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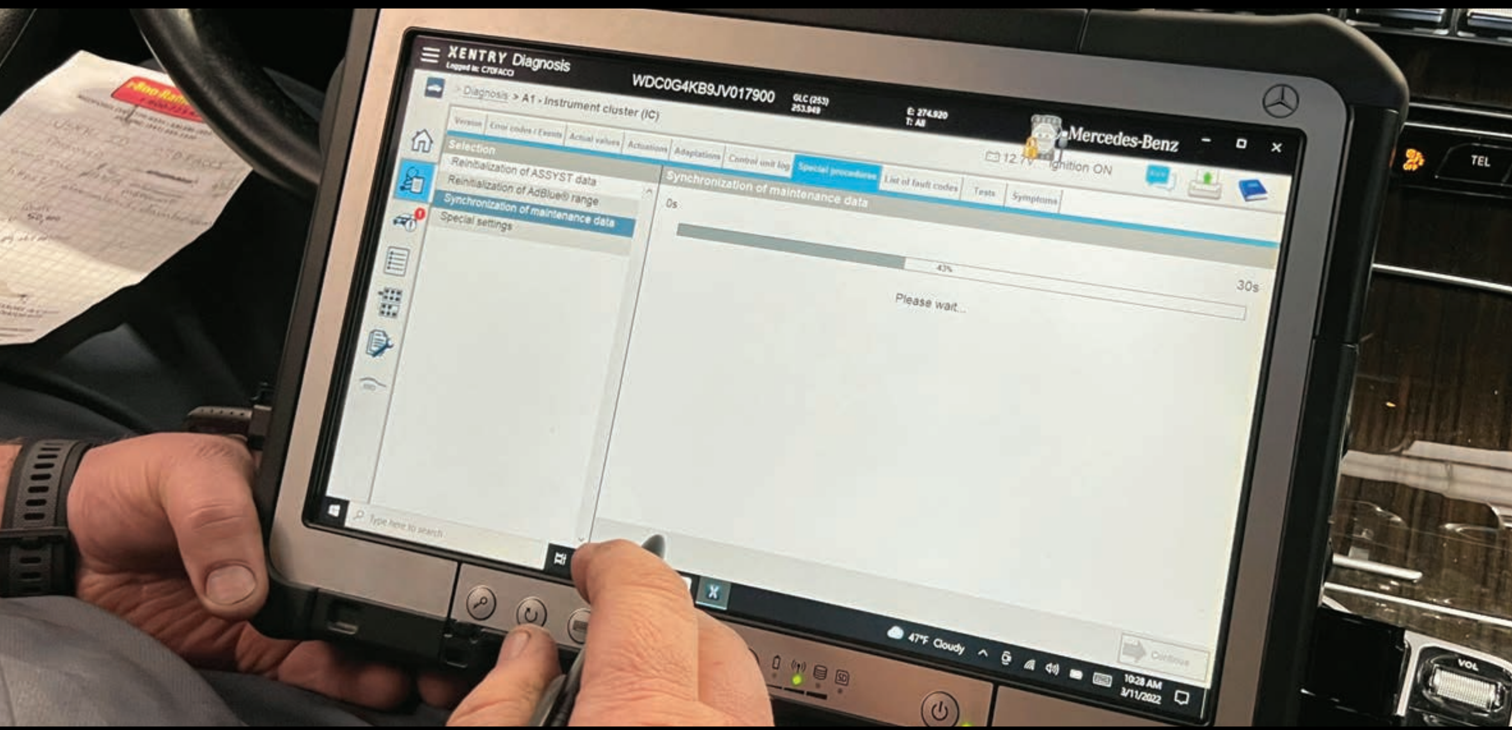
StarTuned®

Information for the Independent Mercedes-Benz Service Professional

StarTuned.com



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SUMMER 2022
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Diagnostic and Repair Information for Independent Technicians

Dear Readers:

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 every day goal: fixing vehicles right the first time.

This information is proudly sponsored by your local Mercedes-Benz dealer Parts Department. We hope you find this information useful and enjoyable, and we welcome your feedback and topic ideas for future articles. You can also find the entire library of previously published articles, searchable by keyword or publish date, on StarTuned.com.

We appreciate the opportunity to support your business and look forward to continuing our 20+ year history of providing Mercedes-Benz approved technical information.

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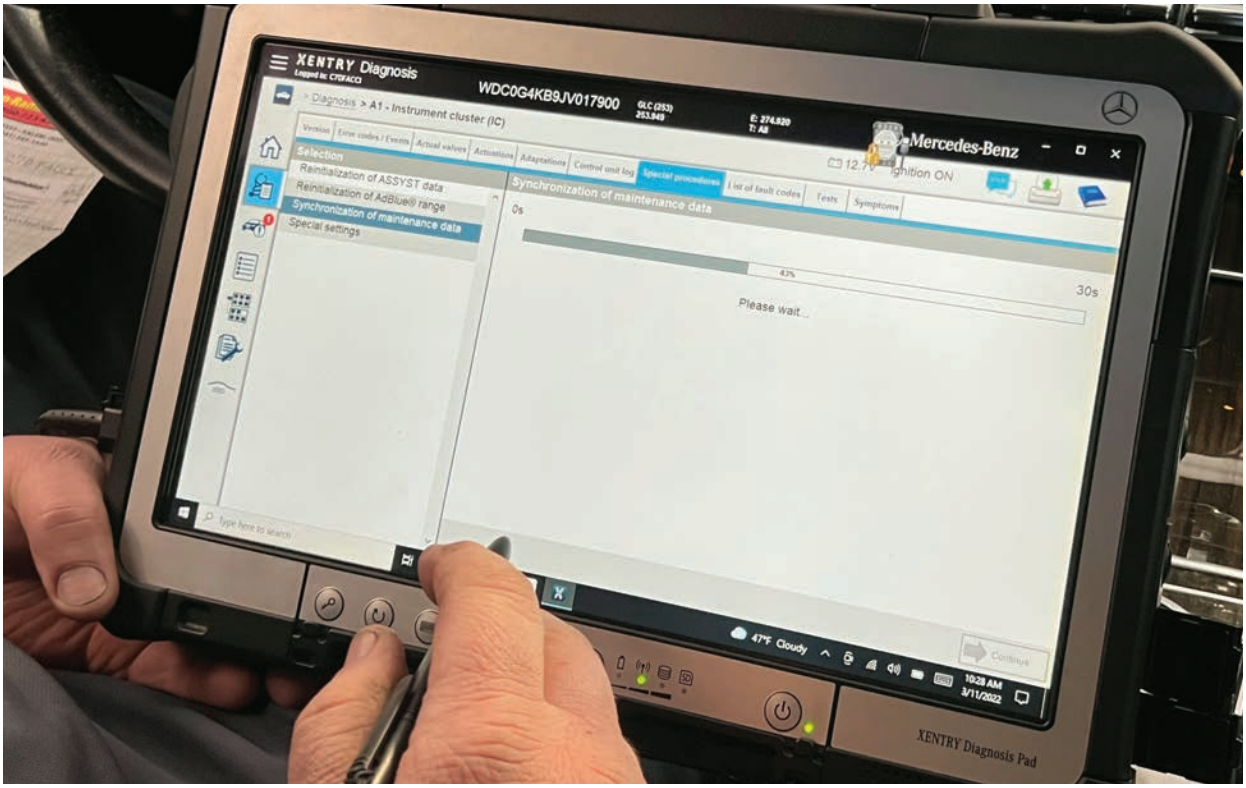
More on BlueTEC and AdBlue Technology

A look at servicing the system, problem areas including diesel particulate filters and countdown to zero



Checking the AdBlue System? Using the XENTRY Diagnosis system will simplify your diagnosis.

If you want to really get into the science behind BlueTEC and AdBlue® technology, take a look at the June 2018 issue of *StarTuned*. In this article today, we will take a look at servicing these systems in your shop and, in particular, some problem areas that may pop up. The dreaded countdown to zero is one of them. This is where your customer says "my dashboard indicates I only have 6 starts left on my vehicle and it needs to go the workshop." Even worse, they've ignored it and are stuck 30 miles from nowhere and the vehicle will no longer start. Unfortunately, Europe has begun the ban on diesel vehicles and they may be on their way out, but you are still going to see them in your shop for some time.

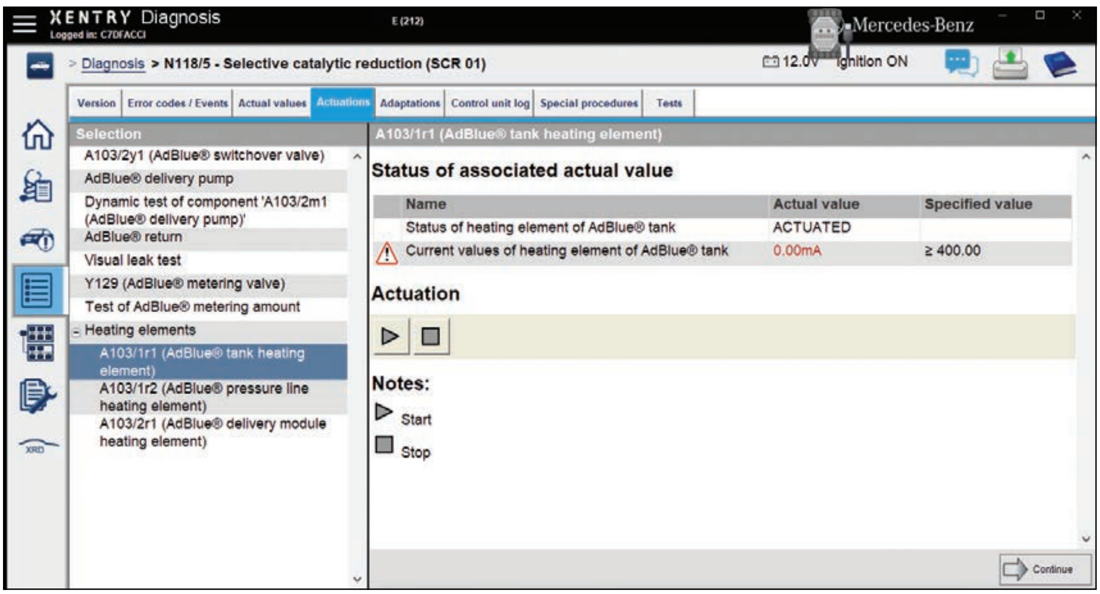
Service Recommendations

Servicing the diesel vehicle in your shop is pretty much the same as servicing the gas engine vehicles, with some obvious exceptions. You will follow the A and B service recommendations with the difference being the addition of the Diesel Exhaust Fluid (DEF). Always top off the tank with a high quality DEF (such as the trademarked AdBlue) at regular service intervals. Your Mercedes-Benz parts department carries a handy container of genuine fluid with the added benefit of a nifty little fill valve. Also at the B service, Mercedes-Benz recommends a drain and fill of the DEF tank in order to eliminate any contaminants. According to most sources, DEF has a shelf life of one to two years. Since it has no preservatives, it can lose its effectiveness over time. Your dealer will always make sure you're getting fresh product.

Always conduct a full scan or quick test of the vehicle with a factory-compatible scan tool so that you can have a clear picture of the whole vehicle. The technology behind BlueTEC is complicated to say the least, and knowing what's working properly and what isn't is the first step to keeping your customers cars on the road safely and trouble free. When it comes to more complicated troubleshooting, such as Diagnostic Trouble Codes (DTCs) and solving them, you won't get far without a XENTRY Diagnosis system. There are sometimes many adaptive resets and programming platforms that need to be applied that just aren't available on most aftermarket scan tools. Plus, the XENTRY has many guided test steps.

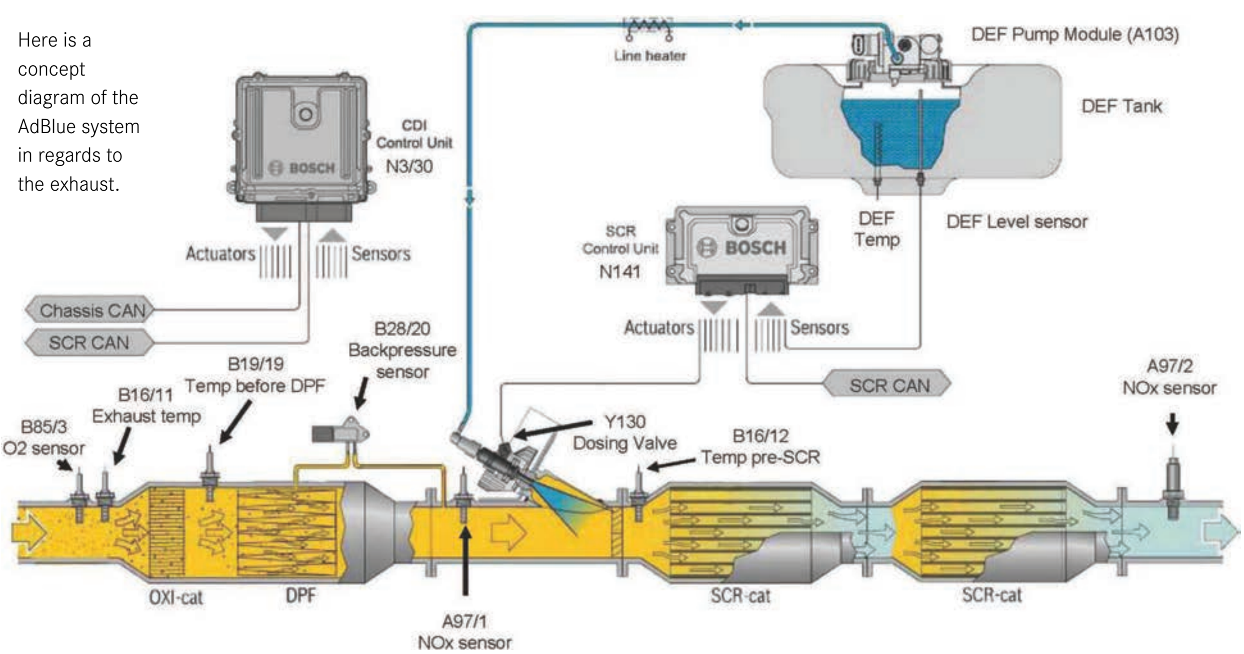
Recalls

There are a number of emissions-related service campaigns and recalls issued regarding the diesel particulate filters and the AdBlue technology. Some go back as far as the days of the Dodge-branded Sprinter vans, so always check for campaigns, bulletins and recalls whenever you encounter a DTC or emissions and drivability complaint. Indeed, in our shop we check every VIN for recalls as standard operating procedure.



You can see the advantage of having a scan tool that can actuate critical components in the system.

Here is a concept diagram of the AdBlue system in regards to the exhaust.



For example, service campaign No. P-SC-2012070004 issued August 2012 performs an update for the Selective Catalytic Reduction (SCR) Control Module Software. This affects models 164, X164, 212 and 251 models from Model Years 2009–2011. This service campaign software update addresses fault codes 203C11 and 20BA1A. (The AdBlue fill level sensor has a short circuit to ground, or the output for heating element of AdBlue pressure line has a malfunction.)

There are actually three different SCR updates in just a short time span if you look up these models, so you get the picture. You need to look up the model you are working on and save your customer some hassle if there is a campaign or recall on their vehicle.

You Have Zero Starts Left!

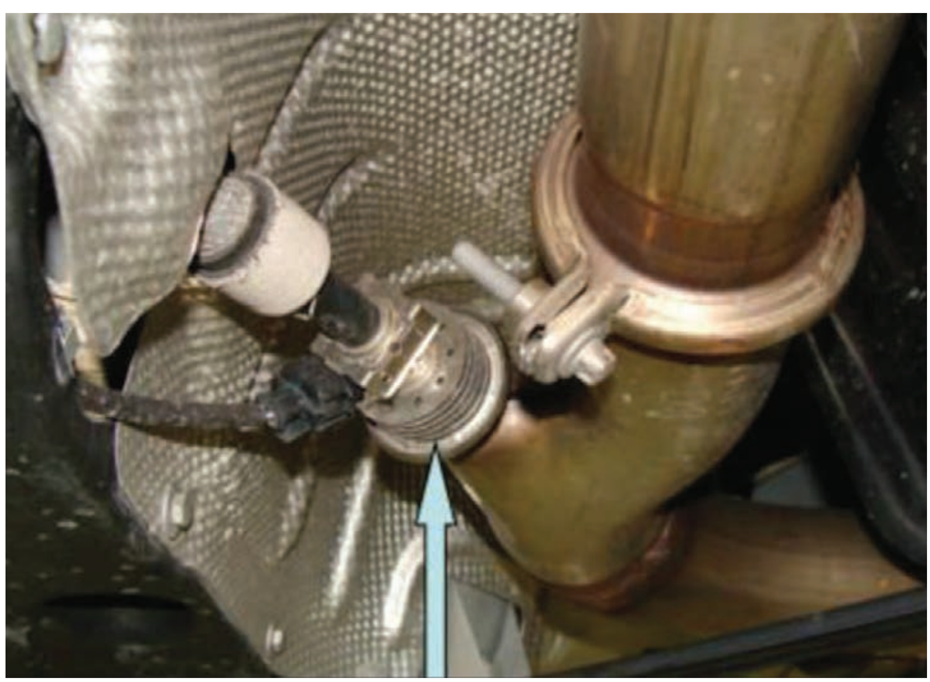
So what happens when the instrument cluster tells your customer there are a limited number—or worse, no starts left? The dashboard readout may also warn you: Check AdBlue. Well, in simplest terms one or more fault codes concerning the AdBlue system are stored in the engine control unit. It is important to understand that there is a distinction made in the fault codes between system fault codes and cause fault codes. The cause fault code must first be rectified in the engine control unit with the guided XENTRY Diagnosis guided test(s) in order to enable the AdBlue system fault code to be erased. This has caused many a technician to pull their hair out trying to clear a code for the system. These system fault codes are always shown together with at least one cause fault code in the engine/SCR control unit. The quick test results must not be erased; otherwise, the information on the cause fault code will be lost.

XENTRY Tips document LI49.20-P-053539 makes this statement: "Important: If an active system error is present, the AdBlue tank doesn't necessarily need to be filled. Keep in mind you may have to empty the tank for a repair to rectify the cause." It makes sense to this writer and technician that making sure the tank isn't empty, however, is prudent before proceeding further. After processing the cause fault(s), the AdBlue fill level should definitely then be checked. If the fill level is correct, then it does not need to be topped up to rectify the fault.

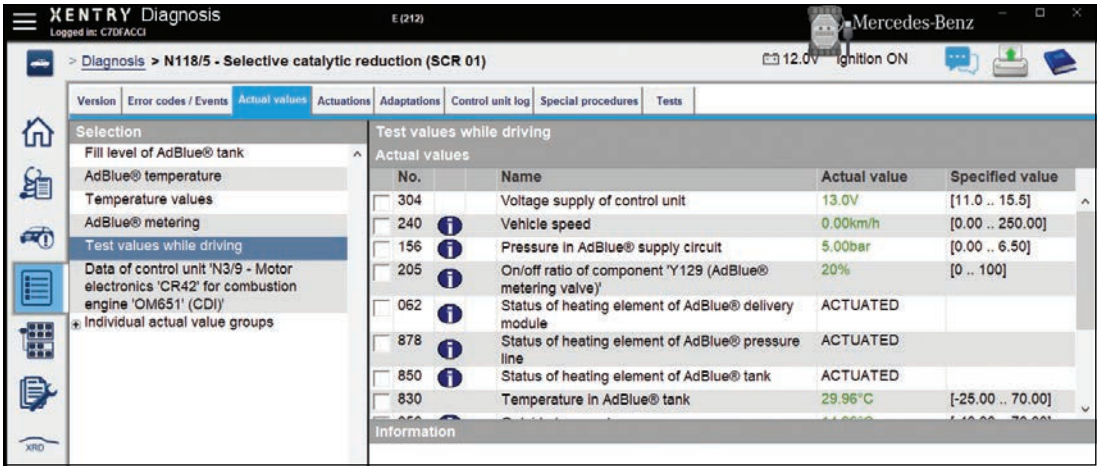
We're going to address this issue on a 2015 Mercedes-Benz E250 BlueTEC 4MATIC Diesel with engine type OM651.924. This will also apply to any Model 164/166/212/221/251 with engine OM642 and SA code U42 (BlueTEC (SCR) diesel exhaust treatment), Model 166/204/212 with engine OM651 and SA code U42 (BlueTEC (SCR) diesel exhaust treatment) or Model 463 with engine OM642 and SA code MC7 (Engine OM 642 D 30 BlueTEC).

Possible system fault codes include 16D300, 16D400, 16D500, 15EA00, 15EB00, 15EC00, 16CE00, 16CF00, P13DF00, P13E300, P13E400, P13E500 and P13DF09.

These system fault codes are always shown together with at least one cause fault code in the



Here is where the AdBlue is injected. Also a spot where some techs insert a camera to check the filter.



Here is a screen shot showing the correct pressure of AdBlue® at 5 bar.

engine/SCR control unit. Once again, remember the quick test must not be erased; otherwise, the information on the cause fault code will be lost. Once all the cause faults have been rectified, the quick test faults can be erased.

The Procedure

Let's say in the above vehicle you have scanned the CDI control unit and have a 16D400—the remaining driving distance is limited due to a malfunction in the AdBlue system. A scan of the SCR control unit displays a P20E800 reductant pressure low code. So the system fault is in the AdBlue system and a possible cause is the pressure of the reductant (a fancy name for the DEF). This is where you need a factory-compatible scan tool because you're going to have to activate some components.

Follow the screen prompts for the test plan. Your scan tool will need to provide an activation test of the DEF pump. While doing this, verify that the pressure sensor data reaches specified values of 5000 hPa or 5000 mBar. If the pump test fails and the AdBlue tank is not empty, your pump may be faulty. If the pump runs yet fails the test there may be a blockage to the pump inlet inside the tank. Remove the injector from the exhaust and run the pump test again. Check for any fluid leaking out of injector, pressure line or pump to line fittings. If your tests prove that the pump has failed then it is a matter of replacing it and following the procedure to reset the system. It should be noted that techs in the field have sometimes gotten air locked in the pump when filling, so be sure use a syringe to fill all the openings and lines with DEF to prime the pump. Also, fill the tank all the way to the filler neck; failure to do this will result in setting the fault code.

Be aware that when the quick test has been erased, the existing system fault code and the combined message "Check AdBlue" or "No start in XXX km" will remain active. To erase the system fault code and the combined message, you will need to proceed as follows:

Check that the engine and BlueTEC control unit software is up to date, then proceed with the guided test plan and click on the link "Reset warning message..." If "Completed successfully" is shown, the system fault can be erased and an additional adaptation test drive is no longer required. This particular model we are looking at actually has a service campaign No. P-SC-2012100005 issued November 2012 attached to it that calls for a SCR control unit update. If you can't perform this update the dealer should provide it for you.

It is only necessary to perform an adaptation test drive to erase the system fault code if the message "Reset not completed successfully" appears.

The adaptation test drive must be performed according to the following criteria:

1. Warm up the vehicle for approx. 10 minutes (coolant temperature at least 80°C/176°F, catalytic converter temperature at least 250°C/482°F).

A brand new DPF is available from your Mercedes- Benz parts department. This will assure the highest quality filter with no comebacks!

2. Drive for 30 min as consistently as possible between 80 km/h (50 mph) and 120 km/h (75 mph) with occasional coasting phases.

Then check whether the fault is set to "stored." If so, erase the fault; the message in the instrument cluster should disappear.

Diesel Particulate Filters (DPF)

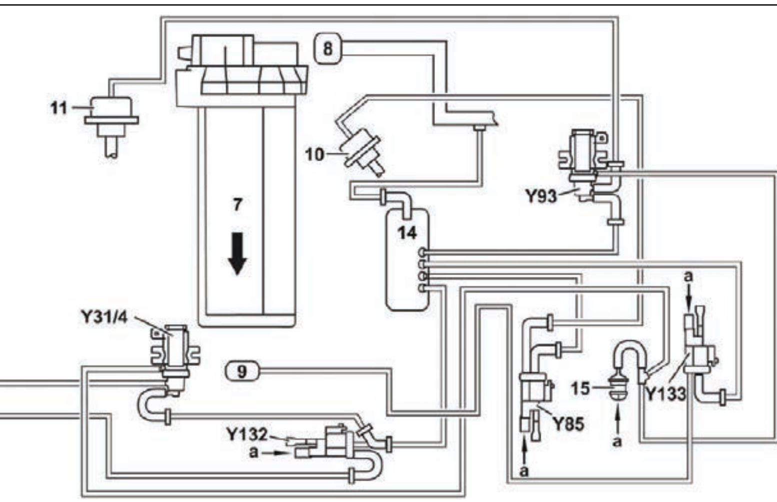
Let's take a look at one of most critical elements of a diesel emission system—the DPF. In the June 2018 *StarTuned* article, you can read about its construction and function. Today, we will look at the lifespan, how you tell if it's restricted and what to do about it. First off, there are dozens of possible codes that can set that might be an indication that your DPF is plugged. You will need to use your brain, scan tool codes and data, and some strategy based diagnostics to narrow down your possibilities.

Why does the filter get restricted? We all know that the filters undergo passive and active regeneration but sometimes it's just not enough. Restricted diesel particulate filters might be caused by short trip driving at low speeds. Vehicles operating at low speeds on short trips are unable to meet the requirements for the filter to clean itself. Soot and ash are two major byproducts of combustion that have to be cleaned up. Regeneration typically removes most of the soot by converting it to carbon dioxide. Ash, on the other hand, is already a byproduct of combustion, so no amount of heat from the engine can convert it. Over time, the ash will build up to the point where the filter has to be physically cleaned or replaced. More on this later.

Looking at a test case on the same vehicle we addressed earlier we have a customer concern of a lack of power and a DTC, P0299FA (boost pressure of turbocharger 1 is too low). At first glance, we might think the turbocharger is at fault but let's list some possibilities and eliminate them.

1. Air filter or restriction of the air entering the system. Using a visual inspection, check for any blockages of air properly getting to the intake.
2. Vacuum leaks. Pull up the vacuum diagram and verify you have proper vacuum at all points. Check all switch over valves and check the waste gate for actuation when applying vacuum.

Having access to a diagram like this one is critical for your diagnostic work.



Vacuum system shown on engine 651.911

➡ ....Travel direction arrow
a ....Ambient pressure
7 ....Cylinder head
8 ....Vacuum pump
9 ....Coolant pump
10 ....EGR cooler bypass vacuum unit
11 ....Boost pressure control flap vacuum unit
12 ....Wastegate vacuum unit
13 ....Charge air bypass flap vacuum unit
14 ....Vacuum reservoir
15 ....Vent filter for Y31/4 and Y93
Y31/4 ...Wastegate control pressure transducer
Y85 ....EGR cooler bypass switchover valve
Y93 ....Boost pressure Control flap pressure transducer
Y132 ......Charge air bypass flap switchover valve
Y133 ......Coolant pump sitchover valve

Here you can narrow this field down even more. No vacuum? Possible faulty pump, intake issue or a leaky hose or valve. A smoke machine is handy in this situation. Thoroughly check the integrity of all vacuum hoses.

3. Sensors. Possibilities would include boost or air charge sensors, backpressure sensor, etc. A faulty sensor may give the system a bogus reading. With the Key-On/Engine-Off the pressure sensor values should all match.
4. Leaks in the charge air system. Pressure test the charge air system with at least 7 psi. Again, a good smoke machine can do this. Verify connections of pipes and make sure there are no leaks.
5. Road test while watching sensor data. If no or low boost pressure is produced, then remove the exhaust and charge pipes from the turbo. Inspect both impellers for damage. If you get some pressure but it goes flat on heavy acceleration and you see an increase in the backpressure sensor reading, remove and inspect the exhaust for blockage. Yes, you may have a blocked DPF.

You may ask "wouldn't the blockage show up with some additional codes?" Maybe a P200200 (the efficiency of the diesel particulate filter—cylinder bank 1—is not sufficient) or P245900 (the soot content of the diesel particulate filter is not OK).

There are several other codes as well that should indicate a problem with a restricted DPF, but in the real world we know this isn't always the case. Don't assume anything and follow where the evidence leads.

A blocked or restricted DPF should be replaced. Your Mercedes-Benz parts department carries a line of brand new replacement filters and also takes your old one in exchange. This way the components are recycled and environmentally sound, and safe practices are used. After replacing the DPF you will need to perform the "teach-in process" to complete the repair. As always, be sure the latest software is installed in the vehicle as well.

There are options for cleaning a DPF as well that some techs in the field have reported success with. A solution especially made for the process is sprayed in upstream of the filter by removing a sensor and a purge solution is injected afterwards. There are also some industries that clean DPFs using an ultrasonic cleaning method. The drawback here is you have to remove the part, ship it out and wait for shipment back. Meanwhile, your customer's car sits on your lot taking up space. It should also be noted that as of this writing cleaning the DPF is not considered a Mercedes-Benz approved repair.

In this article, we've offered some practical advice on the care and feeding of BlueTEC models and the associated anti-pollution controls. Diesels will still be around for a while and you should familiarize yourself with all the components of the AdBlue system. These engines are solid and run for a long time, so you will benefit by staying informed on all the technology to be able to service and diagnose, quickly and efficiently, real world problems in your shop. |

Model 210 E-Class Central Locking

How it works, diagnosis and troubleshooting tips

Hidden in that yellow foam block is the PSE unit, home of the central locking pump and other functions.

The Mercedes-Benz Model 210 E-Class is probably a typical visitor to your shop, with a zillion still on the road, and they are getting to that age where things that are normally bulletproof start to show their age. Pneumatic central locking is one of those systems, and in this article we will have a look at how it works, along with some basic diagnosis ideas and a few tips for a faster identification of any trouble.

The PSE (Pneumatic Special Equipment) pump is the heart and soul of the central locking (CL) system, and is found under the right rear seat. It is responsible for several functions: Pneumatic central locking (with several sub-functions), Anti-theft alarm (ATA), Rear head rest retraction (RHR), Manifold vacuum assist (MVA), Multi-contour seat (MKS) adjustment (via pneumatic bladders), requesting the operation of certain interior and exterior lighting and unlatching the trunk lid (RTR). In this article, we'll be mostly limiting ourselves to the pneumatic central locking function, and specifically the system found in DAS3 models (model year 1998 and later).

For most drivers, their touchpoints with the CL system are when they unlock or lock the car with the remote key or with the dash-mounted central locking switch, automatic locking at a certain speed threshold, retracting the rear head rests and opening the trunk lid in sedans. This is a system that, while certainly not essential to the vehicle's operation, is such a convenience that most customers will want it operating properly.

An original 1998-style DAS3 key. To switch between Global and Selective unlocking, press and hold both the lock and unlock buttons at the same time until the battery-check light flashes. To switch back, repeat the process.

Unlocking the vehicle with a remote key fob starts when the customer presses the unlock button on the SmartKey. Depending on whether the system is set for 'global' or 'selective' unlocking (see nearby image), either all openings (doors, trunk/tailgate, fuel flap) will be unlocked in global mode or only the driver door and fuel flap will be unlocked in selective mode. A second unlock button press in selective mode will unlock all the remaining openings. If the vehicle is unlocked using the remote key, but no door or trunk/tailgate is opened, it will relock automatically after 40 seconds.

The key signal is received by either the radio-frequency (RF) receiver located in the overhead control panel (dome light, N70) or an infra-red receiver in one of the front doors. From there, the coded signal is passed via Interior CAN by either N70 or a door control module (DCM) to the Electronic Ignition Switch (EIS, aka EZS). The EIS decodes the signal and, if it is correct for the specific vehicle, sends a message via CAN to both the PSE and the driver-side SAM (N10/1).

The SAM flashes the turn signal lamps once to confirm unlocking. The PSE then delivers pressurized air to the pneumatic CL actuators, unlocking the appropriate points (selective or global) generally via a mechanical linkage (except the tank flap, which is actuated directly). For locking, which is always global, the process is similar, except that vacuum is used to operate the CL actuators and the turn signals are flashed three times. When locked from outside the vehicle, the ATA is also armed and the headlights, if switched on during the trip, will light for about 20 seconds.

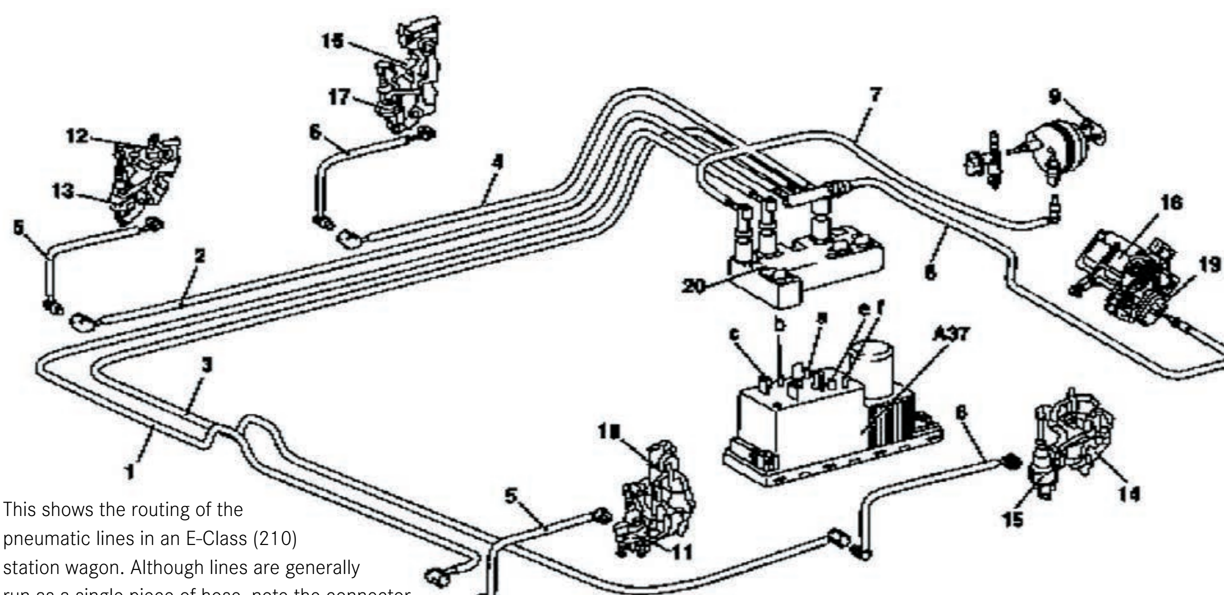
Note that the EIS, remote key and other components are Theft-Relevant Parts (TRP). Anyone can order nearly any TRP from a dealer as long as you are a registered Vehicle Security Professional (VSP). Becoming a VSP is neither difficult nor expensive, but it is probably not cost-effective if you don't usually service Mercedes-Benz vehicles. Visit the North American Service Task Force website at nastf.org to learn about and apply to get your SDRM credentials and become a VSP.

Pneumatically, there are only four circuits involved in CL: The driver's door, the passenger's and two rear doors, the trunk or tailgate lock, and the fuel flap. The three doors and trunk/tailgate are fed from a single PSE outlet and a multi-way connector; the driver door and tank flap have their own outlets.

Operation using the mechanical key, which is a feature only included in vehicles built for the USA and Japanese markets, is nearly the same: A switch in the mechanical door or trunk/tailgate lock actuates the system, either through the respective door control module or a direct wire to the PSE from the trunk/tailgate lock cylinder switch. Again, when locked from outside the vehicle, the ATA is armed.

The interior switch (S6/1e2) also operates the system. It is connected by a direct wire to the front SAM, which sends a signal via CAN to the PSE. Locking the vehicle using this switch does not lock the tank flap or arm/disarm the ATA. If either the driver or passenger door is open then locking via the interior switch is disabled.

Automatic locking occurs when the feature is enabled, the vehicle was initially unlocked from the



This shows the routing of the pneumatic lines in an E-Class (210) station wagon. Although lines are generally run as a single piece of hose, note the connector where each line passes through the door hinge.

exterior and the vehicle speed exceeds about 10 MPH (15 km/h). The effect is the same as if the interior switch was used. Remote trunk release is also inhibited. This feature can be deactivated and activated using the interior CL switch as follows: With circuit 15 on, press and hold the switch for longer than 5 seconds in the ‘unlock’ position to deactivate it or in the ‘lock’ position to activate it. Note that it is possible to set the version coding of the PSE (using the HHT for example) such that automatic locking cannot be activated.

The interior central locking switch is to the right of the hazard flasher switch, and the rear head restraint release switch is to the left.

If the vehicle is locked, any door can be immediately unlocked by pulling the interior door handle. This does not disarm the ATA if it was armed.

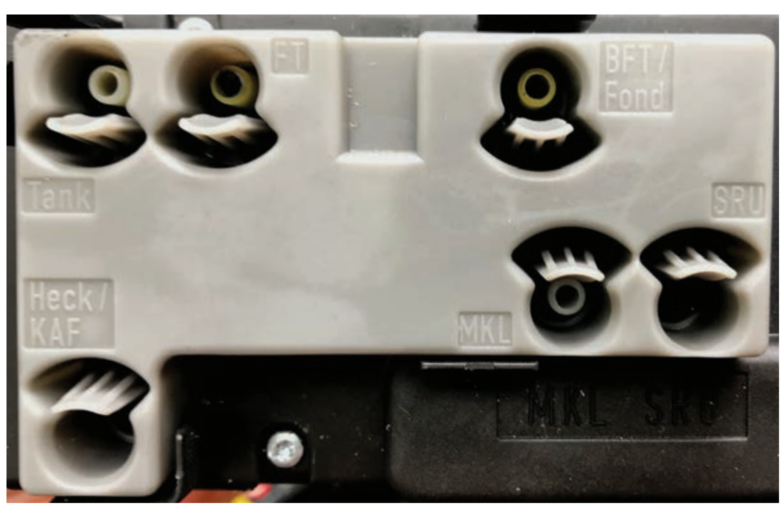
In the case where the PSE’s internal acceleration sensor detects a deceleration greater than about 6 g (e.g, in a crash), the vehicle is completely unlocked after a brief time (8 to 11 seconds). This also does not disarm the ATA if it was armed. If circuit 15 is subsequently switched off for at least 2 seconds, the vehicle returns to its state before emergency unlocking occurred. Note that the emergency opening function has priority above all other CL functions.

The PSE also controls the Manifold Vacuum Assist (MVA), Rear Head Rest (RHR) release, Remote Trunk Release (RTR) and Multi-Contour Seat (MKS) functions pneumatically in vehicles so equipped.

MVA is used to assist the automatic climate control (A/C) system flap actuators at times when manifold vacuum is insufficient. It operates when either the ignition or the REST feature is on, using a pressure switch in the PSE to determine if vacuum is sufficient. This system uses a gray vacuum hose running along the passenger side floorboard to supply vacuum to a vacuum reservoir (also connected to the intake manifold in gasoline models) hidden inside the right front fender, next to the ATA siren. If the A/C flaps seem inoperative, weak or make a thump noise, suspect vacuum supply.

RHR uses vacuum to operate actuators at each rear head restraint, which allow the head rests to fold down into the rear hat shelf and improve the driver’s view to the rear. Head rests should always be up when a passenger is in the seat. When the switch (S6/1e3) on the upper control panel in the dash is pressed, the front SAM sends a CAN message to the PSE to operate the system when the ignition is on. The head rests can be raised by hand. If either the RHR or interior CL switch is closed for more than 25 seconds (e.g., due to a fault) the SAM ignores the switch until the switch is detected to not be closed.

RTR uses pressure to unlatch the trunk lid when the switch (S15, located near the transmission shift lever) is actuated, or when the trunk release button on the remote key is pressed. An indicator lamp in the switch indicates if the trunk is open. In MY 97 and earlier vehicles with the single-button remote, pressing the button twice within about 0.8 seconds will open the trunk lid. From personal experience, it takes a little practice to get the timing just right. Above about 10 MPH, the trunk release switch operation is inhibited.



This PSE unit has only six connections, some have more. Top row connections are for the fuel flap, driver’s door (FT) and the remaining doors and trunk/tailgate. The bottom row are for the trunk release and multi-contour seats, which this wagon doesn’t have, and the filtered air intake.

The fuel filler flap actuator comes with a short metal rod, which when locked extends through this latch to keep the flap from being opened. Vacuum applied to the TANK connection will unlock the flap, but if there is a big enough leak you may need to use the emergency tank flap release handle in the quarterpanel.

MKS uses pressure to inflate air bladders in the driver and passenger seat using pressure. The PSE maintains a certain air pressure on the MKS pneumatic line when the ignition is on via a pneumatic switch in the PSE. A mechanical switch mounted to the seat directs the air to specific bladders to control the various functions.

Diagnosis Function Check

Before trying to repair a problem, after speaking with your customer about the complaint, check all of the PSE functions to note what does and doesn't work. The 11 steps summarized here are from the Mercedes-Benz Workshop Information System (WIS) document AD80.20-P-3001B, which applies to Model Year 1998 and later models. After completing these steps, you should have a good idea whether the system is operating normally or not. If functions other than CL are affected, visit the MBUSA STAR TekInfo website at bit.ly/3N8io5B to access the official Mercedes-Benz Diagnostic Manual, which has function checks for other related systems.

Note: "All points" means all doors, trunk/tailgate and fuel flap, and all locking/unlocking actions should occur in less than about 3 seconds.

1. Lock vehicle with transmitter key (check both IR and RF). All points lock.
2. Unlock vehicle 'selectively' with transmitter key (pre-set the key for this) IR and RF. Driver door and fuel flap unlock. Press unlock again, all points unlock.
3. Lock vehicle, then unlock 'globally' with transmitter key (pre-set the key for this). All points unlock.
4. With vehicle unlocked, enter vehicle and close all doors. Press interior CL switch to lock. All points lock except fuel flap.
5. Press interior CL switch to unlock. All points unlock.
6. In 'global' opening mode: Lock vehicle with interior CL switch, then open a door from inside. Door opens and all other points unlock.
7. In 'selective' opening mode: Lock vehicle with interior CL switch, then open a door from inside. Only actuated door opens and unlocks.
8. Lock vehicle using mechanical key (USA/Japan only) at doors and trunk lid. All points lock.
9. Unlock vehicle using mechanical key (USA/Japan only) at doors and trunk lid. All points unlock.
10. Lock then unlock vehicle using remote key. Wait about 40 seconds without touching the vehicle. All points re-lock.
11. Unlock vehicle and drive it above about 10 MPH. All points except fuel flap lock. **Note:** It is possible this function is deactivated either bia the interior CL switch or via version coding the PSE.

Testing

The PSE has a fault memory and can deliver Diagnostic Trouble Codes (DTCs). The PSE is diagnosed with the Hand-Held Tester (HHT), so most aftermarket testers won't be able to read the DTCs, but any XENTRY Diagnostics system (possibly needing an adapter) fully supports all HHT functions. Disconnecting power from the PSE for about 3 seconds erases the DTC memory. A complete list of the possible DTCs can be found in the official Mercedes-Benz Diagnostic Manual, available to everyone at the MBUSA STAR TekInfo website bit.ly/3N8io5B.

The Actual Values screen on the HHT is very helpful when determining if a given electrical signal is making it to the PSE. Simply display the desired actual value on the HHT screen and actuate the switch; the switch status is displayed.

Now an antique, this hand-held Tester was the mainstay of vehicle diagnosis for Mercedes-Benz at the end of the 20th century. Modern XENTRY Diagnosis systems can still fully diagnose HHT-based vehicles.

The Mercedes-Benz pressure-vacuum tester can deliver up to 1000 mBar of pressure or vacuum, and features an accurate gauge. This, along with a few hoses, lines and fittings, is essential when testing a pneumatic system.

To properly test the pneumatic system, you need a good source of vacuum and pressure. The Mercedes-Benz pressure-vacuum pump (W201 589 13 21 00) is an excellent investment, but you might find something similar in the aftermarket. Whatever you choose, it must not exceed 1-bar pressure or vacuum and be equipped with an accurate gauge.

A set of pneumatic system fittings, lines and plugs will also prove helpful. We suggest visiting your dealer to get a couple of plugs (A202 805 03 44, A202 805 04 44), rubber caps (A000 997 11 45), some rubber hose connectors (A007 997 61 82), a pneumatic line (A129 800 95 15) and a meter or more of vacuum tubing (A000 158 14 35).

Optional but useful are the Socket Box (W124 589 00 21 00) and adapter harness (W202 589 15 63 00), along with the Mercedes-Benz Electrical Connection Set (W201 589 00 99 00 or later). These allow you to easily complete the electrical testing routines described in the Diagnostic Manual with no chance of damaging the wiring. Of course, a good multimeter and someone who knows how to use it is always handy.

And even though it should go without saying: Remember the basics. If the pump isn't working at all, check for DTCs first if you have the ability, and only then check for power (including the fuse!) and ground. If only a certain function isn't working, check that area both electrically and pneumatically. Remember that a new PSE needs to be version coded or it may not function as expected.

Troubleshooting Tips

If nothing works, read the DTCs if possible (before checking power!), then reset the PSE by temporarily disconnecting power. If functions return to normal (or nearly so), suspect a larger leak, which sets the pump into safety shutdown. Listen for the pump running excessively. Safety mode in most PSE versions occurs after 10 ignition cycles with a large leak.

The pump itself should be able to deliver 600 mBar of pressure or vacuum. Less than that indicates a weak or internally-leaking pump.

If the doors lock properly but are slow to unlock you need to check all the rubber pneumatic connections for splits. A split is like a pneumatic diode: It allows pressure (unlock) to leak out, while self-sealing under vacuum.

If the trunk lid doesn't open when released, check if the trunk seal is adhering to the trunk lid. This can be cured with a light coating of silicone spray or grease.

Each actuator has its own hose. The driver door has its own pump outlet and fitting, as does the tank flap, while the other three doors and the trunk/tailgate share an outlet and have a 4-way fitting. Disconnect and test them one at a time. In most cases the three lines are marked A, B, C for LR, RR and RF door.

Pneumatic lines must be completely leak-free. With the far (actuator) end plugged, apply 600 mBar of both pressure and vacuum. The reading must not change at all (zero mBar) in 60 seconds for both tests.

Having an assortment of inexpensive fittings, plugs and hoses makes pneumatic troubleshooting easier.

Pneumatic actuators have a slightly less stringent test standard. Connect your tester directly to the actuator, apply 600 mBar pressure and vacuum, in each case there must be less than 30 mBar leakage in 60 seconds. Actuators not meeting the test value must be replaced.

Your ears can be excellent diagnostic tools. Pressurize a circuit and listen for the leak (it needs to be pretty quiet for this). This might help you avoid removing much of the interior.

If a line needs replacement, just run a new one, leaving the old one in place. Since lines are generally incorporated into the wiring harnesses it may be both extra work and adding a risk of harness damage if you try to remove it.

If a circuit passes the pneumatic tests, but still has trouble, look for mechanical issues between the actuator and the mechanism. This is about as common as a failed actuator.

If the system operates, just not using the remote key, first make sure the key batteries are good, then synchronize the key by inserting it into the ignition switch.

Version Coding

All PSE pumps require version coding at installation. This list shows all possible coding possibilities, but note that some options are not included with certain PSE versions. Always use the correct part number PSE for your specific VIN. The defaults for the USA are underlined.

- Automatic locking (Yes/No)
- Relocking (Yes/No)
- Locking via interior CL switch (Yes/No) (Only relevant if Autom. locking is Yes)
- Alarm siren installed (Yes/No)
- National Variant of ATA (Rest of world/ USA/Belgium) (USA setting allows delayed headlamp function)
- Interior motion sensor (Yes/No)
- Anti-towing sensor (Yes/No) (Default depends on model year)
- Panic alarm (Yes/No)
- Special protection vehicle (Yes/No)

If you don't have the capability of version coding a PSE, your dealer should be able to help. All XENTRY Diagnostics systems have full HHT capabilities. An adapter is needed, available from MBUSA. While it's not a standard part of the Kit 4 system, it is relatively inexpensive and readily available.

This concludes our tour of the Model 210 E-Class version of the pneumatic central locking system. With this knowledge you are able to better understand how the system works, so that you can perform a professional diagnosis using your observation of the symptoms and come to a faster conclusion as to the root cause of the complaint. Some common faults and their cure were given, along with some of the head-scratchers.

In this business we all know that time is money, so a fast and accurate diagnosis is good for everyone. Understanding why the fault occurred helps us make a permanent repair, making our customers happy while increasing the shop's business. And, isn't that the ultimate goal? |

This PSE unit, installed in a station wagon, uses only four connections. The clear line is the intake, which runs into the C pillar with a small filter on the end. The 4-way connector is for the door and tailgate locks, except for the driver door, which has its own connection, as does the fuel flap.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Mercedes-Benz M264/M260 1.5/2.0L Engine

We've previously looked in depth at the M270/274 and M276 engines. What about their replacements? What's new about this engine plus service tips and hints. Also an introduction to the M254 engine.

Replacing the M27x-series engines, the M260/264 engines have already started showing up at independent workshops worldwide. Both engines are nearly identical: The M260 designation refers to the transverse mounted front-wheel/all-wheel-drive version and the M264 refers to the longitudinally mounted rear wheel drive version. These are the new four-cylinder gasoline engines in the family line of comprehensively redeveloped engines from Mercedes-Benz. The output of these 4-cylinder engines approach the power of the previous higher capacity six cylinder engines. At the same time, they consume significantly less fuel than a corresponding six-cylinder engine. Although introduced in 2017, the M264 began showing up in the U.S. in model year 2019 C- and E-class models.

Special Features

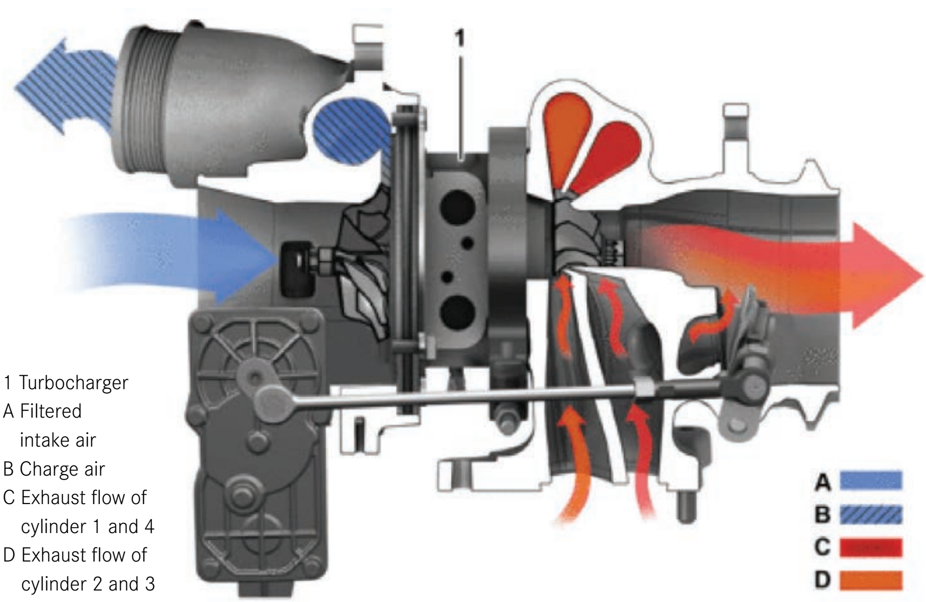
The engine includes twin-scroll turbochargers, an intake manifold having extremely short air paths and an exceptionally compact compressor housing that help guarantee a more spontaneous engine response and a fast reaction to accelerator pedal movements. This engine really approaches the performance of a true sports car. Standard also is direct injection with the latest generation high-end piezo injectors. The valve train sports CAMTRONIC, Mercedes-Benz patented adjustable camshaft technology. A friction loss reduction package rounds out the improvements.

Twin Scroll Turbos

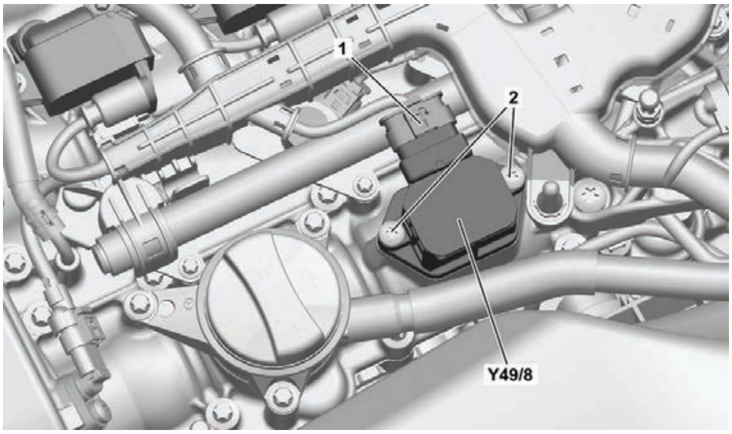
Mercedes-Benz is credited with the first successful application of a turbocharger in a production vehicle, namely the 300SD, they are also on the cutting edge with twin-scroll technology. Just as intake manifolds have developed over time to become more efficient with variable or shorter runners and configurations, the exhaust needed to be tuned more dynamically to optimize performance. Enter the twin-scroll turbo chargers. In the exhaust manifold, the flues of two respective cylinders are combined into one section and brought back together by the structure of the turbine wheel housing directly in front of the turbine runner. By directing the exhaust and “tuning” the pulses by pairing them into a more efficient configuration, the kinetic energy from the exhaust gases are recovered more efficiently by the turbine. The exhaust gas turbocharger is cooled via coolant and integrated into the engine cooling circuit. By incorporating the exhaust gas turbocharger into the oil circuit, lubrication is ensured. An electronically controlled waste gate actuator adds to the performance improvements. The net result of the twin-scroll package is higher output at lower rpms and an overall performance increase.

Internals

Both engines have die cast aluminum engine blocks with cast iron cylinder liners. CONICSHAPE technology is used in the production of the cylinder bores. This means that the cylinder bore is widened at the lower end of the cylinder liners and formed in a (slightly) conical shape, which minimizes piston friction and lowers fuel consumption. The new and old engine series share the same bore and stroke sizes except for the M264 1.5L engine (non-US version)—it was reduced by 2.6 mm cylinder bore size comparing to the previous 1.6-liter



Twin scroll turbo technology results in higher output at lower RPMs and better overall performance.



The CAMTRONIC adjustment solenoid is mounted in the top of the cylinder head cover.

version (also non-US). Like the predecessor, the M260/M264 2.0L version has a balance shaft located in the lower section of the crankcase. In addition to that, engineers introduced a new centrifugal damper into the powertrain plus plastic engine mounts, making engine operation smoother and more comfortable. Pistons have cooling ducts and optimized piston rings to also help reduce friction and improve fuel mileage.

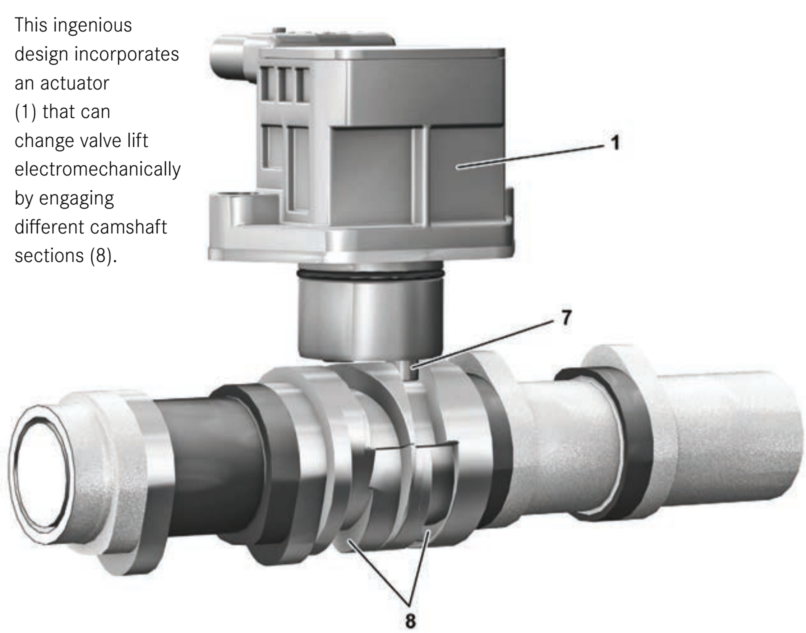
The newly designed cylinder head is made of aluminum-silicon alloy. It features four valves per cylinder, double overhead camshafts and, as mentioned earlier, CAMTRONIC technology for the valve side of things. The CAMTRONIC system allows two-stage adjustment of the valve lift. In addition to the variable valve lift, there are two hydraulic camshaft adjusters providing variable valve timing for both intake and exhaust sides. The M260 and M264 use a toothed timing chain.

CAMTRONIC

Let's take an in-depth look at how the valve timing adjustment is accomplished on this engine. Variable valve control consists of mechanical, hydraulic and electromechanical control of the valve train by the engine control unit. This makes it possible to adapt both the valve timing and lift depending on the load and operating condition of engine. The technology incorporated here contributes to serious reductions in emissions and fuel consumption. Variable valve train can be implemented on both the inlet and exhaust sides. Two principles are at play here: Camshaft adjustment and Valve lift adjustment.

Valve lift adjustment or valve lift switchover is where the actual camshaft valve lift is changed to a flat or steep lift. By implementing a flatter or smaller lift when throttling down or partial load operation, fuel consumption can be reduced. A smaller valve lift also improves the friction loss which results in a cooling advantage. To ensure an optimal combustion despite the smaller valve lift, the fuel is injected multiple times. To improve the reduced turbulence of the fuel/air mixture in the combustion chamber around the spark plugs, the fuel/air mixture is ignited multiple times in low partial-load operation. To achieve a higher torque, a switchover takes place to the large valve lift so that a steeper valve lift can be applied such as in a full load situation.

The valve lift switchover is implemented by means of an electromechanical system. The electromechanical system works with a switchover valve or CAMTRONIC actuator that engages mechanically with the camshaft. The



This ingenious design incorporates an actuator (1) that can change valve lift electromechanically by engaging different camshaft sections (8).

camshafts are designed with two parts, i.e. a hollow shaft with cam pairs and spiral-shaped grooves that enclose a solid shaft with cams. Depending on the rotational speed and engine load, the actuators engage in the spiral grooves on the rotating camshaft pieces. The actuators move each of these axially to one of the end positions (large or small valve lift). This causes the cams to be moved on the camshaft.

In the operation of camshaft adjustment, the valve timing is changed by rotation of the camshaft, thereby producing a valve overlap. The camshaft can be rotated in the "advanced" or "retarded" direction while the valve lift remains constant. The camshaft is rotated via camshaft positioners at the power-transmitting ends of the camshaft. The camshaft positioner sets the camshafts with regard to the crank angle, thereby enabling a valve overlap during gas exchange. This looks quite similar to what you're used to in other modern Mercedes-Benz engines.

The camshaft adjustment is performed by the engine control unit, depending on the engine speed and engine oil temperature. Application of the adjustment of the exhaust camshaft does not occur until a higher engine speed as compared to the intake camshaft. This ensures that the lock position is still reached on the exhaust stroke against the retarded reaction moments of the camshaft even when the oil pressure is low. There is a return spring located for support in each camshaft positioner.

The camshaft adjusters used in the M260/264 engines look very similar to these, which are installed in an M276 engine.

If both camshafts are adjusted, adjustment of the exhaust camshaft takes place after a delay. This prevents oil supply problems and ensures a reliable functioning of the locking mechanism.

XENTRY Tips

Despite being in the market for a few years, there are relatively few service bulletins so far regarding the M264. XENTRY Tips document LI54.30-P-073761 points out some potential problems with the oil level indicator in the instrument cluster: The oil level is not correctly displayed while the instrument cluster display is in workshop mode, or the oil level is reported in an inverted fashion when a correction is carried out (e.g. instead of an instruction to increase the oil quantity, an instruction to reduce the oil level is displayed, or vice versa). The remedy calls for an update to the instrument cluster control unit (N133/1) software using XENTRY Diagnosis.

Service and Maintenance

So far, we know of few reported problems with the M260/264, but time will tell as they get more miles on them and you start to see more of them in the shop. For now, routine A and B services are the norm. Oil service is fairly straightforward as well. Similar to most Mercedes-Benz service, you will need to remove the oil filter cartridge, gaining access by removing some intake ducting. Allow the oil to drain properly from the canister housing into the sump and then lift the vehicle.

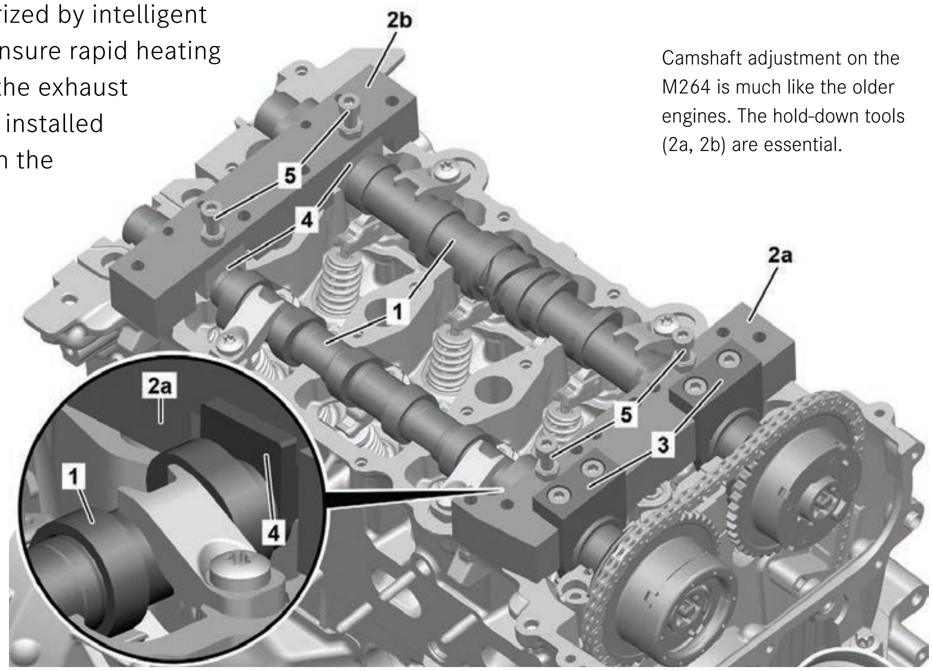
It's always a good idea to remove all three underpanels and not just the middle one to gain access to the drain plug, so that you can give the vehicle a good inspection. As we've said many times before, your customers depend on your technical expertise to spot potential problems before they affect the vehicle's operation. Not to mention, most customers will thank you for recommending a needed repair that you've identified.

Introducing the M254

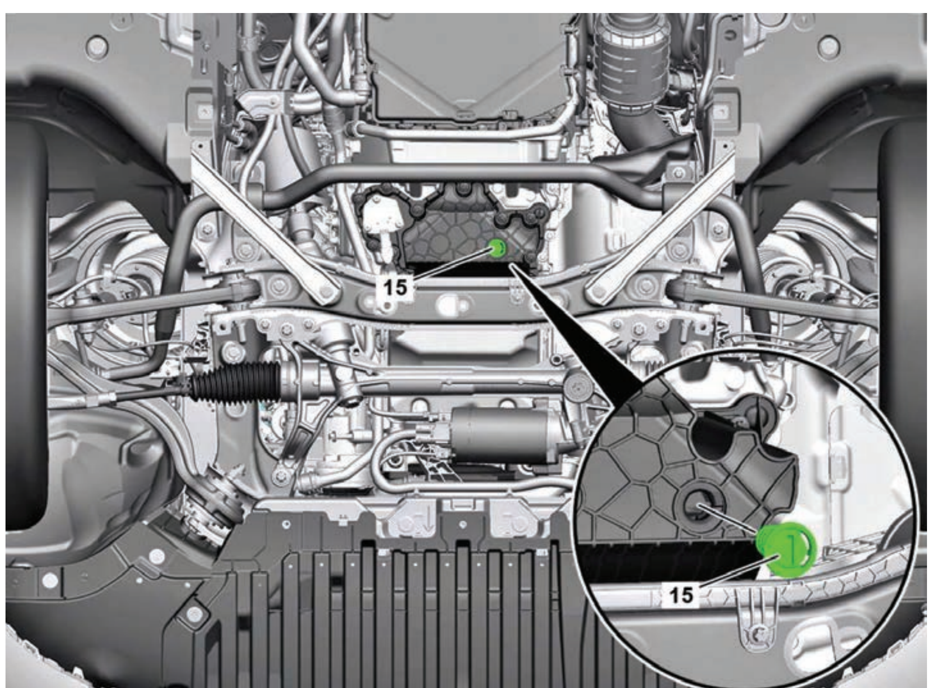
After only three years, the engineers developed a 'third generation' engine if you will: The new M254 engine is a longitudinally-mounted four-cylinder in-line spark-ignition engine also direct injection. The engine is turbocharged by means of an exhaust gas turbocharger with a switchable flow connection. The 2nd-generation integrated starter-alternator (ISG) can deliver an additional 15 kW (20 HP) output for a short time (the 'boost effect').

The new M254 is characterized by intelligent thermal management. To ensure rapid heating of the catalytic converter, the exhaust system in the M254 is also installed directly on the engine, as in the M260/264. The catalytic converter is a two-box catalytic converter and is installed directly downstream of the exhaust gas turbocharger. The exhaust system is equipped with a new coated gasoline particulate filter (COPF) with a third lambda sensor.

The use of next-generation low-friction oils helps to ensure a friction-optimized engine. Also helping with friction loss, the cylinders are treated using Mercedes-Benz NANOSLIDE technology: Twin-wire arc spraying is used to apply an extremely thin coating of an iron-carbon alloy to the inner surfaces of the cylinders in aluminum engine blocks. This produces a nano- to ultra-fine, highly wear-resistant material structure with microporosity. This microporosity ensures effective lubrication in operation. It means that the heavy cast-iron liners measuring several millimeters in thickness are replaced in aluminum cylinder blocks. The result is a mirror-smooth surface, with friction between piston, piston rings and cylinder wall reduced by up to 50 percent, along with weight savings of several kilograms.



Camshaft adjustment on the M264 is much like the older engines. The hold-down tools (2a, 2b) are essential.



When you encounter this type of oil drain plug (15) you must always replace it. Now would be a good time to order a couple for stock.

Valve Train

The biggest difference you find between the M254 and M264 engines is that the M254 has the timing chain in the rear of the engine. Addressing the valve train is quite different in the M254 compared to the M264. Although they both use CAMTRONIC technology, if find yourself having to check the camshaft timing, the initial inspection and adjustment for the M264 is very similar to what you're used to on the older M274/276 engines. To check the basic setting on both is similar, you remove the cam/hall sensors and rotate the engine to line up the marks. To make an adjustment, say after a repair, on the M264 engine you remove the cylinder head cover and install the hold down tools just like in the M274/276 engine. Then remove the camshaft positioners, remove the locking brackets and make your adjustment following the procedure in the Mercedes-Benz Workshop Information System (WIS).

The M254 Camshaft adjustment has a cam setting adjuster that locks the cams from the top without having to remove the cylinder head cover. A rear access cover allows removal of the camshaft adjusters with the aid of a special locking tool. If you plan to service these valve trains you'll need to add some special tools to your arsenal and, as always, follow the procedures in WIS. Having the timing components in the rear may seem like a pain but they are engineered to last. If you do find you have to get into some deep timing chain repairs then you will find yourself pulling the engine.

There's a new wrinkle in the oil service in M254 and other Mercedes-Benz models you may encounter: The oil drain plug is required to be replaced each time when changing the oil, so be sure to stock up so that you will have these on hand when needed. Instead of a tightening torque, you tighten it until it hits the stop.

As these engines rack up the miles you will see more and more of them in your shop as time goes on. Do thorough inspections on the ones you do see in your shop and become as familiar with them as possible to stay ahead of the game. As always, knowing what to do and what to avoid leads to better shop efficiency, making everyone happy. |

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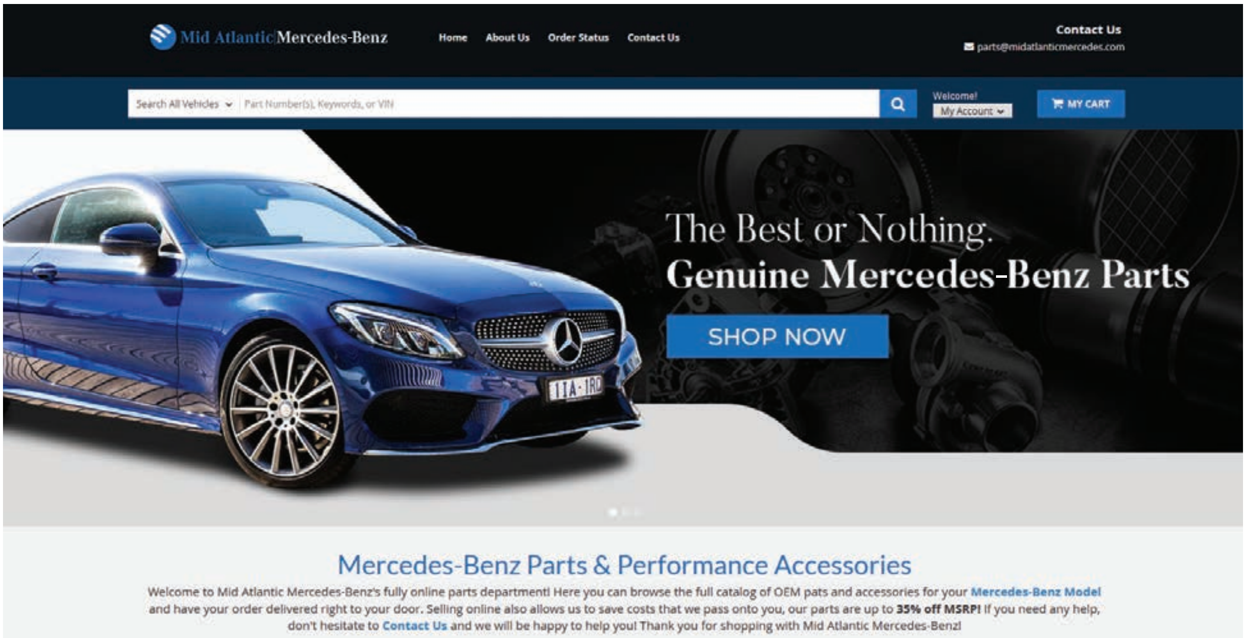

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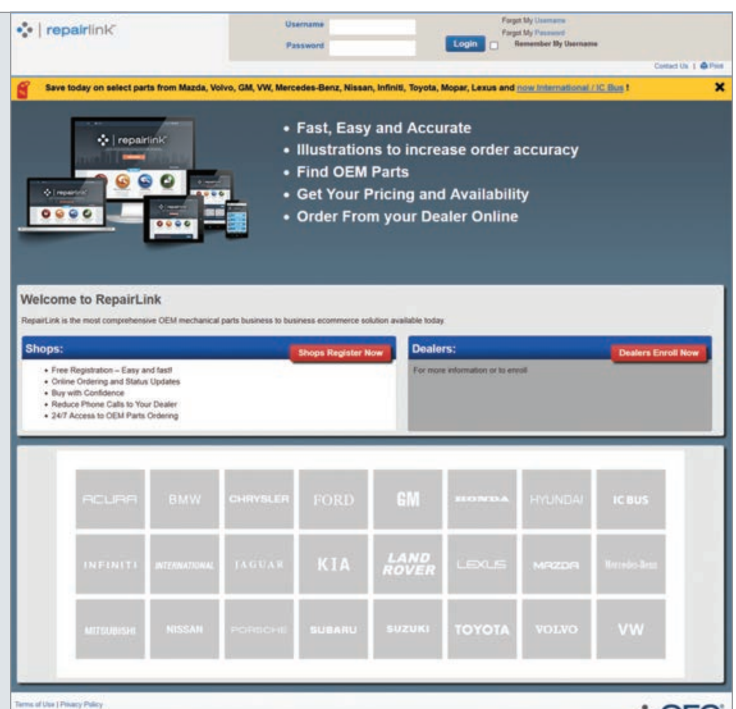

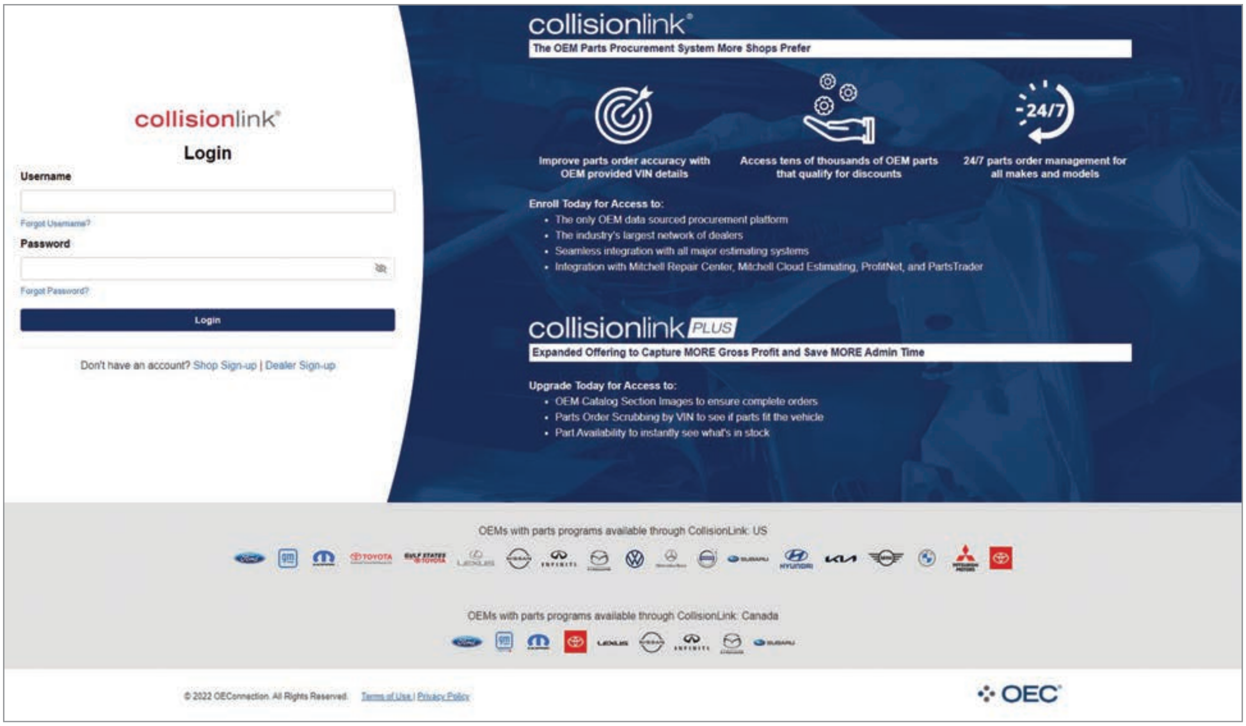

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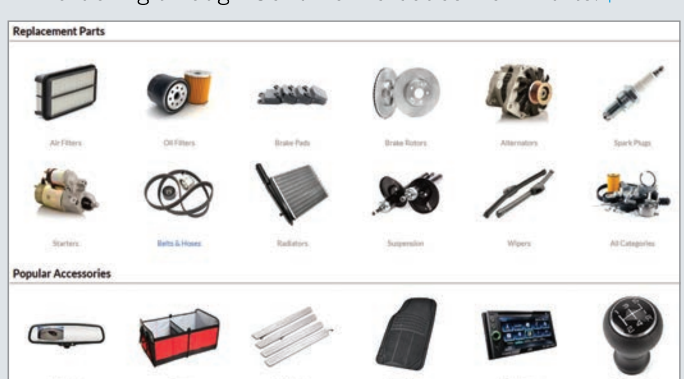
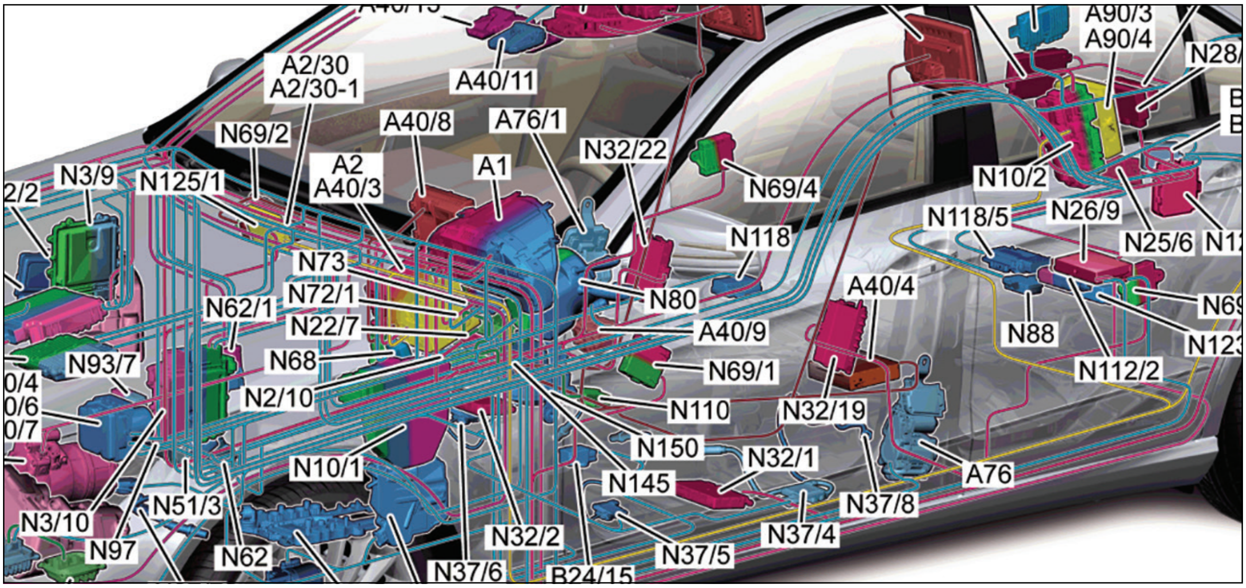


Network Nightmares
Is There a Different Way?

How networks work, diagnosis and troubleshooting tips



Let's face it: Any technician, whether dealer or independent, faces challenges in accurately and efficiently addressing communication Diagnostic Trouble Codes (DTCs), especially when multiple networks on the vehicle have multiple control modules setting communication faults.

Becoming successful and efficient at diagnosing CAN and other network protocols requires us to walk down the study path of different electrical concepts, such as inductance, impedance, phase angle, balanced antennas and more.

Although the majority of CAN faults can be found with a multimeter (See the article in the June 2017 issue of *StarTuned*), sometimes the faults are not so simple. Here we will discuss some ideas for those more-difficult faults.

The backbone of the communication network is it's Physical and Transport Layers wired together, so all of the above listed electronic principles and more are incorporated in its construction and proper, stable operation. This is where we as technicians do our testing. The CAN node (in the module) is engineered with standardized electrical characteristics, so if we can understand what the node is doing in the system and what to expect from it, we can then read the waveform and actually get something out of it that has diagnostic chops.

The issue now becomes how do we approach these network issues, without the knowledge of packet configuration, data content, intended address, data transfer, error reporting, module acknowledgement and other key information needed to track down the faulting module or circuit? We use the tools we have available to us and figure it out on our own, that's how.

The fault code scanner can't help much in many of these situations anyway. Not even XENTRY Diagnostics because often, along with communications faults, sections of modules and even dare I say entire networks become completely invisible to the scanner. However, one valid technique is to look for a module that isn't reporting any faults, or maybe doesn't even show up in the quick test. It may be that the module doesn't know it has gone crazy.

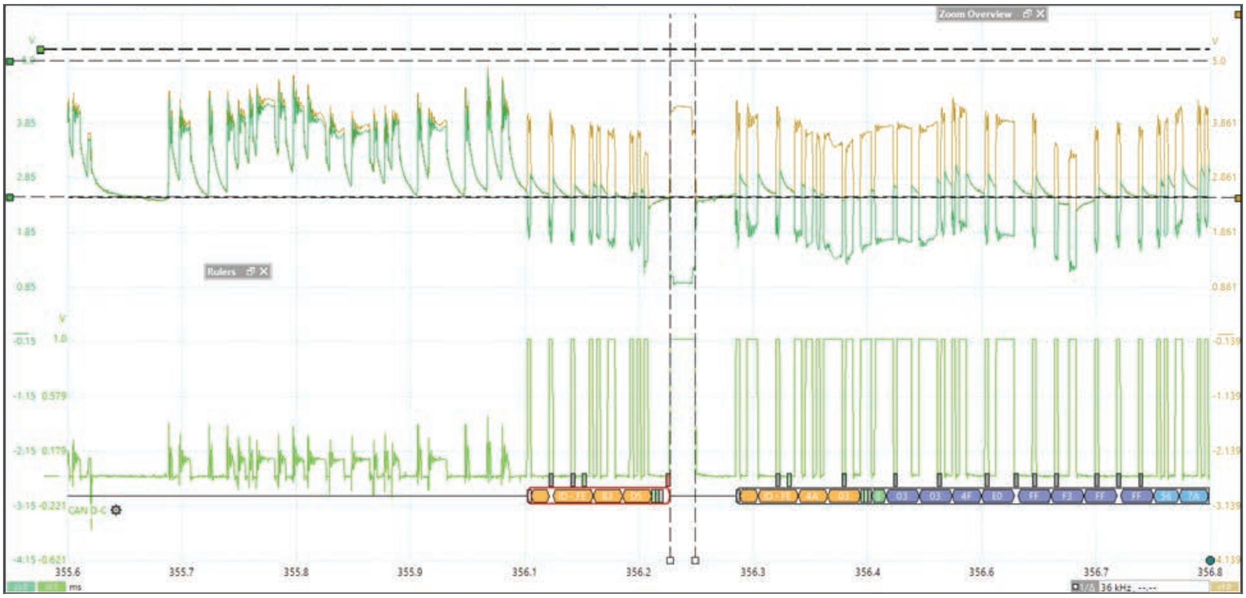


Figure 1: Proof that CAN's fault tolerant system design works. Note that the left side of the serial decoder shows a node glitch occurring, more on that later. The right side shows that in the very next frame after the node glitch stopped, the data packet is received, accepted, and acknowledged by other modules, even in the presence of so much bus line noise and voltage fluctuation.

Moving on, some general thoughts come to mind as to why network and bus line diagnostics can become one of the toughest and most expensive problems to solve on any vehicle platform: there are so many variables and possibilities for faults to occur, and robust as the system is in design and application, it is impossible to cover them all here in this space.

And it is an extremely robust system. The CAN bus was designed to be highly fault tolerant, and man, is it ever (see Figure 1). Let's look at some common causes of CAN faults, investigate how the system works and see if we can use this in targeting the problem at hand.

CAN Radio… Digital Radio, Broadcasting Live in YOUR Vehicle Platform

First, let's discuss the physical layer, the wiring, connectors, termination resistors, voltages and other physical things, what we might call the CAN's antenna. The network wires are terminated at 120 Ohms on each end of the bus (remember that two 120 Ohm resistors in parallel will measure at 60 Ohms). This is our balanced antenna for the CAN node to transmit and receive on. All other nodes are "stubbed" onto the bus in parallel, and supply signal voltage to the network.

Radio antennas are typically terminated for the purpose of "loading" the antenna to match it to the impedance of the transceiver or transmission line. CAN radios are no different: CAN nodes are impedance matched to the wire characteristics so that there is minimal signal reflection, this keeps data clean and collision free.

The CAN Bus operates with relatively high-speed data. The termination resistors are used to reduce or prevent reflections of these data signals which, if left unterminated, would cause the data and reflection voltages to overlap and prevent the bus from functioning. It is important to have a properly terminated bus to avoid these reflections.

We can compare a CAN node chip to a radio: Both are called transcievers (transmitter-receiver), both work best when terminated in their characteristic impedance, and high-frequency signals are used. As technicians, if we can start looking at CAN and data networks as radio systems, we can approach our diagnostics from a more targeted level and with a deeper understanding of how to successfully identify and solve network faults.

In Figures 2A and 2B (next page) a typical test plan is shown, which verifies that power and ground are being supplied to the control unit connector. After

Check CAN connection between components 'N37/5 (Left NO_x sensor control unit)' and 'N3/10 (ME-SFI [ME] control unit)'.

Legend

- B16 (Right temperature sensor upstream of NO_x storage catalyic converter)
- N37/6 (Right NO_x sensor control unit)
- 159 NO_x storage catalytic converter

Test prerequisites

- The battery voltage is OK.
- The fuses are OK.

Test Procedure

- Ignition OFF
- Remove paneling on bottom left and right of vehicle floor.
- Detach plug from component 'N37/5 (Left NO_x sensor control unit)'.
- [N37/5] 2 – (V) + 1 [N37/5]
- [N37/5] 5 – (V) + 1 [N37/5]

Specified value

- The measured value must be between 11V and 15V.

Question

Is the measured value OK?

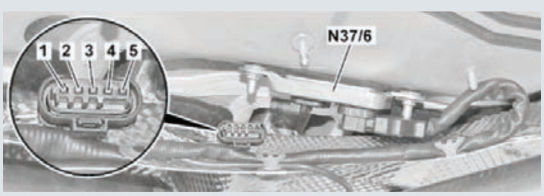


Figure 2A: Procedure for checking the CAN termination resistors and wiring integrity. 55-65 Ohms is considered acceptable. Note that some control units may have test specifications other than 55-65 Ohms, so be sure to check the manual.

Check CAN connection between components 'N37/5 (Left NO_x sensor control unit)' and 'N3/10 (ME-SFI [ME] control unit)'.

Legend

- B16 (Right temperature sensor upstream of NO_x storage catalyic converter)
- N37/6 (Right NO_x sensor control unit)
- 159 NO_x storage catalytic converter

Test prerequisite

- The power supply of component 'N37/5 (Left NO_x sensor control unit)' is OK.

Test Procedure

- Ignition OFF
- Removing paneling on bottom left and right of vehicle floor.
- Detach plug from component 'N37/5 (Left NO_x sensor control unit)'.
- 'N37/5] 3 – (Ω) + 4 [N37/5]

Specified value

- The measured value must be between 55? and 65?.

Question

Is the measured value OK?

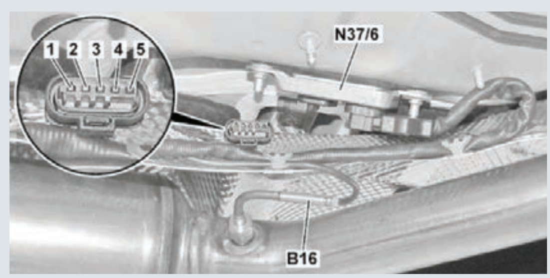


Figure 2B: Procedure for checking the control unit power supply for voltage. 55-65 Ohms is considered acceptable. Note that some control units may have test specifications other than 55-65 Ohms, so be sure to check the manual.

this is verified, we are then directed to test across the connector for about 60 Ohms at the connector's CAN pins. This test sequence verifies the presence of voltage to the node, verifies the termination of the bus is OK, and assumes confirmation of no shorts or opens in the impedance balanced antenna (CAN bus wiring).

OK, so we've measured 60 Ohms. Since the specification is 55 to 65 Ohms, just move on, right? No problem found? *Wrong.*

This may be a good and valid test to check the bus termination resistors, but this is only a static test with the physical layer connector disconnected for unloaded and unpowered measurement. This is where many diagnosticians simply miss, or "cannot duplicate" the fault. Measuring 60 Ohms on an unpowered network line does not necessarily mean everything is OK.

Experience has taught us that getting the fault to happen during static bay testing rarely occurs, unless there is a module that is measurably failed, a termination resistor or wire open circuit or a bus line high-resistance issue through a connector. But these types of easier-to-find hard faults are rarely what we deal with on the street.

Now that the transceiver—antenna relationship is established, let's hook up the scope and look at some of the waveform voltage characteristics that may help us to catch the offender...

The Three Biggies Commonly Missed—All Have to Do with Voltage

One of the most commonly overlooked possibilities for the cause of multiple communication DTCs is power supply problems. I'm talking vehicle power supply, the main and auxiliary batteries, not the CAN network power supply. One supplies the other! When we approach multi-module communication fault strings on the support line, we have learned to start with a DTC code analysis that includes any voltage-related codes outside the network and pay particular attention to solving those first.

Another frequent thing we ask the tech to do right away is to perform a starting and charging test, as we've found that many CAN faults—especially cascading faults—can and will set if the battery voltage falls below 9.6V, even for a fraction of a second. We catch a ton of these multi-module code strings with these first two steps. It usually happens when cranking the engine, by the way.

Beyond that basic diagnostic entry, we now need to gather an organized approach to the physical testing of the live data bus and determine what type of problem our data bus is having. All DTC charts and test plans aside, our reality out here on the street is that just like in war, the "Best-laid test plans" so to speak, can change after the first diagnostic shot is fired.

In fact, one could argue that many communications-related remote support calls we field daily are generated because the test plans provided, great as they are to use as a guide, are not sufficient in solving every issue, nor in sufficiently directing the technician in further targeted diagnosis, especially in the case of intermittent faults, which are varied and many in the communications world.

Node Faulting—Voltage Control Within the Node

These are the most common and the ugliest to catch, as a technician. Due to their intermittent nature, these faults will dog a customer, tech and shop owner, because these are usually heat or movement induced faults (mostly heat) and therefore these faults will almost never be duplicated or caught using conventional static diagnostic methodology, as shown in Figure 3.

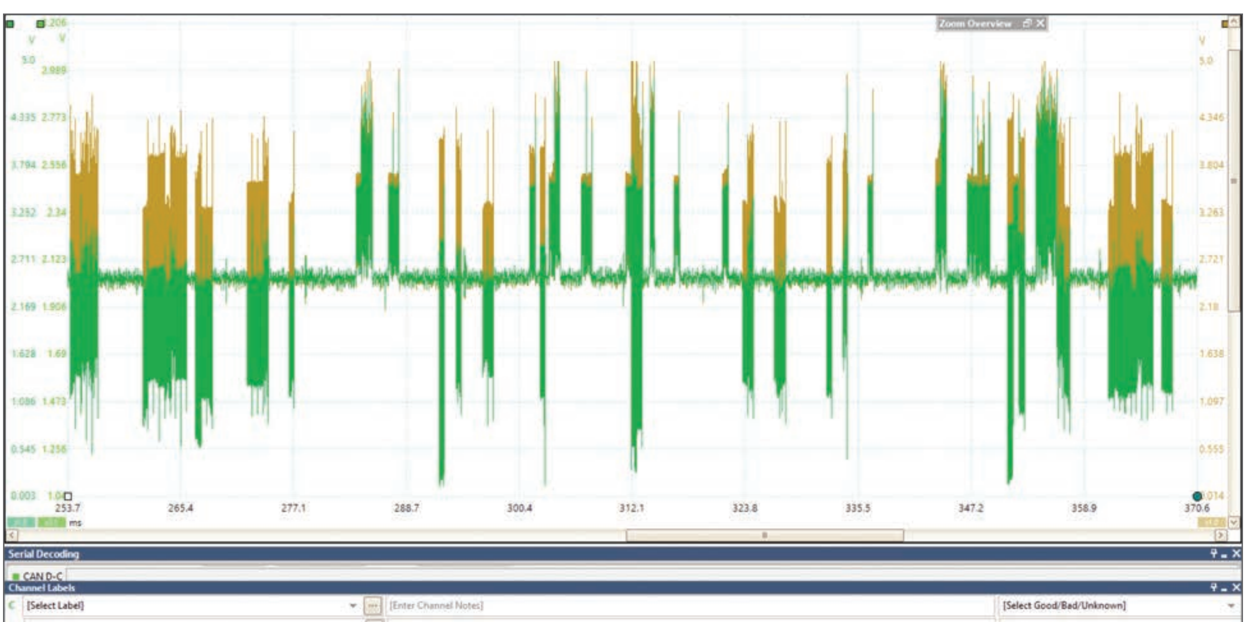


Figure 3: A bus perfectly balanced bus line with good termination resistors, but with a massive node fault, and an intermittent one at that. This bus passed the 60 Ohm test with flying colors but was setting cascading data and communication faults through the modules on the network.

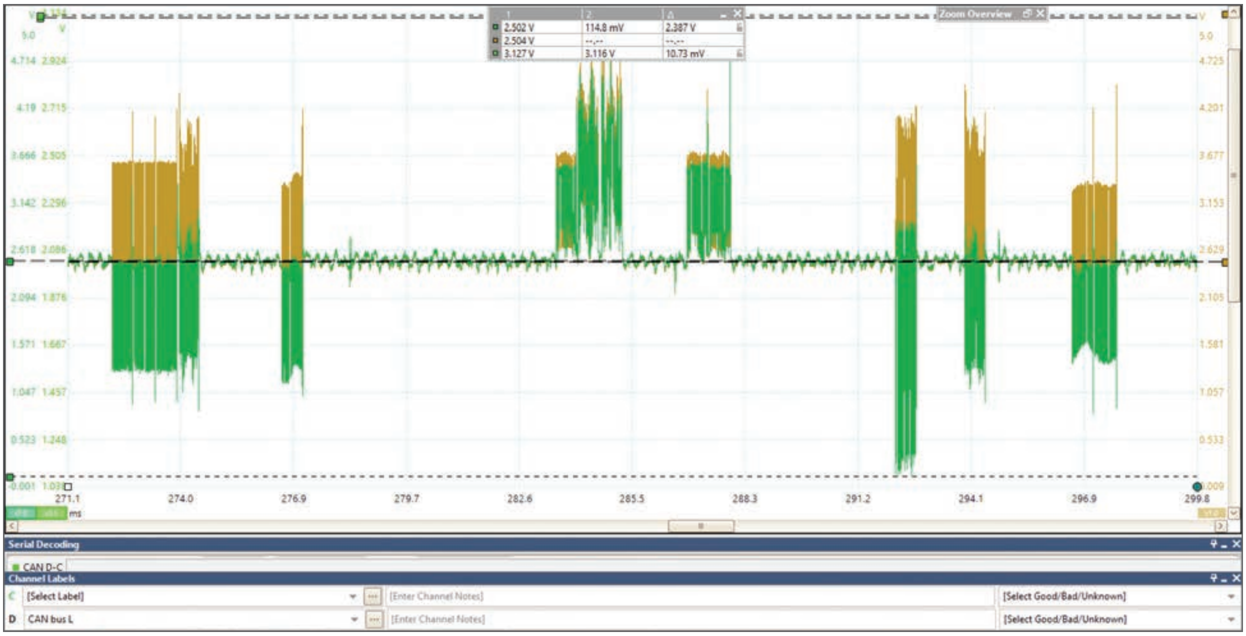


Figure 4: A zoomed in view of the CAN node losing electrical voltage control. Note that when this happens, the low bus signal covers up the high bus packets. Also note that during the fault, the node's signal is intermittently shorting to the power rail near 5v, and also to ground. The idle bus voltages appear to be fine.

Physical Layer (Node) Voltage Supply Problems

The third most common fault? A circuit 15 (key-on power) or circuit 30 (hot at all times) power source missing in one of the module's circuits which, don't forget, can be related to the energy management system's relay control and those battery basic checks mentioned earlier.

But to be direct, more often than not what we find is there is a fuse is out somewhere, and the tech "out-teched" himself because of all of the codes set. This type of fault will throw even the sharpest tech a curve ball. Figure 5 shows the DTC chart for an ME Circuit 15 Off Plausibility fault.

These insidious ignition-on power inputs can come from relays, other modules, even wake up signals from entirely different networks… and are one of the leading causes of needless module replacement, aka misdiagnosis. One single module unpowered in the

Diagnostics information > Engine (ME) > MED17.7+(8-C)+DELA > U-codes > U301100 - Input signal "Circuit 15 OFF" is implausible.

Input signal "Circuit 15 OFF" is implausible.

Implausible data were received from control unit 'Driver-side SAM'.

‣ Continue

Note

- A functional CAN fault code is set due to an implausible CAN input signal.
- At least one of the signals from control unit 'Driver-side SAM - Front signal acquisition and actuation module (N10/1)' was detected as implausible.

Possible cause and remedy

- Read out fault memory of control unit 'Driver-side SAM - Front signal acquisition and actuation module (N10/1)' and process fault codes.

Question

Do you now want to change to the fault code display of control unit 'Driver-side SAM - Front signal acquisition and actuation module (N10/1)'?

‣ No
‣ Yes

End of test

Result:

FC: Communication with ECU required.

Figure 5: DTC information for circuit 15 Off Implausible data, these codes are a huge clue.

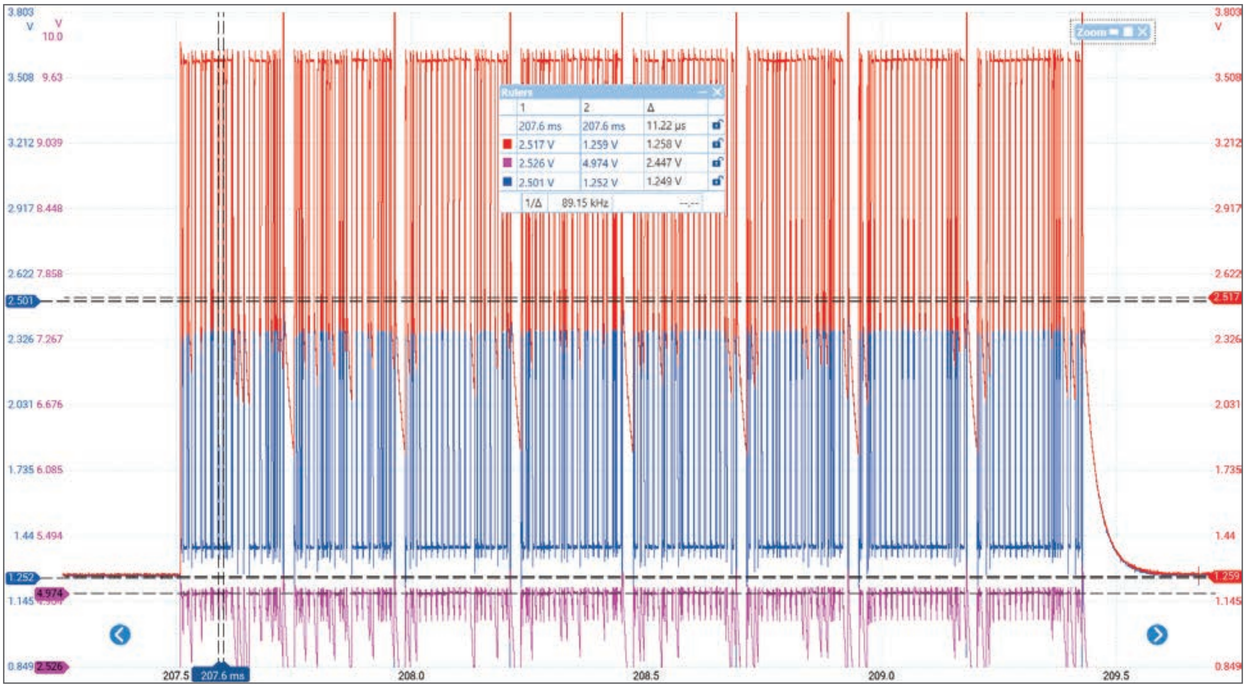


Figure 6: A waveform with a circuit 15 power problem. This bus line is at 60 Ohms and is signaling fine, except of course the depowered module is not available on the bus for scanner access and is setting DTCs in other modules. Note both CAN high and low idle voltages are pulled down to about 1.2V.

network can set strings of DTCs and affect the bias, and eventually the signaling on the bus line. There is an explainable physical reason for this, and an example in Figure 6. If we learn to read and correctly interpret this characteristic in the waveform, we can avoid all manner of needless testing, as multiple steps are covered with one view of the live network.

If we analyze the waveform, we can clearly see that the bias voltage we expect to see at 2.5V on the high and low bus are both pulled down to 1.2V together, yet the powered-up modules are still transmitting good, acknowledged data packets. This is observed because the CAN system is a common mode voltage system where all modules put out the same voltages on the bus, and the bias (idle) voltage is produced by a voltage divider off of a regulated 5V supply rail in the module.

When all the nodes are powered and working properly, the bus operates at the 2.5V bias, and CAN high drives the signal up one volt (3.5 volts) and CAN low pulls voltage down one volt to signal at 1.5 volts, the total differential SIGNAL being 2.0 volts, one volt high and one volt low. Look carefully at Figure 6 again and notice the bias being pulled down to that 1.2V region. Why is this happening, and how can the bus still work in this condition?

Consider the voltage divider in the node that supplies the bias voltage. The 2.5 volts is provided as long as the node is properly powered up. But what if it isn't, like in Figure 6? The node is still directly connected to the common mode system through the twisted pair, AND the termination resistor in the module. But now the common mode voltage from the awake part of the network is dropping through the unpowered node's voltage divider, but at or near 0V ground potential. This affects the bias only, and of course, any unpowered node on the network.

When an unpowered node, or multiple unpowered nodes are on the bus, weird stuff happens.

Looking at this mathematically, we can explain and prove that this waveform characteristic can only be caused by an unpowered node. The proof is that channel A+B (CAN high and low) still totals 5 volts, showing healthy common mode voltage being supplied to the impedance balanced bus by the powered nodes. Differential signal voltage being transmitted is still a total of 2 volts, one high and one low. Also, the serial decoder proves that the nodes that are still on the bus transmitting are not failing packets.

When you encounter this characteristic, we recommend you stop the CAN diagnosis and go find the missing power, wherever it originates, correct this and confirm proper bus operation prior to any module replacement. The unpowered node will get you every time if you're not looking for the signs.

Serial Decoding

We frequently invoke the serial decoder to target faulting modules and data packets, then isolate them from the network in minutes by setting up the decoder software to take us directly to the faulting data transmission.

Since we technicians really are only able to work in the analog realm, meaning we are not in the business of repairing electronics or module repair, our main focus as techs must be on the physical testing of network data bus lines. The serial decoder function on our scope helps us find the problem

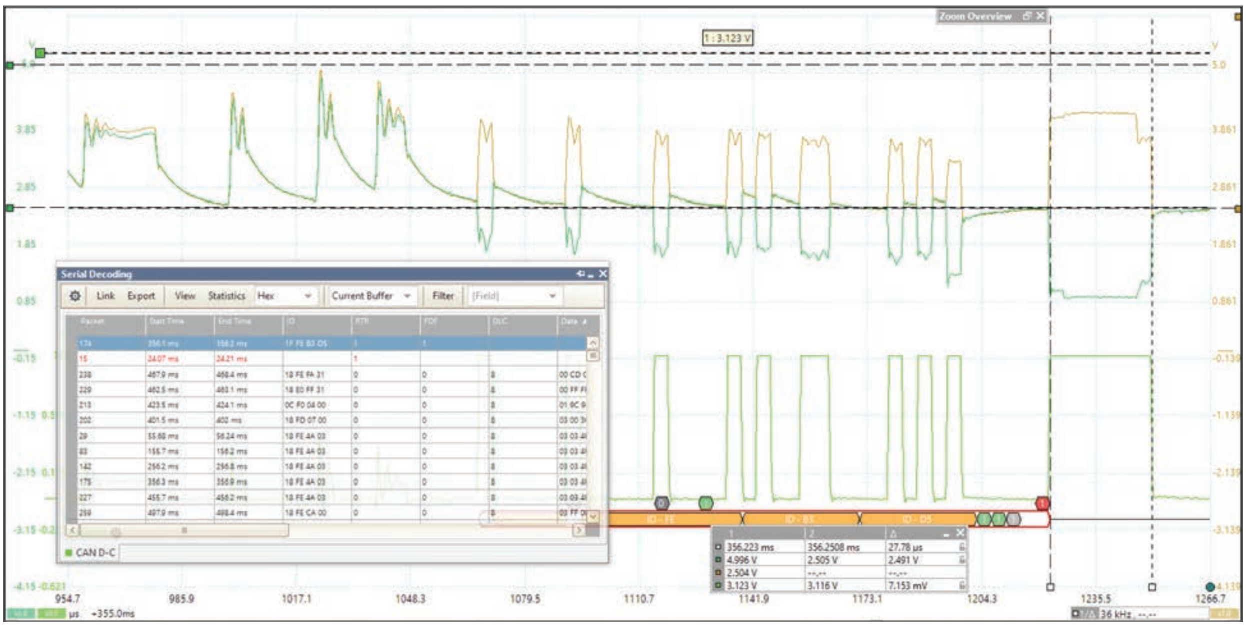


Figure 7: The serial decoding of a CAN packet. Serial decoding is a learned artform but is well worth the study for the advanced technician.

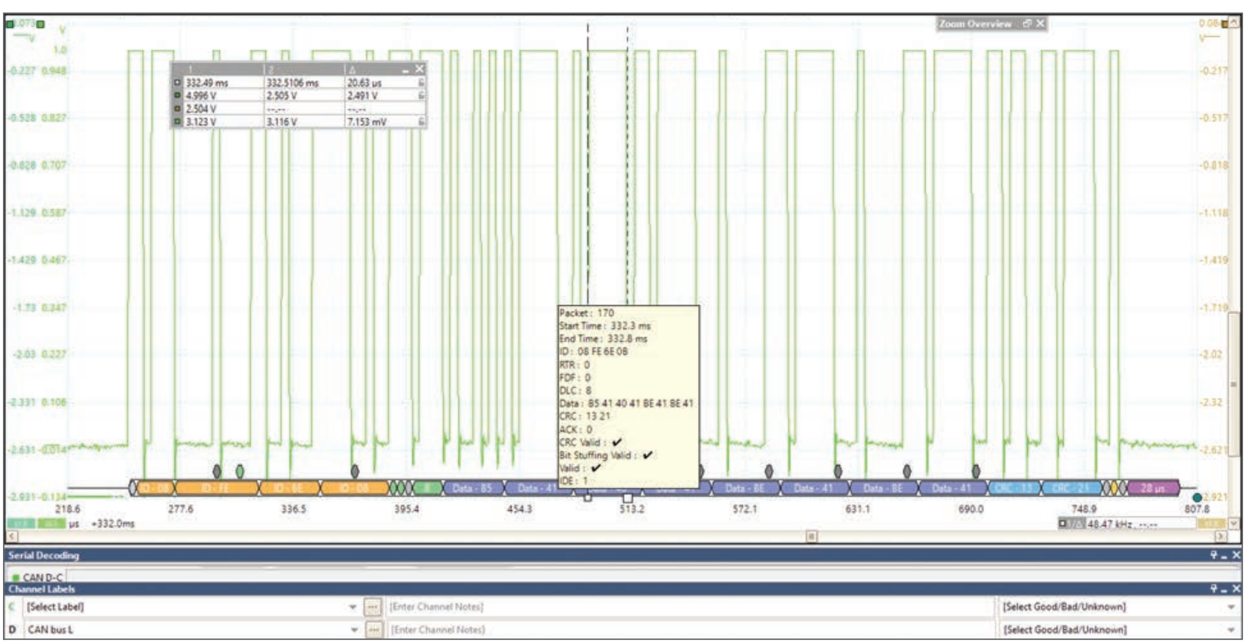


Figure 8: The serial decoder uses software to decode the data, module addresses, packet errors and acknowledgement and more. We use it to quickly target the problem without wasting time searching through long recordings of the bus for the fault.

quickly, when conventional testing and isolation techniques fail.

Specifically, since the published diagnostic pathway often vaporizes into computer code that we are not taught to analyze, we must depend on the physical characteristics of network waveforms to tell us what is really wrong. This means some extra study if one is to become more effective at network diagnostics.

Another important characteristic of the waveform signatures that we key in on to isolate the fault is identifying a module that is Hogging the Bus. This requires capturing and analyzing the faulting packet itself for errors.

“Hogging” the Network Bus

When a module is having a problem processing, transmitting, or receiving this data message, a bit count over 10us fails the packet, and the module tries to re-broadcast its message. Depending on vehicle and the problem in the node, the node will try to rebroadcast the message a preprogrammed number of times and then the node, in theory, should remove itself from the bus. But often, the node will hang, as seen in Figure 9.

In these cases, where this type of waveform is observed, you will need to isolate the suspected modules until the damaged node is removed from the bus. When the damaged node is electrically removed (disconnected) from the bus the waveform will return to normal, and you have found your offending node.

Finally, another node failure characteristic is shown in Figure 10. Note here that communications are being shorted intermittently. These are tough to find, so we typically apply masks (in pink) and alarms (in green) to our scope setup to catch these glitches, without having to search through hundreds of thousands of tiny data packets to locate our fault after we have recorded it.

Across time, many modules have been replaced needlessly due to all of the above factors plus the pressure to get the car fixed, information gaps, complexity of the networks and software, out-teching ourselves along the way and probably a few other factors. But in the final analysis, on our hotline calls, we almost overwhelmingly find something simple was causing the fault the whole time. Don't clear those codes until you capture your clues, and then use your scope for live, physical testing.

If we focus on what we can see and quantify from the analog side of the bus and then focus on learning to analyze the physical properties of our waveforms, a lot of the "communications conundrums" we face can be accurately targeted and solved with a whole lot less fuss.

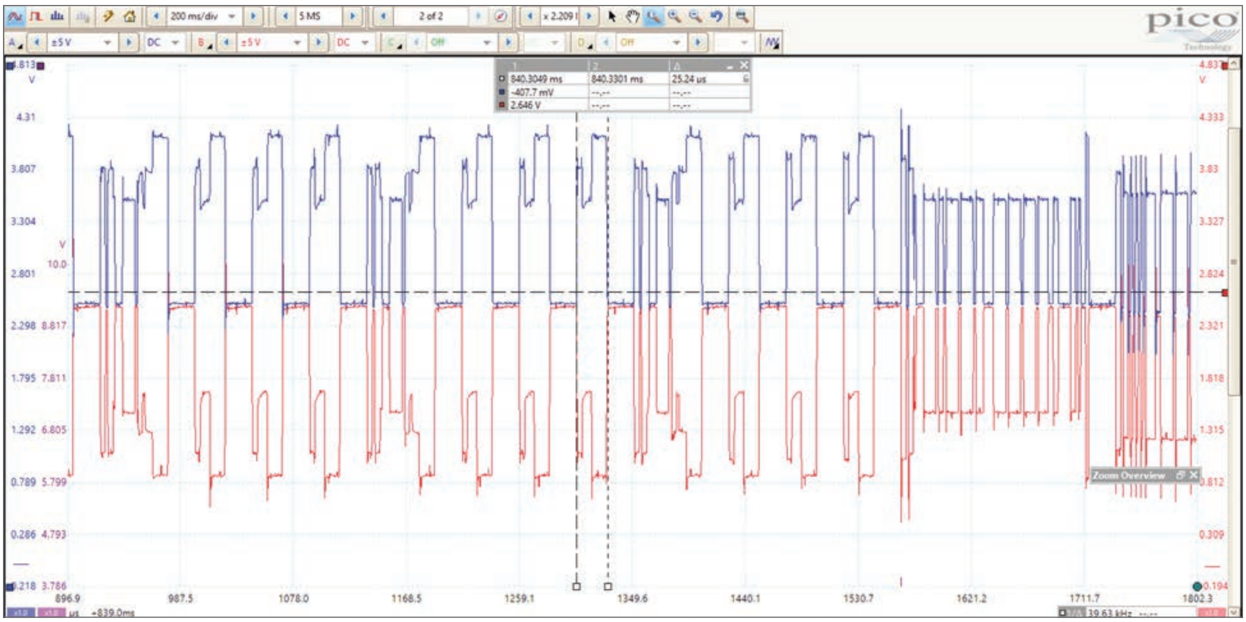


Figure 9: The data message is damaged, and the module keeps trying to talk to the bus, over and over. A nice thing about the CAN standard is that the bit lengths are 2us (microseconds) long each. Knowing this is key to finding a module hogging the bus and setting DTCs.

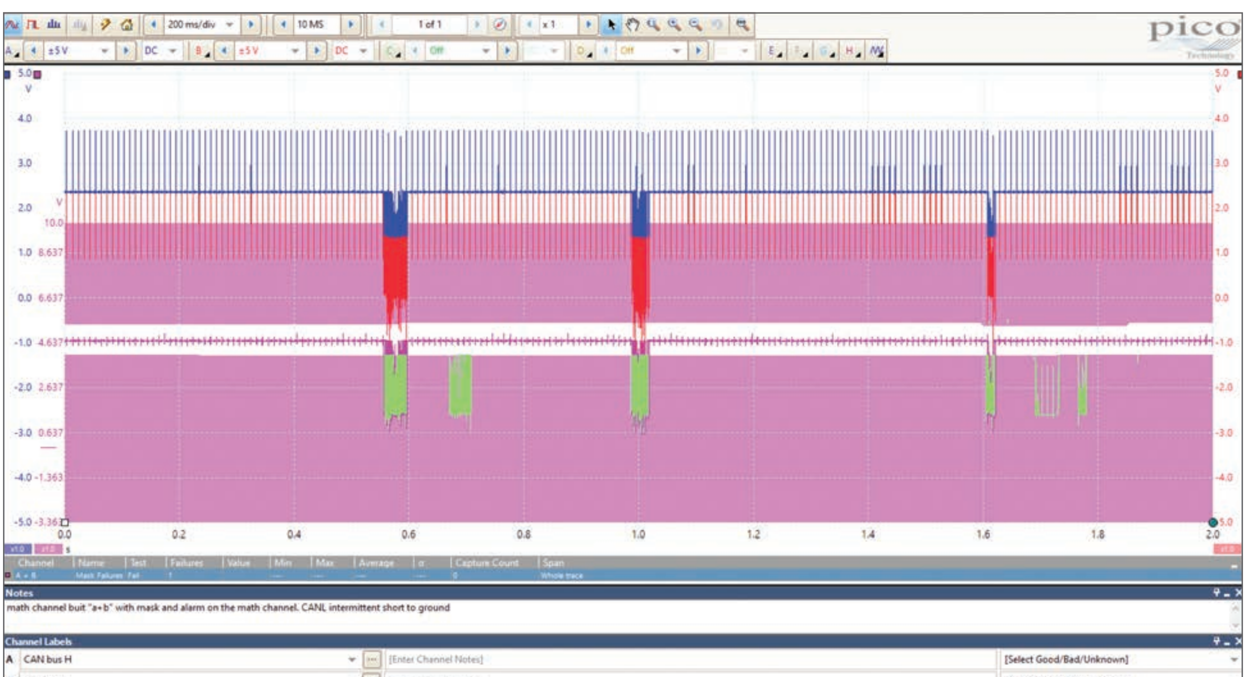


Figure 10: The Mask and Alarm strategy to catch CAN faults on the lab scope. The scope automatically captures and alarms the tech that the fault occurred. Not all scopes have this feature.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