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Information for the Independent Mercedes-Benz Service Professional

March 2007 U.S. $6.00 € 12.50

Disc Brake Runout

Battery Testing

Fuel Pump Circuits

Volume 7 Number 1

TO OUR READERS

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

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

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

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

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

Send your suggestions, questions or comments to us at:

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IN THIS ISSUE

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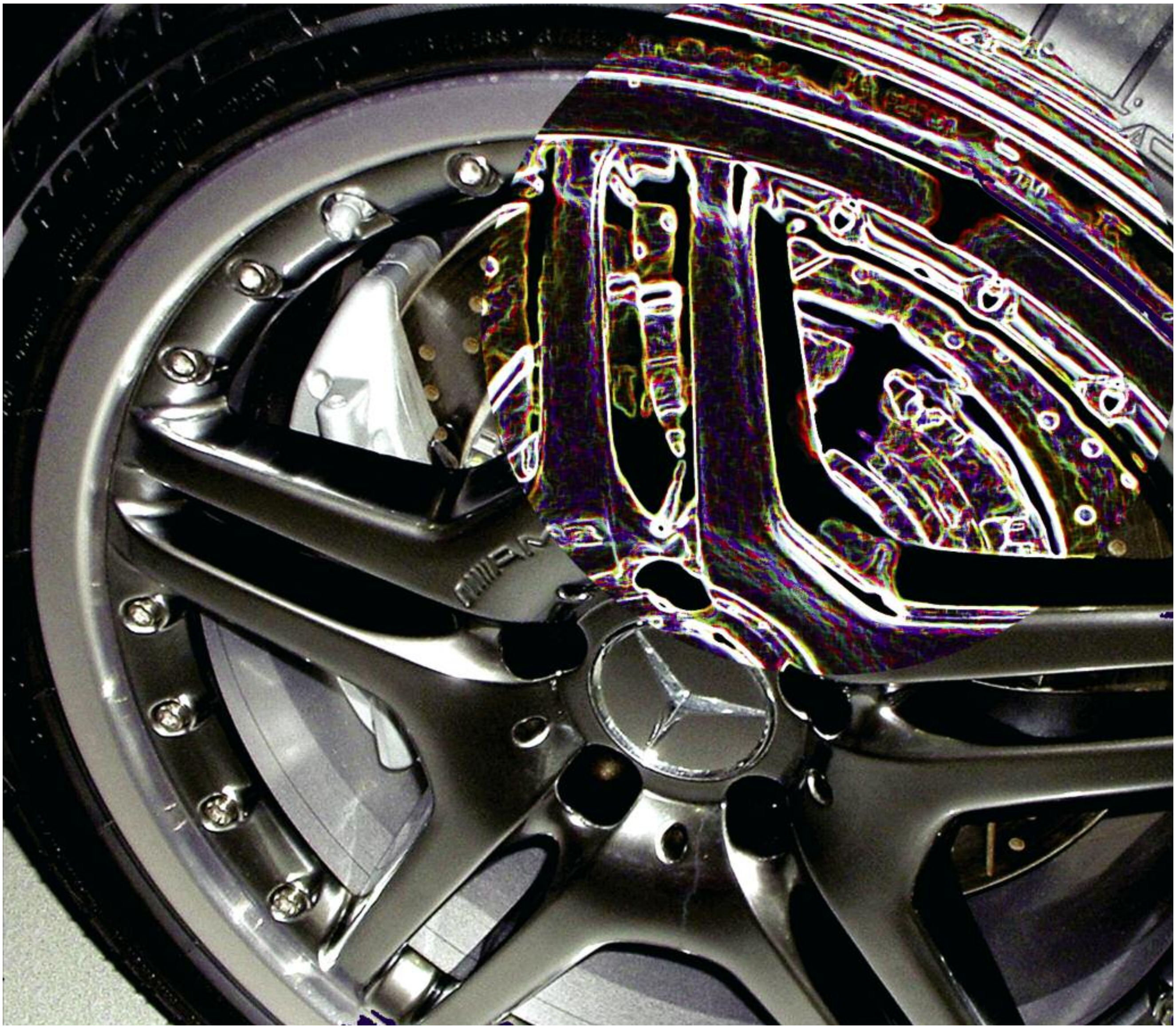
Mercedes-Benz

Premium Brake Service Should Include Correcting Runout



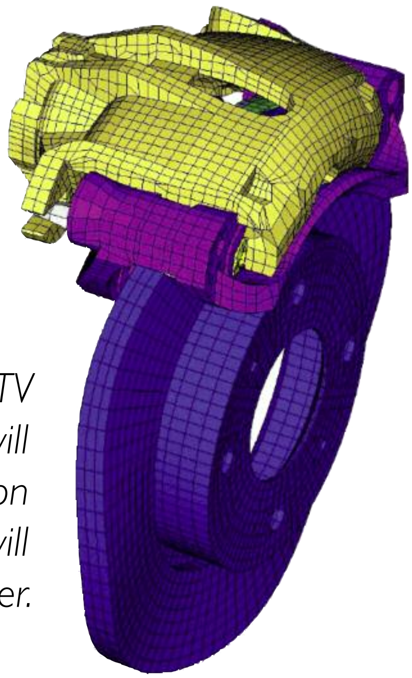
Providing customers with premium brake service goes beyond replacing worn out friction materials. It includes restoring all aspects of the Mercedes-Benz brake system to like-new operation. A working knowledge of disc thickness variation (DTV) issues generated by runout, along with indexing and other techniques for minimizing runout, are proving to be critically important for techs in minimizing comebacks for brake pulsation complaints.

Consumers and technicians alike refer to rotors with disc thickness variation (DTV) as “warped.” What is often misunderstood is that DTV, and resultant brake pedal pulsation or “judder,” is a symptom of excessive runout.

How Runout Creates DTV

The general public as well as many techs blame brake judder on “warped discs.” The truth isn’t quite so simple. At least in theory, a wavy or “perfectly” warped rotor would be the same thickness in all spots, and a floating caliper would simply follow it as it tracked from side to side. In practice, a warped disc, or a disc that doesn’t sit completely flat on the hub will contact the caliper at its high spots, but not the low spots. Constant rubbing leads to the creation of thick and thin spots on the disc. The caliper piston(s) follows these variations in and out, pushing fluid back against the pedal, creating the all-too familiar brake pedal pulsation, or judder. Hence DTV, or “disc thickness variation” is the actual cause of brake judder, not “warped” rotors.

The best rotors in the world will soon come back with a pulsation problem if mounting errors produce even a small amount of wobble.



A wavy rotor will develop DTV because certain spots will contact the pads on every revolution, which will make those areas thinner.

Genuine Mercedes-Benz O.E. replacement linings are formulated to provide the highest possible braking performance. These aggressive friction material recipes, however, do take a toll on rotors, so DTV can develop fast.

The sources of runout are the stacked tolerances of the hub, mounting faces, and rotor. Turning or replacing "warped" rotors may not sufficiently reduce runout to prevent a brake pulsation problem from returning, although use of an on-car brake lathe can sidestep the problem.

Comebacks for noise issues are hard enough to prevent, but if a vehicle comes back in just a few thousand miles with brake pulsation because of runout issues that weren't addressed, the owner isn't going to be happy, and profits may very well go down the drain. Frequent pulsation comebacks more than justify the additional time and effort required to measure and correct for runout the first time around.

So what is runout exactly, and how can technicians correct it to prevent comebacks? Simply stated, runout is the amount of wobble, or side-to-side (lateral) motion, measured on a disc that's rotating in a horizontal plane. It's typically measured using a dial indicator attached to Vise-grips, mounted on the steering knuckle or some other solid point.

Rotor runout is a "stacked" tolerance with the wheel bearings, bearing installation inside the hub, hub, rotor hat "face" and rotor disc all potentially contributing to the total.

Root cause

Bearing wear, accident damage ("curb checking") and corrosion on the hub face all have the potential to cause runout and resulting DTV. Bearings not adequately snugged down, or not pressed absolutely flat into the hub could generate significant runout. Manufacturers of hub-mounted versus caliper-mounted brake lathes argue the relevance of wheel bearing preload to runout.

Rust on the face of the hub where the rotor mounts is probably the leading cause of runout. Iron combines with oxygen to form rust, which takes up sixteen times the space that iron itself does. Just like a tree root lifting a concrete sidewalk, rust in a pitted hub surface, or the back of the rotor "hat" can lift the rotor off the hub even with the lug nuts securely snugged down. This will, of course, cause runout.

There are other potential sources of runout. A bent arbor on a brake lathe can machine rotors that are beautiful to look at, but become ugly when measured using a dial indicator. The same result can occur if the center hole, flange, and/or face of a rotor aren't adequately cleaned of rust before it gets mounted on a lathe.

Unequally torqued lug nuts can generate as much as .003 in. of runout, another good reason to use a torque wrench to tighten lugnuts.

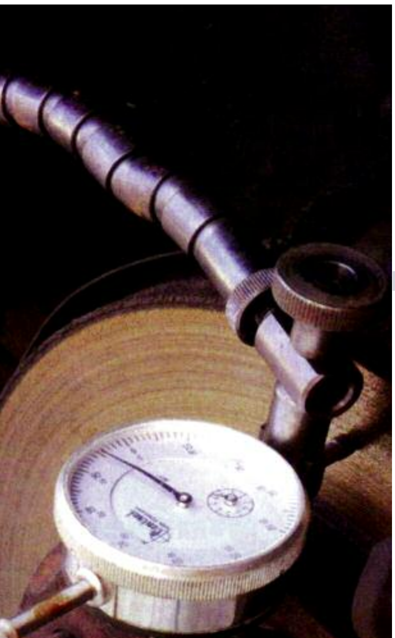
As They Say in German, "Wieviel ist Zuviel?"

How much runout is too much? In other words, how much will generate DTV? The answer is that it depends on the vehicle. The lighter the car, and the less unsprung weight, the more prone it may be to DTV and brake pulsation. Certain models are known for being more sensitive than others. In general, manufacturers are calling for .002 in. or less runout, measured near the edge of the rotor disc, and .0015 in. on more sensitive models.

If you are turning rotors to eliminate pedal pulsation, you must make sure you mount them on the lathe arbor perfectly.

How do we properly measure runout? A dial indicator clamped to the steering knuckle is the right tool, but where on the face of the disc should we place the indicator's tip? One tapered shim vendor states 1/2 in. from the outside edge of the disc. Another authority says 5mm from the edge, and yet another says, "In the middle of the path the pad travels." The closer to the edge one measures, the greater the reading will be. Clearly, you don't want to measure runout on the rough, corroded ring beyond the contact area of the lining, but doing it somewhere along the outer third of the path the pad travels won't get you into any trouble.

Measuring rotor runout requires securing the rotor to the hub using a minimum of three lug nuts. You'll usually need spacers or washers. In theory, the lug nuts should be torqued the same as if the wheel itself were mounted. Since the car is no longer on the ground, snugging may be challenging, since applying the brakes during tightening could prevent the rotor from self-centering on the hub. Snugging them finger-tight, then jiggling the rotor may help you to center it before the final tightening.



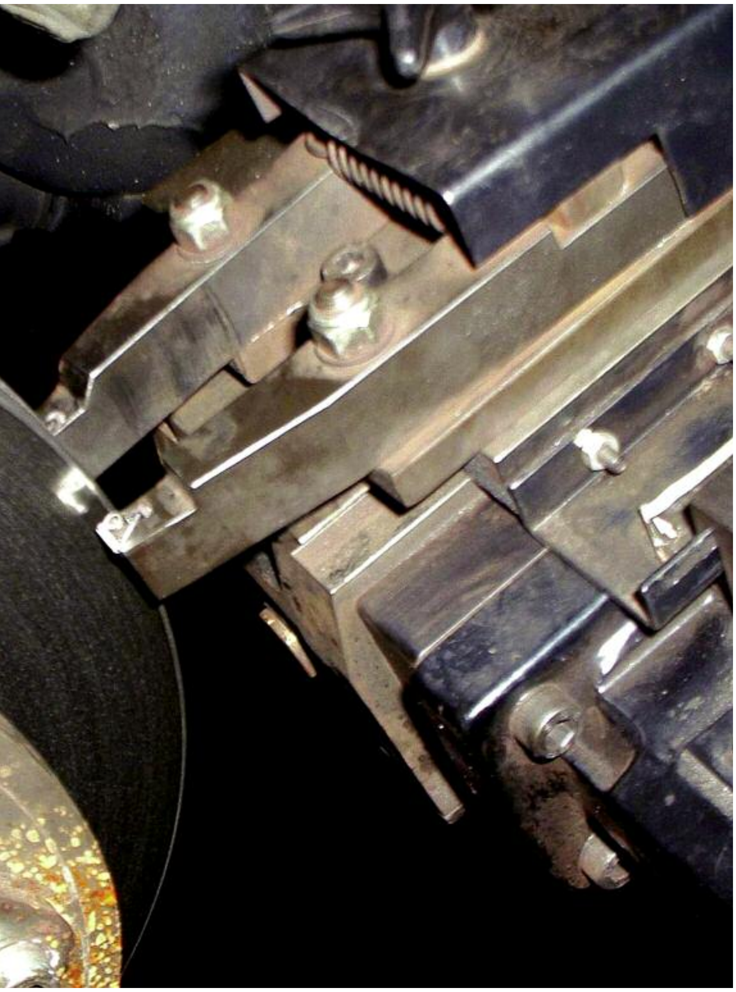
It takes a little time to set up your dial indicator to read runout, but it's definitely worth it. Anything over .002 in. is too much.

On-car Brake Lathes

Eliminating the potential addition of runout caused by removing and re-installing rotors on rusty or otherwise imperfect hub flanges has led several manufacturers to insist on the use of an on-car lathe whenever techs address pulsation problems for warranty repairs. Mercedes-Benz, however, expects the technicians who are servicing its vehicles to be craftsmanlike enough to make sure nothing interferes with hub mounting perfection, so doesn't have this requirement. Still, this option can be used to correct stubborn problems, as we'll explain.

The setup of most on-car lathes incorporates a step where existing runout is measured, and compensated for by the tech prior to cutting. The latest models from Pro-Cut International and others, use a microprocessor-based system to compensate for runout automatically. As a result, rotor indexing, shimming, hub cleaning, and all of these other steps are avoided, provided the rotor

Although an on-car brake lathe can eliminate runout and DTV, you still haven't addressed the mounting error. So, there's apt to be trouble at the next reline.



The mounting surface inside the rotor "hat" must be perfectly clean, or runout will be inevitable.

has enough "meat" left to allow resurfacing.

Yet, all rotors will eventually have to be replaced. So the solution is for techs to understand the causes and cures of runout rather than solely relying on the use of an on-car lathe every time the problem appears. Without such an understanding a tech would have to cut every brand new rotor on the car simply to correct for runout in the hub itself that gets "stacked" out to the rotor.

Correcting Runout: Hub Cleaning, Indexing, and Shimming

There is a variety of techniques for cleaning up a hub, depending on how badly rusted it is. Simple wire brushing and "zipping" with a Scotchbrite pad will often suffice. Since Mercedes-Benz vehicles use lug bolts instead of wheel lug studs, cleaning the mating surface is relatively easy. If the hub is corroded badly enough, it may require replacement. One manufacturer markets a miniature sandblasting booth for cleaning up heavily rusted hubs. It incorporates a drawstring curtain to prevent abrasive dust from getting where it shouldn't. If a hub is that bad, consider replacing it.

After cleaning up the hub and rotor mating faces, should you apply anti-seize to prevent future rusting? Some authorities say it's unnecessary, while others recommend the application of a small amount of a high-temperature, nickel-based anti-seize compound. We tend to agree with the latter opinion, although you can go that one better by spray painting with a rust-resistant coating, such as zinc-rich primer. Just make sure you don't overdo it so that there are large drips or lumps of paint that could interfere with mounting, or a thick coating that might impede heat dissipation.

Every hub and bearing set has some lateral runout. If the hub has tapered roller bearings, they may need to be snugged to minimize bearing-created runout. In general, runout originating from the hub is something you will measure, and attempt to reduce rather than eliminate altogether, which may be nearly impossible.

If de-rusting the rotor bevel and hub doesn't reduce runout to under .002 in., try indexing the rotor from one lug position to the next. After measuring the runout and removing the rotor, if you measure the hub runout as well, you can attempt to match up the high and low spots. This "matching" is often performed at the factory when hubs and rotors are initially assembled, so if this is the car's first brake job, you should definitely make index marks either with a punch or paint so you can put the rotors back on in the original position.

If cleaning and indexing fail to achieve the desired result, the final corrective action available to techs is to install tapered shims. A variety of manufacturers offer rotor shim kits. If shims are already present, they need to be replaced with new ones. Before removing them, however, mark how they were oriented to save time should re-shimming still be required after rotor service or replacement.

Lug Nut Tightening Procedures – Revised!

Most experts agree that in order to prevent lug nut-created runout, wheel installation procedures should be improved. They recommend adding an intermediate tightening step of torquing each nut to half of spec before cinching each down to its final torque setting, as always following the proper tightening pattern.

Using a lower-powered, 3/8 in.-drive impact gun, pneumatic or electric, to spin the nuts down lightly will allow you to add this step to wheel installation without slowing down the operation. Never use your 1/2 in.-drive impact for final tightening – grab that torque wrench!

Summary

Premium brake service consists of more than just restoring how well a vehicle stops after brake service is performed, and preventing irritating noises. It also includes making sure how well every component in the brake system works, as well as how long it will continue to work.

For example, if worn caliper pins aren't replaced and various sliding components adequately cleaned and properly lubed, new pads won't wear evenly. Excess brake dust left behind can quickly contaminate lube on shoe or pad motion points. "Weeping" cylinders that are ignored can quickly ruin an otherwise good brake job. Virtually every component in the brake system that isn't cleaned, lubed, or replaced as necessary during brake service has the potential to lead to comebacks, future brake problems, or to reduce brake life. There's even the frightening possibility of brake failure.

Despite the high potential for pedal-pulsation comebacks, runout remains unmeasured and uncompensated for at many shops mostly because of the additional time and complexity it adds to performing brake service. This is an unwise shortcut that will typically lead to unhappy customers and complications in the shop's schedule when the job has to be done a second time.

Always use a torque wrench for final lug tightening. Never use a 1/2 in. drive impact gun at all. Spin them down with a 3/8 in. drive tool on a low setting.

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Battery Testing: Dea

The 1886 Benz Patent Motor Wagen is generally considered to be the first viable automobile. Its battery was used exclusively for ignition.

d, or Alive and Well?

For more than a century, lead-acid batteries have been used in automobiles. Here's a new take on testing them.

Most service-lane complaints regarding batteries go something like this: The customer had to have his or her vehicle jump-started because of a "dead" battery. After this happens a second time, the unfortunate motorist decides to bring the car to you. Diagnosis at this point consists of confirming the correct operation of the charging system and ruling out excessive parasitic drain, followed by charging and testing the battery. Prior to handing the vehicle over to a tech for diagnosis, the service advisor should fully determine the circumstances leading up to the dead battery since nowadays driving habits and consumer-added electrical devices are often partly to blame.

1926 Mercedes 630 24/100/140 HP

By the 1920s, of course, electric starting and lights had made motoring in a Mercedes-Benz much more convenient and safe.

Today's lead-acid batteries have evolved to be vastly more powerful, dependable and long-lived than earlier specimens. The improvements were absolutely necessary considering the huge electrical demands of modern cars.

Damage from a lengthy discharged condition

By far the greatest amount of life-reducing damage is done to automotive SLI (starting, lights, ignition) batteries by unintentionally leaving them partially or completely discharged for days or weeks. Unlike marine or "Deep Cycle" batteries, SLI batteries are designed to be recharged immediately after delivering the brief burst of current needed to start the engine. There are stories of batteries on a vehicle assembly line dying after a mere four or five days of sitting around partially discharged from workers intermittently operating power windows, sliding doors, or just listening to the radio. One deep discharge is capable of significantly reducing the capacity and lifespan of even a brand new battery.

The problem comes when consumers unintentionally leave their vehicle's battery in a state of partial discharge without ever realizing it. Without an ammeter, which most cars haven't had for decades, how could they know? With heated seats, front and rear defrosters, dual-zone air conditioners, electric power steering and water pumps, dozens of electronic modules, navigation systems, and all sorts of consumer accessories plugged into the multiple cigarette lighter outlets, a short, low-speed run to the grocery store is just as likely to discharge the battery on a modern vehicle as it is to charge it back up. Increasing traffic congestion is gradually eliminating the high-speed travel that used to fully recharge batteries. What's the solution?

A lead-acid battery will self-discharge at a rate of about 1/100th of a volt per day without any current draw whatsoever. This means that a fully charged battery, at 12.6 volts, will drop to 12.3 volts, which is 50% discharged, in around 30 days, just sitting parked in the garage. Add even a "normal" parasitic draw of 10-30 milliamperes to keep the radio and PCM memories alive and you can quickly see how a couple of weeks in an airport parking lot is all it takes to create a no-start situation. By the way, the simple answer to long-term parking woes is a solar battery charger placed in a south-facing window, or a trickle charger for a car stored in a garage. MBUSA makes a perfect charger available for this purpose – P/N W900 589 02 63 00.

High-tech battery chargers, such as this small "overnight" unit from Sweden, use multi-level voltages to add amps without doing as much damage as old-fashioned chargers.

But consumers have more tricks up their sleeves than just long-term parking and electrically-powered cupholders to run batteries down. Their use of unapproved accessories can defeat the best in engineering, and is simply a fact of life we must deal with. Aftermarket stereos, with subwoofer amps that remain powered on after the ignition is turned off are infamous battery killers. Ditto for miswired remote starters, security systems, phone systems, and faulty trailer hitch wiring. Kids left watching DVDs in the grocery store parking lot with the ignition on can run a battery down. By far, consumer-added accessories that remain constantly powered "on," creating unsuspected parasitic drains, are the biggest culprits when it comes to dead batteries these days.

Age, heat and dehydration

Other battery-killers include age, heat and dehydration resulting from overcharging. As techs, we're always under time constraints, but a fast charge, even when done using a computer-controlled charger, is never as healthy for a battery as a slower, lower-amperage charge. Overcharging can quickly boil off enough electrolyte to expose the plates, leading to battery-killing sulfation of the air-exposed portions. What's sulfation? It's when non-conductive crystals of sulfate form instead of lead sulphate reconstituting itself back into elemental lead and sulfuric acid as a battery charges. Sulfation is the primary chemical process by which batteries die of "old age." Various hi-tech, computer-controlled and "pulse" chargers promise to "zap" sulfation and help "recondition" a tired battery, but, as always, your mileage may vary.

(Continued on page 20)

Genuine Mercedes-Benz Rema

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Rebuilt Process (Typical Aftermarket)

1. Identify damaged part or parts.
2. Replace damaged part with non-OE part and clean.
3. Re-assemble, test and box.

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BATTERY *(Continued from page 17)*

Never allow a battery being charged to exceed 100° F., boil, or feel hot to the touch. Heat isn't good for batteries, and not just because it leads to dehydration. When Consumers Reports recently tested batteries, they used a 100 hour discharge/charge cycle while soaking the batteries in 157° F. water to simulate harmful underhood temperatures. Maintenance-free batteries are less prone to dehydration than regular batteries, but suffer from the fact that you can't top them up if they ever do get low on electrolyte. The very low-humidity environment you find in places like Arizona further contributes to battery "dehydration." In these locales, running low on electrolyte may contribute more to premature battery deaths than elsewhere – and is a valid reason for replacing maintenance-free batteries with traditional ones that have removable caps for adding water – distilled, of course.

If heat is so bad for batteries, why do so many cars need a new battery at the first bitter cold snap of winter? A sub-freezing engine, with oil as thick as molasses, can require as much as 50% more current to turn over than one kept toasty in a warm garage. And a battery at 32° F. can only put out 85% as much current as it can at 70° F. So, a battery that might have adequate capacity for cranking in spring, summer, and fall, simply can't clear the bar when the real cold hits.

The measure of a battery

There are two measures of a battery: state of charge, and, for lack of a better term, "capacity." Like a water tower on a hill, a battery can only supply so many amps of current for so long before it's empty. Cranking Amps and Cold Cranking Amps are both industry standard measures of capacity, at 32° F., and 0° F., respectively. As a battery ages, its CA and CCA will decline, just like a water tower slowly clogging up with rust and sediment.

Let's say you have two batteries rated at 550 Cold Cranking Amps, and they both show 12.4 volts open circuit, (completely disconnected, no loads applied). How can you tell the good battery from the bad one? The answer is using either a load tester, or a conductance-based battery tester.

This voltage reading indicates that a surface charge is present. Burn it off before testing.

To use a traditional carbon-pile load tester, such as a VAT-40, the battery needs to be fully charged beforehand. With a conductance-based tester, such as a Midtronics, testing can occur without charging – although the readout on the tester may be "Battery Needs to be Charged."

A fully charged battery should read approximately 12.6 volts, a 50% discharged battery 12.3 volts, and a 75% discharged battery 12.2 volts. If you hook up a DMM, or other test device that incorporates a voltmenter, and you read more than 12.65 volts, you've got what's called a "surface charge" on the battery. Burn it off by turning on the headlights for

Nothing is faster or easier to use than a modern conductance-based battery tester.

three minutes, wait a minute, then proceed with the rest of your testing.

Conductance-based testing

As a battery ages, its internal resistance increases. It starts out with a very low resistance in series with the battery cells – in the milliohm range. As the battery ages, the resistance gets higher and higher. Because of this, the battery ability to put out current gradually reduces. This can be measured using a conductance-based tester. Mercedes-Benz, along with virtually every other carmaker, has approved the use of conductance-based battery testers, and many models incorporate several charging system analysis features as well.

With a conductance-based battery tester, you simply attach the leads to the battery terminals, punch in the battery's stated cranking amps (CA) rating, and the tester displays the battery state of charge as well as the "Remaining Cranking Amps" available – the figure of merit used to decide whether to replace the battery or not. Even with added charging system testing features, they're so quick and easy to use, it may make sense to take a preliminary reading on a vehicle's battery and charging system in the service lane before filling out a ticket and committing the customer to a more in-depth diagnosis.

Load-based testing

Purists will never give up their carbon pile VATs. That's because watching the needles swing as the applied load is increased provides the user with a "feel" for the condition of a battery being tested, something you don't get with a digital readout. Someone skilled using a VAT40, or comparable, newer unit, can perform a complete battery and charging system analysis, including performing key voltage drop measurements, in a matter of minutes, with a very high degree of confidence in the results.

The bottom line in load testing is whether or not the battery can sustain 9.6V, the minimum cranking voltage, while a load approximating half its CA rating is applied over a specified period of time. How fast the voltage dives during the load test gives a direct indication of battery condition. Used VAT40s are easily found because at one time almost every shop had one. Newer, digital-readout load testers really don't offer much more in the way of features, asides from step-by-step instructions for those techs who need it.

Gotcha's

The leading "gotcha" when it comes to battery problems are dirty or corroded terminals.

Corrosion can add up to a full ohm of amperage-killing resistance. We once encountered a case on a vehicle with equipment for aiding the handicapped that required special steel terminals. A brand-new battery refused to

In the right hands, a traditional carbon-pile VAT is still hard to beat for finding out the truth about a battery's condition.

accept a full charge. Two or three cranks and it was done. So, the tech ordered a replacement battery. When he removed the old one, the steel terminals, which looked absolutely pristine from the outside, revealed a thin layer of white corrosion on the inside where they clamped onto the lead battery posts. After cleaning this off, the battery charged and performed fine.

Had the tech first "stabbed" the lead battery posts and the steel terminals with the leads of his DMM with a significant load applied (such as during cranking) he would have been able to measure a noticeable voltage drop, say, 200 amps x .01 ohms = 2 Volts. This is one place where the voltage drop testing feature of a VAT tester can, in the hands of an expert user, quickly diagnose a problem. But simply cleaning the terminals is usually easier.

Consumer behavior is the ultimate "gotcha," since they typically don't realize what they're doing that may contribute to a battery problem. Late model vehicles won't put their modules to sleep until every last door and hatch is closed. If the motorist's habits interfere with that, the on-board computers will stay awake and alert, and there will be a significant drain on the battery.

Three strikes and you're out!

- Consumer complaint about having to jump start a vehicle – strike one!
- Lack of parasitic draws or charging system problems – strike two!
- Any significant loss of battery capacity – strike three!

This article might be summarized by saying, "When in doubt, replace the battery." That's because battery testing remains an inexact science, regardless of how high-tech your computerized, transconductance-based battery tester is, or how many years of experience you have using a carbon-pile VAT tester. The only measure of a battery that truly counts is, "Is it able to do the job the customer needs it to do?" If the customer wasn't having battery problems, he or she wouldn't have gone to the trouble to bring the vehicle in for diagnosis in the first place. The reasonable approach, then, is for the tech to rule out other likely causes of trouble, such as charging system problems, parasitic draws, and unusual consumer behavior, then test the battery. If the reading(s) leave any doubt as to the battery's capacity to hold a charge, then it's prudent to replace it.

Service Advisor Questions

How old is the battery?

Have you had any problems before this?

Did it seem to be getting weak, exhibit slow cranking, or dim headlights before this?

How long was the vehicle parked before this happened?

What did you have plugged into the cigarette lighter/accessory outlets?

How far do you typically drive the vehicle each day?

Have you recently had an aftermarket stereo/alarm/trailer hitch installed?

Did you leave any doors/hatches open, by chance?

Are any warning lights on the dash illuminated?

Has the battery been disconnected for any reason?

Has anyone else tested the battery or alternator, i.e. an auto parts store?

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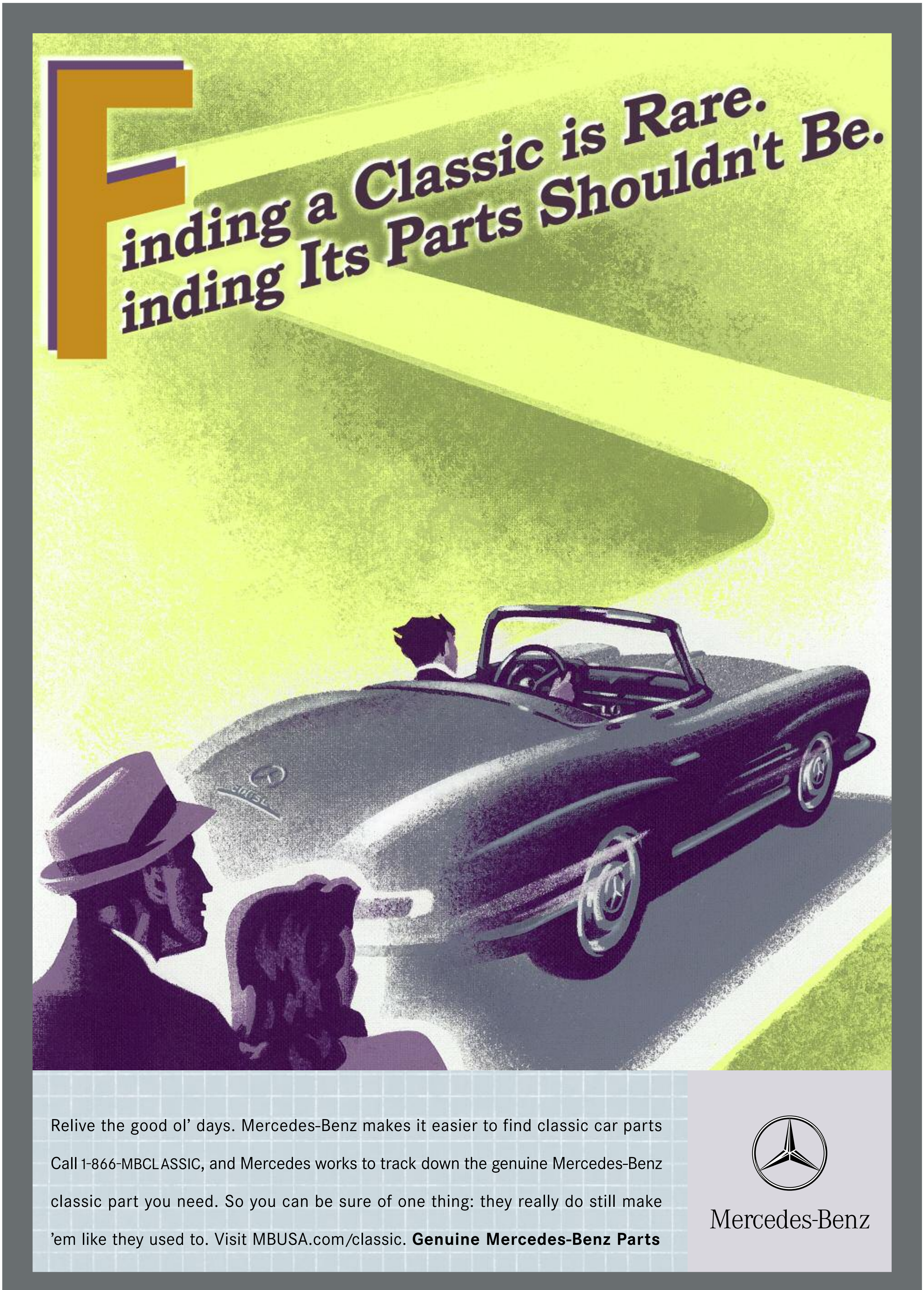
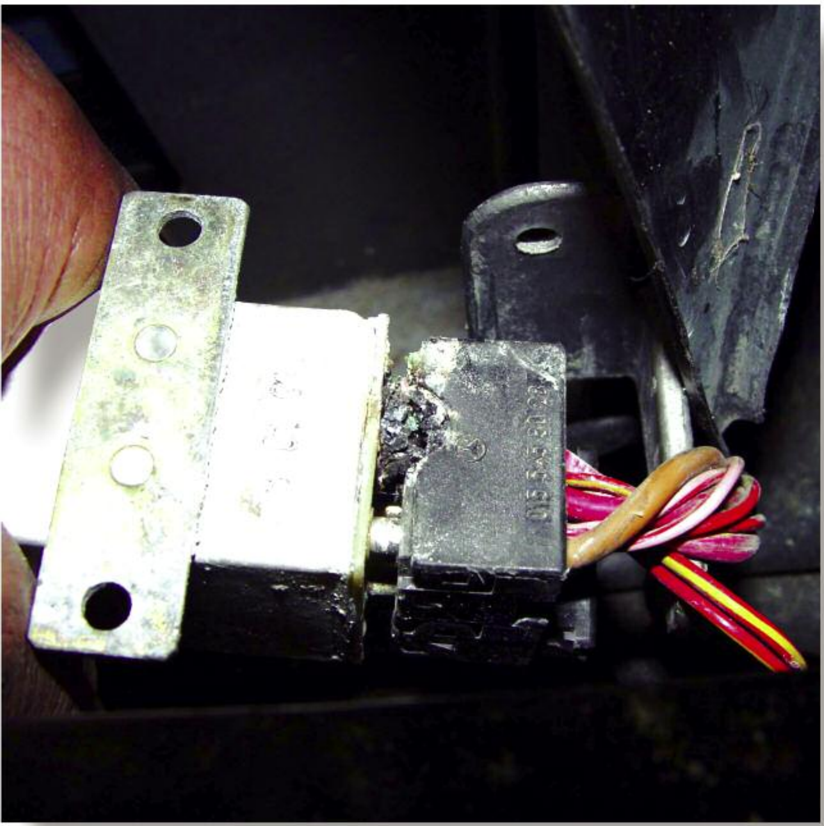


One Point of the Star: Fuel Pump Circuits

Ignition, fuel distribution & fuel supply make up the three points of driveability diagnosis

Mercedes Benz manufacturers some of the most technologically advanced vehicles in the world. Many of the company’s advancements help reduce wiring, increase self-diagnostic capability, and, above all, provide an additional level of safety. This kind of progress, however, comes at the price of increased complexity when it comes to driveability diagnostics.



A heavy current load through this relay can damage the terminals.

Always keep in mind that there are three major things to think about whenever you're confronted with a driveability problem: ignition, fuel injection control, and fuel supply. You could call them the three points of the Mercedes-Benz star because each is critical to good performance. If any one fails, the engine will not run, period. In this installment, we’ll focus on fuel supply, its electronic controls in particular.

Fuel supply logic

Of the three points, the fuel supply system is often considered the simplest to control. The goal is to have it provide proper fuel pressure and volume for engine cranking and running, and only during engine cranking and running. It would be a waste and very dangerous to have the system generate pressure for any appreciable period of time without the engine running.

Mercedes-Benz has advanced the logic of fuel supply control for several good reasons – ease of manufacture, component consolidation, and increased safety. Due to the integration of computer controlled systems, fuel supply can be disabled after an accident in which the SRS has been activated. This also means that there are additional factors involved in getting the fuel pump to run. Very often these factors are not directly linked to the fuel supply system. Here we'll go over the direct and indirect control of fuel supply.

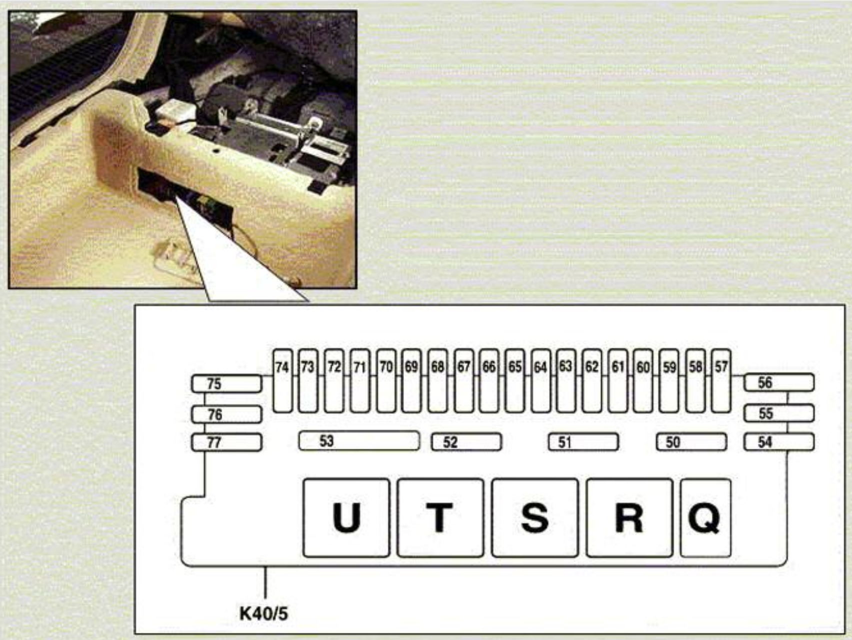
Previous to 1994, Mercedes-Benz utilized a fuel pump relay that assured that no fuel would be pumped if the engine stopped running. It would close for one second during cranking, but if it received no rpm input, it opened again, interrupting the circuit to the pump(s).

When it isn't incorporated into a control unit, this evolved into a four-prong fuel pump relay. This has terminal designations that are universal in operation and wiring according to DIN (Deutches Industrie Norm, which sets German standards). The relay has two circuits in it. They are the switched circuit and the control circuit. The switched circuit is made up of terminal #30, which is the power supply to the relay, and terminal #87 which is the output of the relay. This output is actually the voltage to the pump. The switched contacts are normally open, and are only closed when the control portion of the relay is "energized." The control portion is made up of terminals #86 and #85. Depending on how Mercedes-Benz chose to energize the relay, terminal #86 is either powered up with the ignition key, or by the fuel injection control unit (ME). This terminal is attached to the coil inside the relay, and the coil is also attached to terminal #85. This terminal is either connected to whatever control unit is in charge of turning on the fuel pump relay, or directly to ground. In essence, the relay is energized either by providing power or ground to the control coil.

Fuel pump relay

Since '94 when Mercedes-Benz designated its vehicles C-, E-, and S-Class, it has used a fuel pump relay. M-B wiring diagrams give every component on the vehicle a letter and number designation. The fuel pump relay is K27. The component designation may stay the same from model to model, but its location will vary. On the 202 chassis ('94 to '01 C-Class), the relay is mounted next to the rear fuse box in the trunk on the passenger's side. Before November of '94, there was an additional 25 amp fuse mounted in the rear fuse panel (Component ID F4), which provides power to the switched portion of the relay, terminal #30. After December of '94, direct battery power is fed to the fuel pump relay switched circuit, so the only protection is the 30 amp fuse in the relay. This relay is controlled by the HFM control unit. In this case, relay terminal #85 is grounded all the time at the same point where the fuel pumps are grounded. The HFM control unit provides power to the control coil of the relay terminal #86 to energize it. It commands the relay on for one second, and also after it receives a signal from the crankshaft sensor.

In '97, both relay control and location were modified. At this point, the fuel pump relay is either incorporated into the relay module (mounted in the electronics box in the engine compartment on the passenger's side by the firewall, or in its' original location in the trunk). So, here we can have one of two options for controlling the fuel pump circuit. If the fuel pump control is from the relay module underneath the hood, then the fuse for the switched circuit is also incorporated in that same relay module. If the location of the relay is still in the trunk, the fuse for that switched circuit is in the rear relay box. The fuse in the relay was eliminated. In this case the relay control circuit has an ignition switched power supply, and the HFM provides the ground to energize the relay.



A rear relay module, designation K40/5, controls the fuel supply system on 2000 MY S-Class cars.

Crash signal from SRS

Starting with the '99 model year, Mercedes-Benz introduced the Crash Signal, which comes from the SRS control unit. A single wire connects this to the ME control unit. This allows SRS to signal the ME in the event of a crash that involves an air bag deployment. The ME control unit will then shut off the fuel pump relay to prevent the possibility of a ruptured fuel line releasing fuel at an accident scene. This additional control must be considered during a diagnosis of a "no start, no fuel pressure" situation. These vehicles very often come from body shops where they've been repaired after an accident. There should be a code in the HFM indicating that the fuel supply system has been shut down due to a signal from the SRS.

To further advance computer controls starting with the 203 chassis, (C-Class '01 and later), then the 211 chassis (E-Class '03 and later) Mercedes-Benz has incorporated the fuel pump relay into the rear SAM (Signal pickup and Activation Module). As a result, the engineers had to designate the relay module/fuel pump relay N10/2kA. The "N" indicates a control unit, the "k" indicates that it's a relay, and the "A" indicates its location in the control unit.

Despite the fact that the "relay module" is called a "module," there is direct wiring between the fuel pump relay switched circuits and the control circuits. Here, care must be taken when diagnosing "no fuel pressure" issues. There are two fuses in this fuel pump circuit. One fuse is for the switched portion of the relay and the other fuse is for the control circuit. The fuse for the switched circuit is mounted in the rear SAM. This is the actual power that is being supplied to the fuel pump and/or fuel pump control module.

Why the blown fuse?

There are three possible causes for a blown fuse here: the wire after the fuse is shorted to ground, the fuel pump control module is shorted to ground internally, or the fuel pump has increased its current draw to the point that it exceeds the fuse's amperage limit. If the fuse in the rear SAM is okay, then check the fuse for the control circuit, which is mounted in the front SAM. If this fuse is blown, the fuel pump relay will not be activated, and as a result the fuel pump relay in the rear SAM will never receive voltage. Either fuse being blown could lead to a "no fuel pressure" situation. The fuse in the front SAM receives its power from the engine relay, which is also incorporated into the front SAM.

With E-Class vehicles (124, 210 & 211 chassis) in '94, the fuel pump relay is mounted in the engine compartment behind the battery along with the Over Voltage protection relay and the fuel injection control unit. Constant battery voltage is supplied to the switched circuit with the 40 amp fuse being incorporated in the relay. On the control circuit side, the relay is constantly grounded at terminal #85. The HFM provides the power to energize the relay on pin #86. Once again the relay is activated for one second when the ignition key is turned on, and also continuously after receiving a crankshaft signal. In '95 and '96, the relay is relocated under the rear seat on the passenger side, but everything else pretty much stays the same.

Revamped

With the '96 model year, Mercedes revamped fuel supply control. Both the fuses and the relays are all incorporated into the relay module. This is mounted in the electronics box in the engine compartment on the passenger side by the firewall. This module also houses the HFM power supply and electric air pump relay as well as all the fuses for those systems. Production dates are important in diagnosing "no start, no fuel pressure" symptoms. If the vehicle was manufactured before June of '96, the switched circuit receives its voltage supply through fuse f5. This voltage passes through the switched circuit and on to the fuel pump. The control circuit is constantly grounded, and the ME control unit provides power to the control circuit to energize the relay.

Vehicles manufactured after June of '96 are slightly different. The control circuit of the relay is supplied voltage from fuse f3, which gets its power from the ME power supply relay. The ME control unit grounds the fuel pump relay for one second after the ignition key is turned on and also after receiving a crankshaft signal. So, a blown f3 fuse will get you "no fuel pressure," but you will probably not have injector pulse, either (or spark, for that matter). The switched circuit of the fuel pump relay receives its power supply directly from the battery through fuse f5. This is the voltage that is actually supplied to the fuel pump. A blown fuse here may indicate that the fuel pump wiring is shorted to ground, and/or the fuel pump is drawing too much current and may have to be replaced. After March of '97, the fuel pump relay is once again mounted underneath the rear seat on the passenger side. Vehicles built before June of '96 have the switched circuit of the relay constantly powered up by a 25 amp fuse (#6) in the rear fuse box. The control circuit receives ignition-on voltage at pin #86 of the relay, and pin #85 is commanded to ground by the ME to energize the relay. In vehicles built after June of '96, everything is the same except that instead of the control circuit receiving voltage from ignition-on, it receives it from the 20 amp fuse f5 in the relay module mounted in the electronics box.

In '03, the E-Class received the same treatment the C-Class did, relocating the fuel pump relay in the rear SAM. The same operation for fuel pump control is still used. Through the 25 amp fuse (#53), the front SAM provides power to the fuel pump relay's control circuit terminal #86. The HFM directly grounds the control circuit terminal #85 of the relay to energize it. The 15 amp fuse (#4) in the rear SAM provides voltage to the switched circuit terminal #30 of the fuel pump relay. After the relay is energized, the relay provides power out of terminal #87 to the pump.

Finally, on the S-Class models there are some subtle variations. From '94 through '99 models (140 chassis), the fuel pump relay is mounted in the rear fuse panel. The relay's switched circuit receives its power from the 30 amp fuse #13 in the rear fuse panel. The control circuit of the relay, pin #86, receives its voltage from a base module, which is a power distribution unit that provides current to multiple computer-controlled systems on the vehicle. This voltage supply from the base module also provides power to the ME control unit. When the ME wants to energize the fuel pump relay, it provides a ground to terminal #85. This is done with the ignition key turned on for one second and after the HFM receives a crankshaft signal.

There were some significant changes in the 2000 model year when the S-Class evolved into the 220 chassis (215 for the two-door coupes), especially with the advent of the V12 and turbo models. A rear relay module, designation K40/5, controls the fuel supply system. This module is mounted below

As a fuel pump's commutator and brushes wear, it tends to draw more amperage than the system is designed to handle.

the seat on the passenger side, but you do not need to remove the rear seat. There is an access panel you can pull out to expose the relays and fuses. The control circuit of the fuel pump relay, pin #86, is powered up by the right front fuse and relay module. The ME control unit provides the ground to energize the relay. Fuse f52, which gets its power from terminal/fuse block X4/22 100 amp fuse #2, powers up the switched circuit of the relay. This power is sent directly to the fuel pump. In the cases of the V12 and turbo models, however, this voltage is passed on to a fuel pump control module. This can vary the current supply to the fuel pump depending on perceived fuel demands. The fuel pump control module also has a sensor that gives feedback on fuel pressure. While adding a an extra level of control over fuel supply requirements, it also adds a level of complexity. If the fuel pump control module were to short internally, it could cause the fuel pump fuse to blow. This means more testing in our itinerary for a "no start, no fuel pressure" diagnosis.

Perhaps it's the pump itself

Testing these various circuits may appear difficult, but after evaluating the proper wiring diagram for the vehicle, you should be able to come up with a diagnostic plan.

First, make sure that there are no other symptoms to be concerned with. If there is no injector pulse and/or ignition spark, then you should not only focus on the lack of fuel pressure. If you've determined that fuel pressure is the only issue, then you should check the fuses for both the switched circuits and the control circuits. If either of the fuses is blown, you may choose to investigate the cause of the excessive amperage draw, particularly if it is the fuse for the switched circuit of the relay. Performing a current draw test of the fuel pump, either with an ammeter or by current-ramping with a scope, you may be able to determine if the fuse will blow again from a failing fuel pump.

If the fuses are okay, you will need to test the relay or module control. We usually activate the relay by either powering up terminal #86 of the relay, or by grounding terminal #85, depending on the wiring for that particular vehicle. If the fuel pump runs, you know that the wiring is intact. You will have to see if the relay control is functioning.

With the Mercedes-Benz Star Diagnosis tester, you can communicate with the various control units on the car, and very often you can ask the computer to activate the relay. You can also use the scan tool to determine if there are fuel pump codes in the HFM control unit. If you can determine that terminal #87 is outputting voltage from the relay, then your next step should be to make sure the voltage is making it to the fuel pump itself. You may find that the fuel pump itself is not the problem, but that there is a broken wire or a corroded ground. This will involve accessing the fuel pump assembly, which takes some labor to get to. This is why you should test the fuel pump relay first.

At this point, you can inform the customer of the additional labor that will be involved in diagnosing his or her "no start" problem, and that you are leaning toward a worn-out fuel pump. The customer can then make a more informed choice as to what he or she wants to do with the car.

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All models

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Note:
During a control module flashing/coding, any fluctuation, spiking or loss of voltage can interrupt the operation, which could cause the control module to lock up. When used during flashing/coding, the PSC-550 supports loads and charges the vehicle's battery. When the battery is charged, the charger acts as a regulated power supply to sustain accessory loads and offset parasitic or quiescent drain.

The PSC-550 has the following additional features:

- Fully regulated output prevents overcharging
- Output current approximately 55 Amps at full load
- Over-current protection
- Output voltage approximately 13.4 VDC at full load
- Reverse polarity protection
- Works with 12 Volt flooded lead batteries as well as Fleece/AGM (absorbed glass mat) batteries
- Switch-mode design reduces heat build-up
- Proportional fan control regulates fan speed according to converter's temperature, minimizing fan noise

Refer to the SSEP catalog under STAR TekInfo / MB Equipment.

ESP Displayed

Models 170.447/449/465/466,202. 022/023/024/028/029/033, 208.365/370/374/465/470 474,210.020/025/055/065 070/072/074/082/083 265/282

If a customer reports that "ESP Visit Workshop" is displayed on the instrument cluster and there is a fault code C1200-S9/1 (Stop Lamp Switch) Plausibility displayed, the stop lamp switch must be replaced with a new, revised unit. Depending on the model, the replacement switch will be either P/N A001 545 64 09 or P/N A001 545 01 09. Instructions on replacing the switch can be found at WIS document AR42.10-P-0040A.

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Nevada

Las Vegas
Fletcher Jones Imports
702-364-2700 702-898-3776

Reno
Mercedes-Benz of Reno
775-326-4000

New Hampshire

Greenland
Dreher-Holloway
603-431-8585

Manchester
Holloway Motor Cars of Manchester
603-669-6788

New Jersey

Bridgewater
Millennium Automotive Group
908-685-0800

Cherry Hill
Mercedes-Benz of Cherry Hill
856-663-3200

Edison
Ray Catena Motor Car
732-549-6600

Englewood
Benzel-Busch Motor Car
201-567-1400

Fairfield
Globe Motor Car
973-227-3600

Freehold
David Michael Motor Car of Freehold
732-462-5300

Lawrenceville
Mercedes-Benz of Princeton
609-771-8040

Little Silver
Contemporary Motor Cars
732-842-5353

Millville
Quality Lincoln Mercury Hyundai
856-327-3000

Morristown
Mercedes-Benz of Morristown
973-267-9200

Newton
Intercar
973-383-8300

Paramus
Prestige Motors
201-265-7800

Union
Ray Catena of Union
908-379.7200

West Atlantic City
Precision Cars of AtlanticCity
609-645-9000

New Mexico

Albuquerque
Mercedes-Benz of Albuquerque
505-821-4000

New York

Amityville
Mercedes-Benz of Massapequa
631-789-1600

Bayside
Helms Brothers
718-631-8181

Binghamton
Empire Motor Car
607-772-0700

Brooklyn
Sovereign Motor Cars
718-258-5100

Fayetteville
Romano Motors
315-637-4500

Goldens Bridge
Estate Motors
914-232-8122

Huntington
Mercedes-Benz of Huntington
631-549-2369

Larchmont
Mercedes-Benz of Larchmont
914-275-4000

Latham
Keeler Motor Car
518-785-4197

Long Island City
Silver Star Motors
718-361-2332

Nanuet
Mercedes-Benz of Nanuet
845-624-1500

New York
Mercedes-Benz Manhattan
212-629-1600

Rochester
Holtz House of Vehicles
716-424-4740

Rockville Centre
Lakeview Auto Sales and Service
516-766-6900

Roslyn
Rallye Motors
516-625-1600

Southampton
Mercedes-Benz of Southampton
631-283-0888

St. James
Mercedes-Benz of Smithtown
631-265-2204

Wappingers Falls
Friendly Motorcars
845-298-0600

White Plains
Mercedes-Benz of White Plains
914-949-4000

Williamsville
Mercedes-Benz of Buffalo
716-633-0088

North Carolina

Ashevillle
Skyland Automotive
828-667-5213

Cary
Mercedes-Benz of Cary
919-380-1800

Charlotte
Beck Imports of the Carolinas
704-535-6400

Fayetteville
Valley Motors
910-487-0000

Greensboro
Mercedes-Benz of Greensboro
336-856-1552

Hickory
Hendrick Motors
828-322-5640

Pineville
Mercedes-Benz of South Charlotte
704-889-4444

Raleigh
Leith
919-876-5432

Wilmington
Bob King Autohaus
910-799-3520

Winston-Salem
Mercedes-Benz of Winston-Salem
336-760-4580

North Dakota

Fargo
Valley Imports
701-277-1777

Ohio

Akron
Ganley Akron
330-733-7511

Bedford
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440-439-0100

Canton
Kempthorn Motors
330-452-6511

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Mercedes-Benz of North Olmsted
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Coppus Motors
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Mercedes-Benz of West Chester
513-870-1000

Willoughby
Leikin Motor
440-946-6900

Youngstown
Fred Martin Ford
330-793-2444

Oklahoma

Oklahoma City
Mercedes-Benz of Oklahoma City
405-236-1224

Tulsa
Jackie Cooper Imports
918-249-9393

Oregon

Bend
Mercedes-Benz of Bend
541-749-2500

Eugene
Mercedes-Benz of Eugene
541-687-8888

Medford
Mercedes-Benz of Medford
541-857-8072

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Mercedes-Benz of Portland
503-228-8351

Salem
Valley Motor
503-585-1231

Wilsonville
Mercedes-Benz of Wilsonville
503-454-5000

Pennsylvania

Allentown
Knopf Automotive
610-967-4121

Camp Hill
Sun Motor Cars
717-737-3030

Devon
Mercedes-Benz of Devon
610-687-1500

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Keenan Motors
215-348-0800

Erie
Contemporary Motorcar
814-868-8622

Ft. Washington
R&S Imports
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Greensburg
Bud Smail Motorcars
724-838-1200

Lancaster
Mercedes-Benz of Lancaster
717-569-2100

Pittsburgh
Mercedes-Benz of Pittsburgh
412-683-5000

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Tom Masano
610-777-6587

State College
Leitzinger Imports
814-238-2447

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West Chester
Mercedes-Benz of West Chester
484-313-1100

Wexford
Bobby Rahal Motorcar
724-935-9300

Wilkes-Barre
Motorworld
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Garage Isla Verde
787-620-1313

Rhode Island

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Charleston
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843-852-4000

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Modern Classic Motors
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Vern Eide Motorcars
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Chattanooga
Long of Chattanooga
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Mercedes-Benz of Nashville
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Mercedes-Benz of Austin
512-454-6821

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Park Place Motorcars of Fort Worth
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Cardenas Autoplex
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Houston
Mercedes-Benz of Houston North
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Momentum BMW West
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Star Motor Cars
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Alex Rodriguez
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Britt Imports
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Mercedes-Benz of San Antonio
210-366-9600

Sugar Land
Mercedes-Benz of Sugar Land
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Pete Mankins Pontiac-Cadillac
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Classic-Tyler Motors
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Allen Samuels Chevrolet-GEO
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Mercedes-Benz of Lindon
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Ken Garff Imports
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Vermont

Shelburne
The Automaster
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Alexandria
Mercedes-Benz of Alexandria
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American Service Center
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Brown European Imports
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Noble Cars
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Lynchburg
Kenneth Hammersley Motors
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David R. McGeorge
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Hammersley of Roanoke
540-344-6284

Vienna
Mercedes-Benz of Tysons Corner
703-442-8200

Virginia Beach
Phillips Automotive
757-499-3771

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Mercedes-Benz of Bellevue
425-455-8535

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Wilson Toyota
360-676-0600

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Mercedes-Benz of Lynnwood
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McCurley Imports
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Phil Smart
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Hahn Motor
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Smith Company Motor Cars
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University Motors
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Parkersburg
Astorg Motor
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Wisconsin

Appleton
Enterprise Motorcars
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Concours Motors
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Madison
Zimbrick European
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Waukesha
Mercedes-Benz of Elmbrook
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