as a feature in the Summer 2022 issue of *StarTuned* and its use in the M264 engines. Let's take a more in-depth look at its design and function. The technology is so groundbreaking that Mercedes-Benz is featuring it in its whole line up of engines.

Valve timing, lift, and duration are all critical aspects of the modern ICE (Internal Combustion Engine). As modern-day engineers continue to develop ways to squeeze out more horsepower and better fuel efficiency, the camshaft and valves were one of the toughest problems to solve in terms of a system that could actually adjust on the fly, based on engine needs and drivers demands.



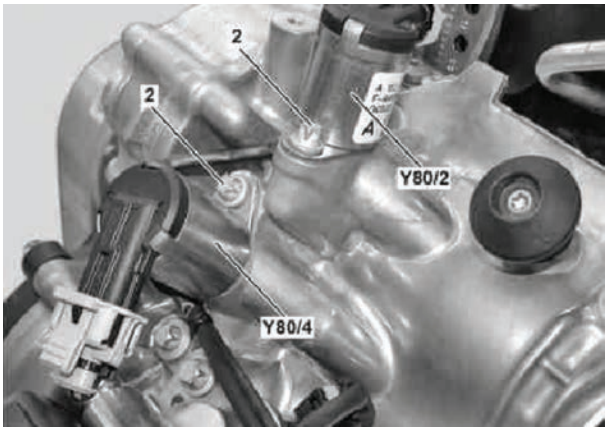
Trying to get the engine to breathe better requires better air flow. To get better air flow we began to see multivalve engines, two or more intake and exhaust valves per cylinder as well as variable intake manifold runners. So now we have better all-around air flow, but it is still set at a fixed flow rate which is a compromise. When an engine's RPMs increase, the duration of each intake and exhaust stroke decreases so that fresh air is suddenly not fast enough to enter the combustion chamber, while the exhaust is not fast enough to leave the combustion chamber. One of the best solutions is to open the inlet valves earlier and close the exhaust valves later. In other words, the overlapping time between the intake period and exhaust period should be increased as RPMs increase.

Now enter the variable valve timing (VVT) concept. We all remember the debut of this feature in the M272 engine. Problem solved in terms of valve timing, but what about the fixed lift of the valve train? Enter CAMTRONIC. Instead of having a single fixed lobe shape designed to be a compromise for best performance in all driving scenarios, CAMTRONIC can have two different lobe profiles for each valve and possibly more as engineers develop the concept.

On the four cylinder engines currently, two different lobe profiles are machined next to each other, each one for a certain driving condition, sometimes referred to as small lift and large lift. In its simplest form CAMTRONIC uses a camshaft that has the lobes on the shaft able to move axially in order to position the proper lobe over the valve at the proper time. This is achieved by having an actuator mounted above the camshaft in the cylinder head cover drive a tappet down into a spirally cut groove in the camshaft. As the tappet moves in the spiraled groove, the camshaft profile is forced to move axially so that the correct profile lobe is over the valve at the right time.

The intake camshaft is made up of several components: two hollow-drilled sub-shafts of equal size are mounted on a carrier shaft. These are referred to as "cam-pieces" in the Mercedes-Benz Workshop Information System (WIS). The first sub-shaft controls the intake valves of cylinders 1 and 2, and the second those of cylinders 3 and 4. The surface operating the valves via roller-type rocker arms is only half as wide as on a conventional cam, therefore the space requirement is the same. When the steeper half of the cam is active, the valve lift is increased and the valves remain open for longer. Switching to the flatter half of the cam shortens the valve lift and the valves close sooner.

Load control with the smaller valve lift is incorporated by using various components. At very low engine torque the load control is conventional, using the position of the throttle flap, while at medium torque levels control uses the position of the intake camshaft, and finally at high torque levels the charging level of the turbocharger is used.



Early style M152 cylinder shutoff actuators

As the torque increases, the valve lift is switched to the larger level, load control once again being conventional via the throttle flap or, in the charged operating range, via the charging level of the turbocharger. Mercedes-Benz development engineers took numerous measures to ensure the most efficient combustion even with the smaller valve lift. Because of the smaller valve lift and early intake valve closure, the turbulence in the combustion chamber is reduced at the spark plug. This turbulence decisively influences the combustion speed and complete combustion of the fuel/air mixture. To compensate for this apparent disadvantage, the turbulence is increased in the lower partial load range by using a multiple injection strategy with injection ignition, while multi-spark ignition ensures reliable combustion.

The switchover from the smaller to the larger valve lift goes unnoticed by the driver. As cylinders 1 and 2 as well as 3 and 4 are coupled in pairs with one cam-piece each, it is possible to adjust the valve lift of all four cylinders within one camshaft revolution using just one double actuator. The variable, hydraulic vane-type camshaft adjusters on the intake and exhaust sides have a wide adjustment range of 40 degrees with reference to the crankshaft. This new development excels by virtue of its significantly smaller dimensions. The installation space along the engine's longitudinal and vertical axes can therefore be made very compact.

Faults

There are not too many faults yet directly related to CAMTRONIC failure, but XENTRY TIPS bulletin LI01.20-P-070268 dealing with power loss may lead you to think you might have an issue with cams or timing. This bulletin refers to an issue in the M178/M177: Engine intermittently has reduced power (no boost reading).

Complaint: M178/M177 Engine intermittently has reduced power (no boost reading) and there are no fault codes in quick test and engine output is restored after an ignition reset.

There are two reported causes for this occurrence.

First cause: Pressure transducer or vacuum supply to turbocharger not OK.

Second cause (affects the M178 only): Crankcase ventilation/purging does not operate correctly.

Remedy 1:

1. Check wastegate linkage for proper operation.
2. Check pressure transducer, actuation via XENTRY.
3. Check vacuum supply of vacuum pump (approx. 800-900 mbar).

If the function of the pressure transducer and the vacuum supply are OK, continue with Remedy 2.

Remedy 2 (M178 only): Replace crankcase purge line A178 010 37 01 using A178 018 04 00 purge line with check valve.

What About Cylinder Deactivation?

The M152 as mentioned above is first in the Mercedes-Benz lineup to use cylinder deactivation. In order to achieve a smooth transition between an 8 cylinder engine and a 4 cylinder, in this and subsequent engines such as the M177, a number of obstacles had to be overcome. One such improvement was the addition of a dual mass flywheel to absorb unwanted vibrations. The resulting transition is so smooth the driver only knows the processor has made the switch is by viewing the instrument cluster.

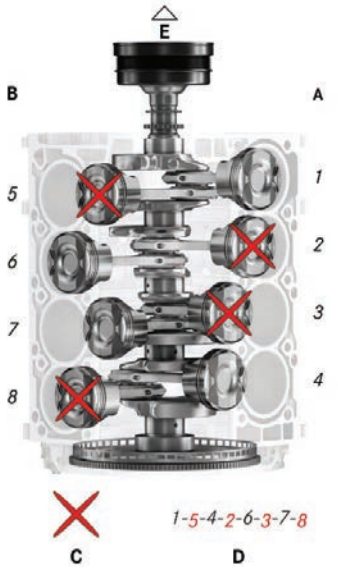
The engineering marvel is the use of CAMTRONIC to achieve cylinder deactivation. We mentioned above that in its simplest form CAMTRONIC has two lobe profiles per valve, a large lift and a small lift. In the

Mercedes-AMG engine with cylinder deactivation a zero cam lobe rides next to the regular lift cam lobe.

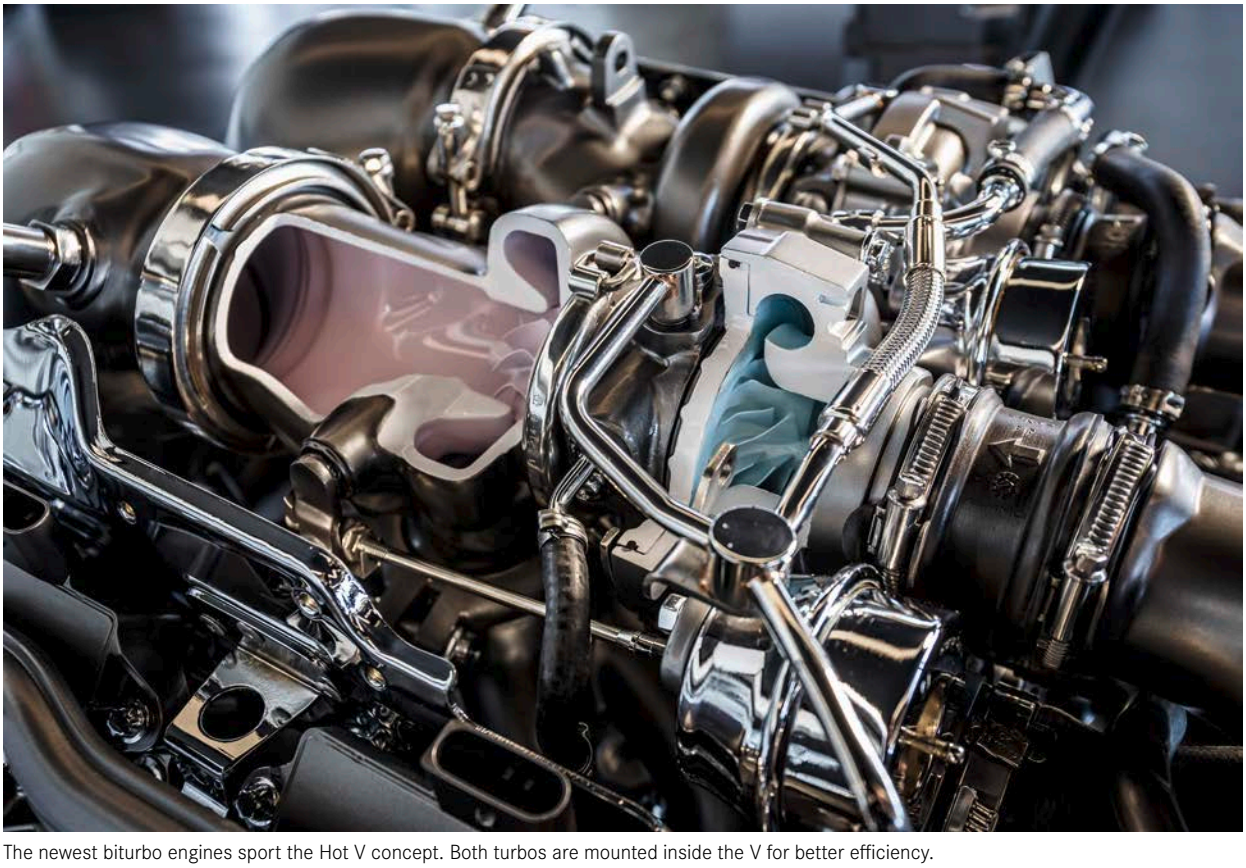
There are 4 actuators on each cylinder bank, two on the exhaust camshaft and two on the intake camshaft. On cylinders 2, 3, 5, and 8 there is a zero cam lobe next to the regular cam lobe. When called for, a tappet from the actuator moves into the spiral cut groove on the camshaft and causes it to move along its axis to position the zero cam lobe over the valve so the valve no longer opens. When the cylinder is cut off, the exhaust valves are deactivated first. At the same time, fuel injection and ignition are cut off for the respective cylinder. Air is then drawn through the intake valves at which time they are then deactivated. The purpose behind this is so that the air in the cylinders prevents a vacuum from being created causing oil to be drawn up past the piston rings. A second tappet from the actuator engages in the spiral groove in order to move the cam profile back to the 8 cylinder position as the engine management determines need.

Engine Management

All the engine functions in the M152 are executed and controlled by an extremely efficient Bosch MED 17.7.3. control unit. Subsequent control units for newer models are continually improved upon. Remember what we mentioned about the failure of the GM V8-6-4? Not only was it a mechanical failure but the processing of the changeover was just too slow. This state-of-the-art Bosch engine computer controls not only the direct fuel injection, cylinder shut-off and variable oil



This diagram depicts which cylinders are cut off during deactivation.



The newest biturbo engines sport the Hot V concept. Both turbos are mounted inside the V for better efficiency.

supply, but also communicates with other onboard control units. The microprocessor has more than 30,000 different parameters and functions stored in its memory, and is able to perform up to 260 million individual operations per second. To reduce the load on the engine control unit, there are eight individual ignition coils with an integral electronic module known as an ignition amplifier at each cylinder. These ensure a strong ignition spark at all engine speeds and under all load conditions. Eight high-voltage power stages are responsible for highly precise actuation of the piezo-electric injectors.

Handcrafted AMG 4.0L V8 Biturbo Engine

Not satisfied with the status quo, Mercedes-Benz engineers are continually improving and getting more power and efficiency out of smaller power plants. Mercedes-AMG has developed a high-output yet more compact engine for a new era of performance. The 577-hp 4.0L V8 biturbo engine is more responsive, yet more fuel-efficient, than its larger predecessor. Its massive torque reaches its 627-lb-ft peak from 2,500 to 3,500 RPM, for a 4.5-second 0-60 time and instant acceleration at any speed. Yet even with its advanced design and technologies, each Mercedes-AMG G 63 engine is still hand-built and signed by its own craftsman.

This new Mercedes-AMG V8 engine has two turbochargers which are not mounted on the outside of the cylinder banks but rather inside the engine V, sometimes known as a "hot V configuration." The advantages of this is that the engine has more compact dimensions, which allow a low installation position as well as optimum weight distribution between the front and rear axles. The "hot V" also optimizes the supply of fresh air to both exhaust gas turbochargers.

The larger 5.5 liter V8 may be one of the last big displacement V8s you'll ever see from Mercedes-Benz, as engineers are continually getting more and more performance out of smaller power plants. But you should still brush up on these engines, as well as getting more familiar with CAMTRONIC, as this is the technology of the future.

Mercedes-Benz Direct Fuel Injection

Unlocking the Mysteries behind Gasoline and Diesel Piezoelectric Injectors

The legendary 1954 Gullwing was ahead of its time in many ways, including its status as the first gasoline direct-injected automobile.

I recently read David McCullough's book *The Wright Brothers* about their work as pioneers of aviation. One interesting fact was that they built their own engines, and the very first engine they successfully flew had no carburetor; apparently, they just engineered it so the fuel just "dumped' into the air flowing through the intake. I assume they rigged some way to regulate it but I don't recall any mention of how so. It would be a stretch, but you could call that system an early prototype of fuel injection!

Although many sources indicate various claims to the very first use of fuel injection, suffice it to say that we've certainly come a long way from the early

days. In 1936 Daimler-Benz began mass production of the precombustion-chamber-injected Mercedes-Benz OM138 diesel engine, one of the first passenger car engines with fuel injection. The world's first gasoline engine with direct injection was the legendary 1954 Mercedes-Benz 300SL Gullwing.

As a young technician working primarily on domestic models, I quickly became drawn to the import automotive market where my fuel injection training began. Carburetion and fuel injection were worlds apart, but I was fascinated by the efficient design of fuel injection.

Fuel Injection 101

Let's take a quick review of different types of fuel injection so that we might compare and appreciate the advances and advantages of piezoelectric direct fuel injection.

First, we have single point fuel injection, where a single injector sprays fuel into a central location in the intake manifold to be distributed into all the cylinders as the valves open. This type of injection is also termed Throttle Body Injection. Although it can be an improvement over carburetion, it is still lacking in the efficiency department along with some drivability concerns.

Next, we have multi-point injection. Each cylinder has its own injector mounted in the intake manifold in front of the intake valves. The ECU is programmed to fire all injectors at the same time emitting only a fraction of the fuel required for each cylinder so that at the end of the engine cycle the sum total amount of fuel required is injected. An improvement over single point injection but still some inefficiencies as fuel is pooling in the intake for several milliseconds while waiting for the intake valve to open.

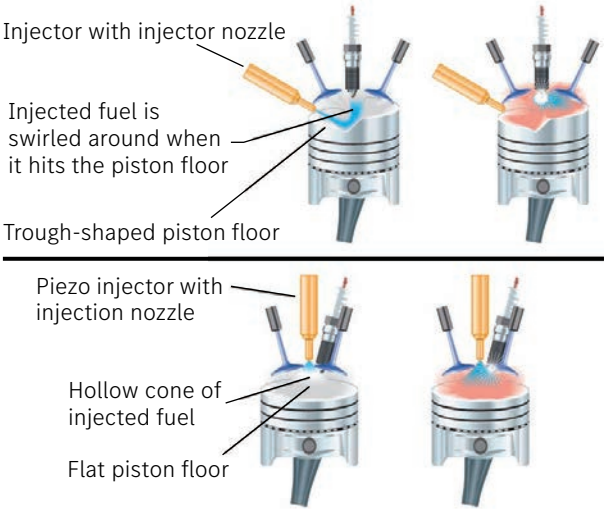
Sequential fuel injection solves the problems of multi-point injection in that the fuel is only injected for each cylinder at the precise time it is needed, thereby increasing the efficiency and improving emissions. Until direct injection, this was the most common type of fuel injection used on modern production engines.

Mercedes-Benz has a long history of fuel injection systems, including D-, L- and K-Jetronic, CIS and CIS-E, KE, LU and so on. You can read about classic Mercedes-Benz fuel injection systems in the November 2001 issue of *StarTuned*.

A Game Changer

The development of direct injection was certainly a game changer. Diesel mechanics have had the advantage of understanding the technology, as it has been a fundamental part of introducing fuel into the combustion chamber when Daimler-Benz switched from precombustion chamber injection to helix-controlled direct injection in the summer of 1964. Mercedes-Benz introduced at the 2005 Frankfurt Auto Show the world's first gasoline engine with piezoelectric direct injection and spray-guided combustion. Known as the Stratified Charge Gasoline Injection (CGI) engine, the spray-guided direct injection system first appeared in a mild-hybrid concept car Mercedes-Benz showed at the Frankfurt show in 2005. The new 215 kW (292 hp) 3.5-liter six-cylinder engine entered the European market during the second half of 2006 in the CLS-Class as the CLS 350 CGI. This established an improvement of 10% in fuel efficiency over its predecessor but due to United States emissions regulations it never made it to the US market.

In 2012, a number of Mercedes-Benz models were introduced stateside with new engines that featured direct fuel injection with homogeneous charge (as opposed to stratified charge). The newer



Here you can see how spray guided fuel injection directs the fuel to the most efficient area of the combustion chamber, helping to improve power and fuel economy.

Correct indexing is shown on the left, using a genuine Mercedes-Benz spark plug. An aftermarket spark plug (right) has incorrect indexing, and directs the flame front in an undesirable direction. This can lead to misfires, detonation and piston damage.

four-cylinder and V6 got better fuel economy while producing more pulling power, fairly impressive considering that increasing either power or fuel economy usually decreases the other.

So, what is spray guided fuel injection? To help understand, you must compare the principle to wall guided injection. In wall guided injection, the fuel mixture is injected from a side angle, which hits the top of the piston and swirls around the wall of the combustion chamber. In spray guided injection, the injector nozzle is placed directly above the piston next to the spark plug, allowing the fuel mixture to stay in a more stable condition until combustion. The greatest advantage of this new technology compared to direct injection with wall-guided combustion is its significantly better thermodynamic efficiency: the fuel is sprayed into the cylinders with great precision according to engine requirements and the driving situation, where it burns almost completely with a very high amount of excess air and is most efficient.

Here's an important tip: Be sure to use only genuine Mercedes-Benz spark plugs, as the indexing of aftermarket plugs can be incorrect, leading to misfires and possible piston damage! For more details on why spark plug indexing is important, please see the March 2021 issue of *StarTuned*.

Let's Get Technical

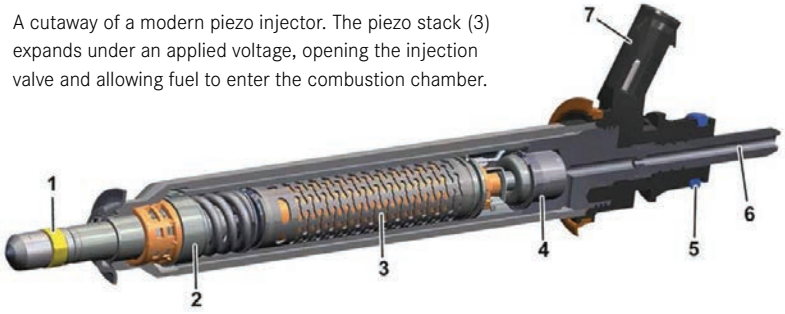
We must thoroughly understand the technology behind this enhanced injection system in order to service, diagnose and repair automobiles so equipped. Stratified charge is a word thrown around when coupled with Mercedes-Benz spray guided injection, but what is it exactly?

The principle of stratified charge operation is to deliver a mixture that is sufficiently rich for combustion in the immediate vicinity of the spark plug, while the remainder of the cylinder receives a very lean mixture that could not be used in a traditional engine. Stratified charge operation greatly reduces fuel consumption while driving under lower loads. In a stratified charge mode, the higher compression engine operates with significant excess air. Thus, the fuel is not injected into the chamber until the compression phase, after the air has been compressed by the pistons. Thanks to a highly sophisticated electronic multiple injection process, a fuel-air cloud localized in the area of the spark plug forms only at the time of ignition. This fuel-air cloud is ignited by the spark plug and in turn ignites the very lean mixture which is distributed throughout the rest of the combustion chamber. This enables extremely efficient combustion coupled with a tremendous amount of excess air.

Because the last injection takes place immediately before ignition, with the piston located almost at TDC, the requirements for depth of spray penetration and vaporization behavior are much higher than for intake stroke injection in order to prevent the moistening of pistons and walls. Also known as BlueDIRECT combustion, this process required an injector capable of distributing very short injection pulses with both extreme precision and stability.

Enter the Piezoelectric Injector

Now that engineers have found a way to get more bang for the buck in the combustion chamber with stratified charge direct injection, an injector had to be developed that could fill that need. So, what is piezoelectric and what does the word even mean? The word piezo come from a Greek root meaning to squeeze or press. The French physicists Jacques and Pierre Curie discovered in 1880 that electric charges could accumulate in certain solid materials in response to an applied mechanical stress. Using



A cutaway of a modern piezo injector. The piezo stack (3) expands under an applied voltage, opening the injection valve and allowing fuel to enter the combustion chamber.

this principle, the piezoelectric injector has at its core this material, usually quartz crystal. It rapidly expands when a voltage is applied, allowing its use as an actuator for the movable pintle, or nozzle valve, in a fuel injector. A piezo injector can operate up to five times faster than a standard injector solenoid and the motion is frictionless, which allows for precise fuel measurement and multiple injection events per combustion cycle.

A piezo element only expands a miniscule amount so hundreds of slices are stacked on top of each other so that the net movement is only about .004 inches. The actual movement is microscopic, but enough to make the piezo element act as the valve. Since this movement is a downward motion, a lever and spring mechanism inside the injector allows for the pintle to open and, when the electrical signal is switched off, close. We're also talking about a much higher voltage, enough to be harmful if contacted by a person.

After high pressure fuel enters the injector, the pressure throughout the injector is equal. Once the electrical signal causes the piezo stack to expand, the injection valve opens and the injection event takes place.

Operation and Safety Concerns

This is a high-pressure system consisting of a high-pressure pump and fuel rail, coupled with a supply pump with filter, usually in the tank. With a pressure of 130 to 250 bar (about 1900 to 3700 psi), the new system develops around 50 times the fuel pressure used in a conventional port-injection system.

Obviously, you need to be sure the system is depressurized fully before opening any connection on the high side of the system. Fuel at those pressures can be injected through the skin, and your body doesn't take well to petroleum products.

Another concern is voltage: Piezo injectors normally operate at voltages up to 200 volts, which is enough to injure you or worse.

The engine control unit generates the control voltage of around 140 to 210V and actuates the injectors with a ground signal. The piezo actuator module represents a capacitive load for the engine control unit. When opening, a current of approximately 8A flows for a few milliseconds. The control unit then reverses the polarity for opening and closing. The very short switching times of the injectors facilitate a multiple injection with short breaks during the combustion cycle.

Extreme care should be taken to protect against mechanical shock. The piezo element stack is as fragile as thin glass, so dropping or hitting it will quickly damage it. Do not touch any of the injector terminals while the engine is running and do not disconnect any connectors while running as well. Accidentally connecting either of the control wires to ground or power will also damage the injector.

Diagnosis and Testing

Before checking individual injectors, you should be guided to do so by using your XENTRY or another factory compatible scanner. If you suspect a faulty injector(s) here are some steps to take to verify a concern.

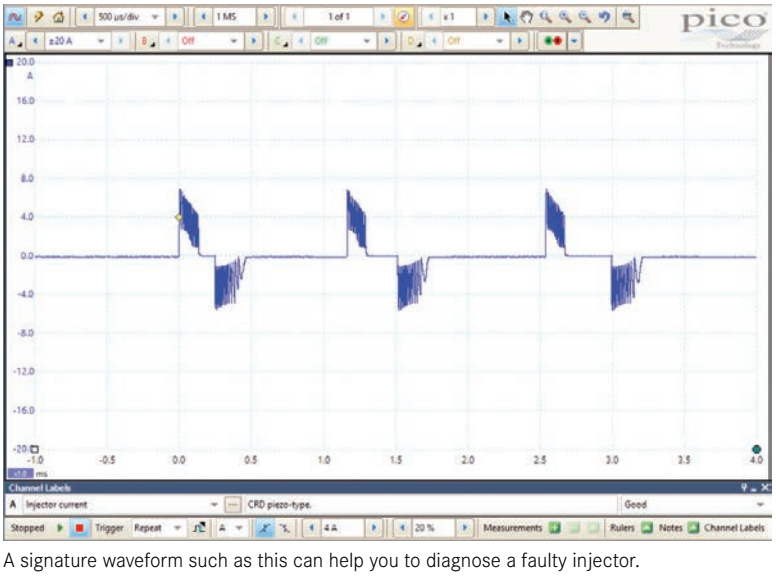
It is recommended, due to the electrical hazard, that you use certified Class-0 (low voltage) insulated electrician's gloves rated to 1,000 volts, or better. While we can't explain how to safely use gloves such as these, understand that they are typically used with leather or other durable over-gloves to ensure they don't get damaged. Be sure to read and follow the manufacturer's instructions for use, checking functionality and complying with the requirements for recertification after the expiration period. It is also recommended to wait about 5 minutes after the key is turned off, to allow the capacitors to bleed off. Don't take these comments lightly: Your life could depend on it.

Using a clamp-on low-amp probe and a lab scope you can conduct a signature wave form test of the

injectors to verify integrity. If you have a known good waveform, it is advisable to store it in the library feature of your scope. At any rate you'll want to compare waveforms to identify any possible faulty injectors. We suggest clamping around the control-side injector wire, which typically has green insulation.

Note: The engine control module powers the input side of the Piezo electric injectors, which are linked together. Each injector in the group that receives power will see the voltage rise and stay at around 140 volts. The control side is then switched by the engine control unit to allow current to flow, actuating the injector during the compression stroke, with the on-time varying according to engine load.

Use a clamp-on low-amp probe to get a signature waveform of your injector operation. Never connect directly to any of the injector wires, as you will almost certainly damage the injector.



A signature waveform such as this can help you to diagnose a faulty injector. XENTRY Diagnosis has engine-specific sample waveforms for reference.

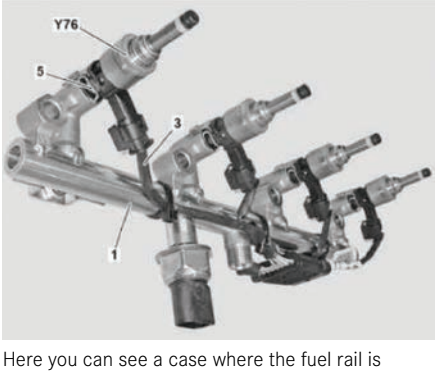
However, if there is a fault in the high-pressure fuel system, the injector will open on the intake stroke as a fail-safe measure. This allows at least some fuel to be drawn into the combustion chamber, since the fuel pressure may be too low to overpower the compression in the cylinder.

Removal and Replacement

When directed to remove and replace an injector, or perhaps just replacing the seals, you should definitely consult the instructions shown in the Mercedes-Benz Workshop Information System (WIS) for the specific model you are servicing. Some models call for removing the rail with the injectors and some may be able to be removed individually. There is a handy tool for injector seal removal and replacement (W278 589 01 15 00) that can make life easier as sometimes they can be fairly stubborn to remove. Use extreme care when removing if you hope to reuse the injectors as they are fragile as glass and can crack internally. If you find you have to use a slide hammer type puller you're definitely going to have to replace them. Also, if you find yourself reusing injectors be sure to replace them in the exact same cylinders, as each one is specifically coded and 'taught' into the control unit.

Cleanliness is a must and the bores should be thoroughly cleaned prior to installation. Be careful not to use any abrasives but only nylon and or woolen brushes with a chemical cleaner.

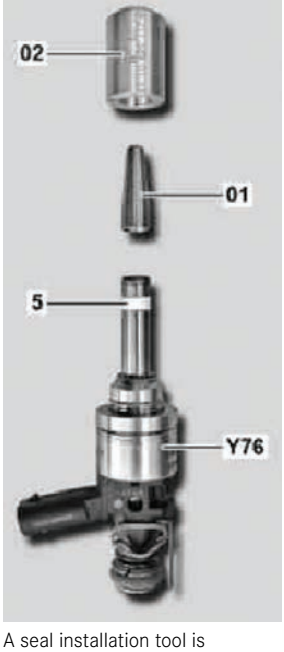
When installing or re-installing the injectors, replace the seals. There are special tools available for installing the seals in the bore for the injector as well as the seal on the



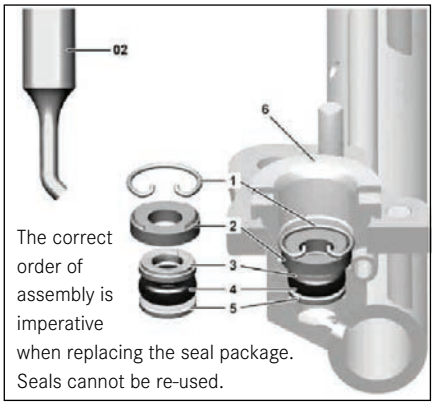
Here you can see a case where the fuel rail is removed along with the injectors for replacement.

injector nozzle itself. Check in WIS for the specific tool number(s) for the vehicle in your shop. The important thing is to not damage the seals upon installation, and to always use a new seal service kit available from your parts dealer. Trying to re-use either seal, or installing them without the special tools, will end in a quick comeback.

Injector calibration is a must. Each injector has a calibration code that you must teach in to the engine control unit in order for it to inject the proper fuel quantity for each individual cylinder. This is why it's important to make sure if you are reusing injectors to return them to the same hole. There is a XENTRY TIPS article dealing with some models having a fault code for fuel injector control. The procedure, shown here, is the same as if you were calibrating a new injector:



A seal installation tool is necessary to install the seals without damaging them.



The correct order of assembly is imperative when replacing the seal package. Seals cannot be re-used.


Important to have a proper set of brushes to get those bores clean! Shown here: W611 589 00 68 00

XENTRY tips # LI07.08-P-057357 Fault code P061194—The fuel injector control unit has a malfunction (output stage fault of engine control unit)—is stored in engine control unit (sometimes with active engine diagnosis warning lamp) XENTRY Diagnostics → MED control unit → "Adaptations" tab → Select "Configuration" → "Manual settings" → "Injector injection quantity adjustment"

Check whether the entered values in XENTRY match the values on the connector housing of the individual injectors.

1. If the XENTRY values differ, overwrite them with the values on the connector housing and delete the fault memory.

Control unit replacement is not necessary in this case.

After the values have been corrected, the control unit must be reset by parking the vehicle, locking it and then leaving it in this state for at least two minutes.

2. If the XENTRY values are correct, follow the instructions of the guided test in XENTRY.

Recalls and Campaigns

One of the more important campaigns you should be aware of regarding fuel injectors is one concerning various models from 2016 -2020, "RECALL CAMPAIGN 2022030003 - REPLACE THE FUEL RAIL AND FUEL INJECTORS." The issue is that a fuel leak can occur between the fuel injector and rail with a possible fire hazard as a result. Check your customer's vehicles for the campaign sticker to be sure they have had this done.

Undoubtedly you've seen plenty of GDI and CDI vehicle in your shop already, most likely without too many problems in the injection system. Nonetheless, as they are getting older you would be wise to invest in some of the specialty tools to service them when the time comes.

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.

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

Benz and the Art of Mercedes Maintenance

Maintenance procedures are not always as simple as you think.

The technician didn't read the instructions and ended up with this oil-soaked air filter.

Saying that Mercedes-Benz invented the automobile could be argued, but there's no doubt that the Benz Patent Motor Car from 1886 holds the distinction as the world's first internal combustion engine powered vehicle. Subsequently, Mercedes-Benz has been first to market with countless patents, innovations and new technologies. Automobiles have changed immensely over the past 136 years, but one thing has remained consistent: Maintenance. The Patent Motor Car and other early automobiles needed almost daily maintenance, from filling oiler caps and greasing joints to adjusting belts and lubricating chains. Thankfully today's vehicles can be driven thousands of miles between required services, but they are still required.

Service indicator display on the instrument cluster

Some shops make the mistake of looking at basic maintenance as a loss leader or a necessary evil to retain customers and sell more profitable service and repair work. These basic services need to be taken very seriously though. Maintenance messages that were not reset or oil level warnings in the information display after an oil service eat up valuable shop time and sour client relations. An over-tightened drain plug can easily crack or pull the threads out of an aluminum oil pan leading to costly warranty work. Rolling the o-ring of a cartridge type oil filter can cause a huge mess in the engine bay or worse, engine damage. All this to say there are many points at which basic maintenance errors can lead to costly damage. The easiest way to avoid these costly mistakes is to read through and follow factory service information, even for the simplest items like oil services, vehicle lifting points and installing air filters.

Oil Services

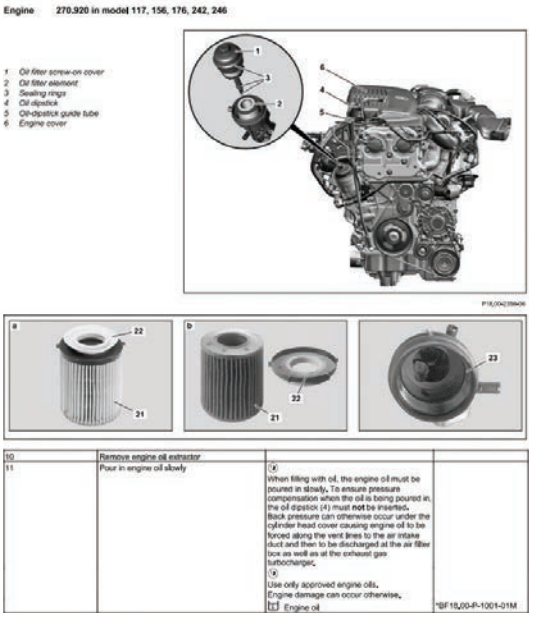
The first vehicle for consideration is a Polar White 2019 GLA250. This is the smallest SUV Mercedes-Benz offers and is equipped with a 2-liter turbocharged inline 4-cylinder, engine type 270.920, and can also be found in A-Class, B-Class and CLA-Class vehicles.

The vehicle was dropped off at the garage for regular scheduled maintenance and the service was assigned to an apprentice technician—a capable young man, but he was still rather inexperienced and green. This is common practice for the industry and for good reason; a shop cannot afford to have more experienced certified technicians performing oil services on a regular basis. Unfortunately, many younger techs are only given a few days or maybe a week of training and supervision before being set loose to sink or swim.


Mercedes-Benz 270.920 2-liter turbocharged engine

The technician raised the vehicle on the hoist and began

Oil pooled in the air cleaner housing



WIS instructions for the engine oil change.

draining the oil while performing an inspection of the undercarriage. Once the oil had finished draining the drain plug was tightened, under trays reinstalled and the SUV was lowered to the ground. A new cartridge oil filter was installed and at this point, the technician pulled down the overhead oil reel, reset the fluid counter and began pumping in 5.6 liters of 5w40 oil. After the oil was pumped in, the technician walked over to the oil sticker printer and printed out a windshield sticker. When he returned to the vehicle, he was confused and dismayed to see fresh oil steadily dripping out from under the left side of the vehicle. He quickly raised the vehicle back up and checked the drain plug; it was clean and dry. The engine hadn't even been started yet and it really wasn't clear where the oil was dripping from. Further inspection revealed the fresh oil was dripping out of the bottom of the air filter housing.

Now the technician was thoroughly confused and asked the foreman to take a look at the vehicle. Removing the air filter confirmed there was significant amount of oil soaking the air filter and pooling in the bottom of the air cleaner. The foreman decided to take a few minutes and read through the service information for this vehicle, and that is where everything became clear.

The Engine Oil and Oil Filter procedure clearly stated "*When filling with oil, the engine oil must be poured in slowly. To ensure pressure compensation when the oil is being poured in, the oil dipstick must not be inserted. Backpressure can otherwise occur under the cylinder head cover causing engine oil to be forced along the vent lines to the air intake duct and then to be discharged at the air filter box as well as the exhaust gas turbocharger.*"

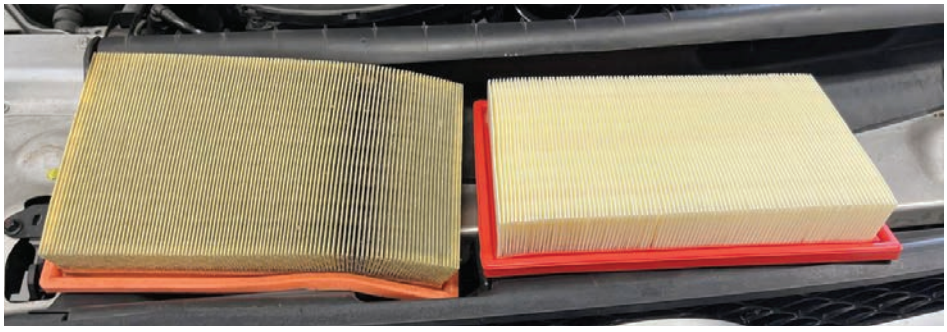
So where did the technician go wrong? He was unfamiliar with this Mercedes-Benz engine and did not read through the Mercedes-Benz Workshop Information System (WIS) maintenance instructions before beginning the oil change. He had not pulled the dipstick up out of the tube, which as a side note, is good practice for any oil service as it serves as a visual indication that the engine needs oil and should not be started, and he pumped in the oil as fast as the overhead oil gun would pump, resulting in an oil bath air filter and an oil slick under the vehicle. To dig a little deeper, where did the shop go wrong? The shop had not created a standard practice where any time a new vehicle or unfamiliar engine is being serviced or repaired the first step is to consult the factory service information.

The cost of wasted oil at $12 a quart and a new $50 air filter adds up quickly, not to mention the lost production time to figure out what went wrong and to clean up the mess. All of this could have been avoided if the technician had simply read through

the Engine Oil and Oil Filter Change procedure.

Air Filters

Air filter replacement is another basic service where costly errors can be made. To start with, a quality OE filter needs to be installed. Some aftermarket filters can adversely affect the air volume and air flow rate coming through the filter, resulting in air mass faults and performance issues. Always use factory air filters, or for price-sensitive customers, consider the Mercedes-Benz StarParts line of maintenance parts (a lower-cost alternative). Ask your dealer about them.

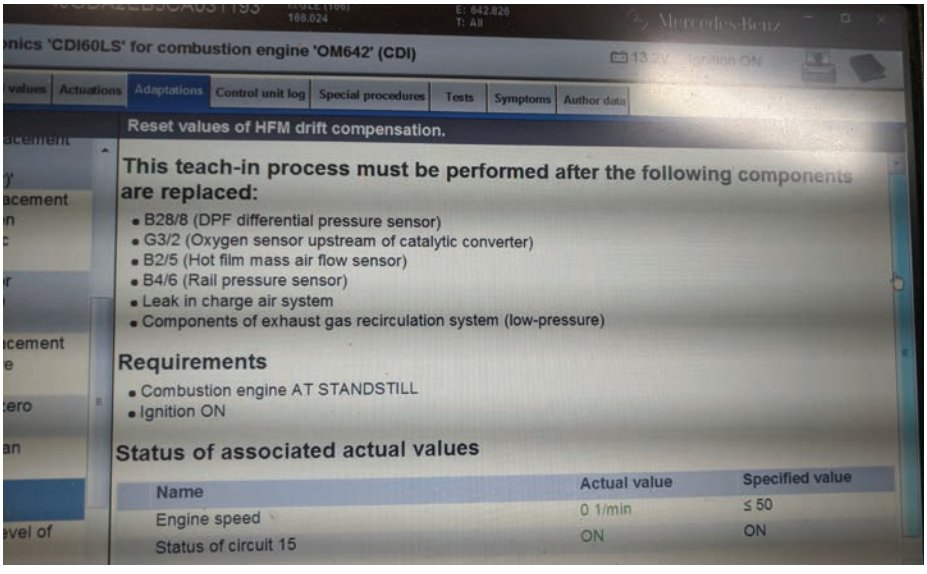


Genuine Mercedes-Benz air filters

There are several issues to be aware of when replacing air filters on vehicles equipped with turbocharged diesel engines. The turbocharger system introduces additional components like intercoolers, charge air tubes and pressure sensors. Any of the components can cause drivability issues, limp modes and warning lights if not addressed properly. Often times, charge air pipes need to be loosened or even removed to gain access to an air filter. These are usually plastic pipes with clips or clamps holding them in place. Great care needs to be used when dealing with these plastic pipes to ensure they are not damaged. One specific area that needs to be paid close attention to are the charge air pipe seals. These are usually thick rubber seals that are used to seal two air pipes together, or used on the inlet of the turbocharger. Any time a charge air pipe is removed these seals need to be inspected and replaced if there is any sign of damage or deformation. Air leaks at these seals will quickly cause under-boost and air mass faults, but more importantly, a torn seal can damage the turbocharger. Damaged seals can get sucked into the turbocharger and cause catastrophic damage, as shown in the photo of a turbocharger from a Sprinter Van (note the new charge pipe seal which was unfortunately installed too late, after the damage had occurred).

Failed Sprinter van turbocharger

Deformed charge air pipe seal



HFM drift compensation using XENTRY Diagnosis

Inspect the charge air pipe seals during every air filter replacement and if there is any question of the integrity of the seals, replace them. This is in the best interest of both the vehicle owner and the repair shop.

An additional note on air filter service is that some vehicles may require clearing an adaptation or an air filter monitor reset after a filter replacement. This is especially true for diesel engines and engines that use two mass air flow (MAF) sensors. For example, on the BlueTec 3.0 liter turbo diesel engine (OM642), if one of the mass air flow sensors is replaced due to contamination or damage the HFM Drift Compensation must also be performed, or Mass Air Flow faults will set. This is a teach-in procedure that balances the two Hot Film Mass Air Flow sensor signals together so the engine controller can properly interpret the data.

Another point to keep in mind is that when dealing with aftermarket scan tools you can't always be sure that a reset or service function worked correctly. The option may be in the scan tool software, but there are cases where clicking on the reset button does not carry out the intended function. The best option of course is to use the Mercedes-Benz XENTRY Diagnosis System, but when that is not possible, one needs to test and verify that the scan tool being used correctly performed the reset.

Spark Plugs

Next up is spark plug replacement, which will require veering away from diesel engines back to gasoline powered vehicles. Firstly, do not assume replacement intervals; be sure to check service information for each specific vehicle. The spark plug replacement interval, commonly at 100k miles or more, has been shortened on many of the newer models to 60k or even 45k miles, as in the following case of a 2015 GLK350 that was brought into the repair facility for maintenance just before the odometer hit 50k miles.

The spark plug replacement procedure on this SUV requires the air cleaner assembly be removed on the right bank and the engine control module (N3/10) repositioned to gain access to the left bank. The job has a standard book time of 2.7 hours.


The right cylinder bank in a GLK350

Genuine Mercedes-Benz Spark Plugs from a GLK350. Using aftermarket plugs can lead to engine damage.

Mercedes-Benz now recommends the use of spark plug connector grease in virtually every engine you're likely to see.

There is a specialty socket for the spark plugs on the 3.5L V6 engine (276.957) installed in this GLK350. The special service tool is a thin walled 14 mm 12 point socket; the Mercedes-Benz part number for the socket is W278 589 00 09 00. Attempting to remove the spark plugs with the incorrect socket can result in the tool becoming lodged in the cylinder head or damage to the spark plug, making it more difficult to remove.

Select the correct spark plugs based on the vehicle application and always use genuine Mercedes-Benz plugs. Many aftermarket spark plugs can cause performance issues, and in some cases, lead to misfires due their electrodes being misaligned. See the March 2021 issue of *StarTuned* for the details.

Be sure to torque the spark plugs to the correct amount, which is 23 Nm in the case of this GLK350 SUV. Over-torqueing the plugs can weaken or crack the porcelain insulator. This may not cause an issue immediately, but the vehicle will likely be back in a few days or weeks with a misfire complaint.

The final detail of applying spark plug connector grease to the inside of each ignition coil boot can also be found in service information. The grease (part number A 002 989 80 51 09) aids with reinstalling the coil boots and will help prevent damage to the boots when they are removed again at the next service interval.

Batteries

Between AGM and flooded (liquid acid) starter batteries and whether a battery registration is required, there can be a lot of variables when it is time to replace the battery on a Mercedes-Benz.

Many batteries have a 4-digit date code stamped on the negative terminal or on an adhesive label making it easy to determine the age of the battery. Make sure to confirm if the vehicle requires an

The battery terminal date code can be stamped on the negative post, or found on a label.

AGM battery or not before recommending a battery replacement. Misquoting the battery will greatly change the estimate price and installing the incorrect battery type in a vehicle can cause serious issues with the charging, starting and other electrical systems, not to mention vehicle and passenger safety. Also, most batteries have a vent hose that must be reinstalled on the new battery, along with a plug for the vent hole on the other end of the battery cover. Missing this could cause significant corrosion or allow hydrogen gas to reach dangerous levels.

Some battery replacements require a scan tool function to communicate to the engine controller, charging system or other module that a new battery has been installed. This can vary by year and model, so consult service information closely to determine if a battery registration is required. The battery replacement procedure for a 2018 C300 states, "*Confirm battery change in front SAM control unit in the Actuations menu item.*"

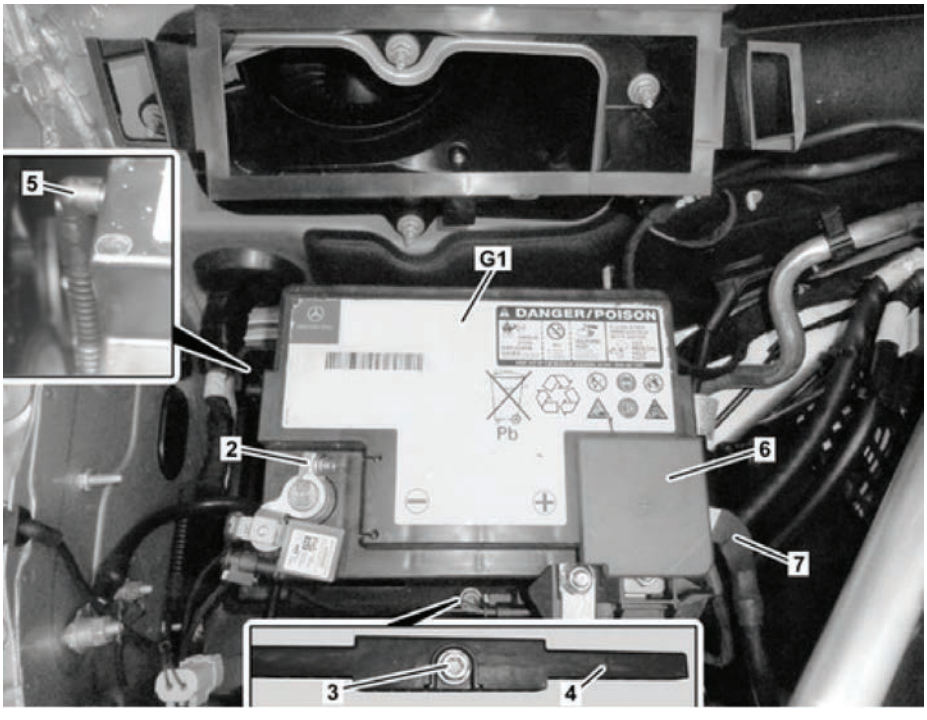
Under a separate heading it goes on to say, "*Due to technical modifications in the energy management system, it is essential to reset the charge throughput of the starter battery using XENTRY DAS each time the starter battery is replaced. Replacement of the starter battery is confirmed in the SAM control unit (N10) in the 'Actuations' menu item.*"

Service Bulletins

Finally, be sure to check for any service bulletins (Known in the XENTRY Portal as Local Information Bulletins or "LIs") that may affect the specific Mercedes-Benz vehicle being serviced. Bulletins are an excellent resource when faced with an unfamiliar vehicle or problem, and there are plenty of bulletins related to maintenance work and service parts. The LI search feature lets you narrow the list of bulletins to those that are related to the complaint or task at hand.

For example, bulletin LI00.20-P-069865 relates to an error with the ASSYST PLUS active service

AR54.1 0-P-0005LW	Remove/install battery	27.11.2019



Model 205 (except 205.012/047/147/212/247)
Model 213
Model 253

Shown on model 213 except code B01 (48V technology)

2 Ground cable
3 Screw
4 Bracket
5 Vent hose
6 Cover
7 Positive line
G1 On-board electrical system battery

13	Confirm battery change in front SAM control unit in the Actuations menu item.	Model 205 (except 205.012/047/147/212/247), 213, 253 except code U98 (LITHIUM-IONENSTARTERBATTERIE (LISB)) When replacing the on-board electrical systerr battery (G1).	AD00.00-P-2000-04B

C300 battery registration procedure

system, in which the remaining mileage and next service date are incorrect. There is updated software for the instrument cluster to deal with this problem. In a case like this, looking for related technical bulletins could save a technician's and client's time when the normal service reminder reset is not working correctly.

Other bulletins make note of specific service parts to be aware of like T-B-54.15/254. This bulletin covers a type of fuse that Mercedes-Benz uses which has silver plated contacts, denoted by the letter "S" after the fuse amperage rating.

There is a great deal of knowledge to be gained by reading through the technical bulletins for the vehicles that come into the shop. Daily workload may not allow for this, but during downtime this is a good practice. A best practice is to scan all the newest bulletins once every couple of weeks.

Vehicle maintenance is as old as the automobile itself, and it is here to stay. Even with the push to full-electric vehicles there will still be service needed for final drive units, battery cooling systems and braking systems. By following factory service information, using OE parts and making sure all their technicians are properly trained a shop can limit costly errors and maintain strong customer relations. |

Model 166 now uses electrical fuses with silver-plated contacts. This is indicated by an "S" (above) at the top next to the fuse rating.

Replace conventional electrical fuses with brass contacts with like fuses having brass contacts. Similarly, replace any with silver-plated contacts with like fuses having silver-plated contacts.

Any mixing of materials between the fuse and fuse slot will cause corrosion and premature failure.

Radio Frequencies and Mercedes-Benz Technology

It's in the Air Around Us

Today's Mercedes-Benz vehicles use many different RF (Radio Frequency) and IR (Infrared) based devices for communications in several of their vehicle control systems. RF and IR signals touch just about every system onboard today's car. Diagnosing the RF systems can be a real mystery and can become necessary when conventional diagnostics and module replacements don't bear out the fault.

While too numerous to list, some of the RF and IR systems used in Mercedes-Benz vehicles include: KEYLESS-GO, Infrared remote entry system, TPMS (Tire Pressure Monitoring System), the Electronic Ignition Switch (EIS) and Drive Authorization, PARKTRONIC, Night View Assist, DSRC (Dedicated Short Range

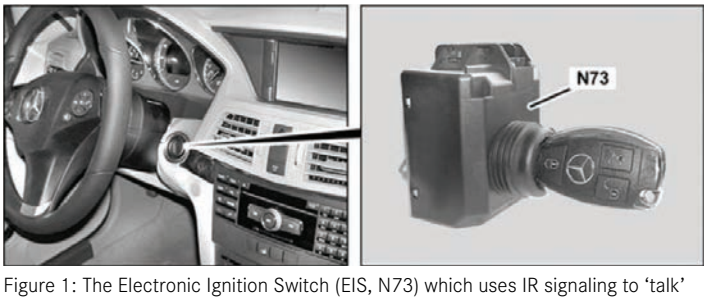


Figure 1: The Electronic Ignition Switch (EIS, N73) which uses IR signaling to 'talk' with the key and RF to supply power to the key. See the Mercedes-Benz Workshop Information System (WIS) for system description and operation, which differs by year and model.

Communications), Bluetooth, GPS navigation, radar adaptive cruise control, Bluetooth connectivity, proximity sensors and yes, even the audio, in-vehicle telephone comms and infotainment systems all utilize RF in their functions. Suffice it to say, RF is with us, around us and will continue to play an expanding role in data transfer, communications, security, autonomous driving features and Pre-Safe safety systems in Mercedes-Benz vehicles.

Yet, we technicians are not generally taught the principles of RF or IR, how it works, what it is and how to measure and quantify its presence. As automotive technicians, we've lived our lives up until now in a linear DC world. This is changing at a rapid pace, and techs must stay on top of the technology we work on to the best of our abilities.

Understanding and testing of RF systems are now becoming necessary skills for a technician who chooses not to become the victim of diagnostic nightmares brought on by the mysterious Hertzian Hooliganism we don't understand. In Mercedes-Benz vehicles, diagnosing RF issues is a common thing, albeit mostly done now with data analysis via scan tool, a multimeter and the Mercedes-Benz special tools for RF and IR diagnosis. Nonetheless, from time to time we've found that we need to go deeper than this to get the answer. This is where becoming a student of RF becomes really handy as a tech.

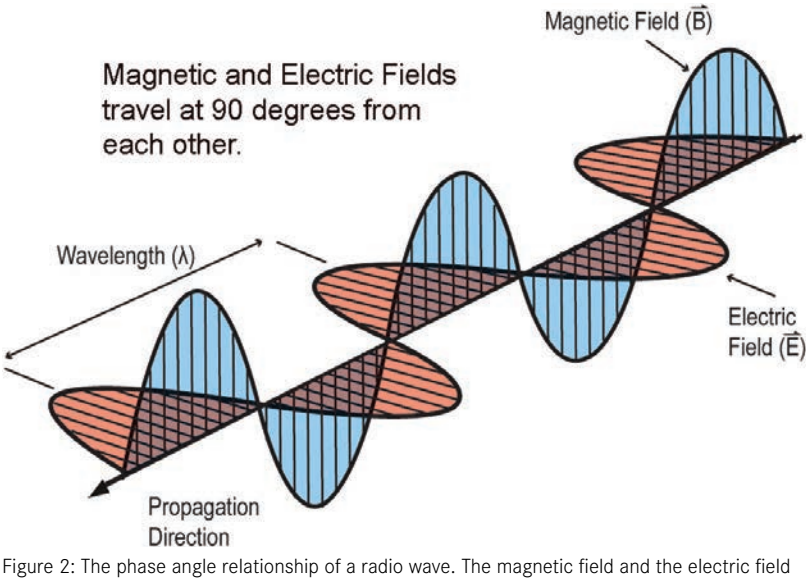


Figure 2: The phase angle relationship of a radio wave. The magnetic field and the electric field are in 90-degree phase relative to each other when perfectly resonant on any given frequency. This is a deep new study for technicians used to only measuring DC electrical current flow.

Fun Fact: Radio wave is a term coined in 1912, which sticks until this day. Prior to 1912, these were known as Hertzian waves, after Heinrich Hertz (1857-1894) a German scientist who first proved their existence.

What is RF?

Radio frequency energy consists of propagating electromagnetic waves, oscillating at certain frequencies and resonant phase angles. Phase angle refers to the relationship between the waves generated in the magnetic field, versus that of the electric field. (See Figure 2.) A radio wave must have both an electrical and a magnetic component.

Electric and magnetic fields are used to produce, transmit and receive RF and IR messages, including data, voice, video, and other signals. As these oscillations are radiated into the atmosphere by being driven from the transceiver's antenna, the waves can travel either very short distances, such is the case with automotive transponders, or very long distances such as High Frequency and Shortwave, where signals can travel thousands of miles.

It was discovered that electric fields had an effect on magnetic waves, and magnetic waves had an effect on electric field waves. Once this activity is put into motion in the form of a transmitted radio message, these radio waves travel at the speed of light in space. (In air, it's a little slower, on a wire it is slower still, but definitely very fast regardless.)

The wavelength is determined by the distance between peaks of the wave, usually specified in meters. This is calculated by dividing the speed of the wave (about 300,000 kilometers per second in air) by the frequency of the wave. Broadcast FM radio has a wavelength of about 3 meters.

The distance over which a radio wave can be detected depends on several factors, including the frequency, atmospheric and solar conditions, as well as the characteristics of the radio transmitter and receiver.

The Frequencies

Radio frequencies are measured in cycles per second, or Hertz (Hz). The US Federal Communications Commission (FCC), who has responsibility in the United States for spectrum allocation and regulations, defines radio frequencies as spanning from 9,000 Hertz (9 kHz) to 300 GHz. Note that 9 kHz, when converted to sound waves, can be heard by most humans. Who can use which frequencies, and for what, is strictly controlled by governments worldwide, and penalties for non-compliance can be severe. The chart (Figure 3) shows the wide span of radio frequencies and their uses in the United States.

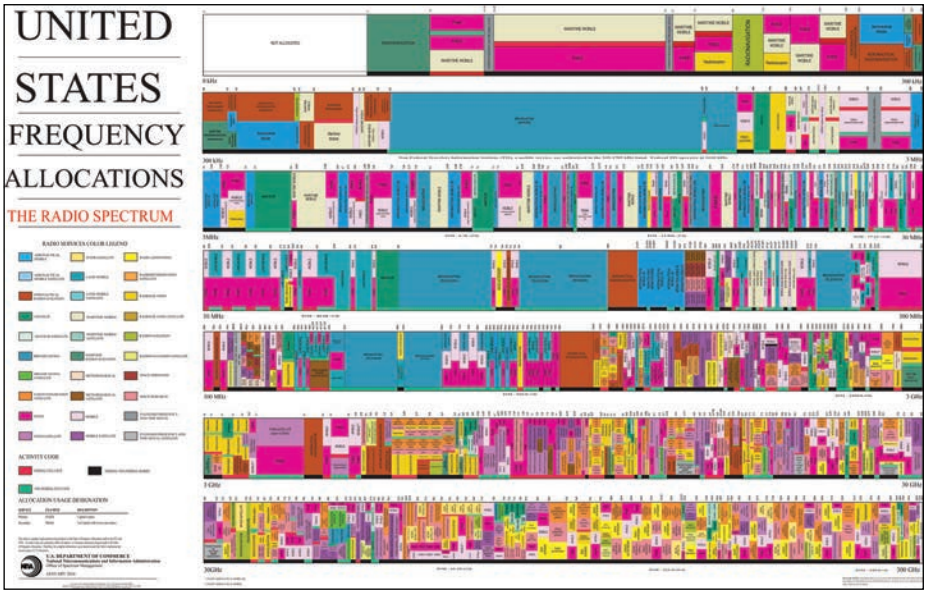


Figure 3: The FCC Radio Spectrum Allocation Chart. This is a highly complex breakdown of what type of radio emissions can legally occur in each part of the regulated radio spectrum. If you search for and download this chart, you will notice that most frequencies used in automotive components fall into the Industrial, Scientific and Medical (ISM) bands.

In Mercedes-Benz vehicles, we have several of these bands in use. Specifically, VLF (Ultrasonics), LF (Transponders), VHF-UHF (RF Remotes), SHF (Wi-Fi and Bluetooth) and EHF (Radar Adaptive Cruise Control). Above the Radio Frequency Spectrum, at frequencies measured in Terahertz (THz) lies the Infrared spectrum, which Mercedes-Benz utilizes heavily in their wireless communications scheme.

In the automotive realm, our RF bandwidths are relatively narrow, meaning we are confined to certain frequency ranges where only certain devices are allowed to transmit and receive. An example of this is the RF remotes for the door locking systems. These automotive devices must operate at one of three frequencies worldwide, 315 MHz (most common in the USA), 433.9 MHz (Primarily Europe) and 868 MHz.

Finding the Signals and Pulling Them Out of Thin Air: The Dark Arts Part of RF

In Automotive platforms, most RF devices are relatively short range, meaning your Keyless-Go remote will not be heard in the Netherlands when it transmits. RF energy, power, modulation and measurement are a lifelong study, even for engineers. As fellow automotive techs, let us welcome you to the Electronic Dark Arts.

Figure 4: RF is a challenge to test. To understand how to capture RF out of the air, one must study different properties of electricity other than Ohm's Law, such as induction, impedance and reactance. Radio antennas are their own dark art, requiring impedance matching and other characteristics.

Frustration can come quickly for the uninitiated tech; RF is difficult to measure and verify unless you (A) have the right pre-designed equipment such as a Mercedes-Benz RF tester or (B) you have

enough curiosity and creativity to design your own tools and methods. Or, you can simply use the many existing tools available for sniffing RF signals out of the air. That's the complicated part that requires a bit of study.

As techs, we are used to linear DC electrical measurement, so the concept of an RF sniffer for a scope and a demodulator circuit are foreign to most of our brains. Sampling RF on an oscilloscope is relatively easy with a homemade or commercially available RF sampler circuit, once you know what you are doing.

We have found several cool tools out there that can help detect the presence of RF, and several more advanced tools and methods for demodulating and decoding the RF signals from automotive platforms without crazy expensive tools.

One really neat setup for this is a $40 USB dongle setup that contains a Software-Defined Radio (SDR) and dipole antenna kit. Connect the dongle to a computer's USB port, install the software, and you have a general-purpose wideband receiver (see Figure 5). While not an approved Mercedes-Benz special tool, this wide-band general purpose receiver is popular with electronics hobbyists. Visit rtl-sdr.com to buy one, but beware: The genuine "RTL-SDR Blog" brand is the one you want, avoid other brands on Amazon as they often perform poorly. This cool setup is what we use to quickly detect the presence of RF keyless remotes, ultrasonic sensors and anything emitting RF energy on most frequencies encountered in automobiles.

With everything installed and configured according to the instructions, select your frequency range and press the remote button. The device nicely captures not only the remote's transmission to the car, but also receives and visually confirms the chirp-back burst from the vehicle to the remote for authentication. This is a handy tool to have to verify many automotive RF systems. Once you identify an operating frequency for any RF emission, you can name and save it to use frequently.

Regardless of which tool you are working with, remember that the positioning of the antenna is important, so when testing for any RF emission, it sometimes becomes necessary to change the angle of the antenna or device to get the best reception. These are the little differences between what we usually test and expect, versus testing for RF in the air.

Let's briefly review a few types of IR and RF systems and identify some general points and testing possibilities for the aftermarket shops sans Mercedes-Benz special tools.

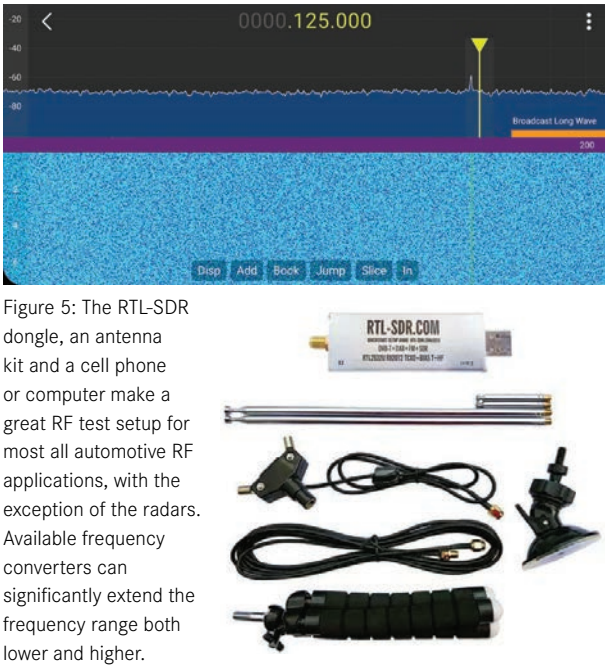
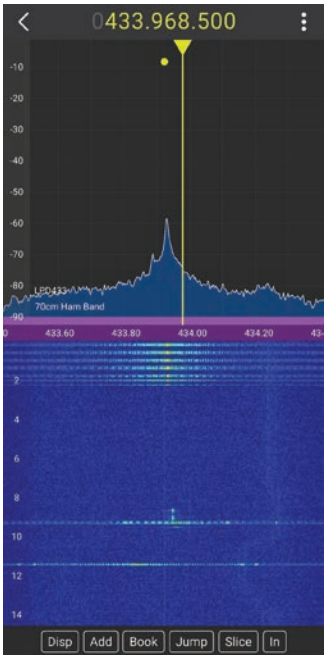


Figure 5: The RTL-SDR dongle, an antenna kit and a cell phone or computer make a great RF test setup for most all automotive RF applications, with the exception of the radars. Available frequency converters can significantly extend the frequency range both lower and higher.



Hint: These vehicle systems, by virtue of FCC band allocations, all operate in the same ISM band ranges, so this discussion covers most all other makes of cars too, not just Mercedes-Benz.

Infrared for door locking and Start Authorization: Quick tips for testing function.

Mercedes-Benz has historically used Infrared for

their remotes and for smart key wakeup and authorization. These signals can be tested using the Mercedes-Benz IR-RF Special Tools along with a scan tool to verify signaling is taking place. However, few non-dealer shops that have the Mercedes-Benz special tool. Instead, we can utilize a few tricks to measure the presence of these signals, and to test the Infrared portion to ensure it is working too.

We can use a couple of different creative methods here: The first and easiest way to see if the Infrared transmitter is working on the vehicle is to take your cell phone camera, simply point the Infrared remote window at your camera and press each button, one at a time. The cell phone camera will detect the Infrared signal as a blueish/greyish glow when transmitting. We can use this method to verify the function of the transmitter itself and often the ignition switch side. However, this test cannot tell us if the signals sent are properly coded.

For this, we would need to utilize the scan tool to verify authentication of signals, or if debugging, we would need to capture and demodulate the signal through an RF sampler, couple the signal into a scope and decode the messages to confirm correct information was being transmitted back and forth. Because the specifics of these signals are confidential information, this is not going to be terribly useful.

Always consult the Mercedes-Benz WIS to get the details of the system on which you are working, including the function description and circuit diagram, to best understand how the system works and which signals you must verify under testing conditions.

Radio Frequency VHF-UHF and Keyless-Go Remote Transmitters (Door locks, Wake-up)

Most automotive RF remotes work at 315 MHz in the U.S., 433.9 MHz in Europe and in the recently allocated 868 MHz bands. ISM frequency allocations can be found throughout the entire radio spectrum, from shortwave frequencies to beyond microwaves. Unlike most frequencies, ISM frequencies don't require the user to be licensed, but the devices that operate on the ISM bands are strictly regulated. For testing the remotes there are several options.

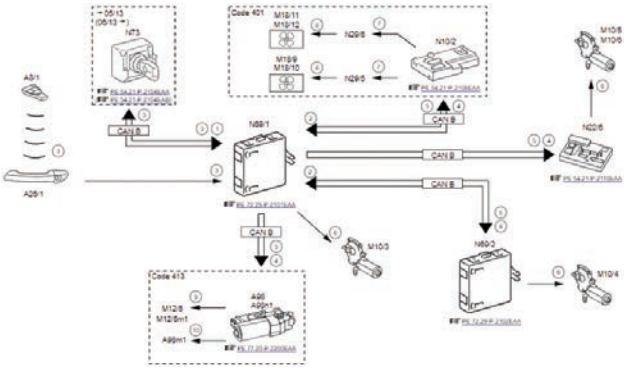


Figure 6: The Keyless-Go and remote sensors all work in unison to automatically grant access and provide Drive Authorization.

If one searches the internet, one can purchase any number of prebuilt RF or IR remote and transponder testers in the $200-$700 range. Some of these products will measure nearly all of the RF signals emitted from vehicular platforms, except perhaps radar units. These tools are great to have, whether you are a dealer tech or an independent garage.

Another method is to buy or build an RF probe. By forming a loop with the tip and ground lead of an oscilloscope probe, we create a simple antenna. We can then place the remote in the loop and press any button to display the RF signal on the scope screen. Now let's be clear here, it is highly unlikely you will actually be able to make use of the decoded signals, as the coding of the signals are unpublished and proprietary, but we will be able to verify transmission and reception nicely, meaning techs can actually verify that the device is working, which is really all we need for diagnosis on any of these systems.

The fact of the matter for technicians is that if the RF device is signaling and the antenna side is verified, any inoperability will become either a coding, data corruption or software issue, which is well beyond the scope of this article. In most cases, this will involve both component replacement, and running of the proper programming, SCN or Variant coding, depending on what you are working on at the time.

Very Low Frequency Transponders (IMMO and TPMS)

Transponders (Transmitter-Responders) are very low power radios in automotive platforms, typically used for immobilizer and Drive Authorization systems.

Controlling functions

The elctronic ignition lock control unit actuates the following functions:

- Central locking (CL)
- Convenience feature (CF)
- Drive Authorization System versions 3 and 4 (DAS 3/DAS 4).

Figure 7: The function list for the ignition lock control unit has several integrated radio and IR functions to unlock and provide Drive Authorization features.

These use frequencies of 125kHz or 134kHz but only at a fraction of a watt of power. Detection of these signals requires a powered transponder to excite the signal, and an amplifier module to receive and decode the signal. A key transponder sends a coded response when interrogated by the vehicle or testing device. There are many transponder testing tools available for the automotive aftermarket.

When the transponder in a key is placed in the ignition switch, a coil surrounding the key head delivers a small amount of electrical energy to the transponder (at around 125 kHz), just enough for it to transmit its authorization request. This means that even with a dead battery the key can be used to start the engine.

However, to unlock the vehicle, the key battery must have enough energy to operate the key's transmitter. The receiver in the vehicle uses an amplifier to strengthen and partly decode the signal received before passing it on to the unlocking system. The amplifier knows the 'vehicle code', which is unique to the vehicle but not a secret, and filters out any received signals that don't have the correct code. In this way, the system can ignore everyone else's key fobs in the mall parking lot. If you are monitoring the signal output from the amplifier and use the wrong key, you won't see any output and might possibly (but incorrectly) conclude the amplifier has a problem.

Ultrasonic Sensors

Ultrasonic (high-frequency sound) sensors are used for parking assist, proximity sensing and other uses in PARKTRONIC and related systems. These typically pulse energy out at a frequency of 40 kHz to 60 kHz, listening for the resulting echo from a hard surface to sense distance. Here, we can use a cell phone spectrum analyzer app to detect these signals. Remember, the car must be in gear for these sensors to operate, and in reverse for those in the rear bumper. We usually have a tech creep the vehicle forward and backward as we test each bumper sensor.

DSRC V2V and V2I Radio Comms

Dedicated Short Range Communications (DSRC) platforms, V2V, V2I and V2X communications occur in the 5.49 GHz to 5.79 GHz range. These radios communicate with other vehicles on the road (V2V) as well as with the infrastructure (V2I) and other systems (V2X). These cool systems allow your vehicle to send and receive messages for collision avoidance, traffic and freeway loading infrastructure. DSRC is an optional accessory in Mercedes-Benz vehicles.

Bluetooth, Wi-Fi and Cellular Radio Modules

Bluetooth is a low power interface. Devices operate at 2.4 GHz in the ISM bandwidth allocation. The Bluetooth Low Energy version has 40 channels allocated at 2 MHz bandwidth spacing, the higher energy standard Bluetooth uses 79 channels with 1 MHz spacing. Interference on these bands is commonplace. Bluetooth radiated power is measured in milliwatts (0.5mW for class 4 up to 100mW for class 1) for maximum allowable broadcast power and is regulated by the FCC for each type and class of device. (See Figure 8, next page.)

Radar Adaptive Cruise and ADAS Systems

Radar Adaptive Cruise Control radars use other allocated microwave ISM bands. Depending on the system version, radar adaptive cruise units and Intelligent Radar Sensing units can run in either the 24 GHz range (older versions) or the newer 76—81 GHz range. Detecting these very high frequencies is a challenge, so diagnosis really depends on XENTRY Diagnostics and the test routines it contains.

We've got wireless signals in Mercedes-Benz vehicles that span nearly the entire range from sound to light. Considering this, studying RF

Wiring > System Information >
GF82.85-P-3136FLJ
Component description for COMAND controller unit
13.3.12

MODEL	212
	with CODE (527) COMAND APS with single DVD drive (with navigation)
	with CODE (498) Japan version
	up to model year 2013
	/YoM 12

Shown on model 212.0

A40/3 COMAND control unit

Location
The COMAND controller unit is installed into the center console.

Task
The COMAND controller unit fulfills the following tasks:

- **Central operating unit for the entertainment and communication systems integrated into the vehicle**
- **Reading in the controls and input signals**
- **Evaluation of input factors**
- **Activation of output media and system components**

Central operating unit for the entertainment and communication systems integrated into the vehicle

The COMAND controller unit provides the user with a structured and uniform interface for the following system components:

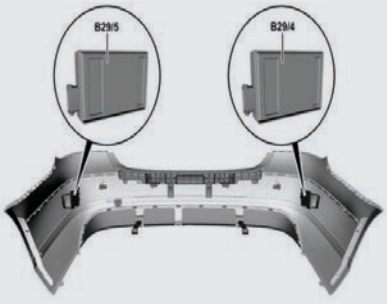
- Audio
- Radio
- CD, DVD
- Memory card
- Music Register
- Bluetooth® audio (as of 1.6.2010)

Figure 8: The COMAND system is one of the major RF hubs in many Mercedes-Benz vehicles.

principles and learning how to capture, measure and verify its presence will become increasingly important going forward in effective diagnosis of Mercedes-Benz vehicles.

Author's advice: A great way to study, grasp and practice in the RF realm is to look into becoming an amateur radio operator, or ham. Your author has been an FCC licensed Amateur Radio operator for several years now and, once you begin to study there, you will quickly come to realize (as I did) how much we don't really know about electricity and electronics. Taking on a hobby such as this will give your automotive technical skills the biggest boost that could possibly be experienced, save an electrical engineering degree. Try it, you might like it and learn some cool new stuff along the way. Visit arrl.org to find a local radio club where you'll be welcomed with open arms and whatever assistance you might need to get your own license. Free education that will help you make more money? What a deal! |

B29/4 Left rear bumper intelligent radar sensor
B29/5 Right rear bumper intelligent radar sensor

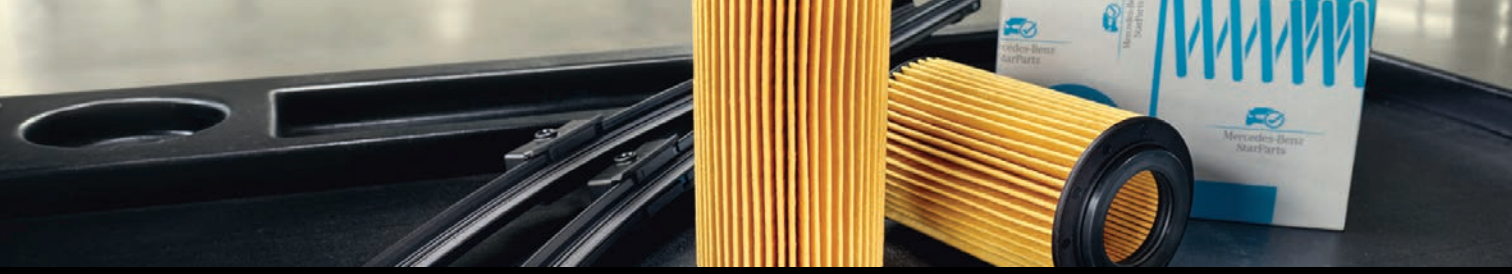


Location
The left radar sensor is mounted on the left of the left inner side of the rear bumper while left radar sensor is mounted on the right on the right inner side of the rear bumper.

Task
The radar sensors detect vehicles in the blind spot via the integrated radar sensor system. The radar sensors are ultra wideband radar sensors with the following properties:

- Radar sensor detection range 0.18 m to 3 m at a resolution of 0.04 m
- Detection of angle of 60° with angle measurement and 130° with detection only
- Radar sensor with 24.125 GHz carrier frequency
- Operation: short pulse method with 5 GHz bandwidth

Figure 9: The Left and Right Intelligent Radar Sensors used in Mercedes-Benz safety and ADAS systems. Note the frequency range called out for these bumper radars is 24.125 GHz.



Mercedes-Benz Star Parts

An authentic, competitively priced parts option

As a Mercedes-Benz gets older and its mileage increases, owners often place different demands on parts and service. So Mercedes-Benz developed StarParts, a price-friendly parts line for vehicles 5 years and older that can offer a greater margin opportunity per part. Since StarParts are age and model specific, they can reach a segment of Mercedes-Benz owners that has been previously underserved, and provide a third option for you alongside Genuine Mercedes-Benz Parts and Remanufactured Parts. When faced with older Mercedes-Benz models in need of service, local auto parts chains often offer alternative lines of common service parts at reduced prices, even though these parts may not match the performance of Mercedes-Benz original equipment parts.

"There's no denying the high quality, precise fit and value of Genuine Mercedes-Benz replacement parts. However, with StarParts, dealerships and independent repair shops will no longer find themselves in a competitive dilemma when sourcing common replacement parts for our older models," said Dianna DuPreez, Vice President of Customer Services at Mercedes-Benz USA. "Shop owners can now provide their customers with quality options designed and guaranteed by Mercedes-Benz and offered at a friendly price, enhancing margins and ultimately helping to grow shop profits."

Mercedes-Benz StarParts are the parts you use the most. Built to exacting standards in terms of fit, quality and functionality, StarParts feature common maintenance parts: Brake pads and disks, Cabin air filters, Engine air filters, Spark plugs, Wiper blades and of course Oil filters. The StarParts line provides another option to the aftermarket for price-sensitive customers. Backed by a competitive warranty that includes parts and labor, the product line offers authentic parts that meet or exceed the strict Mercedes-Benz quality and safety requirements and still fit your needs and your customer's budget.

What did Mercedes-Benz change to allow for a noticeable lower price for StarParts? In general, a few pennies here and there for things that don't matter for the effectiveness and longevity of the part. For example, brake disks might use different production locations to reduce costs, or to use an alternative protective coating instead of zinc dust paint. Wiper blades may come with adapter clips to enable one set of wipers to be used across several different model ranges, leading to volume-based cost reductions, or deletion of the time indicator label. Packaging might use less costly materials, boxes are possibly unprinted and labeled or use just a single color.

At this time, the following models are included in the StarParts program: C-Class (W/S203, W204); CLS (C219, W218); E-Class (W/S211, W212, C/A207); GL (X164); GLK (X204); ML (W164); R-Class (W251) and SLK (R171). As model lines age, additional model series will enter the program.

These are not remanufactured or refurbished items. Genuine Mercedes-Benz Remanufactured Parts have a different parts range from StarParts. Genuine Mercedes-Benz Remanufactured Parts offers customers major assemblies, and mechanical or electronic components (such as turbochargers, alternators, or engines). On the other hand, the StarParts range consists of common maintenance/ wear and tear parts, and has been specially developed for the requirements of Mercedes-Benz vehicles 5 years and older.

To buy StarParts, contact your favorite Mercedes-Benz dealer. They will be happy to quote you a competitive price on StarParts or any other parts you might need. |

Star Rewards

As long as you're buying parts, you might as well get money back!

If you're a regular reader of *StarTuned*, you've probably seen the advertisements for StarRewards, and hopefully registered for the program. If not, then this is your formal invitation!

Mercedes-Benz StarRewards is an online loyalty program that gives Independent Service Providers (ISPs) like you the opportunity to track and earn rebates on Genuine Mercedes-Benz Parts, Mercedes-Benz StarParts, Mercedes-Benz Remanufactured parts and Accessories purchased through authorized Mercedes-Benz dealerships. Workshops like yours have a long and rich history of servicing Mercedes-Benz vehicles. Mercedes-Benz USA knows they wouldn't be as successful without you and want to reward you for doing business with our Mercedes-Benz dealerships.

You're probably already buying parts for your customer's vehicles from your local dealership, so why not get rewarded for it? The more you buy, the more you earn.

How It Works

The first step is to register for the program at mbstarrewards.com/enrollment. You'll need to tell us who you are and provide enough information to verify that you're an eligible business. Once accepted, you need to buy at least $200 worth of parts in the first quarter of eligibility, and from then on MBUSA will set a quarterly goal for your purchases. Hit that goal and you get a 1% rebate of your purchase amount. Exceed it by 5% to 9.99% and the rebate is 2%, and 10% or more gets you 3% back. At the end of that calendar quarter, log in and claim your reward! Rewards are paid via a reloadable MasterCard® award card.

MBUSA adds more purchase programs throughout the year, allowing you to earn more rewards. You don't have to do anything to participate in new programs—you are already registered! You will be notified when a new program begins. Note that you are not limited to purchases from a single dealer: Parts purchases from any authorized Mercedes-Benz dealer are all eligible.

Eligible Workshops

Only single-shop traditional mechanical and collision shops are eligible to participate in the StarRewards program. Multi-location shops and parts resellers are not eligible. Once you submit your enrollment application, your shop will typically be approved in one or two business days. Once approved, you will receive an email from Support@MBStarRewards.com with a temporary password. With that and your email address you'll be able to log in to the StarRewards website. Of course, the first step will be to create a permanent password.

On the StarRewards website, you'll see your Dashboard open to the current quarterly program. You can also click on the Dashboard link on the top menu. If you select a Program from the drop-down, you will be able to see your purchase goal for that particular Program. Once you've purchased at least $200 worth in the first quarter after enrollment, the next quarter will start your rewards.

MBUSA looks at your past parts purchases from all authorized Mercedes-Benz dealerships and determines a purchase goal. Your Dashboard shows the purchase goal for each program, the remaining days and dollars until you reach your next goal. Each program ends on the last calendar day of the quarter, and a new program starts on the first day of the next quarter.

Of course, there are certain terms and conditions for the StarRewards program. Browse around the StarRewards website (mbstarrewards.com) and look at the program details provided there. If you still have questions, contact the dedicated StarRewards support team at support@MBStarRewards.com and they'll get right back to you.

Register for StarRewards today and get started on your rewards! |

An authentic line of parts.
A competitively priced option.

Mercedes-Benz StarParts.

Delivering more than just quality, accuracy, and fit, StarParts is a parts line designed for vehicles 5 years and older that is:

- **Built for high functionality and fit**
- **Backed by a two-year warranty* (one-year for brake pads & wiper blades)**
- **Designed to offer *the best or nothing* quality & performance at attarctive prices.**

To order StarParts, contact your MercedesBenz dealership today.

*To learn more, visit www.mbwholesaleparts.com/warranty

Mercedes-Benz
StarParts

We Believe Those Who Deliver Excellence, Deserve A Reward.

Introducing Mercedes-Benz StarRewards.

Servicing Mercedes-Benz vehicles with Genuine Mercedes-Benz Parts, StarParts, Remanufactured Parts and Accessories demonstrates your commitment to using only the highest-quality parts for your customers. To show our appreciation, we invite you to join the Mercedes-Benz StarRewards program. Now, each time you make a purchase through your Mercedes-Benz dealership, you can earn a cash rewards on a reloadable card that you can spend on whatever you desire. Simply sign up and start getting cash rewards for parts you're already installing.

Enroll today at www.MBStarRewards.com

Mercedes-Benz STAR☆REWARDS